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ACTA AGRONOMICA

ТОМ XIV — ВЫП. 1—2

РЕЗЮМЕ

ИССЛЕДОВАНИЕ ОБЩЕЙ И СПЕЦИАЛЬНОЙ КОМБИНАЦИОННОЙ СПОСОБНОСТИ 18 ЛИНИЙ САХАРНОЙ КУКУРУЗЫ (ZEA MAYS L. CONVAR. SACCHARATA KÖRN.) ПРИ ДИАЛЛЕЛЬНОМ СКРЕЩИВАНИИ

Л. ДАНИЕЛЬ

Нами изучалась хозяйственная ценность 18 линий сахарной кукурузы при диаллельном скрещивании. Изменчивость общей комбинационной способности по отдельным признакам в большой степени достоверна и только по двум признакам не была выше специальной комбинационной способности; один из них важный с хозяйственной точки зрения — длина первого початка ($V_{Ga}/V_{Sa} = 0{,}99$; $h^2 = 0{,}26$). Это показывает, что по этому признаку селекцию надо проводить на основе общей комбинационной способности, но она не должна быть очень строгой, и специальной комбинационной способности тоже надо придавать большое значение. Наш материал чрезвычайно богат по генному составу и пригоден без нового дополнения для выведения высокоурожайных гибридов различного срока созревания. Исследования корреляции частично подтверждают взаимосвязь характерных признаков в пределах группы южного зубовидного и северного кремнистого типов, однако индекс размеров листа и пасынковость (кустистость) ослабляют связь.

В опытах, проведенных при неблагоприятных условиях, участвовали три известных американских линий, средняя продуктивность которых оказалась намного ниже средней продуктивности опыта, в то время как 5 линий, выведенные в Венгрии из американских сортов и еще не испытанные, обладают средним выше среднего опыта.

ФЕНОЭКОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ НА ЯРОВЫХ ЗЕРНОВЫХ

ДЬ. МАНДИ

Показанное автором проявление «индивидуальных амплитуд» (степень отклонения фенологических явлений внутри стеблестоя) изучалось в сроках посева у яровых овса и ячменя. Показано, что сорта ярового ячменя в меньшей степени чувствительны к крайностям погодных условий, чем сорта овса. Сорта овса были требовательны не только к осадкам, но и к температуре. Было определено, что температурный оптимум для развития обоих видов намного ниже, чем это обычно приводится в специальной литературе.

ВОЗМОЖНОСТЬ ПРЕМУНИТАЦИИ У ПУЗЫРЧАТОЙ ГОЛОВНИ КУКУРУЗЫ

(Ustilago maydis [D.c.] Eda)

Е. ХАЛАС

Доказана возможность премунитации у пузырчатой головни кукурузы при исследовании ее в полевых условиях. Семена гибридов, использованные для маркировки, замачивались в культуре с живыми, умерщвленными или претерпевшими деструкцию путем центрифугирования возбудителями болезни. Растения, полученные из этих семян, заражали на различных этапах развития в течение всего вегетационного периода; заболевание у отдельных вариантов было в меньшей степени, чем у контроля.

ИССЛЕДОВАНИЕ ВЗАИМОСВЯЗИ МЕЖДУ ТЕМПЕРАТУРОЙ ВОЗДУХА И РАСТЕНИЯ

К. РАДНАИ, ДЬ. ПАЛ, Б. ПАПП

Наименьшее колебание температуры наблюдается у стебля растения, наибольшее — на нижней стороне молодого листа. Колебание температуры больше у молодого листа, чем у старого. У старого листа не наблюдается разницы в колебании температуры на верхней и на обратной стороне листа; у молодого листа колебание температуры больше на обратной стороне листа, чем на его поверхности. Когда поднимается температура воздуха, температура растения также поднимается, но в большей степени, чем температура воздуха. Когда же температура воздуха снижается, температура растения снижается в большей степени, чем воздуха. При нагревании (облучении), следовательно, тело растения, подобно почве, поглощает тепловые лучи, а затем отдает окружающему воздуху. При охлаждении (излучении) растение сильнее и быстрее охлаждается, чем окружающий воздух.

ВЫБОР ИСХОДНОГО МАТЕРИАЛА ДЛЯ ВЫВЕДЕНИЯ ТЕТРАПЛОИДНОГО КРАСНОГО КЛЕВЕРА

А. ЯНОШШИ

В 1952—1953 гг. в Таплансенткересте (Западная Венгрия) нами было исследовано 67 сортов красного клевера, в том числе и сорта местного происхождения с целью использования сортов, обладающих хорошими признаками, для получения тетраплоидных форм. На основании исследования, произведенного с точки зрения изучения всех признаков, были выбраны 27 сортов. В 1953 г. скрестили два показавших себя наилучшими сорта и первое поколение обработали колхицином. Всего в январе 1954 г. подвергли обработке 28 образцов. Тетраплоидный материал размножался и селектировался попеременно в Тапиоселе с сухим климатом Большой Венгерской низменности (количество осадков в среднем за 50 лет было равно 551 мм) и в Таплансенткересте с большим количеством осадков (700 мм).

Изучение потомства подтвердило, что линия тетраплоида, происходящая от первого поколения двух лучших диплоидных сортов по продуктивности лучше, чем тетраплоиды, происходящие от родительских сортов, а также лучше, чем смесь тетраплоидов, происходящих от 28 образцов.

РЕПАРАТИВНАЯ РЕГЕНЕРАЦИЯ У ОВСА (AVENA SATIVA L.)

Ш. ФАЗЕКАШ

На основании опытов было определено, что овес в виду большой способности к регенерации способен восстановить целое растение. Срезание побегов овса стимулирует процессы роста и развития и это проявляется косвенно на повышении жизненности отдельных кустов. Срезание побегов может повлиять на вегетационный период, удлиняя его, и может послужить образованию новых свойств (повысить способность к регенерации) у отдельных кустов.

ЯРОВОЙ ЯЧМЕНЬ МК—42, УСТОЙЧИВЫЙ ПРОТИВ МУЧНИСТОЙ РОСЫ

Э. ПОЛХАМЕР

Разница в урожае между сортами ярового ячменя, восприимчивого и устойчивого против мучнистой росы, полученная в результате ущерба, вызванного мучнистой росой, в среднем за четыре года оказалась большей, чем ее оценивали раньше. Мучнистая роса снижала урожай, прежде всего в годы, когда урожай был меньше среднего.

На опрыскивание 0,5%-ным раствором каратхана сорта реагировали по-разному. На устойчивом сорте-кандидате, МК—42 появились пятна ожога; урожай зерна и показатели по другим признакам снизились. Опрыскивание вызвало повышение урожая восприимчивых сортов, а показатели по другим признакам в зависимости от сорта изменялись по-разному.

МК—42, несмотря на отсутствие зимостойкости, может служить хорошим компонентном для скрещивания с целью выведения озимого ячменя, устойчивого против мучнистой росы.

СРАВНЕНИЕ НЕСКОЛЬКИХ ЛИНИЙ ГИБРИДНОГО МАКА БЦ—2 С ТОЧКИ ЗРЕНИЯ ЛЕКАРСТВЕННОЙ ПРОМЫШЛЕННОСТИ

Ш. ШАРКАНЬ, И. ШАРКАНЬ-КИШ, Г. В. ПЕТРИ, А. С. КОВАЧ

Авторы исследовали 10 линий гибридного мака БЦ—2 в нескольких повторностях, всего на 50 делянках. При сравнении исследовали формирование наиболее важных с практической точки зрения особенностей. С вниманием следя за рядом морфологических признаков оценивали также окраску семян, урожай, вес 1000 зер., вес коробочки, урожай семян из одной коробочки, далее содержание морфина и близких к нему алкалоидов (кодеин, тебаин, наркотин, папаверин). Определено, что линии относительно выровненные морфологически отличаются между собой по урожаю семян и коробочек. По продукции алкалоидов также наблюдаются различия, хотя линии из массового материала не дают сигнификантной разницы, но по близким к морфину алкалоидам линии различаются. Некоторые из новых линий «А», происходящие от индивидуумов, выбранных из наилучших гибридных линий БЦ—2 (напр. 57/1964, 60/1964) по содержанию близких к морфину алкалоидов приближаются к наиболее продуктивному родителю ШЦ, тогда как и по ряду других особенностей их продукция также является хорошей.

БИОХИМИЧЕСКИЕ ПРОЦЕССЫ ЯРОВИЗАЦИИ

III. Изменение активности окислительной системы аскорбиновой кислоты

М. ДЕВАИ

Нами исследовалась окислительная способность аскорбиновой кислоты молодых побегов и корней в различной степени яровизированных пшениц и определено, что:

1. Окислительная способность аскорбиновой кислоты молодых побегов и корней по мере прохождения яровизации изменяется в зависимости от температуры. Температурный оптимум окислительной системы аскорбиновой кислоты по мере прохождения яровизации сдвигается в сторону низких температур и при прохождении яровизации на 50% достигает 5° С. Это явление можно объяснить синтезом или активизацией энзимов нового типа, показывающих большую активность при более низких температурах.

2. Наблюдаемое явление играет важную роль в создании зимостойкости и морозостойкости возможно тем, что обеспечивает уровень кофермента дегидроаскорбиновой редуктазы, управляющей содержанием SH.

3. Образование нового энзима требует затраты ДНК и энергии ввиду того, что акридиноранж, DNP и хлорамфеникол тормозят процесс.

В результате исследований получены данные, указывающие на связь процесса яровизации с зимостойкостью.

ДАННЫЕ К АЗОТНОМУ И АМИНОКИСЛОТНОМУ ОБМЕНУ ВЕЩЕСТВ У ПШЕНИЦЫ

Л. ДЕЖИ, Г. ПАЛФИ, М. БАРКОЦИ

Среди свободных аминокислот и амидов концентрация аспарагина в побегах при нормальных условиях, возможно, является показателем азотного питания. Количество аспарагина обыкновенно изменяется соответственно концентрации наиболее важных аминокислот, т. наз. «ключевых аминокислот». Под влиянием сильно разнящегося уровня азотного питания в спектре свободных аминокислот качественное изменение не наблюдалось (рис. 2 и 3).

Общее содержание аминокислот в побегах пшеницы чувствительно отражает величину азотного обеспечения: среди вариантов наблюдалось отклонение, достигающее даже 300% (рис. 4). Корни пшеницы содержат значительно больше глютамина и глютаминовой кислоты, чем побеги (рис. 6). Побеги же содержат больше γ-аминокислоты, аланина и аспарагина (рис. 5).

В пшенице, выращенной в среде с полным раствором Кноппа и в среде с раствором Кноппа с 1/2 дозой азота, концентрация азота почти не показывала отклонения (рис. 1). В пшенице, выращенной в среде с раствором Кноппа, где количество азота было сокращено до 1/10, концентрация азота была значительно ниже, чем в предыдущих двух случаях. Данные количества азота, приходящегося на сухое вещество побега, оказались более реальными, чем данные концентрации (рис. 1, 4).

Пшеница, выращенная на полном растворе Кноппа и на растворе Кноппа с 1/2 дозой азота, нормально развивалась; пшеница, выращенная на растворе Кноппа с 1/10 частью азота, осталась карликовой и не кустилась.

ОПЫТ ПО МИНЕРАЛЬНОМУ УДОБРЕНИЮ ОЗИМОЙ ПШЕНИЦЫ

А. КОЛТАИ

В течение двух лет исследовалось влияние фосфорного и калийного удобрений во взаимодействии с различными дозами азотного удобрения. В оба года удобрение азотом оказалось очень действенным. Фосфорное удобрение только совместно с большой дозой азотного удобрения сказалось в умеренном повышении урожая. Влияние калия в опыте обнаружить не удалось.

ИЗМЕНЕНИЕ СОДЕРЖАНИЯ АЛКАЛОИДА У ВИДОВ DATURA, ВАЖНОЙ С ЛЕЧЕБНОЙ ТОЧКИ ЗРЕНИЯ, В ПРОЦЕССЕ ОНТОГЕНЕЗА

Г. ВЕРЗАР-ПЕТРИ

Исследовалось изменение общего содержания алкалоидов в отдельных органах у видов **Datura**, где в качестве основных алкалоидов являются **hyoscyamin**-и **scopolamin** в процессе онтогенеза в выделенных нами II фазах. Определено, что абсолютное содержание алкалоида и его процент в равной мере показывают онтогенетическую изменчивость. Было замечено, что у различных видов и органов наблюдается два, редко три максимума по содержанию алкалоида, меняющегося в процессе онтогенеза. Это явление позволяет предположить о наличии ремобилизации и повторного возникновения алкалоидов.

ПРИБЛИЖЕННОЕ КОЛИЧЕСТВЕННОЕ ОПРЕДЕЛЕНИЕ ЛИНАООЛА В КОРИАНДРОВОМ МАСЛЕ МЕТОДОМ ПОСЛОЙНОЙ ХРОМАТОГРАФИИ

Ж. ЛАШШАНИ

Разработан быстрый метод тонкослойной хроматографии для определения содержания линаоола, почти соответствующий количественному определению. Если содержание линаоола в растворе находится в пределах 60—62γ — 180—187γ размер круга, полученного пятна пропорционален концентрации. Так путем измерения площади можно определить количество. Точность измерения $+\mu = + -6{,}5\%$.

АНАЛИЗ — «PATH» ЭЛЕМЕНТОВ СТРУКТУРЫ УРОЖАЯ ОЗИМОЙ ПШЕНИЦЫ ОПЫТА ПО МИНЕРАЛЬНОМУ УДОБРЕНИЮ

Я. ОШВАТ

В опыте по определению влияния минеральных удобрений и др. факторов, как например, влияния условий внешней среды был произведен анализ — «**path**» элементов структуры урожая озимой пшеницы. Опыт проводился в течение двух лет. Несмотря на то, что ошибка взятия пробы была большой (51%), хорошо можно было показать, что минеральные удобрения почти не оказали действия на число колосьев. Но внесение азота оказало влияние на вес зерен одного колоса (37%).

ИССЛЕДОВАНИЕ УСТОЙЧИВОСТИ ПРОТИВ СТЕБЛЕВОЙ И ЛИСТОВОЙ РЖАВЧИН СОРТОВ ПШЕНИЦЫ В ПОЛЕВЫХ УСЛОВИЯХ В МАРТОНВАШАРЕ 1960—1964 ГГ.

М. МАННИНГЕР

В 1960—1964 гг. в Мартонвашаре в полевых условиях изучалась устойчивость против стеблевой (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. et Henn.) и листовой (*Puccinia recondita* Rob. ex Desm. f. sp. *tritici* Erikss.) ржавчин в провокационных опытах при микроклиматических условиях наиболее благоприятных для развития ржавчины; для заражения использовались популяции уредоспор превалирующих в Венгрии рас. Приведенные в статье сорта испытывались в течение 2—5 лет. Устойчивыми против обеих ржавчин оказались сорта: Пембина, Рафаэла, Пергамино Гобото, Клейн Петишо; устойчивыми только против стеблевой ржавчины: Ли, Селкирк; только против листовой ржавчины: Безостая 1, Скороспелка 3б, Скопле, Клейн Аниверзарио, № 10 (болгарский), Мида, Эль Гаучо, Керн 11, Фертёди 249, Ранняя 27, Осетинская 3, Моцинаве, Феранол Пинто, Атлас 50, Бледсо.

ОСУЩЕСТВЛЕНИЕ СОВРЕМЕННЫХ ГЕНЕТИЧЕСКИХ ПРИНЦИПОВ С ЦЕЛЬЮ ПОВЫШЕНИЯ ЭКОНОМИЧНОСТИ ПРОДУКЦИИ КОРОВ ВЕНГЕРСКОЙ ПЕСТРОЙ ПОРОДЫ

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Обсуждая вопросы направления разведения и современного типа крупного рогатого скота автор показывает, что в будущем главная задача разведения будет составлять принцип увеличения интенсивности производства продукции животноводства, приходящейся на единицу производственной площади. В результате этого на передний край выдвигается то стремление, чтобы на определенной площади, где возможно произвести определенное количество кормов можно было произвести продукцию животноводства в наибольшем количестве и наилучшего качества. Корова с высоким удоем сравнительно эффективно трансформирует и грубые корма и этот факт значения молочной коровы по всей вероятности выдвигает ее на передний план и в будущем. Автор приводит среди наиболее важных хозяйственно-ценных признаков венгерской пестрой породы определенные фенотипические и генетические корреляции, а также те заключения из данных мировой литературы, на основании которых (табл. 8) он разработал следующие предложения: в стаде коров, находящейся под контролем определения молочной продукции, формирование групп потомков по количеству производимого жира (кг) и по продукции стандартизированного молока 4% жирности (FCM), приходящейся на 100 кг. живого веса, служили бы основой селекции, таким образом, что эти признаки при селекции учитывались бы на равных началах. Оценка продукции, произведенная таким образом, дает «хозяйственную эффективность продукции», которую целесообразно выразить в отношении к продукции хорошего типа коровы (650 кг. живого веса, удой 4000 кг. с жирностью молока 4%), приняв ее продукцию за 100%. Это отношение к общей основе дало бы возможность для решения того, что использование определенных абсолютного достоинства быков в какого уровня продукции стадах целесообразно, далее в определенном отношении может служить в какой-то мере основой даже для международного сравнения. С целью поддержания венгерской пестрой породы, характеризующейся разносторонним использованием, благоприятной силой роста и откорма, автор рекомендует, чтобы на станциях по выращиванию быков подвергались браковке быки с наименьшим дневным привесом, браковка может достигать 30%, далее при централизованном исследовании потомства в средних условиях крупного хозяйства, быки, у которых дневной прирост потомства не достигает 850—1000 г. не должны квалифицироваться как улучшатели стада.

A STUDY OF GENERAL AND SPECIFIC COMBINING ABILITY IN THE DIALLEL CROSSES OF 18 SWEET CORN VARIETIES (ZEA MAYS L. CONVAR. SACCHARATA KÖRN.)

By

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Economic value of our sweet corn material has been studied in the diallel crosses of 18 lines. The variation of the general combining ability is highly significant for each character and was only for two characters not higher than the specific combining ability; one is the first ear's length important from the economic point of view ($V_{Ga}/V_{Sa} = 0.99$; $h^2 = 0.26$) indicating that selection for general combining ability must be carried out but it must not be too strict and great attention must be paid to the specific combining ability. Our material contains a very rich stock of genes and is suitable without further completion for the production of productive hybrids with different ripening dates. Our correlation examinations partly support the relationship within the group of features characteristic of the Southern Dent and Northern Flint types but leaf blade index and suckering loosen the relation.

The mean performance of the three known USA lines included in the tests conducted under unfavourable conditions lagged substantially behind the average of the experiment while the mean value of five lines produced in Hungary out of USA varieties and not tested so far is higher than the mean of the experiment.

Introduction

Sweet corn had been probably known by the Indians for a long time past; however, since it is much more demanding than common maize, it could not spread under the primitive conditions of production. Its economic importance begun to rise in the United States of America during the past century and whereas in 1858 a total of six varieties were recorded, their number exceeded sixty in 1899. From these some are still under general cultivation but a great part is superseded by single cross hybrids (Huelsen, 1954). Particularly in large-scale production only the hybrids continue in our days to enter into consideration (Smith, 1955) but instead of double crosses widely used in the breeding of maize for stock feed in sweet corn single crosses yielding more uniform commodity are used. The testing of the value of inbred lines forming the basis of heterosis breeding is carried out on the grounds of their performance shown in crosses. For this purpose Sprague and Tatum (1942) introduced the concept of general and specific combining ability. These authors publisshed formulae for the diallel table containing $\frac{n(n-1)}{2} F_1$ generations of then inbred lines, but proper statistical evaluation of the diallel table has been realized only later by Yates (1947).

GRIFFING, utilizing both works and the gene model of KEMPTHORNE (1955) deduces the relationship between combining ability and genetic variance ($2\ s^2Ga = A + 1/2\ AA + 1/4\ AAA + \ldots; s^2Sa = D + 1/2\ AA + AD + DD + 3/4\ AAA + AAD + ADD + DDD + \ldots;$) (1956a), and discusses the variance analysis of general and specific combining ability according to components for four methods on the strength of two models (1956b). Genetic variability of sweet corns studied with this method proved to be narrow (DANIEL and VÁRÓCZY, 1959) and the present objective of the author is to evaluate the material completed in the mean time.

Materials and Methods

The diallel crosses of the 18 lines (Table 1) characteristic of the material have been accomplished without reciproques and a comparative trial was established on April 26 1962 in Pesthidegkút in a 3×3 Latin rectangle design (MUDRA, 1952) with 0.6×0.6 m quadratic spacing, 10 hill plots, leaving one plant in each hill. From the 153 $F_1\left(\frac{n(n-1)}{2}\right)$combinations possible without reciproques twenty were missing. The values of these were substituted by

Table 1

Data of the lines used in the trial

Number of line	Starting material	Extent of inbreeding	Grain colour
1	C13; USA line	I_n	Yellow
2	Fehér Mazsola	I_{13}	White
3	Population of Szentes	I_{14}	White
4	Population of Szentes	I_{14}	White endosperm brown pericarp
5	Inst. für Kulturpflanzenforschung (Gatersleben N. D. K.)	I_4	White
6	Bantam Evergreen	I_5	Yellow
7	Mauthner Arany Bantam $I_6 \times$ Lila Mazsola I_6	I_6	Yellow
8	Arany Mazsola	I_6	Yellow
9	Open pollinated material	I_7	Yellow
10	Mauthner Arany Bantam	I_{12}	Yellow
11	Mauthner Arany Bantam	I_{14}	Yellow
12	P39; USA line	I_n	Yellow
13	Open pollinated material	I_7	Yellow
14	Early Evergreen	I_5	White
15	Burpee and Wilke's Evergreen	I_5	White
16	Stowell's Evergreen	I_5	White
17	C53; USA line	I_n	Yellow
18	Stowell's Evergreen	I_5	White

minimizing the specific combining ability and the number of the degrees of freedom has been reduced accordingly (Table 4).

In a previous paper (DANIEL, 1954) the 3×4 and 3×11 combinations (lines Nos 1249 and 1265) were already involved; the lines No 2, 3, 4 and 10 are the lines No 1, 5, 7 and 9 of our 1959 communication (DANIEL and VÁRÓCZY, 1959) while the basic material of line No 7 is the combination 9×4. With the aid of these, the results of the three tests are comparable.

The data — except for the values concerning the grains — have been assessed individually, averaged for each plot and the comparative trials subjected to variance analysis. Since the variance attributed to the combination was significant for all features analysed, the variance analysis of the general and specific combining ability (GRIFFING, 1956b) II. model of method 4 could be carried out, variances, variance ratios (Table 2) and values for the two combining abilities were calculated (Table 3). Table 4 presents data for length of first ear judged to be most important from the economic point of view as well as the march of statistic elaboration. For some characters also individual variances were calculated and coefficients estimated.

The relationship of general combining abilities proportionate to the additive genetic effect was studied with the aid of the usual correlation coefficient (Table 5) the formula of which, since $\bar{x} = \bar{y} = 0$ in the present case, can be simplified to the following form: $r = Sxy : \sqrt[2]{Sx^2 \, Sy^2}$.

The following characters have been individually assessed: Flowering date (some outstandingly late flowering plants have greatly increased the means of certain combinations and, to eliminate this, flowering date has been established as the average of 50 per cent male and female inflorescence); suckering; plant height; number of branchings on the tassel, apical-, branching part and length of the stalk from the lowest branching to the nodus; width, length, index of the leaf below the highest ear; width and length of the largest husk-blade of the highest ear, (at the highest ear of some plants of certain combinations there was no husk-blade and, therefore, no real width/length index could be calculated); width and length of the first (uppermost) ear; mean length of all ears (the sum of the length of all ears in the plot divided by the number of plants); number of kernel rows. Furthermore, a typical ear was put aside from each plot and on these assessed — in laboratory air-dry condition — width, thickness and length of the kernels, the difference between cob and ear diameter and kernel-weight (on the strength of test-measurements the mean water content was found to be 8.19 per cent; $Chi^2_9 = 0.043$) but no significance calculations were made for these characters. Moreover, the economic value of the individual combinations was determined by utilizing the weighted data based on the deviation from averages for the flowering date (1 day = 3 units) length of first ear (1 cm = = 20 units), total ear length (1 cm = 5 units) and kernel weight (1 gr = 50 units).

Results and Discussion

The variation ascribable to general combining ability was for each of the 16 characters subject to variance analysis significant at the 0.1 per cent level while the variation ascribable to specific combining ability was significant for eight characters at the 0.1 per cent, for one at the 1 per cent, and for 4 ones at the 5 per cent level while for three ones it did not significantly deviate from zero. The variance ascribable to the general combining ability ranges only for two characters (length of the apical part on the tassel and length of first ear) on the same level with the variance ascribable to the specific combining ability; for two characters it is twice as high, for three ones nearly three times as high and for the others much higher (Table 2). The five heritability coefficients calculated present some relationship with the ratio of the variances of general and specific combining abilities; the regression coefficient $b = 10.17$, $V_b = 0.71$; h^2 and the ratio between the variances of general and specific combining ability

Table 2

Variance analysis of the general and specific combining ability of 18 sweet corn lines according to GRIFFING *(1956b)*

Denomination	MSg	MSs	MS_E	Vg	Vs	Vg/Vs
Flowering date	187.38***	2.77*	1.59	10.88	1.18	9.22
Suckering	2.89***	0.12*	0.06	0.17	0.06	2.83
Plant height	2006.97***	45.51**	21.67	122.59	23.84	5.14
Tassel:						
Number of branchings	266.60***	3.73***	1.13	16.43	2.60	6.32
Length of apical part	49.34***	3.95***	0.95	2.84	3.00	0.95
Length of branching part	66.25***	0.70***	0.09	4.10	0.61	6.72
Stalk length	57.88***	2.32***	1.01	3.47	1.31	2.65
Leaf blade:						
Width	4.07***	0.18***	0.06	0.24	0.12	2.00
Length	292.58***	6.63*	3.44	17.87	3.19	5.60
Index $\times$ 10^4	5.20***	0.19	0.30	0.31	−0.11	
Largest husk blade:						
Width	2.99***	0.20	0.19	0.17	0.01	17.00
Length	247.95***	8.27***	2.55	14.98	5.72	2.62
First ear:						
Width	1.12***	0.02	0.02	0.07	0.00	
Length	20.04***	1.70***	0.54	1.15	1.16	0.99
Total ear length	66.88***	5.03*	3.14	3.87	1.89	2.05
Number of kernel rows	43.52***	0.57***	0.07	2.68	0.50	5.36

* Significant at the 5% level;
** significant at the 1% level;
*** significant at the 0.1% level.

is 0.26 and or 0.99 for the length of the first ear, 0.33 and 2.83 for suckering, 0.39 and 2.00 for leaf blade width, 0.65 and 6.32 for the number of branchings on the tassel and 0.73 or 5.36 for the number of kernel rows.

The correlation of the general combining abilities of lines is highly significant for the following characteristics: number of tassel branchings and length of the branching part, width and length of the largest husk-blade and length of first and all ears; the individual pairs of characters behave almost uniformly towards the other characteristics. Further, the combining ability for the leaf blade index exhibits a significant correlation with that of leaf blade breadth only. If possible, we may consequently discuss number of tassel branchings and length of branching part under the term of tassel branchings, leaf blade width

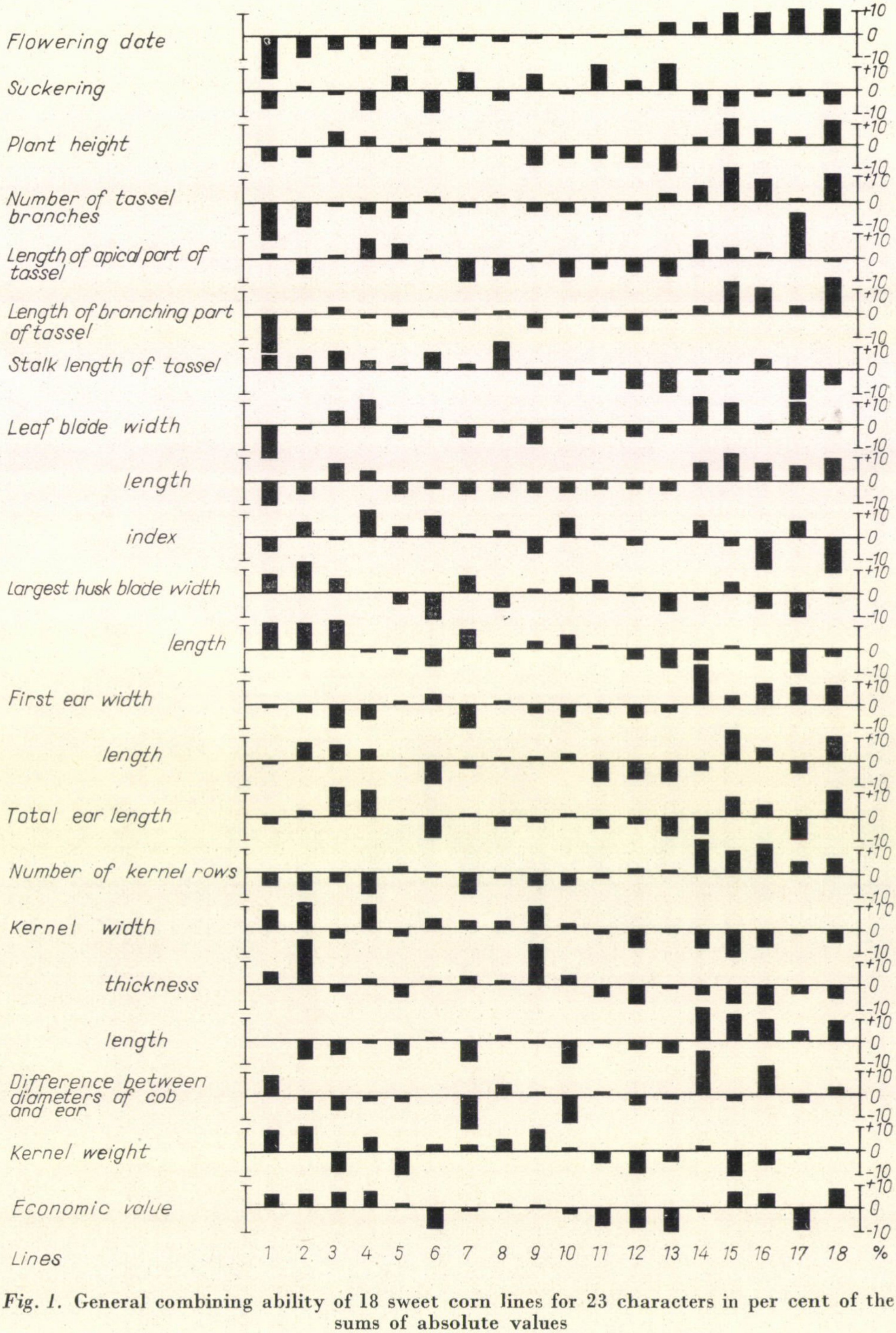

Fig. 1. **General combining ability of 18 sweet corn lines for 23 characters in per cent of the sums of absolute values**

Table 3

General combining ability

Denomination	1	2	3	4	5	6	7	8	9
Flowering date	−8.48	−4.45	−2.41	−2.40	−2.12	−1.17	−0.77	−0.73	−0.34
Suckering	−0.35	+0.12	−0.02	−0.53	+0.39	−0.56	+0.51	−0.24	+0.43
Plant height	−10.56	−6.69	+10.04	+6.19	−3.64	+5.25	−3.08	+3.22	−14.43
Tassel:									
Number of branchings	−8.93	−5.42	−0.67	−2.03	−3.29	+1.30	−1.26	+0.16	−2.17
Length of apical part	+0.50	−1.55	+0.16	+2.03	+1.48	+0.24	−2.31	−1.63	−0.17
Length of branching part	−4.49	−1.77	+0.85	−0.25	−1.27	+0.09	−0.63	+0.27	−1.45
Stalk length	+1.99	+1.64	+2.11	+1.24	+0.12	+2.03	+0.61	+3.35	−1.21
Leaf blade:									
Width	−0.98	−0.07	+0.41	+0.80	−0.21	+0.17	−0.38	−0.23	−0.58
Length	−6.73	−3.21	+4.53	+2.63	−3.21	−1.93	−3.17	−3.03	−3.31
Index $\times 10^2$	−0.43	+0.43	−0.03	+0.76	+0.26	+0.56	+0.03	+0.13	−0.47
Largest husk blade:									
Width $\times$ 10	+4.93	+8.48	+4.11	+0.03	−3.06	−7.02	+4.24	−3.76	+0.84
Length	+6.15	+6.20	+6.77	−0.65	−0.90	−4.09	+4.90	−2.26	+1.52
First ear:									
Width	−0.03	−0.10	−0.37	−0.24	+0.04	+0.16	−0.38	+0.02	−0.10
Length	−0.21	+1.13	+1.00	+0.68	+0.11	−1.61	−0.53	+0.23	+0.15
Total ear length	−0.85	+0.67	+3.42	+3.20	−0.23	−2.77	+0.23	−1.15	−0.66
Number of kernel rows	−1.17	−1.62	−1.02	−2.14	+0.47	−0.56	−2.17	−0.56	−1.13
Kernel $\times 10^2$:									
Width	+5.06	+7.06	−2.86	+6.88	−2.05	+2.81	+2.13	+2.19	+5.94
Length	+0.31	−6.62	−4.81	−0.25	−4.75	+0.43	−7.50	+1.93	−0.25
Thickness	+1.18	+4.43	−0.78	+0.43	−1.22	+0.12	+0.81	+0.18	+4.00
Weight	+2.81	+3.76	−2.72	+2.06	−3.00	+1.02	+1.07	+1.58	+2.81
Difference between thickness of cob and ear $\times$ 10	+1.15	−0.72	−0.67	−0.23	−0.29	+0.03	−1.91	+0.70	+0.20
General economic value	+29.85	+33.59	+36.57	+35.44	+2.92	−42.03	−25.84	+8.68	+4.09

of 18 sweet corn lines

10	11	12	13	14	15	16	17	18	*u*
−0.26	−0.02	+1.02	+2.29	+2.42	+3.94	+4.18	+4.61	+4.69	100.60 days
−0.03	+0.73	+0.27	+0.73	−0.37	−0.45	−0.13	−0.12	−0.38	1.47 pieces
−8.07	−8.61	−12.41	−18.06	+4.68	+20.36	+11.27	+5.79	+18.75	117.80 cm
+2.06	−2.25	−1.45	+1.68	+3.16	+7.92	+4.81	+0.02	+6.36	15.63 cm
−2.00	−0.87	−1.37	−1.87	+1.80	+0.88	+0.42	+4.57	−0.31	23.46 cm
−0.20	−0.74	−1.90	−0.46	+0.80	+3.45	+2.81	+0.85	+4.04	9.74 cm
−1.02	−0.54	−2.13	−2.91	−0.62	−0.47	+1.00	−3.64	−1.55	18.36 cm
−0.04	−0.23	−0.35	−0.23	+0.84	+0.65	−0.18	+0.75	−0.14	6.45 cm
−3.23	−1.83	−1.90	−3.00	+4.67	+7.33	+4.50	+4.46	+6.43	60.63 cm
+0.53	−0.01	−0.27	−0.03	+0.46	−0.27	−0.97	+0.43	−1.11	0.11
+3.61	+3.21	−0.30	−4.86	−2.10	+2.74	−4.53	−6.53	−0.03	2.42 cm
+2.76	+0.33	−3.03	−4.62	−2.90	+0.21	−3.01	−5.75	−1.53	14.77 cm
−0.20	−0.13	−0.20	−0.12	+0.63	+0.11	+0.33	+0.27	+0.31	4.39 cm
+0.27	−1.43	−1.36	−1.50	−0.68	+2.16	+0.81	−0.86	+1.64	15.98 cm
+0.14	−1.35	−0.86	−2.33	−1.86	+2.43	+1.33	−2.74	+3.38	17.95 cm
−1.15	−0.49	+0.30	+0.18	+3.40	+2.17	+2.88	+1.15	+1.46	12.44
+1.38	−1.36	−5.36	−0.86	−5.24	−7.93	−4.61	−0.12	−3.06	0.91 cm
−7.62	−0.43	−3.31	−4.18	+10.78	+8.47	+7.48	+3.41	+6.91	0.98 cm
+0.75	−1.22	−1.87	−0.31	−0.93	−1.94	−1.81	−0.63	−1.19	0.37 cm
+0.43	−1.28	−2.81	−1.22	+0.77	−3.31	−1.78	−0.25	+0.06	0.23 g
−1.71	+0.16	−0.58	−0.26	+2.63	−0.28	+1.72	−0.40	+0.46	1.61 cm
−9.74	−34.46	−41.85	−51.65	−4.15	+37.21	+29.35	−48.91	+40.93	0.00

and length under leaf blade size, greatest husk blade width and length under husk blade size and length of first and all ear combined under ear length.

Flowering date. Lines 1 and 2 display a rather high negative, whereas lines 15, 16, 17 and 18 a rather high positive general combining ability; between the single crosses of two lines each representing extreme values, a deviation of 22 days can be expected. The greatest deviation realized was 22.2 days but this occurred partly between the means of 1×4 and partly between 14×17, and 15×17; the difference between the hybrids 1×2 and 17×18 was — instead of the 22 days expected — no more than 18 days.

The correlation is significantly positive with the tassel branchings, kernel row numbers, leaf blade size and ear width, while negative with the husk blade size and tassel stalk length general combining abilities.

Suckering. The extreme experimental values 0.07 (4×15) and 3.47 (7×11) respectively exceeded in both directions the estimates. The correlation of the general combining abilities is significantly positive with the general combining ability corresponding to flowering date and negative with those corresponding to plant height, leaf blade length and length of first ear.

Plant height. In conformity with the extreme values of general combining ability the combination 9×13 is the lowest (81.37 cm) while 15×18 the highest one (169.13 cm) being in a positive correlation with tassel branching, ear length, kernel row number and flowering date, whereas in a negative correlation with suckering.

Tassel branchings. The general combining abilities are in a close positive correlation, with flowering date, leaf blade size (especially length) kernel row number and somewhat more loosely with the corresponding data of ear size. The highest mean realized was found in conformity with the estimate in the combination 15×18 (19.1 cm or 31.5 units) while — instead of the combination 1×2 — the lowest value was observed in 1×9 (3.9 cm and 3.8 units).

Tassel length at the apical part. There is a significant positive correlation with leaf blade size and width of the first ear; it is strikingly high in line No. 17.

Tassel stalk length. The general combining ability is very low in the line No. 17 and shows a significant correlation only with the flowering date.

Leaf blade size. The general combining ability for lines 15 and 18 is positive for length and negative for width from which it follows that in these cases combining ability for leaf blade index is negative with a high absolute value. Extreme values are 48.8 cm (1×9) and 76.0 cm (3×15) for length, 4.1 cm (1×9) and 8.4 cm (2×15) for width, while the leaf blade index ranges from 0.09 to 0.13. The general combining ability is in positive correlation with plant height, tassel length at the apical part and with branching, in addition, length with flowering date, number of kernel rows and ear size; while in negative correlation with the corresponding data of suckering; out of 28 correlations examined 12 are significant.

Table 4

Analysis of the length of the first ear in 18×18 sweet corn diallel crosses

Parents	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	T_i	Ga_i
1	14.13 16.90 −2.77	16.17 16.77 −0.60	15.10 16.45 −1.35	15.13 15.88 −0.75	12.60 14.16 −1.56	13.07 15.24 −2.17	14.33 16.00 −1.67	16.23 15.92 +0.31	15.13 16.04 −0.19	16.26 14.34 +1.92	16.50 14.40 +2.10	15.97 14.27 +1.70	14.53 15.09 −0.56	19.23 17.93 +1.30	17.27 16.58 +0.69	18.70 14.91 +3.79	17.90 17.42 +0.48	268.25	−0.21
2		17.67 18.11 −0.44	17.60 17.79 −0.19	16.97 17.22 −0.25	16.16 15.50 +0.66	17.10 16.58 +0.52	16.07 17.34 −1.27	16.53 17.26 −0.73	17.93 17.38 +0.55	16.33 15.68 +0.65	15.74 15.74 0.00	16.83 15.61 +1.22	16.13 16.43 −0.30	19.57 19.27 +0.30	17.37 17.92 −0.55	19.00 16.25 +2.75	18.57 18.76 −0.19	289.70	+1.13
3			17.03 17.66 −0.63	16.13 17.09 −0.96	15.13 15.37 −0.24	16.67 16.45 +0.22	16.27 17.21 −0.94	17.13 17.13 0.00	18.07 17.25 +0.82	15.23 15.55 −0.32	16.23 15.61 +0.62	15.50 15.49 +0.01	18.47 16.30 +2.17	19.53 19.14 +0.39	17.47 17.79 −0.32	16.40 16.12 +0.28	18.62 18.63 −0.01	287.72	+1.00
4				16.77 16.77 0.00	15.05 15.05 0.00	16.40 16.13 +0.27	17.07 16.89 +0.18	18.30 16.81 +1.49	17.10 16.93 +0.17	15.23 15.23 0.00	14.63 15.29 −0.66	14.67 15.16 −0.49	15.83 15.98 −0.15	20.30 18.82 +1.48	17.80 17.47 +0.33	15.20 15.80 −0.60	18.53 18.31 +0.22	282.61	+0.68
5					13.53 14.48 −0.95	16.43 15.56 +0.87	15.43 16.32 −0.89	18.47 16.24 +2.23	16.53 16.36 +0.17	16.83 14.66 +2.17	14.60 14.72 −0.12	14.77 14.59 +0.18	15.37 15.41 −0.04	18.67 18.25 +0.42	16.90 16.90 0.00	13.57 15.23 −1.66	17.37 17.74 −0.37	273.47	+0.11
6						15.20 13.84 +1.36	15.80 14.60 +1.20	16.87 14.52 +2.35	15.43 14.64 +0.79	11.87 12.94 −1.07	13.01 3.00 +0.01	12.20 12.87 −0.67	12.80 13.69 −0.89	14.80 16.53 −1.73	15.97 15.18 +0.79	12.17 13.51 −1.34	17.23 16.02 +1.21	245.82	−1.61
7							16.33 15.68 +0.65	15.47 15.60 −0.13	13.13 15.72 −2.59	14.53 14.02 +0.51	13.10 14.08 −0.98	13.96 13.95 +0.01	16.83 14.77 +2.06	17.67 17.61 +0.06	16.13 16.26 −0.13	14.03 14.59 −0.56	17.09 17.10 −0.01	263.14	−0.53
8								17.43 16.36 +1.07	16.60 16.48 +0.12	13.50 14.78 −1.28	14.17 14.84 −0.67	16.40 14.71 +1.69	14.83 15.53 −0.70	18.93 18.37 +0.56	17.60 17.02 +0.58	16.87 15.35 +1.52	17.86 17.86 0.00	275.49	+0.23
9									14.60 16.40 −1.80	15.43 14.70 +0.73	14.77 14.76 +0.01	10.90 14.63 −3.73	15.45 15.45 0.00	17.13 18.29 −1.16	17.43 16.94 +0.49	14.30 15.27 −0.97	17.78 17.78 0.00	274.22	+0.15
10										15.47 14.82 +0.65	15.10 14.88 +0.22	12.70 14.75 −2.05	17.83 15.57 +2.26	19.23 18.41 +0.82	17.97 17.06 +0.91	15.40 15.39 +0.01	17.90 17.90 0.00	276.12	+0.27
11											12.30 13.18 −0.88	13.06 13.05 +0.01	13.37 13.87 −0.50	15.90 16.71 −0.81	14.90 15.36 −0.46	12.37 13.69 −1.32	16.19 16.20 −0.01	248.77	−1.43
12												12.67 13.11 −0.44	13.50 13.93 −0.43	16.93 16.77 +0.16	17.30 15.42 +1.88	13.76 13.75 +0.01	15.50 16.26 −0.76	249.81	−1.36
13													14.97 13.80 +1.17	18.13 16.64 +1.49	14.97 15.29 −0.32	13.63 13.62 +0.01	16.37 16.13 +0.24	247.70	−1.50
14														15.40 17.46 −2.06	15.13 16.11 −0.98	12.40 14.44 −2.04	17.97 16.95 +1.02	260.81	−0.68
15															17.53 18.95 −1.42	17.07 17.28 −0.21	20.20 19.79 +0.41	306.22	+2.16
16																16.40 15.93 +0.47	16.50 18.44 −1.94	284.64	+0.81
17																	16.63 16.77 −0.14	257.90	−0.86
18																		298.21	+1.64

$2T =$ 4890.60 0.00

$u =$ 15.9824

$$Ga_1 = \frac{18\times 268.25 - 4890.60}{18\times 16} = -0.21$$

☐ missing combination

Schema of the comparative trial

	1	2	3	Total
1	663.3	760.3	717.2	2140.8
2	703.2	599.3	823.4	2125.9
3	766.0	663.5	697.7	2127.2
Total	2132.5	2023.1	2238.3	6393.9

Variance analysis of the comparative trial

Denomination	Degree of freedom	Variance	Variance ratio	Probability
Combination	132*	10.85	6.66	<0.001
Row	2	0.52	0.32	
Column	2	87.07	53.42	<0.001
Rest	262**	1.63		

*; ** Reduced by 20 and 60 according to the missing combinations

The analysis of variance for general and special combining ability

Denomination	Degree of freedom	Variance	Variance ratio	Probability
General combining ability	17	20.04	11.79	<0.001
Specific combining ability	115*	1.70	3.15	<0.001
Error		0.54**		

* reduced by the number of the missing combinations (20)
** 1.63/3

Upper rows: the means of the individual combinations; middle rows: sums of the general combining ability of the two components and the mean of the whole trial (u); lower rows: specific combining ability loaded with error of the two lines involved in the cross.

Husk blade size. The lowest average found in trials was 4.2/0.8 cm (14×17) and the highest 30.1/3.9 cm (2×7). On the strength of general combining ability it is in negative correlation with the flowering date and partly with the number of tassel branchings (length) as well as with the ear width and number of kernel rows (width).

Width of firsetar. In conformity with estimation the highest value realized is 5.55 cm (14×16) while the lowest 3.58 cm (3×7). The correlation is significant and positive with flowering date, tassel branchings, length of apical part and kernel row number; negative with the data of suckering and husk blade.

Ear length. The mean of hybrids of the two best lines is 20.2 cm exceeding expected value only by 0.4 cm (about 2 per cent) while the highest average (4×15) was 0.1 cm above this, surpassing estimated value by 1.5 cm. According to general combining ability of the individual lines it is in positive correlation with plant height, tassel branchings and leaf blade, but not with the flowering date ($r = +0.058$).

Among the combining abilities for characters not subjected to statistical analysis kernel width and thickness show — on the strength of Fig. 1 — a close positive correlation and both with kernel length a negative correlation, the latter determining roughly the cob—ear diameter difference. Combining ability for kernel weight seems to be in positive correlation with the sum of kernel width, thickness and length. By the combining ability of economic value lines separate rather readily into groups of good [18, 15, 3, 4, 2, 1, 16], bad [13, 17, 6, 12, 11] and medium [5, 7, 8, 9, 10, 14] lines.

Conclusions and Summary

The high significance of general combining ability for every feature as well as the ratio of its variance to that of specific combining ability (Vg/Vs) stresses the importance of the additive genic effect. JINKS (1955) after having elaborated trials with maize, flax, egg-plant, *Galeopsis* and *Nicotiana rustica* demonstrated that specific combining ability was invariably associated with non-allelic interaction while general combining ability was the result of non complicated dominance. According to the given formula, however, the general combining ability contains, besides the simple additive effect, also additive × additive interactions, while specific combining ability is loaded, besides the effects indicated, also with genotype-environment interaction (ROJAS and SPRAGUE, 1952). Recent studies (GAMBLE, 1962a, b, SPRAGUE *et al.* 1962) have also attracted attention to the epistasis effects, and the Vg/Vs ratio can not be regarded as a true characteristic of dominance conditions (if $2\ Vg = D$ and $Vs = H$ then $\bar{a}^2 = Vs/2\ Vg$) still it explicitly marks the pathway to be followed in breeding. First of all a not too rigorous selection must be in the given material conducted for general combining ability (for first ear length important from economic point of view the Vg/Vs ratio is 0.99), then lines that proved to be better must be grouped and tested — as far as possible in complete or partial diallel crosses — also for specific combining ability. In sweet corn breeding single crosses are generally used. There is no need for a number of single crosses to predict yields of the double crosses as in common maize, and therefore, the use of partial diallel is more justified. The complete diallel, however, offers more reliable information, supplying useful data both on general and specific combining ability for the next step of breeding, the improvement of the individual lines.

Genetic variability of our completed material is rather wide but we are still short of lines suitable for production of very early hybrids with short vegetation period. A material with short growing period is important from two viewpoints. On the one hand off-season produce fetches high prices and

Table 5

Correlation coefficients of the general

Denomination	Suckering	Plant height	Tassel: Number of branchings	Tassel: Length of apical part	Tassel: Length of branching part	Tassel: Stalk length
Flowering date	−0.017	+0.443	+0.861	+0.210	+0.805	−0.616
Suckering		−0.698	−0.299	−0.139	−0.366	−0.362
Plant height			+0.651	+0.436	+0.830	+0.202
Tassel:						
Number of branchings				+0.063	+0.925	−0.295
Length of apical part					+0.203	−0.197
Length of branching part						−0.161
Stalk length						
Leaf blade:						
Width						
Length						
Index	$r_{16\ P5\%} = 0.468$					
Largest husk blade:						
Width						
Length						
First ear:						
Width						
Length						
Total ear length						

therefore attempts are made to shorten the vegetation period even by technical procedures (MILLER and BUNGER, 1963), and on the other hand, it can be well grown after autumn fodder mixtures, mixture of oat and vetches, lettuce, peas and new potatoes. The general combining abilities of the three earliest lines are −8.48; −4.45 and −2.41 days, while for the latest ones +4.69. Accordingly, there are 4 days between the earliest and subsequent line, 2 days between the second and third one whereas between the third and 18th there are 7 days which involves a lower average deviation than 1/2 day. If the experimental matter, on the whole, is truly reflected in the 18 selected lines, which needs — according to HAYMAN (1960, 1963) — a minimum of ten lines, the number of the early lines have to be multiplied. Insertion of late lines raised conspicuously the variance of the general combining abilities for leaf blade length, length of first ear and kernel row number; for the latter the average of the whole trial was raised from 9.29 (DANIEL and VÁRÓCZY, 1959) to 12.44.

BROWN and ANDERSON (1947, 1948) and ANDERSON and BROWN (1952) distinguish the Southern dent and Northern flint types and assume that the

combining abilities in 18 sweet corn lines

Leaf blade			Largest husk blade		First ear		Total ear length	Kernel row number
Width	Length	Index	Width	Length	Width	Length		
+0.422	+0.687	−0.283	−0.516	−0.687	+0.512	+0.057	+0.005	+0.720
−0.466	−0.472	−0.078	+0.156	+0.111	−0.468	−0.415	−0.289	−0.254
+0.602	+0.850	−0.172	−0.167	−0.153	+0.457	+0.612	+0.558	+0.476
+0.467	+0.737	−0.272	−0.376	−0.492	+0.479	+0.312	+0.249	+0.672
+0.603	+0.523	+0.178	−0.414	−0.359	+0.522	+0.098	−0.029	+0.409
+0.539	+0.863	−0.312	−0.306	−0.382	+0.469	+0.491	+0.440	+0.618
−0.232	−0.208	+0.122	+0.248	+0.463	−0.184	+0.272	+0.258	−0.354
	+0.739	+0.478	+0.247	−0.321	+0.344	+0.190	+0.187	+0.350
		+0.019	−0.204	−0.301	+0.489	+0.483	+0.480	+0.547
			−0.051	−0.026	−0.164	−0.311	−0.323	−0.349
				+0.907	−0.544	+0.409	+0.465	−0.474
					−0.349	+0.395	+0.442	−0.423
						+0.048	−0.235	+0.849
							+0.843	+0.114
								−0.064

USA hybrids are built upon the heterosis effect arising from differences between the two groups. Taking in consideration only the characters studied in our trials the following features are for the first group characteristic: long vegetation period, poor suckering, tall growth, abundantly branching tassel, broad and comparatively short leaves, husks without blades, short and thick ear turning conical, many kernel rows and long kernels, while the second group is at complete variance with all stated above: short growing period, good suckering, low size, poor tassel with few lateral branches, long and thin leaf, large husk blade, cylindrical ear, few kernel rows and broad, flat kernels.

Accordingly the lines Nos 14 and 17 tend towards the Southern dent type while the lines Nos 7 and 9 are near the Northern flint type, the rest representing different types of transition. The gene stock of our material when assessed from this viewpoint seems to be also very rich. The related lines 16 and 18 are rather interesting, their combining ability for flowering date (suckering), plant height, tassel branching (husk blade), kernel row number and kernel shape corresponding to the Southern dent while as to leaf shape they explicitly do to the Northern flint type; in line No. 1 the value of suckering conspicuously differs from the positive values expected on the grounds of other combining abilities.

The correlation coefficients of the general combining abilities (Table 5) support the theory of ANDERSON and BROWN concerning the Noithern and Southern types. The long vegetation period, large size, the abundantly branching and short stalked tassel, reduced husk blade, broad ear, high kernel row number and, by means of ear width and plant height the poor suckering form a group of more or less close inheritance. It is interesting to note that the leaf blade index which belongs, according to general theory also to the group, shows a significant correlation only with leaf blade width and suckering is independent of earliness.

The calculated few heritability coefficients (h^2) supply a useful information as well. Unfortunately, the lowest value was found at the most important feature, the length of the first ear ($h^2 = 0.26$), which, on the strength of the low Vg/Vs ratio and great environmental effect is not surprising. The value is the highest in the kernel row number determined by genes of primarily additive effect (DANIEL, 1963) and only slightly depending on environmental effects ($h^2 = 0.73$) as well as in the number of tassel branchings ($h^2 = 0.65$) being also known as a rather constant character and recently used to determine mutational frequencies arising in quantitative characters (SPRAGUE *et al.*, 1960; RUSSEL *et al.*, 1963).

The behaviour of the three USA lines deserves attention, too. Only the very early C13 (line No 1) belongs to the better ones, occupying among 18 the place, while C53 (line No 17) — it being tardy when compared to the average of the experimental material — was 17th and the mid-late P39 (line No 12) was the 15th. The poor achievement of P39 is particularly striking; in the

Table of Smith (1955) on popular American hybrids it is a component of four out of the 10 open pedigree single crosses although its quality, however, being medium (Huelsen, 1954) its spreading is probably due to high combining ability. The poor achievement of the USA lines can be explained by adverse conditions (mean plant height 118 cm). They have not got acclimatized to growing conditions prevailing in Hungary and their high demands are evident also in the hybrids; their yield under the conditions of poor nutritional status and water supply lagged — with few exceptions — below average. Although they are lines introduced into general cultivation, their average combining ability for general economic value is —20.30 while the average of five lines selfed from USA varieties in Hungary but not selected is +12.26.

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PHENOECOLOGICAL INVESTIGATIONS IN SPRING CEREALS

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The manifestation of "individual amplitude" (i.e. the range of dispersion of phenological phenomena within stands) was studied in so-called periodical crops of spring barley and oat varieties (established by delayed sowing technique). It was demonstrated that spring barley varieties were far less sensitive to weather extremes than oats; the latter being highly particular not only about precipitation but also about temperature. The optimum temperature for the development of both species was found much lower than pointed out in general by special literature.

Introduction

Ecological investigations performed some years ago by the author revealed that the individual dispersion ("individual amplitude") of some phenological phenomena in crops depends to a considerable degree on weather influences. It was found that the range of dispersion was smallest if the weather was favourable and much greater under adverse conditions. Results pertaining to this problem were obtained in the course of investigations on wheat, maize and hop varieties (MÁNDY 1960, MÁNDY 1962, MÁNDY 1963, MÁNDY—SZÉKÁCS 1963).

The discovery of the phenomenon of individual amplitude (MÁNDY 1962) has opened new possibilities in ecological research, exactly in recognizing the character of species and varieties. The dispersion of phenological phenomena within stands proves to be very suitable for the demonstration of the ecological reaction of varieties and thus the evaluation of phenological data gets deeper ecological importance too.

The climatic ecological series established by delayed sowing technique showed a regular distribution of the values of individual amplitude: they generally decreased from "unfavourable" toward "favourable" sowing times and increased, respectively, in the opposite direction. In winter cereals the values were mostly distributed according to the optimum curve, because both too early (September) and too late (November-December) sowings created unfavourable ecological conditions for the varieties of the crop series.

Contrasted with winter cereals in spring stands examined so far (maize and hop) only asymmetric distribution was obtained. In fact the long vegetation period did not permit to establish a too late crop, because due to autumnal frosts its ripening could not be expected. Therefore, the distribution of values showed only a "half curve".

It seemed desirable to examine the changing values of periodical crops also in spring cereals of short vegetation period in order to find out the type of distribution of the values.

Material, Method and Conditions of Investigations

Investigations were started with 10 spring barley and 13 oat varieties in 1963; chiefly native and — in smaller strength — foreign varieties of promising outlook were used. The estimation was carried out on the basis of variety means. The values of the different varieties were examined in a separate paper (MÁNDY—KOVÁCS 1964a and 1964b).

It was of particular interest that as to their general ecological feature both species were essentially different.

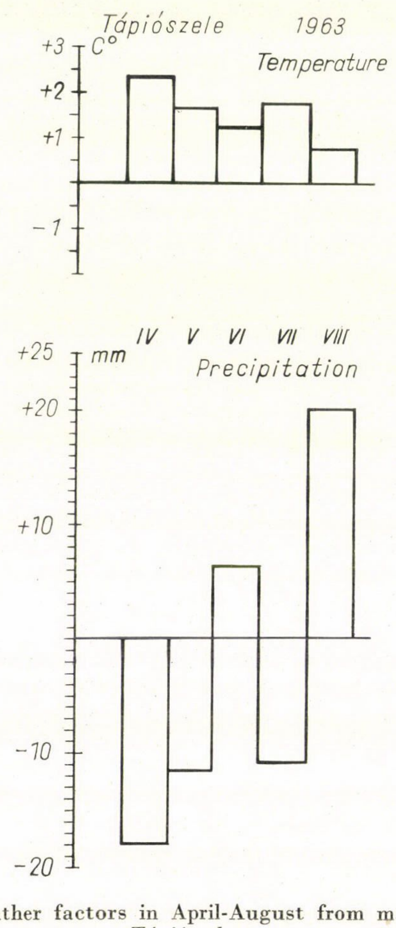

Fig. 1. Deviations of weather factors in April-August from many years' mean values at Tápiószele

According to MERKENSCHLAGER and KLINKOWSKI (1963) *barley* has an arid, cosmopolitan constitution of alkali demand, while *oat* is a hygrophilous, drosophilous "hygro-limno-constitution" sensitive to wind and salt content.

Thus these species are nearly inconsistent with one another.

The series of spring barley varieties were sown at four dates (April 3, 17, 30 and May 30) that of oat varieties on five occasions (April 3, 17, 30, May 15 and 30). All varieties were at every seeding date sown in six replications and from each replication three specimens were held under systematic observation.

Investigations were conducted at the Experimental Station of the National Institute of Agrobotany at Józsatanya on chernozem-like humous sand, covered with a 60 cm thick humus layer. The surface soil shows an alkaline reaction (pH = 8.2) and a low $CaCO_3$ content of 0.68 per cent; the subsoil is alkaline too (pH = 8.5) and calcareous (8 to 23 per cent). The humus content amounts to 2.06 per cent.

From April to August — and especially in April — the weather was generally warmer than the many years' mean temperature in the same period (Fig. 1). The precipitation of April, May and June lagged considerably behind the average of many years but reached a somewhat higher level in July and surpassed the average a good deal in August.

The soil was prepared, after harvesting the autumnal mixed fodder crop, by stubble ploughing and was held in good culture condition, free of weeds till the beginning of experiments. Before seeding no manure was applied.

Grains were sown by hand to 4—5 cm depth and at distances of 2 cm, in rows 10 cm apart from each other.

Results

Phenological phenomena were registered by individual observation. On previously selected specimens, in every periodic crop and in all varieties the appearance of phenomena was carefully recorded and on their estimation the earliest and latest moment of their manifestation established. The time difference between both values represents the range of individual dispersion, the individual amplitude. In barley the assignation of the beginning of efflorescence is uncertain, therefore, only the moment of earing was registered. Similarly to barley also in oat were noticed the data of clustering. The phenological valuation was carried out on the strength of variety means. Accordingly, for the establishment of the behaviour of spring barley 1080 and in oat 1404 individual data were recorded.

a) *Examination of spring barley varieties*

The development of plants in question had accomplished according to the change of weather conditions during the vegetation period (Fig. 2). Maximum height was proportionate to the amount of precipitation and average temperature. The "arid" feature of barley manifested itself clearly in moderate decrease of height, remaining even in the 4th periodical crop over 50 per cent of the maximum value. In oat — as will be seen later — the drop was much greater.

The amplitudes both of earing and waxy ripeness show unequivocally a V-shaped dispersion curve. The lowest value occurred in the 2nd periodical crop (Fig. 3) and demonstrated that the development of spring barley was mostly favoured by weather conditions of the 2nd periodical crop. Moreover, plants reached also their maximum height in this crop. The weather in the phenophase of vegetative development (emergence, earing, Fig. 3) revealed that spring barley was satisfied best by the mean temperature of the 2nd

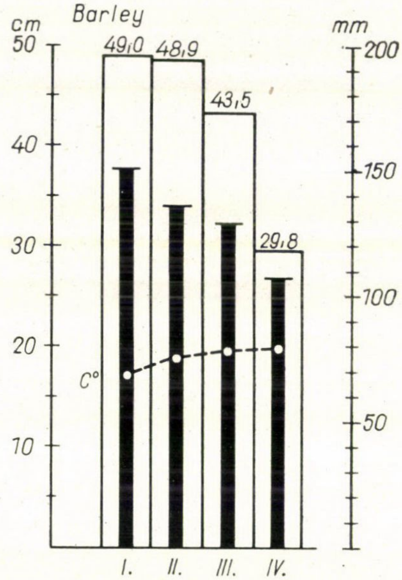

Fig. 2. Changes in average stand height of spring barley varieties in the different periodical crops and the connection of height with precipitation sum and mean temperature of the vegetation period

The right vertical axis shows the precipitation (in millimetres), the left one the stand height (in centimetres) and temperatures, while on the horizontal axis the periodical crops (I to IV) are plotted. The broad columns marked with heavy line represent the average stand height, the narrow columns designed with thin full line portray the precipitation sum and those sketched with dotted line the mean temperature

periodical crop (17.4° C) and average values over 20° C were less favourable. This observation differs considerably from "optimum" data that may often be found in literature, indicating temperatures of 25 to 30° C as best conditions of barley development (HAJAS—RÁZSÓ 1962). As it may be concluded even much lower values affect the development of spring barley unfavourably, because a phenophase average of 20° C increases not only the range of individual amplitude in earing, but diminishes also the height and even the yield of crops. The amplitudes of waxy ripeness evidence that yield development of barley is promoted by temperatures of about 20° C if simultaneously the stands receive an adequate amount of precipitation. In the vegetative development period of spring barley a precipitation sum of 95 to 100 mm is very

beneficent. An amount surpassing or lagging behind this quantity increases the individual dispersion of phenological phenomena. *Spring barley is a plant very sensitive to climate*, because the dispersion of its phenological phenomena is considerably affected by weather changes of even low degree. In the stage

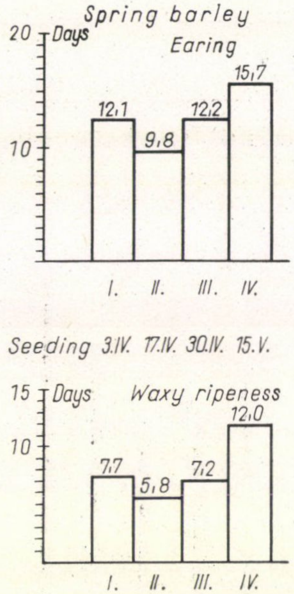

Fig. 3. **Phenoecological diagram of spring barley. The graphs on the left side above show the individual amplitudes of earing, the columns below those of waxy ripeness in the different periodical crops (values are given in days). The small table below contains the totals and averages of most important weather factors in the phenophases preceding the examined phenological phenomenon. Above: the data pertaining to the stages from emergence until earing; below: from earing until waxy ripeness. The numbers of the columns indicate the following factors: 1 = temperature sum in °C, 2 = mean temperature of the phenophase (°C), 3 = precipitation sum of the phenophase in mm**

	Phenophase	1	2	3
		Σ °C	°C	mm
I.	IV. 14—VI. 6	912.7	16.9	71.2
II.	IV. 23—VI. 13	916.4	17.4	93.4
III.	V. 6—VI. 20	841.6	23.4	82.7
IV.	V. 20—VII. 9	1024.2	20.1	118.4
I.	VI. 7—25	355.2	18.7	69.9
II.	VI. 14—VII. 1	396.2	22.0	40.0
III.	VI. 21—VII. 6.	382.9	23.9	31.8
IV.	VII. 10—19	227.6	22.8	0

of generative development a precipitation sum of about 40 mm proved most beneficent.

For spring barley the individual amplitude of earing seems to be — most characteristically — of a larger range than that of waxy ripeness, because in the latter stage the values of the amplitude decrease by 25 to 40 per cent.

b) *Examination of spring oat varieties*

In the series of periodical crops the average height of stands successively and considerably decreased (Fig. 4). This value scale does not follow the changes of precipitation sum in the vegetation period being given the fact that the quantity of precipitation diminishes till the 3rd sowing date only and increases

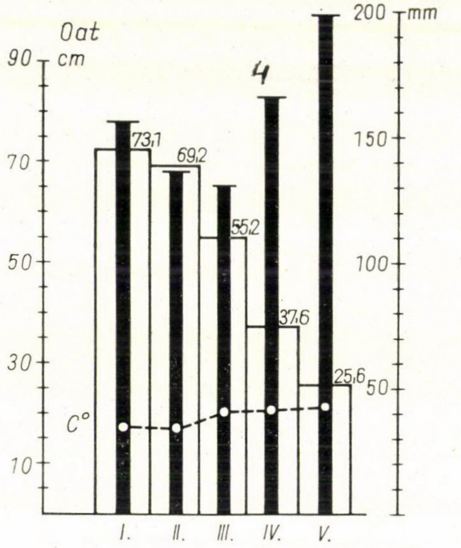

Fig. 4. Changes in average stand height of oat varieties in the different periodical crops and the connection of height with precipitation sum (black columns) and mean temperature. Designation as in Fig. 2

thereafter notably. In the 4th periodical crop the height comes but nearly to the half of the maximum in the series and remains even below this level in the 5th periodical crop. Accordingly in both latter crops precipitation had no stimulative effect, while the values of average temperature in the vegetation period successively increased. Between the height of oat stands and mean temperatures there seemingly exists an inverse mutuality, i.e. *temperature is the most important growth factor of oat* being in this respect much more sensitive than barley.

As to the individual amplitudes of phenological phenomena (Fig. 5) a sensitiveness similar to that of height and greater than in barley can also

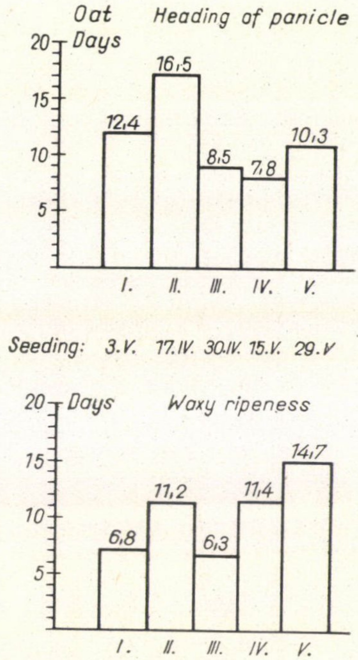

Fig. 5. Phenoecological diagram of oat. Designation and arrangement as in Fig. 2

	Phenophase	Σ°C	°C	mm
I.	IV. 17—VI. 20	1143.7	17.6	101.6
II.	IV. 26—VI. 26	1125.4	18,4	127.2
III.	V. 8—VII. 4	1135.4	19.9	114.0
IV.	V. 22—VII. 13	1096.3	20.7	118.4
V.	VI. 4—VII. 23	1088.5	22.2	74.4
I.	VI. 21—VII. 12	512.2	23.3	36.3
II.	VI. 27—VII. 16	493.6	23.5	4.5
III.	VII. 5—21	396.2	23.3	4.5
IV.	VII. 14—28	389.9	26.0	35.5
V.	VII. 24—VIII. 18	585.4	22.5	99.9

be observed. Therefore, the amplitudes of oat have a wider range and fluctuate more irregularly. Though in its general course the gradient of amplitudes resembles the dispersion curve, in details the distribution of values has a wave-like shape. The values of the 2nd periodical crops protrude remarkably from the regular course and display greater unevenness especially in clustering.

Let us examine more closely the cause of this disturbance. As the conditions of the later vegetative development have proved favourable, the reason must probably be sought in the most extreme factor of postemergence weather. Accordingly the most important diurnal values of post-emergence weather in the first three periodical crops are to be analyzed (Fig. 6).

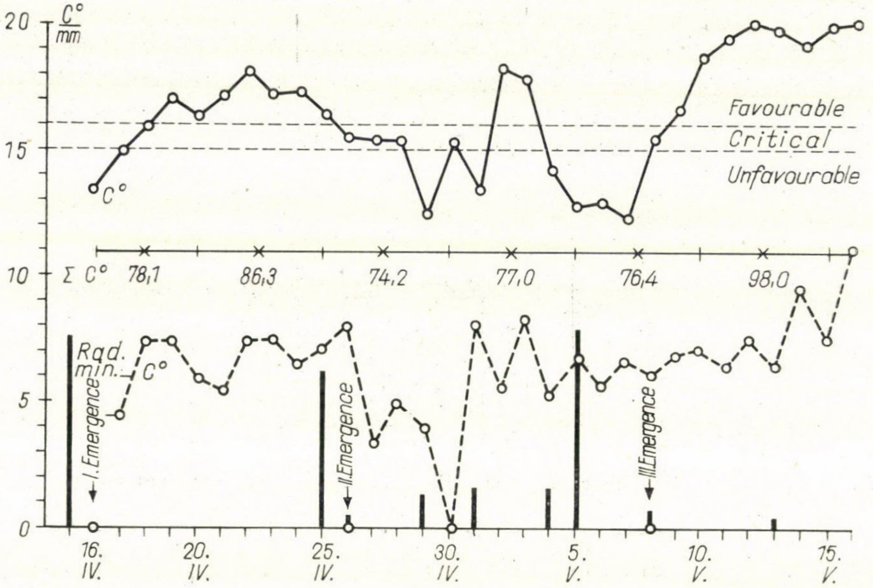

Fig. 6. Diurnal values of weather at Tápiószele in the period of April 16 to May 16. Vertical axis shows the data of temperature (°C) and precipitation (mm), on the horizontal axis the days are plotted. The upper diagram drawn with a thin uninterrupted line represents the diurnal mean temperatures (°C), below it the numbers put under a horizontal line indicate the temperature sums (°C), the dotted thin line displays the diurnal data of radiation minimum (°C) and the vertical heavy lines the amount of daily precipitation. Average emergence data observed in the different periodical crops are marked with small arrows

The data reveal that after the average emergence moment of the 2nd crop daily temperature and radiation minimum successively diminish and the former remains — with the exception of two days — below 16° C nearly for 2 weeks and the latter drops one day (April 30) to freezing point. As it may be seen from registrations these adverse conditions did not affect the young stand of the 1st crop (the plants being already two weeks old on the day of the +0.5° C radiation minimum), but supposedly influenced the seedlings of the 2nd crop. The high-grade drop in temperature and the long-lasting cool weather may have had a considerable effect on the stand of the 2nd crop, and the wide range of dispersion in phenological phenomena, so in clustering and waxy ripeness, can be attributed to this fact. In the identical development stage of the 1st and 3rd crop warmer conditions prevailed, therefore the range of their individual amplitudes remained remarkably narrower. The amplitude of clustering in the 1st crop developing under lower temperature was naturally larger than in the 3rd crop (due to different temperature, see Fig. 6).

These data repeatedly confirm the observations of the author on the higher sensitiveness of oat to temperature. This sensitiveness is of an increased degree especially in young seedlings, just after germination. If in this stage the seedlings have to endure temperatures below 5° C (or near to freezing point for a short time) and also the diurnal mean temperature remains below 15° C, the development of oat may be disturbed and the dispersion of phenological phenomena in its stands notably increases. These conditions — as it was shown previously — do not damage spring barley, on the contrary, they should be considered as rather advantageous.

From the individual amplitude values of clustering it may be seen that for the vegetative development of oat a mean temperature of about 18 to 20° C and a precipitation sum of 110 to 120 mm in this phenophase are favourable. The data reveal that during the stage of development as to most important weather factors oat is rather more exigent than barley, by requiring higher temperature and larger amounts of precipitation than the latter still both species concour with one another in preferring fairly temperate conditions. Barley is not so much affected by the extreme fluctuation of weather, oat is sensitive to this factor in an increased degree. *The development of oat is promoted best by temperate and equalized weather.*

The higher heat demand of oat, similar to that of barley, manifests itself also in the generative development stage. The individual amplitudes of waxy ripeness (Fig. 5) display that oat requires as best condition a mean temperature of about 23° C (a temperature sum of 400 to 500° C) and a total precipitation not less than 30 mm in the stages of clustering and waxy ripeness. Spring barley is satisfied with less heat but needs more precipitation.

Comparing the amplitudes of clustering and waxy ripeness in oat it turns out that the ranges in earlier (1st—3rd) crops diminish, but those of later ones increase, as a consequence of higher temperatures. This is in comparison to spring barley a difference showing consequently a considerable decrease of the amplitude of waxy ripeness in all periodical crops. It is interesting to note that the aftermath of cold effect prevailing in seedling stage comes also forward here in the 2nd crop. Though the range of this amplitude is not so wide as in clustering, it touches — however — nearly the double of that in the 2nd and 3rd crop and approaches even the value in the 4th crop (Fig. 5). Accordingly the more favourable weather prevailing in the stage of waxy ripeness is able to moderate the effect of early cold very adverse for vegetative development. At this point a cooler and highly rainy weather is already rather unfavourable.

Conclusion

Phenoecological investigations in spring cereals have proved the assumption that in plant stands of shorter vegetation period and established by delayed sowing technique the distribution of individual amplitude value shows the same dispersion curve as in winter cereals. New data obtained from the author's examinations evidenced again the applicability of the phenoecological method elaborated by him.

Also individual amplitudes of phenological phenomena in spring barley and oat varieties depend on weather changes and disclose in detail the climatic ecological requirements of examined spring cereals.

Investigations on spring barley varieties have revealed that in the stage of vegetative development (i.e. the phenophase from emergence until earing) a mean temperature of 17 to 18° C is very favourable if, at the same time a proportionately distributed total precipitation of 95 to 100 mm is falling down. In the stage of generative development (from earing until waxy ripeness) temperatures about 22° C and a precipitation sum of 40 mm represent the optimum. These conditions diminish to the lowest degree the fluctuation of phenological phenomena in the stands of spring barley varieties and promote their uniform development.

Amplitude changes observed in periodical crops have revealed that spring barley is a plant very sensitive to climate.

Temperature and precipitation — as development factors — prevail in oat to a larger extent than in barley. The development of the latter is influenced by weather elements within a wider range, while oat grows within narrower bounds. This proves that spring barley endures even more extreme weather fluctuations better than oat requiring rather *equalized conditions*. But both species concur in demanding temperate weather for optimum growth.

Phenoecological investigations of oat varieties have manifested that in the stage of vegetative development a mean phenophase temperature of about 18 to 20° C is favourable if at the same time the stands get a total precipitation of about 110 to 120 mm in adequate distribution. The demand on heat surplus differentiating oat from barley, manifests itself even in the stage of generative development. In the stage of ripening the best growth condition for oat is a mean temperature of about 23° C but it may also be satisfied by a precipitation sum less than 30 mm. The temperature demand of oat is especially high in seedling stage. Cold effects below 15° C or dropping even to freezing point disturb in this period the equal development of stands and increase highly the range of individual amplitude every moment of the whole individual development is harmfully influenced by such an adverse impact.

The investigations described here make clear that special literature points out temperatures of 25 to 30° C erroneously as best growth condition for spring barley and oat, because the developmental optimum of these cereals lies considerably below this level, and 25 to 30° C temperatures are already unfavourable or exert even an inhibitory effect. As to optimum demand spring barley differs notably from oat, it is, therefore, wrong to present them as species of identical developmental requirements. Equally is erroneous the statement of literature that oat is particular only about precipitations, since it lays an exceedingly high claim also to temperature.

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THE POSSIBILITY OF PREMUNITY IN MAIZE SMUT (USTILAGO MAYDIS [D. c.] Cda.)

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Investigations in a field test prove that the possibility of premunity in maize smut has been verified. Seeds of hybrids used as indicator plants were soaked in viable and killed cultures of the pathogen or in cultures which had suffered destruction by centrifugation. Plants obtained from these seeds were inoculated during the vegetation period in different developmental phases and in some treatments incidence of a slight degree was observed as compared with the controls.

Introduction

According to the term introduced by SZEPESSY (1963), "by premunity such type of reaction is meant that is activated as a consequence of the infection of the parasite and upon its action, hindering the reinfection by identical or closely related pathogens but being unable to destroy the primary invader in the organism". As examples from among mycoses the experiments of MÜLLER and BÖRGET with *Phytophtora infestans*, while from viruses the experiments of SALAMAN with the tomato X virus are cited by the same author. He attracts attention to the fact that almost nothing has been done to exploit premunity.

MILINKÓ (1961) demonstrated premunity when elucidating phylum conditions of DMV infecting tomato. The green strain of Aschersleben induced premunity to the strain isolated by the author from tomato on *Nicotiana sylvestris* test plant.

No effective method exists so far for protection against maize smut except for the breeding of resistant hybrids. Should it be possible to induce premunity by methods which can be applied also in practice, an immediate procedure of protection could be gained.

In the present experiments the possibility of inducing premunity has been investigated by various seed treatments. A preliminary condition of the application of seed treatments is infection in an early age and occurrence of the spreading of the pathogen in the plant tissues. When setting up the experiment we relied on the related positive findings of DIETRICH (1953), YAKOVLEVA (1961) and KECHEK (1959).

Material and Method

The characteristic data of the experiment are: Plant/plot: in the main plot (time of infection): 180, in the subplot (seed treatment): 45, Spacing (sq.m.) 0.32, Seeding date: in 1963 8. V. in 1964 29. IV. Number of replications: 4. Design: split-plot, Latin square.

The seed treatment with which we attempted to induce premunity were:

a) Control: the seeds were soaked in water.

b) The seeds were soaked in vital sporidium suspension.

c) Sporidium suspension was centrifuged. After centrifugation practically no sporidium was left in the liquid in which the seeds had been soaked.

d) Seeds were soaked in a sporidium suspension which heated on 55° C for 2 minutes.

The duration of soaking was 2 days in both years. The sporidium suspension has been produced on a liquid carrot medium.

During the vegetation period artificial infection was carried out in various developmental phases of the plant, as to control the duration of premunity induced by seed treatments.

The treatments were as follows:

Serial No	Developmental phase of plant at infection	Date of infection for indicator plants employed in each year		
		Mv 42		Mv 5
		1963	1964	1964
1.	Control (non-infected)	—	—	—
2.	3—4 leaf phase	31. V	23. V	23. V
3.	1 m	9. VII	27. VI	30. VI
4.	Female inflorescence	23. VII	16. VII	27. VII

The method of infection during the vegetation period was dusting with chlamidospores. In the 2. and 3. treatment the inoculum was first of all given into the leaf funnel.

In 1964 the two maize hybrids were included in two separate experiments. Maize smut incidence was established from 30. VI to 10. IX every five and/or ten days. In the course of the survey the number of the infected plants and the location of the galls were established.

Experiments were carried out in the trial grounds of the College of Agricultural Sciences Mosonmagyaróvár.

Results and Discussion

Characteristic data of incidence observed in the experiment set up in 1963 are presented in Table 1.

Examination of the effects of seed treatments in the average of infection periods revealed that in treatment "a" incidence up to 30. VII was higher than in the others while after this date it was lower. Significant difference could be observed only as related to "b" at the 10 September survey.

Examination of the seed treatments during the vegetation period at the various dates of infection revealed that:

there is no significant difference between the incidence of plants obtained from seeds soaked in water. In the case of sporidium suspension treatment on 5. VIII in the control, on 10. IX in the treatments 1, 2 and 4 (infection period) incidence was significantly lower than in treatment 3.

In the case of centrifuged sporidium suspension seed treatment on 5. VIII. in treatment 2, on 25. VII. in treatments 1, 2 and 4 and on 10. IX. in treatment 2 incidence was significantly lower than in treatment 3. On 10. IX. incidence was higher even in the control than in 2.

In the case of heated sporidium suspension seed treatment incidence was in the control lower during the whole vegetation period than in treatment 3.

On examining, in the average of seed treatments, the result of the infection period it turned out that incidence was lowest when it took place in the 3 to 4 leaf age. This gave a significantly lower value as compared both to treatments 3 and 4.

From these it follows that if no inoculation takes place during the vegetation period the seed treatment with heated sporidium suspension, while if combined with inoculation in the 3 to 4 leaf age the centrifuged sporidium suspension seed treatment seems to be useful in protection from smut.

When the experiment was repeated in 1964, data obtained followed not perfectly the same trend (Table 2) concerning the seed treatments. In the case of indicator plant *Mv—42* a prominently high incidence was also in this year obtained in treatment 3 (infection carried out when plants were 1 m high). The smut reducing effect of treatment 2 (inoculation in the 3 to 4 leaf age) now appeared still more acutely than in 1963. In the case of heated sporidium suspension treatment both in the control and treatment 2 incidence was lower as related to the water soaking treatment but the difference was not significant.

In *Mv 5* when inoculation was carried out at female inflorescence (treatment 4) and in the 3 to 4 leaf age, (treatment 2) higher incidence was obtained than in the control or in treatment 3. The difference was significant only as compared with treatment 4. Among the seed treatments, similarly to previous experience, the greatest amount of smut was found in "b". The smut-reducing effect of heated sporidium suspension treatment was found to prevail in the 2 and 3 while that of the centrifuged suspension in treatment 3.

Upon the effect of seed treatments changes were observed in the ratio of gall types (Fig. 1). Both in the centrifuged and in the heated sporidium suspension treatments there have increased the proportion of galls above the ears as well as in *Mv 42* that of the smut-infected suckers and, in *Mv 5* that of infected tassels. Treatment "d" has also increased, in *Mv 42* the infection of ears and, in *Mv 5* that of the leaves.

Upon the effect of seed treatment "b" an increase appeared in the proportion of galls found on suckers, at *Mv 42* in that of the galls on and above the second ear and at *Mv 5* in the proportion of the galls below the ear.

As a result of inoculation carried out in the 3 to 4 leaf age, at *Mv 42* the same occurred to the proportion of galls found on and above the ear, at *Mv 5* to that of the galls on the leaves. As an effect of inoculation con-

Table 1

Incidence of maize smut (%)

Serial No	Infection during the vegetation period	Treatment (soaking)	Maize smut incidence (%) 28. VI.	5. VII.	10. VII.
1	Control (not inoculated)	in water		1.1	1.1
		in sporidium suspension			
		in centr. spor. suspension			
		in spor. suspension heated 55° C			
		Average		0.3	0.3
2	In the 3–4 leaf age (31. V.)	in water	0.6	1.1	1.1
		in sporidium suspension			
		in centr. spor. suspension			
		in spor. susp. heated 55° C			
		Average	0.2	0.3	0.3
3	In 1 m age (9. VII.)	in water			
		in sporidium suspension		0.6	0.6
		in centr. spor. suspension			0.6
		in spor. susp. heated 55° C			0.6
		Average		0.2	0,4
4	At female inflorescence (23. VII.)	in water			
		in sporidium suspension		0.6	0.6
		in centr. spor. suspension		0.6	0.6
		in spor. susp. heated 55° C		0.6	0.6
		Average		0,4	0,4
	Average	in water	0.2	0.6	0.6
		in sporidium suspension		0.3	0.3
		in centr. spor. suspension		0.2	0.3
		in spor. susp. heated 55° C		0.2	0.3
		Average	0.0	0.3	0.4

$SD_5\%$	Between two infection periods in the mean of seed treatments	0.6
	Between two infection periods in the same seed treatment	1.6
	Between two seed treatments with the same infection date	1.6
	Between two seed treatments in the mean of infection dates	0.8

in various treatments, 1963

on the day of survey							
15. VII.	25. VII.	30. VII.	5. VIII.	10. VIII.	20. VIII.	30. VIII.	10. IX.
1.6	1.6	2.8	2.8	9.1	18.4	18.8	18.8
	0.6	0.6	0.6	7.2	11.7	15.6	15.6
	0.6	1.1	2.2	11.2	18.1	20.3	20.3
			1.1	4.5	8.4	10.6	11.8
0.4	0.7	1.1	1.7	8.0	14.2	16.3	16.6
1.1	1.1	1.1	2.3	5.7	12.7	14.4	14.4
		0.6	1.6	6.7	13.9	16.6	16.6
	0.6	0.6	1.1	7.9	12.5	12.5	12.5
	0.6	1.6	4.4	8.3	11.8	15.7	15.7
0.3	0.6	1.0	2.4	7.2	12.8	14.8	14.8
		1.1	2.2	8.9	13.9	14.5	14.5
1.1	1.1	1.1	3.9	17.3	23.6	25.8	25.8
0.6	1.1	1.6	5.0	17.3	23.6	27.5	27.5
1.1	1.1	1.1	4.6	10.2	22.9	24.4	24.4
0.7	0.8	1.2	3.9	13.2	16.9	23.0	23.0
			2.2	7.2	10.1	17.1	17.1
0.6	0.6	0.6	3.3	7.7	12.0	18.9	18.9
0.6	0.6	1.1	2.2	9.4	12.9	15.1	15.1
0.6	0.6	0.6	1.6	11.9	17.6	19.1	19.1
0,4	0,4	0.6	2.3	8.7	13.2	17.4	17.4
0.7	0.7	1.3	2.4	7.7	13.8	16.2	16.2
0.4	0.4	0.7	2.4	12.2	15.3	19.2	19.2
0.3	0.7	1.1	2.6	11.5	16.4	18.8	18.8
0.4	0.6	0.8	2.9	13.7	15.2	17.5	17.8
0.5	0.6	1.0	2.6	11.3	15.2	17.9	18.0
	0.9		1.1	4.9	4.0		3.0
	1.9		3.7	9.3	12.8		10.6
	1.9		2.2	9.3	10.1		9.1
	0.9		1.1	4.9	4.0		3.0

Table 2

Incidence of maize smut (%)

Serial No	Infection during the vegetation period	Treatment (soaking)	Maize smut incidence by the Mv 42 25. VI.	5. VII.	15. VII.
1	Control (not inoculated)	in water			0.6
		in sporidium suspension			0.6
		in centr. spor. suspension			1.4
		in spor. suspension heated 55° C		1.3	3.8
		Average		0.3	1.6
2	In the 3–4 leaf age (23. V.)	in water			1.3
		in sporidium suspension			3.0
		in centr. spor. suspension			0.6
		in spor. susp. heated 55° C	0.7	0.7	1.3
		Average	0.2	0.2	1.6
3	In 1 m age (27. VI., 30 VI.)	in water		0.7	1.3
		in sporidium suspension			2.7
		in centr. spor. suspension			1.4
		in spor. susp. heated 55° C			2.8
		Average		0.2	2.1
4	At female inflorescence (16. VII., 27. VII.)	in water			
		in sporidium suspension	0.8	—	0.6
		in centr. spor. suspension			
		in spor. susp. heated 55° C			0.6
		Average	0.2		0.3
	Average	in water		0.2	0.8
		in sporidium suspension	0.2		1.7
		in centr. spor. suspension			0.9
		in spor. susp. heated 55° C	0.2	0.5	2.1
		Average	0.1	0.2	1.4
$SD_{5\%}$	Between two infections in the mean of seed treatments				
	Between two infection periods in the same seed treatment				
	Between two seed treatments with the same infection date				
	Between two seed treatments in the mean of infection dates				

in various treatments, 1964

(%) on the day of survey											
					by the Mv 5						
25. VII.	5. VIII.	15. VIII.	25. VIII.	10. IX.	5. VII.	15. VII.	25. VII.	5. VIII.	14. VIII.	25. VIII.	10. IX.
0.6	9.6	15.0	22.0	24.0		1.3	1.3	1.9	3.8	4.4	5.0
4.0	10.0	19.0	20.9	21.6		2.7	4.0	5.2	6.4	7.0	7.7
4.0	12.7	23.7	26.5	28.6	0.6	2.6	3.3	4.0	4.0	4.0	4.0
6.5	14.7	18.5	22.3	22.3		0.6	1.3	3.1	3.1	5.0	5.6
3.8	11.8	19.1	22.9	24.1	0.2	1.8	2.5	3.6	4.3	5.1	5.6
4.0	10.0	14.6	17.3	19,4		0.6	3.2	4.5	5.2	5.9	5.9
3.0	12.8	17.3	22.6	22.6		0.6	1.9	5.2	6.0	8.1	8.8
4.0	10.0	13.9	16.6	18.5			2.5	2.5	3.2	5.8	6.4
3.3	7.3	10.0	14.9	17.8		1.9	3.8	3.8	3.8	3.8	3.8
3.6	10.0	14.0	17.9	19.6		0.8	2.9	4.0	4.6	5.9	6.2
3.2	18.1	22.6	24.6	25.3	0.6	1.3	1.9	3.1	3.1	4.4	5.6
7.2	22.8	24.3	28.4	31.2	0.6	3.2	3.8	4.5	4.5	4.5	6.3
7.7	13.8	22.1	26.9	29.3		0.6	0.6	1.9	3.2	3.2	3.2
5.6	10.9	21.4	27.6	30.0	1.3	3.1	3.8	3.8	4.4	4.4	4.4
5.9	16.4	22.6	26.9	29.0	0.6	2.1	2.8	3.3	3.8	4.1	4.9
1.3	9.0	13.6	14.2	17.4		0.6	1.3	1.9	1.9	1.9	3.2
3.5	11.9	18.4	23.5	24.9		2.1	2.1	3.3	4.6	5.2	9.4
2.0	8.0	13.7	17.0	17.7		1.3	2.6	3.8	4.4	5.7	7.0
5.1	9.0	15.5	18.1	20.1		1.3	2.5	3.8	5.1	7.0	7.6
3.0	9.5	15.3	18.2	20.0		1.3	2.1	3.2	4.0	5.0	6.8
2.3	11.7	16.5	19.5	21.5	0.2	1.0	1.9	2.8	3.5	4.2	4.9
4.4	14.4	20.0	23.9	25.1	0.2	2.1	3.0	4.6	5.4	6.2	8.1
4.4	11.1	18.4	21.8	23.5	0.2	1.1	2.3	3.1	3.7	4.7	5.2
5.1	10.5	16.4	20.7	22.5	0.3	1.7	2.8	3.6	4.1	5.1	5.3
3.0	11.9	17.8	21.5	23.2	0.2	1.5	2.5	3.5	4.2	5.1	5.9
1.6				3.8			0.2				2.4
4.1				9.5			0.6				6.0
1.6				3.8			0.2				2.4
3.2				7.9			0.4				4.9

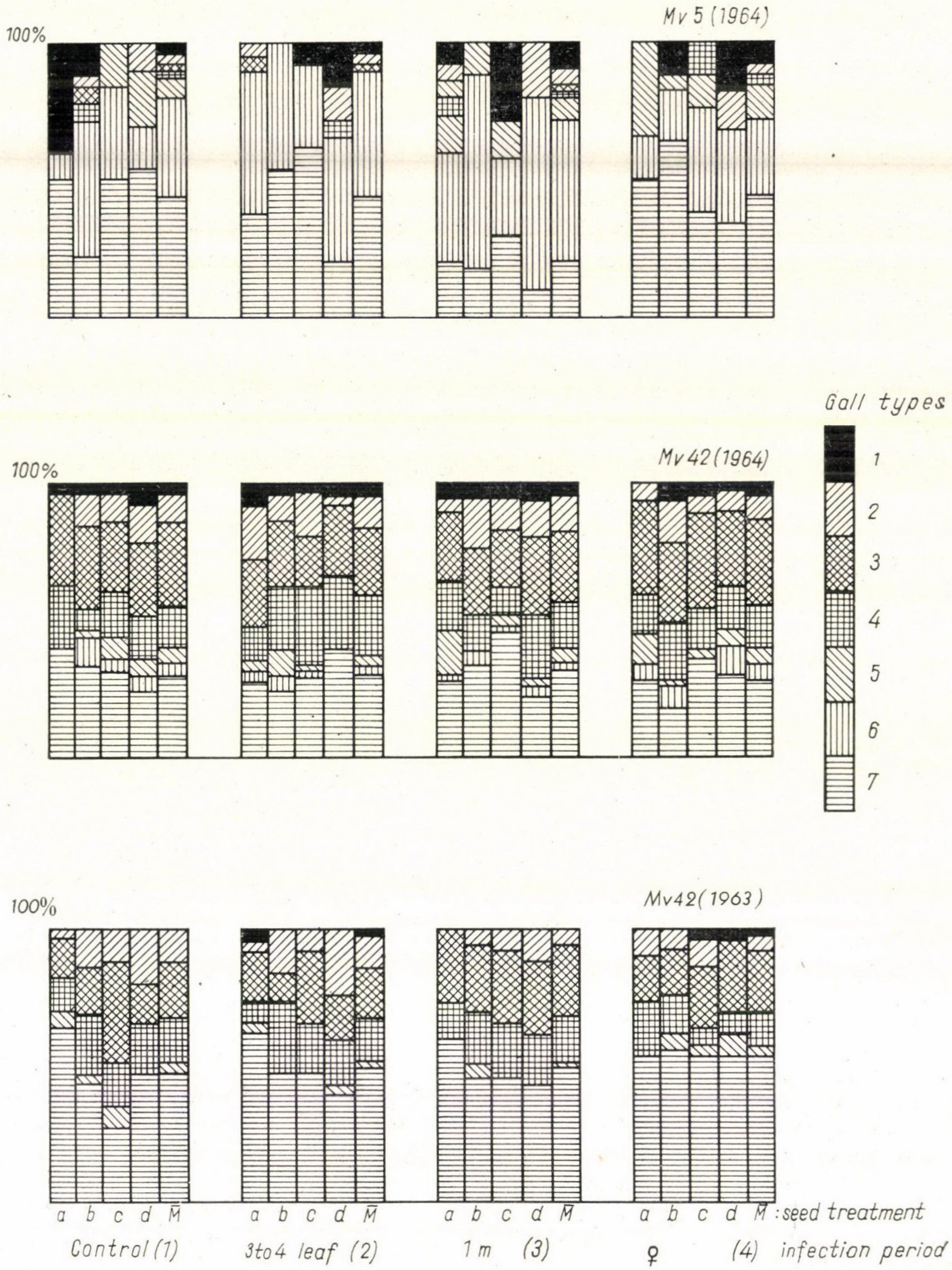

Fig. 1. The proportion of gall types depending on the seed treatment and the period of infection 1. on the tassel, 2. above the ear, 3. on ear 1, 4. on ear 2, 5. below the ear, 6. on the leaf, 7. on the sucker

ducted with 1 m high plants at *Mv 42*, the proportion of the galls grew above the ear, at *Mv 5*, below the ear and on the leaves; in the case of inoculation carried out at female inflorescence the proportion of galls found above the ear and on the tassel increased.

Conclusions

At *Mv 42*, maize smut incidence was reduced as a consequence of seed treatment with heated sporidium suspension (1963 and 1964 in the control, 1964 at inoculation conducted in the 3 to 4 leaf age) and upon the action of seed treatment with centrifuged sporidium suspension (in both years inoculation being carried out in the 3 to 4 leaf age).

Similar effect was obtained by inoculation conducted in the 3 to 4 leaf age.

At *Mv 5* again a similar effect was obtained with heated sporidium suspension in treatments 2 and 3, with centrifuged sporidium suspension in treatment 3. From all this it follows that by seed treatment with the killed culture of the pathogen or with a suspension containing the metabolic products of the pathogen, with inoculation in a certain developmental stage of the plant or with a combination of these methods premunity can be induced.

The method must be developed individually for each hybrid.

In plants originating from seeds soaked in vital sporidium suspension the maize smut incidence was prominently high. From this fact it may be concluded that the infection of seedlings may occur also in nature and for part of the later symptoms the primary infection is responsible.

Changes arising in the proportion of the gall types on the action of seed treatments and inoculations carried out in various developmental stages of the plant also support this statement.

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EXAMINATION OF RELATIONSHIPS BETWEEN AIR AND PLANT TEMPERATURE

By

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In the course of the present investigations there have been examined at each hour of a space of 24 hours both the temperature of the stem on *Asparagus sprengeri* Rgl. and *Coleus scutellarioides* (L.) Benth at 5 cm height from the soil surface and that of the leaves of *Dracaena indivisa* Rgl. and *Sansevieria hyacinthoides* (L.) Druce. In addition, a measurement of air temperature has been carried out at the same height of the plant but 5 cm from stem and/or leaf. Determination of temperature at plant surface and that of air temperature were conducted by a thermistore type 4 TH-1.5 manufactured by the Tungsram factory.

Introduction

Chemical and biological procedures taking place in the vital activities of the plants depend, to a significant extent, on temperature. In the course of metabolic processes there are such periods when heat is released in the plant, that is the temperature of the plant does not unconditionally agree with the temperature of the environment. The temperature of plant organism is determined by irradiation and emanation, air motion and evaporation as well as by air temperature (BACSÓ 1963).

The temperature of various plant species and varieties can of course be different even under identical meteorological conditions.

All these data and factors draw attention to the fact that in glass house and outdoor experiments, in case of biological and micrometeorological test, beside the measurement of air temperature great attention must be paid to the exact determination of plant temperature since the difference of the two may in extreme cases attain even 10°C.

Realization of the examinations is rendered difficult by the fact that no uniformly accepted measuring instrument has evolved so far. The mercury thermometers of great extension are unserviceable for such measurements while none of the various electric thermometers — thermocouple, resistance thermometers, thermistores — became universally adopted so far.

According to MÄDE (1952) the accuracy of thermoelements may attain 0.1°C. The temperature values obtained can be recorded; HUBER (1937) has employed multicoloured recorders for this purpose. The greatest drawback of this measurement procedure is that it is very difficult — especially outdoor in the field — to keep the "cold ends" at constant temperature.

The accuracy of resistance thermometers is lower and they are only suited for measurement of larger organs, owing to their comparatively great extension; thus with the resistance thermometer of MÄDE (1939) only the mean temperature of the surface of leaves longer than 4 cm could be measured.

The advantageous properties of thermistores (small dimensions, higher susceptibility, etc.) lend themselves to the measurement of the temperature of plant surfaces. Their application makes it possible to carry out approximately simultaneous measurements, though the recording of data requires more complicated installations. The disadvantage of this device is that temperature can be established only by measurement of low amounts of electricity, since only a comparatively small amount of current can be released on the small sized thermistores without the hazard of self-heating (HÖHNE 1957).

Several research workers were dealing with the measurement of temperature at various plant species and varieties in Hungary. BERÉNYI and SZÁVA-KOVÁTS (1948) have found the temperature of the leaf of tobacco and soybean in the period of light irradiation 5—8 or 10 degrees higher than air temperature. MANNINGER, PLETSER and PUSZTAI (1960) examined the temperature of winter flax. ERDŐS, PLETSER and PUSZTAI (1959) measured plant temperature in frost protection and winter hardiness experiments. Conclusions drawn from the results of HUBER and MÄDE according to which the temperature of the plant is between that of soil surface and air — are not of general validity. RADNAI (1961) has measured the temperature of the tillering node in winter wheat. According to the data the daily fluctuation of temperature at the tillering node was following the soil temperature, its value still being some tenths of degree lower.

Relationship between the temperature of plant and its environment — as it appears from the few examples referred to — is not sufficiently elucidated so far. In our opinion a more thorough investigation of the question requires polyfactorial test series to be conducted for a longer period under various meteorological conditions.

Experimental Procedure

Investigations were conducted in one of the glass houses of the Department of Plant Genetics of the Agricultural Research Institute of the Hungarian Academy of Sciences in Martonvásár. The glass houses are facing North and South, their surface being 65 sq.m., their height 3 m. The heating system is hot water heating, the temperature of the introduced heating water being 30 to 35°C.

The plants examined were placed 1 m high in one row on the shelves of the glass house. Material of examinations was *Asparagus sprengeri* Rgl., *Coleus scutellarioides* (L.) Benth, *Dracaena indivisa* Rgl., and *Sansevieria hyacinthoides* (L.) Druce. The temperature of 10 individuals of each species was measured. Two of these *Dracaena indivisa* Rgl. and *Sansevieria* *hyacinthoides* (L.) Druce are ornamental leaf plants, *Asparagus sprengeri* Rgl. and *Coleus scutellarioides* (L.) Benth are stem plants. *Dracaena* has leaves with broad blades, the *Sansevieria*'s are succulent and the *Coleus* leaves are of soft tissue while *Asparagus* has phylloclodia. The surface of leaf blade of the plants is also different (waxy leaves, strongly thickened epidermis and leaves with tomentose hairs). Similarly the structure of the leaf tissue and the stems are different. On selecting the species we aimed at having the possibly greatest differences in the structure of plants in order to obtain information on the response of plants of different structure to the evenly changing temperature.

Plants of different species and ecological requirements, together with temperature values measured on various organs and their parts made it possible to demonstrate differences or agreement between plant and air temperature of the environment even within a daily space on plants of different ecological types. Measurements were carried out on 30—31 October 1963. According to the observations obtained from the meteorological station at Martonvásár belonging to the Agrometeorological Observatory of the Hungarian Meteorological Service the mean diurnal temperature was — on the above days — 7.4 and/or 9.0°C while the highest values of the air temperature 13.0 and 14.1°. At two metres height the air cooled down to 3.5° and the radiation minimum of the night was —3.2°. In the observation period the number of sunlit hours were 3; the sky was mostly covered by clouds of low and middle level,sunshine observed only at measurings taken at 1, 2 and 3 p.m. According to the air volume calendar of the Daily Weather Report of the Hungarian Meteorological Service, continental cool (ck) air masses prevailed on October 30—31 1963. The impact of the external atmospheric conditions was eliminated by the glass house so that the experiments were carried out under balanced conditions.

Determination of plant surface and air temperature was conducted with 4 TH—1.5 type thermistore manufactured by the Tungsram factory. The electric resistance of the thermistore was measured with the Wheatstone bridge zero shift method according to Czelnai (1957), Pletser—Pusztai (1959). Since the same thermistore was used in all experiments, we could avoid the error caused by correction of instruments which is difficult to eliminate when several gauges are used and besides, measurement itself could be accomplished more rapidly. Two observators could carry out the determination of 80 temperature values in about 5 minutes so that the data can be considered as nearly simultaneous.

Measurements were taken every hour. In every full hour the temperature at a height of 5 cm from the soil surface was determined on the stem of *Asparagus sprengeri* Rgl. and *Coleus scutellarioides* (L.) Benth and on the leaves of *Dracaena indivisa* Rgl. and *Sansevieria hyacinthoides* (L.) Druce as well as air temperature at the same height at a distance of 5 cm from stem and/or leaf. Temperature was measured on the surface of plant organs because the pointed shape of the thermistore, i.e. the small extent of its perceptive part made it possible to measure the surface of plant organ reliably and without the destruction of its tissues. The measurements were conducted for 24 hours; the first measurement took place at 11 a.m. on October 30, 1963 while the last at 10 a.m. on October 31.

Results obtained from the measurements were evaluated by statistical methods. The value of $\bar{x}$, s and t, the mean, the standard deviation, the reliability of the difference between the two values were calculated, i.e. whether the difference between the two values is significant on the $P = 5$; $P = 1$; and $P = 0.1$ per cent probability level.

In the course of these experiments the following problems were examined:

1. On which organ of the plant is the variability of temperature values the lowest?
2. Is there a difference between temperature values measured on the plant organs and in the air?
3. Is the temperature of the individual plant organs identical or different?
4. What is the diurnal course of the temperature of plant surface and of the air?
5. Is there a difference between the plant and air temperature in the course of the day?

Results

This part of the examinations was conducted in a glass house — that is under comparatively balanced conditions as to temperature — eliminating hereby the action of other environmental factors which might — under field conditions — have modified experimental results.

1. Variability of the temperature values measured on plant organs.

In the course of experiments the first problem to be examined was the variability of temperature value measured on various organs of the plant. Measurements were conducted on *Coleus scutellarioides* (L.) Benth. Temperature on the surface of the organs referred to was determined on blade surface and back side of the young leaf, on blade surface and back side of the aged one and on the stem. Examinations have been invariably conducted on plants of the same age and leaves of the same developmental stage. In the Table the values of $\bar{x}$, s, $s_{\bar{x}}$ and CV were indicated for the plant organs and

Table 1

Variability of temperature values measured on various organs of the plant
(Coleus; $n = 10$; 10 o'clock a. m.)

Serial number	Places of measurement	$\bar{x}$	s	$s_{\bar{x}}$	CV
1.	Surface of young leaf	29.99	0.40	0.12	1.33
	Air	30.05	0.37	0.09	1.23
2.	Back side of young leaf	29.96	0.47	0.14	1.56
	Air	30.03	0.21	0.06	0.69
3.	Surface of old leaf	30.11	0.36	0.11	1.19
	Air	30.08	0.66	0.20	2.19
4.	Back side of old leaf	30.13	0.36	0.11	1.19
	Air	30.11	0.65	0.20	2.15
5.	Stem of plant	29.12	0.20	0.06	0.69
	Air	29.58	0.22	0.07	0.74

the air temperature. From the data of this Table it can be established that the lowest variability is found in temperature measured on the stem of the plant while the highest on the back side of the young leaf. Temperature fluctuation of the young leaf seems to be wider than that of the old one. In the aged leaf no difference was found between the temperature fluctuation on surface and back side of the leaf while in the case of young leaves the back side of the leaf blade exhibits more significant fluctuations of temperature than the leaf surface. The first phenomenon, i.e. that the temperature fluctuation of the young leaf is more significant, may be brought in connection with the more intensive metabolism and change of the developing and growing leaves. The latter, i.e. the fluctuation of temperature being more apparent on the back side of the young leaf than on the leaf surface, can be interpreted by higher amount of stomata on the back side or it may as well be caused, by fluctuation of evaporation as a consequence of the operation — opening and closing — of the stomata. The least fluctuation of temperature is found on the stem of the plant which can be explained by partial absence in the primary cortex of metabolic processes as related to the leaf and — besides — by the lower number of stomata as related to the unit area in the primary epidermis tissue of the shoot. It should be noted as an interesting phenomenon that the fluctuation of air temperature measured beside the various organs changes according to the organs, i.e. the fluctuation of the temperature measured this way is not identical. It can be explained by several assumptions but a number of complementary examinations are needed to elucidate the question.

Table 2

Development of t values calculated between the values measured on the plant organs and in the air

(Coleus; $n = 10$; 10 o'clock a. m.)

Serial number	Places of measurement	Calculated t value	Is the difference significant at the 5% probability level	1%	0.1%
1.	Surface of young leaf .... Air	0.468	—	—	—
2.	Back side of young leaf .... Air	0.423	—	—	—
3.	Surface of old leaf .... Air	0.223	—	—	—
4.	Back side of old leaf .... Air	0.156	—	—	—
5.	Stem of plant .... Air	0.512	—	—	—

2. The development of the difference measured on the individual plant organs and on the air.

The second part of our experiments was focussed on the problem whether a significant difference could be found between the temperature values measured on the various organs and the air temperatures measured beside them at a distance of 5 cm. Table 2 presents the development of the t value between surface and back side of young leaf, surface and back side of old leaf, plant stem and air temperature. As it can be established from the data of the Table no significant difference can be found between the individual plant organs and the air temperature measured at a distance of 5 cm from the organs at the $P = 5$, $P = 1$ and $P = 0.1$ per cent probability levels, since the calculated t values are lower than the t values of the Table (0.700; 1.812; 3.169). So the examinations point out that the temperature of the plant at the date of the examinations did not differ from the air temperature measured at 5 cm from the plant, i.e. the temperature measured on the surface of the plant organs is identical with the air temperature of the environment.

3. The development of temperature values measured at the surface of the individual plant organs.

In the third part of our experiments it was examined whether a significant difference could be found among the temperature values measured on the surface of plant organs. Putting it in another way, the question is whether at a given air temperature the various organs of the plant are of identical or different temperature. The results of these examinations are seen in Table 3. According to these results none of the four combinations between the young and aged leaf, the surface and back side of the leaf blade exhibits a significant difference at the $P = 5$; $P = 1$; and $P = 0.1$ per cent probability levels, that is, the temperature of the organs of identical physiological function is — at a given air temperature — identical. If on the other hand the temperature values measured on the stem surface are compared with that on surface and back side of the young leaf, as well as on surface and back side of the old leaf, it is found that a significant difference exists between the temperature of stem

Table 3

Development of values calculated between the temperature values measured on various organs of the plant

(Coleus; $n = 10$; 10 o'clock a. m.)

Serial number	Places of measurement	Calculated t value	Is the difference significant at the		
			5%	1%	0.1%
1.	Surface of young leaf .... Back side of young leaf	0.133	—	—	—
2.	Surface of old leaf .... Back side of old leaf	0.111	—	—	—
3.	Surface of old leaf .... Surface of young leaf	0.735	—	—	—
4.	Back side of old leaf .... Back side of young leaf	1.914	—	—	—
5.	Stem of plant .... Surface of young leaf	6.244	+	+	+
6.	Stem of plant .... Surface of old leaf	7.871	+	+	+
7.	Stem of plant .... Back side of young leaf	5.195	+	+	+
8.	Stem of plant .... Back side of old leaf	8.028	+	+	+

and leaf of the plant at the P = 5; P = 1 and P = 0.1 per cent probability levels. Thus it may be stated that the surface temperature of organs both with different age and developmental stage still with identical physiological function is also identical, while the temperature of the organ surface of different physiological function is different, should their age be the same. It can be also surmised that the leaf in a transverse position gets more intensively warmed up than the stem of vertical position the latter being mostly in shadow and parallel to the direction of convection.

4. Diurnal march of the temperature of plant surface and air.

Also the problem has been examined whether in case of changing air temperature, the temperature of the plant surface follows this change. Such measurements were conducted 24 times in each hour, so that a possibility was obtained to examine also the development of temperature of the day. Measurements were conducted — at 5 cm from the soil surface — on the stem of *Asparagus sprengeri* Rgl. and *Coleus scutellarioides* (L.) Benth. and on the lowest foliage leaf of *Dracaena indivisa* Rgl. and *Sansevieria hyacinthoides* (L.) Druce. Also the temperature of the air was determined at the same height, at 5 cm from the plant. The results of these measurements are presented in Fig. 1. On the ordinate the temperature values while on the abscissa the date of measurements are seen.

Examining the march of trend of temperature from Fig. 1 it can be seen that the course of the curves of the temperature of air and plant surface is nearly identical in the case of the four plant species examined being measured both on the leaf and on the stem. In all four plants as well as in the surrounding air the highest temperature was measured at the same time (14 h) — when the sun was shining — similarly was measured the lowest temperature (19 h).

The fluctuation of temperature — the difference between maximum and minimum — was higher on the surface of all four plants than in the air. The greatest diurnal fluctuation was observed in the temperature measured on the stem of *Coleus scutellarioides* (L.) Benth. (9.5 degrees) and the smallest in that measured on the stem of *Asparagus sprengeri* Rgl. (8.8 degrees). The diurnal fluctuation of air temperature was highest near *Dracaena indivisa* Rgl. (8.8 degrees), the lowest near *Coleus scutellarioides* (L.) Benth. (8.5 degrees). In this — beside a number of other factors — also the direction of the metabolic processes and the measure of evaporation may be substantially involved. It is interesting to note that on the organs in which intensive metabolic procedures are conducted (leaf) the temperature measured at the surface closely follows the march of air temperature; while in the organs where metabolic processes are less significant (stem) the march of the two curves shows a more important deviation.

5. Development of the difference between the temperature of the plant and of the air in the course of the day.

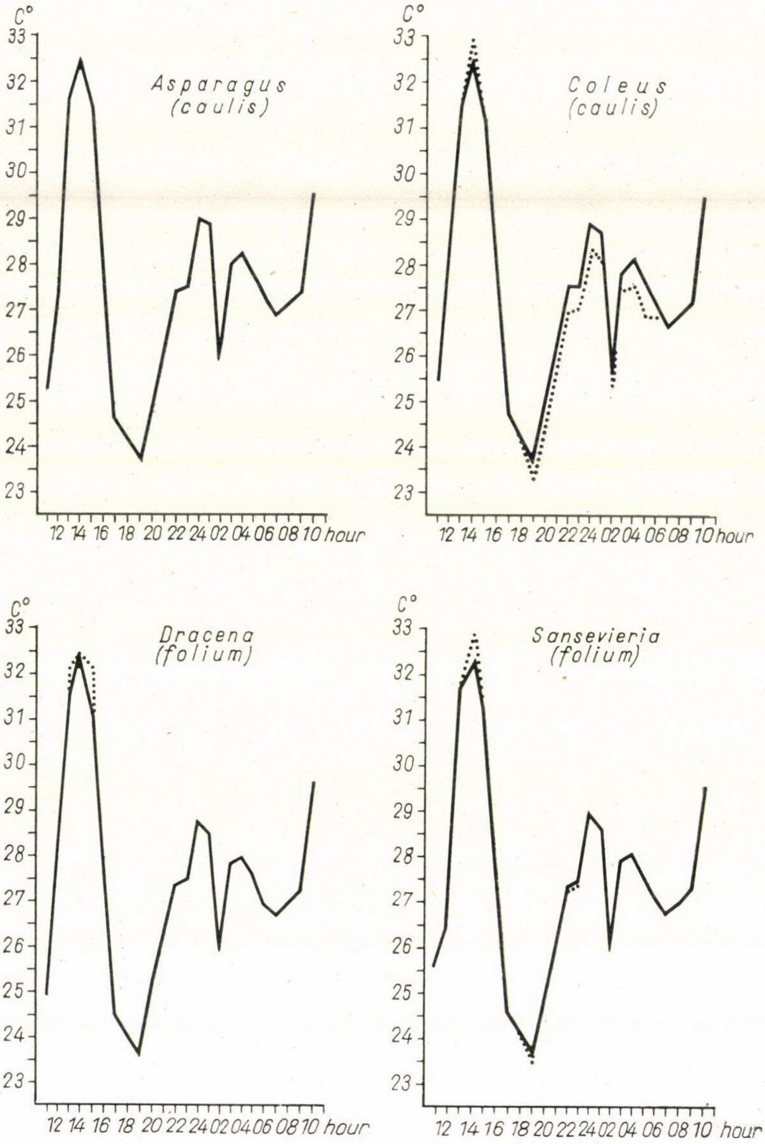

Fig. 1. Development of the temperature of the plant and of the air at a distance of 5 cm in the course of a day (24 hours)

——— air temperature ...... temperature of plant surface

In the last part of our investigations the question was examined whether there were such moments during one day when a significant difference was found between the temperature measured at the surface of the plant and air temperature. For evaluation the data on temperature of plant surface from Fig. 1 and on air temperature were utilized. In the case of all four plant species measured every hour the index of the reliability of the difference between the two values — temperature of plant surface and air temperature — the t value was calculated on the $P = 5$; $P = 1$ and $P = 0.1$ per cent probability levels. The yes or no indications of the values thus obtained are seen in Table 4. The temperature of the stem of *Coleus scutellarioides* (L.) Benth at 12 h, on the $P = 5$ per cent probability level is significantly lower than the

Table 4

The development of the difference between the temperature of plant and air in the course of one day

October 30—31 1963

Date of measurement	Coleus			Asparagus			Dracaena			Sansevieria		
	Is the difference between the temperature of plant and air significant?											
	at the probability level of											
	5%	1%	0.1%	5%	1%	0.1%	5%	1%	0.1%	5%	1%	0.1%
October 30.												
11 o'clock	—	—	—	—	—	—	—	—	—	+	+	—
12 ,,	+	—	—	—	—	—	—	—	—	—	—	—
13 ,,	—	—	—	—	—	—	+	—	—	—	—	—
14 ,,	+	—	—	—	—	—	+	+	—	+	—	—
15 ,,	—	—	—	—	—	—	+	—	—	—	—	—
16 ,,	—	—	—	—	—	—	—	—	—	+	+	—
17 ,,	—	—	—	—	—	—	—	—	—	—	—	—
18 ,,	+	+	—	—	—	—	—	—	—	+	—	—
19 ,,	+	+	—	—	—	—	—	—	—	—	—	—
20 ,,	+	+	+	—	—	—	—	—	—	—	—	—
21 ,,	+	+	+	—	—	—	—	—	—	+	—	—
22 ,,	+	+	+	—	—	—	—	—	—	—	—	—
23 ,,	+	+	—	—	—	—	—	—	—	—	—	—
24 ,,	+	+	+	—	—	—	—	—	—	—	—	—
October 31.												
1 o'clock	+	+	+	—	—	—	—	—	—	—	—	—
2 ,,	+	—	—	—	—	—	—	—	—	—	—	—
3 ,,	+	—	—	—	—	—	—	—	—	—	—	—
4 ,,	+	+	—	—	—	—	—	—	—	—	—	—
5 ,,	+	+	—	—	—	—	—	—	—	—	—	—
6 ,,	+	—	—	—	—	—	—	—	—	—	—	—
7 ,,	—	—	—	—	—	—	—	—	—	—	—	—
8 ,,	+	—	—	—	—	—	—	—	—	—	—	—
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	+	—	—

air temperature; it is higher at 14 h and again lower than the air temperature between 18 and 8 h in the morning. It should be noted that between 18 and 01 h the plant temperature is significantly lower than the air temperature also at the P = 1 per cent probability level.

On the stem of *Asparagus sprengeri* Rgl. in the course of a day not a single moment was found when a significant difference existed between the temperature of the plant and the air temperature, not even at the P = 5 per cent probability level.

On the leaves of *Dracaena indivisa* Rgl. in the period between 13 and 15 h a difference was found at the P = 5 and P = 1 per cent probability level, when the temperature of the plant was higher than that of the air of the environment. On the leaves of *Sansevieria hyacinthoides* (L.) Druce at 10, 11, 14 and 16 h the temperature of the plant was higher at the P = 5 per cent probability level than the air temperature, while between 18 and 21 h it was lower.

Upon inspection of Fig. 1, Table 4 and the above considerations a conclusion may be ventured i.e. when the air temperature rises the temperature of the plant increases to a greater extent than the air temperature. When again the air temperature diminishes, the temperature of the plant falls to a greater extent than the air temperature. This may be interpreted by the fact that in the course of irradiation the plant body, similarly to the soil absorbs the heat-rays then transmits them to the surrounding air. Once cooling down started the plant, arising from its general habit, grows strongly and more rapidly cooler than the environing air.

Conclusion

The lowest fluctuation of temperature is found on the stem of the plant while the greatest on the back side of the young leaf. The temperature fluctuation of the young leaf is more definite than that of the old one. On the old leaf no difference is found between the temperature fluctuation on surface and back side of the leaf blade; in the case of young leaves the back side of the leaf blade exhibits a greater fluctuation of temperature than the surface. The more definite temperature fluctuation of young leaf can be brought in connection with an intensive metabolism and its change in the developing and growing organs. The greater fluctuation of temperature on back side of the young leaf may be explained with the higher number of stomata on back side. The lowest temperature fluctuation on plant stem is caused by the partial absence of the metabolic processes in the primary cortex.

The temperature of the plant, in the moment of our examinations and in the case of the examined plant species and their organs did not significantly differ from the air temperature measured at a distance of 5 cm from the plant. Thus, temperature measured at the surface of the plant organs is identical with the temperature of the environment. The temperature at the surface of organs of different age and developmental stage but identical physiological function is identical, while the temperature at the surface of organs of different physiological functions differs from each other.

The diurnal march of temperature measured both on leaf and stem of the plant and compared with air temperature is almost identical in the case of the four plant species examined which means that the temperature of plant surface follows the march of temperature of the environment. The examinations also allow the conclusion that when air temperature rises the temperature of the plant increases — too — to a greater extent than the air temperature. When the air temperature diminishes the temperature of the plant falls to a greater extent than the air temperature.

*

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SELECTION OF FOUNDATION MATERIAL FOR THE PRODUCTION OF TETRAPLOID RED CLOVER

(PRELIMINARY COMMUNICATION)

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In 1952—53 at Táplánszentkereszt (Western-Hungary) 67 red clover varieties and local (land) races had been tested with the purpose of utilizing varieties with good properties in the production of tetraploid forms. On the strength of these examinations 27 varieties were chosen which had been found to be outstanding for some character or other. The two varieties which seemed to be best of all were crossed in 1953 and the F_1 generation treated with colchicin. Treatment of all 28 lots was carried out in January 1954. The tetraploid material was increased and selected in succession at Tápiószele, a station of dry lowland climate (50 year average of precipitation 551 mm) and at Táplánszentkereszt which is more abundant in rain (700 mm).

Progeny tests have revealed higher productivity of tetraploid deriving from the cross of the two good diploid varieties (F_1 generation) than was found in the tetraploid progeny of the parents and in the tetraploid mixture originating from 28 lots.

Introduction

The certified Hungarian red clover varieties (Táplánszentkereszti and Fertődi) are, in proper surroundings and with suitable farm technology, capable of high yields, but in the national variety trials the examinations of Taróczi (1955) and later of Kelemen (1962) verified that they did not significantly exceed the best land races. This is not a special phenomenon restricted to Hungary, for several research workers in various parts of Europe have stated that the improved red clover varieties are superior only in relation to some characters (resistance, seed production capacity) to land races grown in their own regions (Lisicin 1951, Wolffhardt 1959, Nüesch 1960, Bingefors and Åkerberg 1961, Lehman 1961, etc.).

A new possibility was involved in breeding red clover by the production of tetraploid forms. First of all Swedish (U. Julén 1950, G. Julén 1954. 1959 etc.), Danish (Frandsen 1948), Finnish (Valle 1961) later German (Schweiger 1957) and Polish (Laczinska-Hulewiczowa 1957, 1958 and 1960) breeders have produced, with colchicine treatment, tetraploid red clover varieties. As a result of attempts having been conducted for more than 20 years in various countries several tetraploid red clover varieties are at present known *(Rea, TPA, Groß-Lüsewitz 551, Weitetra,* etc.) which are in their own country capable to produce 10 to 25 per cent higher green mass and hay yield than the diploids while their resistance, mainly to fungus diseases, is higher, too, but their seed setting capacity is generally poor, not attaining even 60 to 70 per cent of the seed growing capacity of the diploid varieties and, consequently their seed has not been up to now available in considerable quantities.

Different reasons are advanced by research workers to explain the low seed-setting capacity of tetraploid red clover varieties. Opinions generally agree in that the longer corolla tubes of tetraploid offsprings (corolla tube of diploid red clover 7—9 mm, of tetraploids 10—11 mm) must cause difficulties in fertilization by making it difficult for the bees to carry out pollination; in fertilizing tetraploids frequent troubles of the meiosis arise and an early death of the embryo may also occur; according to several workers the tetra forms are liable to a higher grade of selfing which leads after a few generations to depression (?) by inbreeding apparent also in disturbances of fertilization.

The seed-producing capacity of the Hungarian bred tetraploid red clover variety is capable of equalling, upon the effect of alternating selection conducted under different ecological conditions the seed-setting capacity of diploids (JÁNOSSY 1962, 1963, 1963, 1963).

The tetraploid red clover varieties produced in the European countries referred to are late or midlate types and mostly of a single cut. They do not stand the test under Hungarian conditions.

In order to improve red clover growing in Hungary it is desirable to produce an early productive variety of several cuts and of intensive type which reliably yields more than the diploids. This could be expected from tetraploid forms since no notable results had been obtained with the new diploid varieties for a couple of years. The objective of this research work was to clarify the choice of the fundamental material and the methods of selection. In this preliminary communication an account is given of examinations conducted with tetraploid red clover lines originating from different fundamental materials.

Selection of Experimental Material, Methods

In 1952—53 at the variety experiment station of Táplánszentkereszt 67 red clover varieties and progenies were examined. Distribution of origin and types of varieties were as follows:

	Early type	Late type
Hungarian local (land) races	53	
Hungarian improved varieties	2	
GDR varieties	1	1
GFR varieties		2
Swedish varieties		3
Northern French variety		1
Austrian variety		2 (mid-late)
Roumanian (Transylvanian) var.	1	
CSR (Slovakian) variety	1	
Total	58	9

The Hungarian land races were collected in 1950–51 from the following localities:

Őrség district	22	local	varieties
Plains in the eastern part of Vas county	7	,,	,,
Hilly country of Zala county (Göcsej)	10	,,	,,
Hanság district	1	,,	,,
Mezőség district (Veszprém)	1	,,	,,
Bakonyalja district	2	,,	,,
Somogy county	1	,,	,,
Szatmár county	4	,,	,,
Nógrád-Heves county	5	,,	,,

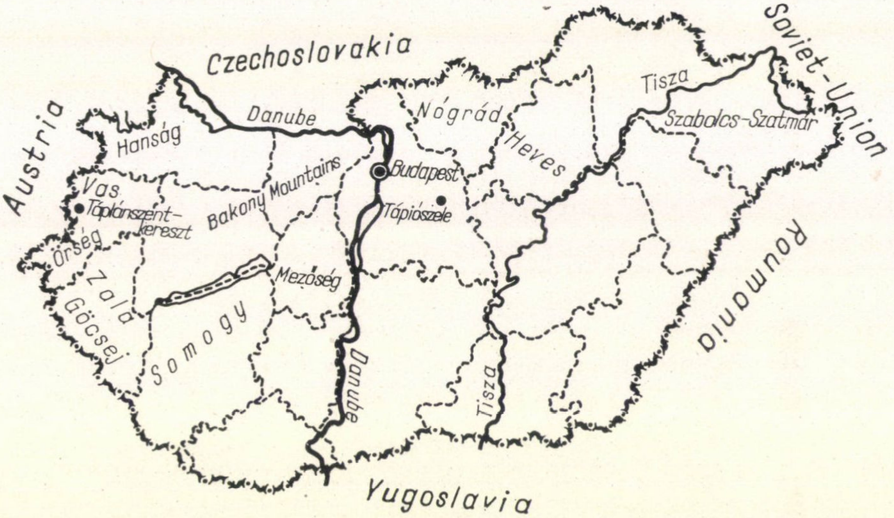

Fig. 1. Regions of Hungarian land races of red clover collected in 1950–51

Varieties had been examined in one series, on 2.4 sq.m. experimental plots during 2 years for the following characters:

Foliage to stem ratio
Number of cuts in each year
Plant height
Early or late type
Winter hardiness

Unfortunately there was no technical possibility to examine the resistance to diseases, and natural infection in the two experimental years was represented only by a slight mildew incidence which could not afford the occasion to establish significant differences.

According to the viewpoints referred to, the varieties showing best results were the following (Jánossy, 1962)

Local varieties of Őrség and other districts in Vas county (10 lots)
Local varieties of Zala county (4 lots)
Local varieties of Szatmár county (4 lots)
Transylvanian red clover (Roumania)
Local variety Véglesi (Slovakia)
Lembkes (GFR)
Ostsaat (GDR)
Northern French
Fertődi
Táplánszentkereszti

Thus the above 27 lots and the first generation of Táplánszentkereszti × Lembkes cross conducted in 1953 served as fundamental material of the tetraploid red clover.

Out of the original seed of every lot 25 individual plants were raised in 5 pots (5 plants in 1 pot). Treatment began in the three-leaf age of the plants. A smal plug of cotton-wool was placed on the growing point and 1% aqueous colchicine solution poured on in drops. After the first treatment a break of two days was inserted and then another treatment given with 1 per cent solution; subsequently the plants were treated every second day with a 0.1 per cent solution for 50 days (2×25 treatments).

50 seeds from each lot were soaked in water for 24 hours and then placed in 0.2 per cent colchicine solution for 24 hours.

Treatments were carried out in January 1954.

As a result of treatments on the growing point on 51 plants — from a total of 700 ones — inflorescences with tetraploid chromosome complement were found.

50×28 = 1400 seeds were treated with soaking. On the action of this treatment 424 normal plants developed while the other seeds or seedlings were destroyed or developed malformed or distorted plants.

The total of 475 plants obtained by the two patterns of treatment were planted out in breeding garden and from these 405 plants which had proved to be tetraploid yielded a total amount of 47.5 g of seed in September 1954 (C_0 generation).

Tetraploid lines originating from the following three fundamental materials have been propagated under isolation:

Part of the polyploid plants originating from the improved variety Táplánszentkereszti

From the 1953 cross Táplánszentkereszti × Lembkes and

Variety Lembkes (GFR).

The rest of the seed was mixed and propagated on microplots with narrow drills in Tápiószele under dry conditions of the lowlands, on calcareous garden loam of good quality, and concurrently in Táplánszentkereszt. In each year, including the year of planting, seed was obtained and sown next year on the other station (seed harvested in Tápiószele was sown in Táplánszentkereszt and vice versa). Thus the following generations were available:

Table 1

Propagation pattern of the tetraploid red clover progenies
Tápiószele—Táplánszentkereszt 1954—1958

Year	Generations			
	Seeding	Standing vegetation of last year	Seed yield	
			from last year's seeding	from new seeding
1954	C_0	—	—	C_1
1955	C_1	C_0	C_1	C_2
1956	C_2	C_1	C_2	C_3
1957	C_3	C_2	C_3	C_4
1958	C_4	C_3	C_4	C_5

The above 3 progenies lifted out had been propagated until 1958 ($C_3 + C_4$) only at Tápiószele, in microplots, with irrigation in case of drought. First selection was carried out in Tápiószele 1957, in Táplánszentkereszt 1958 on plots of 60×20 cm spacing. In the course of selection plants showing

early flowering,
rapidly tillering,
developing many stems,
developing many leaves,
less susceptible to virus and fungus incidence,
good yielders of seed — were marked. Only these marked plants were allowed to pollinate.

To test the seed-producing capacity, examinations were conducted on flowering biology, while after fertilization cytological examinations were carried out.

The plants selected in 1957 at Tápiószele were sown at Táplánszentkereszt on plots with narrow drills and here seed was collected no sooner than in 1959. The seed obtained from the plants selected at Táplánszentkereszt in 1958 were planted in a 60×60 cm spacing for propagation and further selection at Tápiószele in 1959.

The same year the comparative productivity of the progenies lifted out was also tested, while in 1962—63 the productivity of "Tápiói poly" originating from the mixture of 28 varieties and in 1964 the performance of Tápiói poly and of the tetraploids originating from the cross were examined.

Since 1959 propagation of the best lines has been conducted alternately on the two stations of contrasting climate in order to utilize positively the selective action of the climate mainly on fertilization and development of the seed.

Results

On the way to our aim we considered it primarily important to decide whether the fundamental material had been properly chosen. Hence a progeny test was conducted with a material in the early C_3 generation. Owing to technical difficulties only the tetraploid progeny generation of two outstanding diploid varieties (Táplánszentkereszti and Lembkes) and of their preliminary crosses was propagated under isolation. The rest of tetraploid progenies were first mixed up then propagated and selected.

Both on account of the necessary reserve and of the further seed propagated for selection at two stations as well as of the young generation, a very little amount of seed could be used for experimental purposes and therefore, from C_3 generation seed obtained in 1957 (second year's yield of the C_2 generation planted in 1956) microplots of 10 plants each were sown in 20×20 cm spacing in 4 series. Crosses were conducted in 1956 between the line poly 51 of the variety Táplánszentkereszti and the line poly 27 of the variety Lembkes. In the experiment there were included the original diploid variety Tápláni as a standard (lot 1 in Table 2), the tetra line originating from this diploid variety (2), the tetra line originating from the variety *Lembkes* (3), the tetra line originating from the preliminary cross of the two diploid varieties (4), the tetra mixture originating from the 29 starting varieties (5) and the cross between the tetra line from Tápláni and the tetra line from *Lembkes* (6). No more original seed was available from the variety *Lembkes*. Results of this experiment are presented in Table 2.

Hay and protein yield of Tápiói poly available in larger quantities were compared in 1962—63 with the Hungarian diploid varieties and the *Weitetra* (GFR) red clover (4 series, 20 sq. m plots).

Out of the experiment sown in 1964 only one year's data from Tápiószele have been available so far. In this experiment it has been first examined whether the line Tápláni poly 120 originating from the cross maintains its superiority to the Tápiói poly mixture as it has already been established above

Table 2

Green yield in the C_3 generation of tetraploid red clovers of various origin
Táplánszentkereszt 1958—59 10 plants/plot; 4 series

Treatment	Green yield per plot					
	1958) (1 cut)		1959 cuts kg		1958—59 total	Proportional number %
1. Táplánszentkereszti* (diploid)	2.9	±0.24	7.4	±0.79	10.3	100
2. T. poly 51 (from diploid Tápláni)	4.1	±0.53	11.2	±1.75	15.3	148
3. T. poly 27 (from Lembkes)	4.3	±0.66	11.7	±0.90	16.0	156
4. T. poly 120 (from Tápláni × Lembkes diploid)	5.2	±0.54	16.8	±1.90	22.0	213
5. Poly mixture	3.9	±0.64	15.3	±1.57	19.2	186
6. T. poly 51 × T. poly 27	4.3	±0.45	14.8	±1.56	19.1	185

* Synonym: Tápláni

Table 3

Red clover variety trial
Tápiószele, 1962—63.

Variety	1962		1963				Combined table	
			I. Cut		II. Cut			
	Hay	raw protein	hay	raw prot.	hay	raw prot.	hay	raw prot.
	q/ha							
Tápláni	49.38	7.40	55.57	7.75	26.31	4.08	131.27	19.25
Fertődi	47.89	7.49	48.22	7.11	27.99	4.34	124.11	18.94
Tápiói poly	56.16	8.25	57.01	8.13	27.28	4.21	140.48	20.59
Weitetra	51.18	8.39	34.88	5.91	31.31	5.13	117.38	19.44
$GD_5\%$	6.08	—	11.62	1.68	3.70	0.56	5.42	—
$GD_1\%$	8.76	—	16.72	2.43	5.33	0.80	7.26	—
$GD_{0.1}\%$	12.88	—	24.59	3.56	7.84	1.18	9.59	—
M	51.14	7.89	48.93	7.23	28.22	4.43	128.31	19.55
F test	10%	10%	1%	10%	10%	1%	0.01%	10%

in the C_3 generation. The 1964 experiment is set up in 4 replications on 20 sq. m. plots with 8 varieties.

The first year's data reveal that line No. 120 originating from colchicine treatment of preliminary cross of well selected pairs of parents having yielded, in C_3 generation (Table 2), 27 per cent more than Tápiói poly originating from "mixed" material proved to be, even in the C_8 generation planted in

Table 4

Combined table of variance
Red clover, Tápiószele, 1962–3
hay q/ha

Factor	FG	SK	MQ
Total	47	4288.13	
Replication	3	35.88	11.96
Variety	3	225.48	75.16
Cut	2	2943.04	147.15
Repl. × Variety	9	86.94	9.66

Table 5

Red clover experiment 1 year
Tápiószele, 1964.

Variety	1. Cut	2. Cut	Total	Proportional number %
	green yield q/ha			
1. Tápláni poly 120	174.99	219.30	394.28	118.5
2. Tápiói poly	163.86	191.49	372.04	111.8
3. Fertődi	174.29	172.03	355.36	106.8
4. TPA poly (Finland)	134.32	197.75	324.25	97.4
5. Táplánszentkereszti	144.75	179.50	315.39	94.8
6. Red clover "G" (Szarvas)	143.36	171.68	309.66	93.1
7. Szkrezowicka (Poland)	137.97	161.95	300.10	90.2
8. Tammisto (Finland)	128.76	165.78	290.72	87.4
M.	150.28	182.41	332.72	100.0
GD. p. 5%				4.3

1964 (Table 5), of significantly higher productivity by 6.7 per cent. Thus the choice of the fundamental material, the realization of the cross and its utilization have constituted a correct method.

According to 2 year's experiments Tápiói poly originating from the great population mixture supplies a significantly higher hay yield than the Hungarian diploid varieties and the West-German tetraploid red clover *Weitetra* of Swedish origin. No significant difference was found in protein yield.

The results of the microexperiment performed in 1958/59 and those of the 1964 test cannot justify to draw definite conslusions. – However, the similar trend of these two experiments results supports the following assumption.

The choice of the great starting material after preliminary evaluation was the right thing to do because the tetra lines originating from it exhibit already in the C_3 generation and without selection a higher productivity than the Hungarian improved diploid varieties.

Preliminary crossing of outstanding diploid varieties and colchicine treatment of the F_1 generation result in a tetraploid progeny of higher productivity than the tetraploid lines of the same varieties and the tetra mixture of the starting material or the crossing of varieties in tetraploid condition.

The yield of the C_3 generation is still very high after the colchicine treatment of the F_1 generation when compared with the mixed poly (Tápiói poly); with a surplus green yield of 27 per cent. In the C_8 generation the surplus yield of the tetra line originating from the cross is only 6.7 per cent as related to the same variety. Thus the effect in the C_3 shows a decreasing trend.

Examinations are under way to establish what methods of selection are suited to stabilize the "heterosis effect" in the young generation.

Conclusion

The improved red clover varieties are generally hardly better than the local (land) races. A new possibility of increasing productivity arises with the production of tetraploid forms which has been — in some foreign countries (Sweden, Denmark, Finland, Germany, Poland) — successfully conducted for several decades. The cultivated tetraploid red clover varieties exceed in hay yield the diploids by 20 to 25 per cent. The seed production capacity of the tetraploids is, however, low, and this is why they are rather slowly spreading in agriculture.

Experiments to produce Hungarian tetraploid red clover varieties of intensive type were started at Táplánszentkereszt (Western-Hungary) in 1954.

The starting material was selected on the basis of preliminary examinations carried out in 1952—53. A total of 27 varieties and land races and 1 F_1 population were treated with colchicin in 1954.

Cultivated tetraploid populations had been under propagation from 1955 to 1957 without selection. By collecting the seed every year, C_2, C_3 and C_4 generations had been obtained until 1957. The selection was begun in 1957 under dry conditions of the lowlands in Tápiószele. Alternately, one generation was propagated under dry lowland conditions and another under the rainy conditions of Western Hungary (Táplánszentkereszt).

The correct choice of the fundamental material was verified by the productivity examination of C_3 and C_8 generations. Productivity in tetraploid lines is better than that of the Hungarian diploid varieties. From tetraploid lines the line of cross origin has exceeded in C_3 generation by 27 per cent, in C_8 generation by 6.7 per cent green yield the poly line originating from the mixture of 28 varieties.

On the strength of experiments it may be assumed that for the production of tetraploid red clover it would be mostly advisable to select the fundamental material according to the following viewpoints.

Ample starting populations have to be dealt with, i. e. a number of diploid varieties with rich yield are to be selected.

Preliminary crossing of selected diploids and polyploidization of the F_1 generation produce tetraploid progenies of better productivity than the tetraploid progeny of these varieties.

The "heterosis effect" exhibits a diminishing trend.

Examinations are under way to find out what methods of selection are suited for the stabilization of productivity found in the young (C_3—C_4) generations.

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REPARATIVE REGENERATION OF OATS (AVENA SATIVA L.)

By

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We have studied the reparative regeneration of oats for 12 years. The aim of our experiment was to compel oats to perform reparative regeneration i.e. to obtain, after cutting back, productive ears of the sprouts which would mature simultaneously.

Introduction

It has been observed for long time past that when mowing grain crops for fodder, on the vigorous stubs shoots will develop that, in some cases, grow ripe. The idea was suggested to utilize, in some way, this chance granted by nature in such a manner that from year to year, by single selection, high regenerative individual plants should be selected having a number of sprouts being in agreement with or exceeding that of the parents. Certain oat varieties are of high regenerative capacity especially in the early stage of ontogeny. Several varieties are known in France, in England, in U.S.A. and California as being suitable for grazing purposes and, besides, they are to yield grain, too (Coffman 1961). Our target agrees with the above only in part since we do not deal with the I—IV stages (Kuperman 1962) apt for pasture and organ formation, but with the IX, X, XI stages of the plant corresponding to the zygote genesis and karpogenesis stages. Then it occurs, that the ready, developed plant reproduces itself from its parts left behind.

Material and Methods

We have chosen oat as material of our experiment because it is strictly self-fertilizing, in most cases it becomes fertile as early as in the "belly", and allogamy meets with difficulties even when brought about artificially; therefore, breeding is also performed by way of single selection. Weather factors and soil conditions have influence on the work of selection and, for this reason, sowing has been done in newly manured soil every year. On cutting back it was irrigated, but once. Oats are considered mature when the straw is yellow and the grain slightly soft.

In August 1951 we gathered in the first ripe ears from a field that had been cut back for forage purposes, and in the next year on March 31, same were planted. At flowering time the plants were cut back at 5—8 cm. The average height of oat plants was then 102 cm; they were cut back on the 73rd day reckoned from sowing. Our variety corresponds to the medium-high category group determined by STRAMTON (1961), the height of which is 90—120 cm. Oats being first cut will be called hereinafter crop I, while the re-sprouting ears will be referred to as crop II. On the 47th day following cutting, further matured shooting ears could be gathered. The two growth seasons were 73 + 47 = 120 days. From our first-year experiment one individual plant was the only basis of our further experiments. For control we use the progenies of ears that had not been cut back, these having a maturity time of 103 days. This process had been continued up to 1957, throughout 6 growth seasons. In 1958 20 per cent of the experimental plants were allowed to reach the waxen ripeness, and the first crop was cut no sooner than that. This time, our second crop was of less height than that with the plants cut back during flowering (48 cm), however, we obtained well-developed sprout-ears with germinative grans. The ripening of the control ensued on the 110th day.

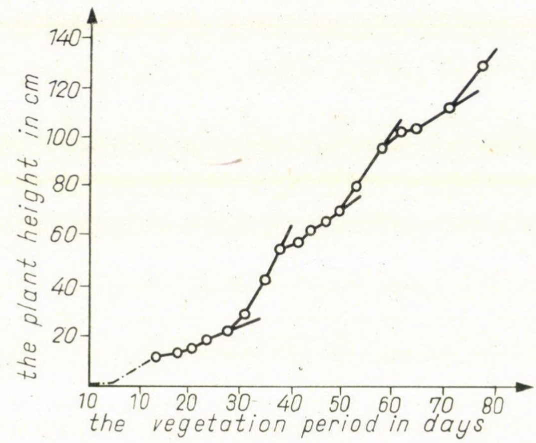

Fig. 1. The growing rate of oat

In the year 1959 the seeds of the two groups, i.e. the progenies of the plants cut back at flowering and at the waxen ripeness were sown simultaneously. Up to the time of flowering no difference whatsoever could be noticed between the two groups. Growth-rate was the same in both groups. In this year the time of cutting back was fixed near the time of full ripening and thus, the first yield was harvested on July 24 (on the 106th day), while the harvesting of the second crop occurred on September 5 (on the 43rd day). Growth season of the first and second crop was 106 + 43 = 149 days. The second crop was not uniform because there still were found young sprouts 3 weeks after harvest.

In 1960 we performed measurings on the progenies of the firts crop concerning growth-rate. The results thus obtained are shown in Fig. 1. In Fig. 1 we see the regular growth-rate curve. According to SABININ (1963) as well as proved by our investigations, sprouts are declining if not cease growing on the 77th day from planting. In this year the material of the experiment was being cut back periodically from the time of flowering (71 day), and the second crop was harvested at a fixed date (September 4).

The values thus obtained are shown in Table 1. In Table 1 we have also indicated the period available for the development of the second crop from the cut-back up to harvesting. The sprouts of the second crops produced in the first week, have ripened, in the course of the experiments carried out so far, within 43—47 days. Therefore, in our this year's experiments the time-interval between the last cutting date up to harvesting, i.e. 47 days, was sufficient for the formation of the second crop. The total growth period of the first and second crop was 147 days, and that of the control not being cut back, was, however, 108 days which means that ripening of our last crop cut back was almost identical with that of the control.

It can be seen from Table 1 that the cut-back has been performed for 24 days. From the 92nd day of the growth season the second crop consisted of individual ears of sprouts only, and the majority of these remained in the "belly". On some plants, however, there could be found occasionally a few normally developed sprouts.

In the 1960 crop, similarly to the previous years, it could be established that bulk of the second yield was made up of sprouts developing in the course of the first week that followed

Table 1

Sowing date: 10th April, 1960

Day of cut-back	Number of days up to cut-back. Growth season of the crop I.	Growth season of the crop II. Number of days from cut-back to harvesting
June 25 appearance of the anther	76	71
27	78	69
29	80	67
July 1	82	65
3	84	63
5	86	61
7	88	59
9	90	57
11	92*	55
13	94	53
15	96	51
17	98	49
19	100	47

From the day on marked with (*) we have obtained single sprouts only, these being hardly able to get matured.

the cut-back, but not sooner than this cut-back had been carried out up to the 90th day of the vegetative period. On the other hand, our supposition, viz. that if the first shoots are cut back during the 76—91 days of the growth season, the number of sprout-ears is greater than in case we cut them back towards the end of the growth season — was not justified. Our experiments have proved that better sprouting capacity is not a result of the longer growth season but rather a peculiarity of individual plants. From the above-said it can be concluded that in the 76—91 days of the vegetative period, at the stage of karpogenesis, efficient selection can be achieved on oats, regarding sprouting capacity.

In 1961 we planted the seeds of the previous year's second crop. Data of the year 1961 proved that the first crop of the plots that had been planted simultaneously, showed uniform behaviour quite independently from the time of cut-back of the second crop. Neither did the progenies of germinative seeds gained from the second crop and having a vegetative period of 47 days, differ from the others. The first crop of the year 1961 reached an average height of 130 cm. In 1961 the first crop was harvested on the 83rd day, at the beginning of waxen ripeness, and the grain yield, too, displayed germinating power on this occasion. From the second crop — quite independently of their origin — five plants were selected for propagation having 6—10 sprout-ears and maturing at the same time. The vegetative period of the first and second crop was $83 + 47 = 130$ days, while that of the control was 109 days.

In the year 1962 out of 5 plants one was carried on: the one that, in 1960, had been cut back on the 82nd day of the growth season. The result of our work of selection was that vigour and regenerative power of the progenies have somewhat increased, from the second stand, however, only few plants could be gained that matured simultaneously.

Likewise, in 1963 we planted the progenies of one plant. The first yield was harvested on the 78th day of the growth season having the ears still in milky stage. Plant-height was then 138 cm, and the vegetative period of the second crop was 58 days. That of the control was 108 days, while the total vegetation period of the first and second crop amounted to $78 + 58 = 136$ days. On the day of cut-back the plots were irrigated to promote sprouting. Due to irrigation, the signs of sprouting could be noticed as early as on the third day, and on the seventh day the shooting sprouts were several cm long.

Results and Discussion

In our experiments we have been dealing with the producing of a second crop from the reparative regeneration capacity of oats. We have studied the process in the course of which, when cutting back the plant in the stage of zygote genesis and especially in that of karpogenesis, it could be established what the feasibilities were to develop, by way of selection, two productive oats from the second crop. In the course of our 12 year selection work it could be observed that, as a result of our work done so far, there were still some plants only, capable to produce a second crop maturing at the same time. The question remains: through how many generations of the present stand has selection to be performed to result in developing the two productive oats. From the results of our present investigations no answer is available to the question raised because the problem itself consists of two factors.

1. The lifetime of the stubs remaining back after the first crop has to be prolonged in such a way as to be apt to produce a so-called second crop.

2. The prolongation of the lifetime requires a change in several properties of the experimental plant, and the developing of new hereditary properties.

The first factor is in connection with the cyclic ageing theory described by KRENKE (1950) viz. that the plant cut back in the given stage of development will start a new ontogenetic period on the old existing bases. While the young plant is capable of this performance without any difficulty (see the varieties suitable for grazing purposes), at the later phase of ontogenesis and especially at that of karpogenesis — as it can be seen from the experiments — there exist very strong limits to this.

However, there are always stubs that acquire these properties, but in the progenies this property doesn't remain constant; in the following generation there will only be a few stubs again having these properties.

From a certain view-point, however, there *is* a considerable development in our experiments, and the fact is that after the regular cut-back performed from year to year, the developing second crop contains less and less such stubs that don't dispose of sprouting capacity. At the start of the experiments the number of stubs without sprouts amounted to 50%, while for the time being it is 4—6%. This means that with the second crop the number of the sproutless stubs has decreased. Another important observation might be considered by the fact that when leaving the first crop for control, its growth period is by about one week longer than it had been at the start. The growth period of the second crop gets longer in a similar way.

Conclusion

In the course of our experiments it has been established that due to their high capacity of reparative regeneration, oats are capable of the regeneration of the whole plant. The cut-back has a stimulative effect on the development and growth stages of oats, and this shows itself indirectly in the vigour and growth of individual plants, too. The cut-back affects the growth season and might evolve new properties with certain stubs.

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THE MILDEW-RESISTANT SUMMER BARLEY VARIETY MK 42

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Damage caused by mildew has been examined for 4 years in a total of 18 trials on the grounds of the difference in yield between the new mildew-resistant selection reported to certification *MK 42* and the standard variety *MFB 104*. The effect of an increasing number of 0.5 per cent Karathane sprayings was compared in a two year glass house and field experiment on susceptible and resistant varieties. The production and breeding values of the new selection *MK 42* have been established by mildew inoculation for seven years and selection of the progeny of crosses.

Introduction

Mildew *(Erysiphe graminis DC. f. sp. hordei)* is one of the most widespread diseases of barley. Incidence and dimensions of the damage caused are essentially dependent on variety and environmental conditions. Accordingly, the damage is highly variable as to years, habitats and varieties. ISENBECK and HOFFMANN (1944) in Germany, GORLENKO (1950) and YURYEV (1952) in the Soviet Union estimate the mean difference in yield between resistant and susceptible varieties to at least 10 per cent of the annual yield. A similar opinion is exposed by CLARK (1952) for the USA. PAPE and RADEMACHER (1934) in Denmark and STEPHAN (1957) in Germany assume a still greater extent of damages by mildew.

LAST (1955) found in his experiments a 16.8 per cent difference in yield between the non-infected treatments sprayed with calcium sulphite, and the non-sprayed, heavily infected ones. In the field experiments of BENADA (1961) mildew caused a 19 per cent reduction of grain yield in the variety *Piroline*, 20 per cent with *Triumpf*, 33 per cent with *Valticky* and 37 per cent with *Opavsky*.

Few experimental data are available for the damage by mildew in Hungary. The mean value of the damage was generally estimated by specialists at less than 10 per cent of the annual crop yield. PODHRADSZKY and CSUTI (1964), in 1961, a year favourable for mildew established losses of 20 to 30 per cent in several countries. In recent years ever more intensive incidences can be observed consequent upon the fact, in our opinion, that winter and summer barley varieties have been increasingly grown side by side. The growing damages render production of varieties resistant to the disease an ever more urgent necessity.

In literature a comparatively great amount of data evidence that damages done by mildew can be controlled and/or diminished by methods of plant protection and farm technology. Breeders have made use for a long time already of *repeated dusting* with *powdered sulphur* in the control of mildew (Sorauer 1928, Briggs 1935, Rademacher 1949, etc.). Isenbeck and Hoffmann (1944) e.g. attained a surplus yield of 14.6 per cent by this method. Benada (1961) found that among Karathane, Polybarit, Thiovit and the powdered sulphur Sphynx the latter proved to be most effective, Karathane stood the test also in the experiments of Croisier and Szkolnik (1956), Parmentier (1956b) and Doling and Happle (1959). Parmentier (1956a) examined a series of fungicides both in the laboratory and in field tests and found that 0.8 per cent dissolved sulphur and 0.1 per cent barium polysulphide displayed the most favourable effect. Podhradszky and Csuti (1964) reported on PFU—26-Wepsyn and Actidion being well suited for diminishing the incidence of mildew in barley. Successful experiments were conducted with Thiovit spray in 1964 within the national trial of barley varieties of the National Institute for the Qualification of Agricultural Varieties and Production Techniques.

Recently Mosolov, Lapsina and Popova (1956), Last (1955, 1957), Krzysch (1958a, 1958b, 1958c) and Krzysch and Eberhardt (1960) have reduced the damage caused by mildew by foliar spraying with 2.0 to 2.6 per cent solutions of potassium magnesia, ammonium sulphate, potassium nitrate, primary potassium phosphate and/or primary magnesium phosphate. In our own 5 series field experiments, upon the effect of preventive spraying conducted with 2 per cent aqueous solution of 40 per cent potassium salt and subsequent spraying with 40 per cent potassium salt and 2 per cent aqueous solution of superphosphate, mildew infection was diminished by 8 to 12 per cent. The effect of spraying, however, was only of quantitative character and far from being satisfactory.

Experimental Procedure

Breeding work to produce a mildew resistant barley variety was started in the Agricultural Research Institute of the Hungarian Academy of Sciences at Martonvásár in 1953. The mildew resistant new selection *MK 42* was reported to the national variety trials in 1962. This new selection has been perfectly resistant (00 type) for 7 years both in the glass house and in the field. With the aid of the new resistant selection it became possible for the first time to establish the damage done by mildew in Hungary. For the comparison a mixture of the lines of the new selection *MK 42* and the standard variety *MFB 104* were used. The data of the best line of the new selection *MK 42* each year are reported for information.

For mildew control in 1962 and 1963 the effect of 0.5 per cent Karathane spraying was examined on three susceptible *(MFB 104, MFB 102, M Korai)* and one resistant *(MK 42)* variety in glass house and field experiments with 4 treatments (I untreated control, II spraying prior to the appearance of mildew, III spraying at the appearance of mildew, IV spraying prior to the appearance of mildew and one week later).

Results and Discussion

During 4 years a total of 18 experiments were set up with the new selection resistant to mildew *MK 42* and with the standard variety *MFB 104* (Table 1). From the 4 experimental years referred to, mildew incidence was insignificant in the breeding garden in 1962, medium in 1963, strong in 1961 and very strong in 1964. The difference in yield between the two varieties developed accordingly. In 1962 there was no substantial difference in productivity between the resistant and the susceptible variety, whereas in the other years the yield difference increased to the benefit of the resistant variety parallel with the intensification of incidence. In a total of 18 field tests of the years 1961 to 1964 the *mixture of lines MK 42* gave on the average a grain yield of 2.01 q/cad.hold (1 cadastral hold = 0.57 ha) or 11.1 per cent higher than the susceptible standard *MFB 104*. Damage caused by mildew varied in conformity with expectations depending on the years on a very wide range (2.1 to 41.9 per cent) and on the average it has proved to be higher than estimated so far. This was particularly evident in the national variety trials 1964 when the new selection *MK 42* was superior in yield by 2.37 q/cad.hold i.e. by 26.4 per cent to the *MFB 104* standard variety.

Table 1

Surplus yield of the new mildew resistant selection MK 42 *as related to* MFB 104
Martonvásár 1961–64

(1) Years	(2) Grain yield of MFB 104 q/cad.hold	(3) MK 42 mixture of lines		(4) Best line of the year of MK 42	
		Surplus yield			
		(a) q/cad.hold	(b) %	(a) q/cad.hold	(b) %
1961	12.30	+1.14	+ 9.2	+4.50	+36.5
1962	21.03	+0.46	+ 2.1	+8.57	+40.7
1963	26.01	+1.08	+ 4.1	+3.51	+13.4
1964	12.84	+5.39	+41.9	+7.56	+58.8
Average	18.04	+2.01	+11.1	+6.03	+34.8
National variety trials 1964	8.57	+2.37	+26.4	—	—

The picture is still more striking when the productivity of the best line of the new selection *MK 42* each year is compared with the parent variety *MFB 104*. The difference in yield between the two is substantially higher (6.03 q/cad.hold i.e. 34.8 per cent) than between the mixture of the lines of *MK 42* and the variety *MFB 104*. It is evidenced by the data obtained that the surplus yield of the resistant variety considerably varies also according

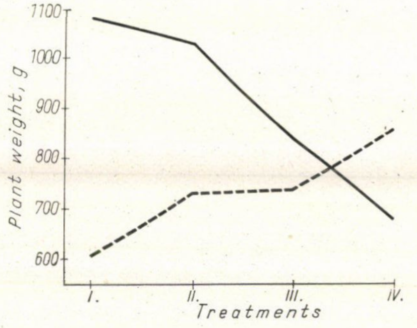

Fig. 1. The effect of Karathane spraying on plant weight. Martonvásár 1962. Vertical axis; Plant weight, g, Horizontal axis; Treatments: I. untreated contro1, II. 0.5 per cent Karathane spraying prior to the appearance of mildew, III. spraying at the appearance of mildew, IV. spraying before the appearance of mildew and one week later

——— MK 42 --------- The mean of varieties MFB 104, MFB 102, M Early and B 40.

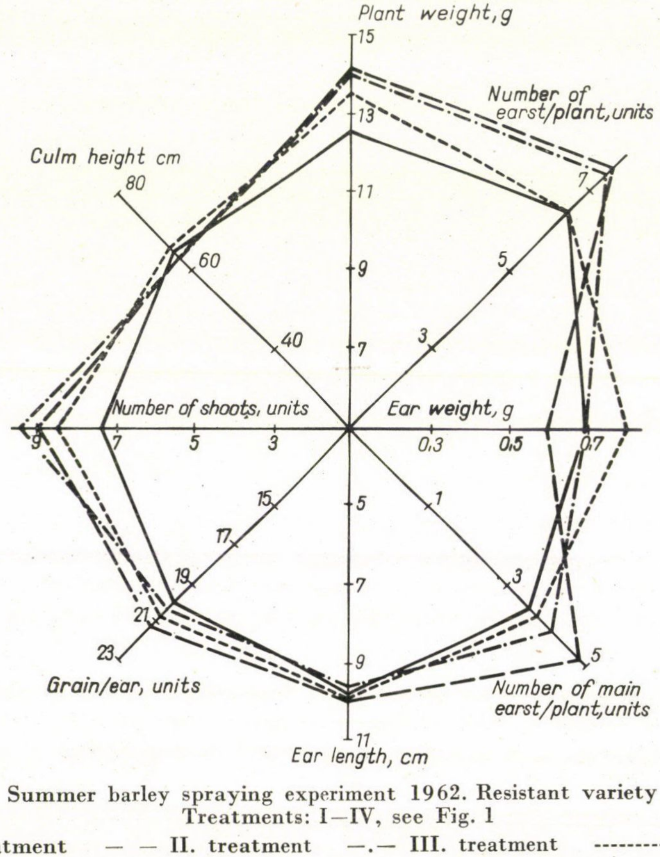

Fig. 2. Summer barley spraying experiment 1962. Resistant variety MK 42. Treatments: I–IV, see Fig. 1

——— I. treatment — — II. treatment —.— III. treatment --------- IV. treatment

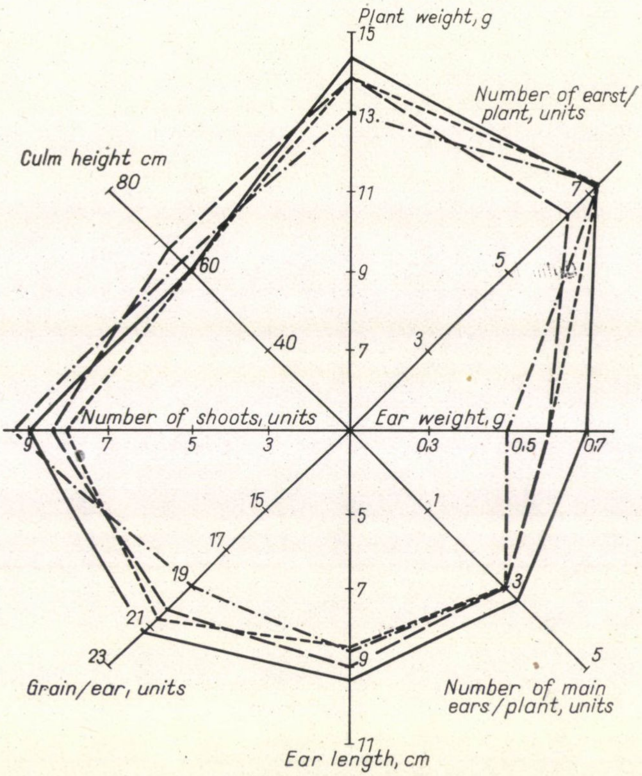

Fig. 3. Summer barley spraying experiment 1962. MFB 104 susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment -------- IV. treatment

to the regions of production and to the lines (genotypes) of the resistant variety. Consequently, with a seed obtained by mixing suitable lines still greater differences can be observed.

On the strength of earlier experience the opinion prevailed that mildew is used to diminishing the yield of barley to the greatest extent on plots with a well developed highly tillering dense stand and, for the most part, in years when crop yields are above average. Contrary to this earlier view, our experimental data seem to prove that resistance to mildew involves, first of all, a higher reliability of yield. The difference between the yields of the resistant and susceptible variety is higher in the years with lower average yields and lesser in years when mean crop yields are higher. Thus, the advantages of the variety resistant to mildew are most conspicuous in the "mildew years" and in those with crop yields lower than the average.

In the glass house experiments the young plants raised in boxes had been previously inoculated with mildew. Under the action of the treatment

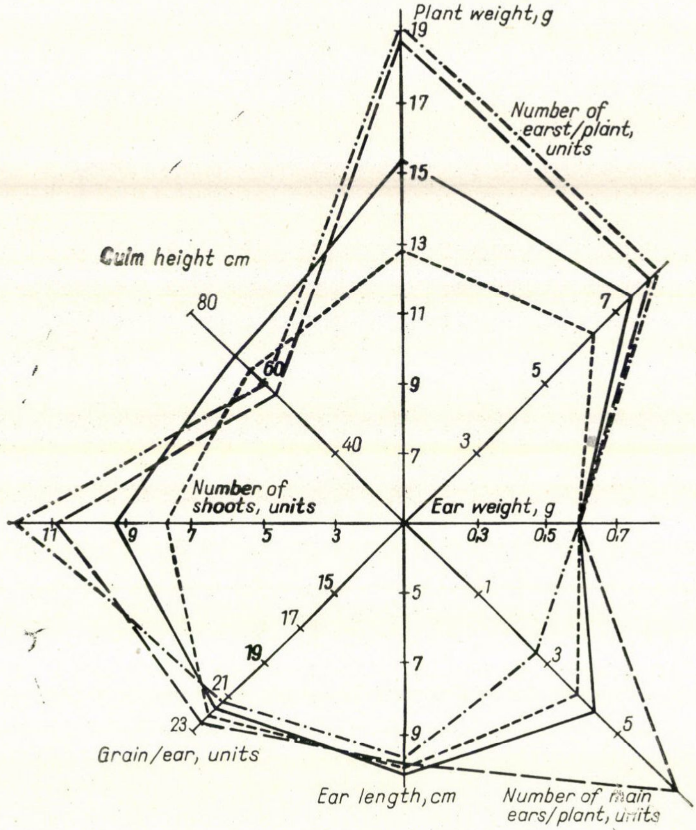

Fig. 4. Summer barley spraying experiment 1962. MFB 102 susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment --------- IV. treatment

(Fig. 1) the green weight of the susceptible varieties gradually increased while that of the resistant variety diminished. The data evidenced that the Karathane spraying exercises a disadvantageous effect on the resistant variety while it is favourable for the susceptible ones. The unfavourable effect of Karathane spraying was indicated on the resistant variety also by scorching spots similar to the so-called "resistance spots". No such phenomena were observed on the susceptible varieties. The grain yield of the varieties developed similarly to the green weight in the field experiments. The new resistant selection and the susceptible varieties responded differently to the treatments.

Yield components and other economically important properties of the new resistant selection *MK 42* obtained the highest scores in the case of the untreated control (Fig. 2). Under the influence of the Karathane sprayings the scores of the properties suffered a reduction unequivocal and proportional to the increase of the number of treatments.

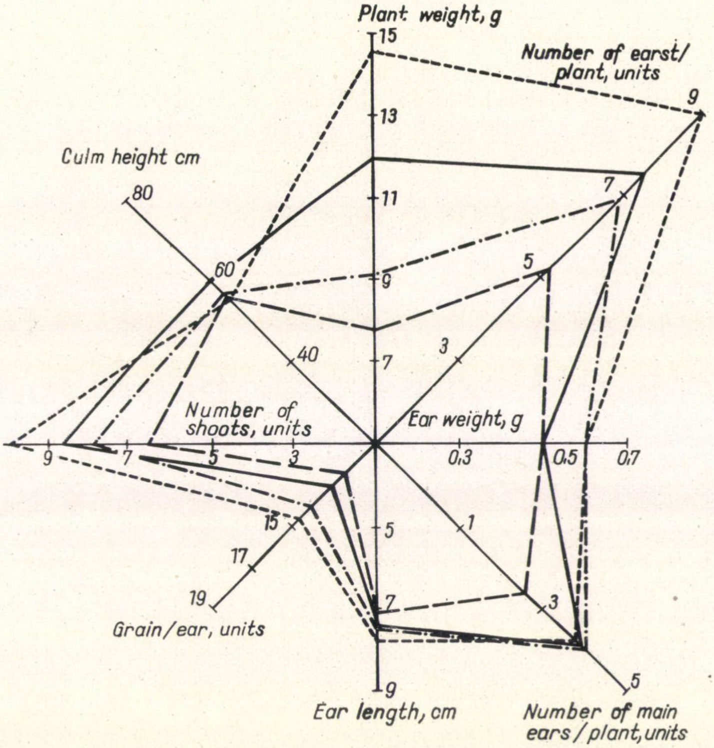

Fig. 5. Summer barley spraying experiment 1962. M Korai (early) susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment -------- IV. treatment

The susceptible variety *MFB 104* responded to Karathane just the other way round (Fig. 3). All treatments, when related to the untreated control, increased the yield components as well as the other economically important features.

The varieties *MFB 102* and *Korai* (early) *M* proved to be intermediary types (Figs 4 and 5!). The treatments did not act unequivocally on these varieties, since some characters improved in certain cases very highly while others, at the same time, deteriorated. The considerable deformation of the curves indicates that the treatments exercised an injurious influence on the life processes of the varieties upsetting the biological equilibrium of the most important properties. The remarkably strong reduction of the value scores of the features in the variety *M Korai* points to the fact that there are substantial differences in the susceptibility to Karathane of the varieties.

The results of the field experiments corroborate the conclusion drawn on the strength of the glass house experiments, i.e. that the new selection *MK 42* resistant to mildew should not be sprayed with Karathane against

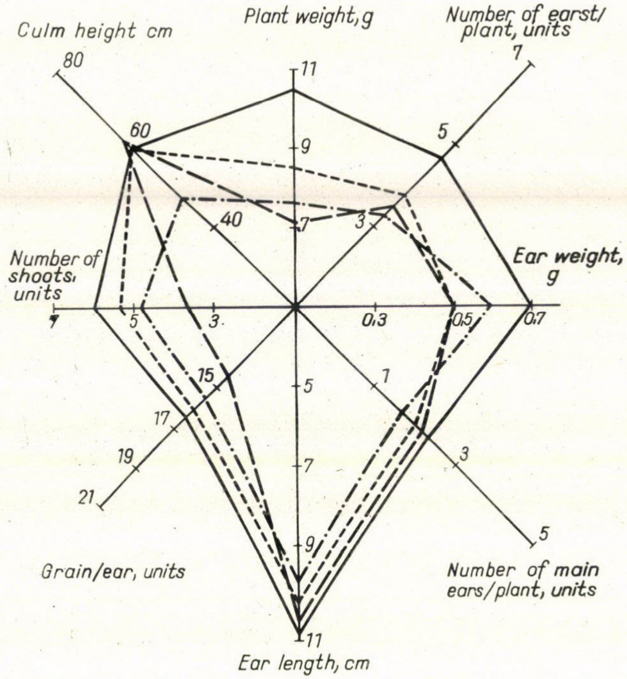

Fig. 6. Summer barley spraying experiment 1963. MK 42 resistant variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment --------- IV. treatment

mildew and that the treatment has not always a positive effect, even in the case of the susceptible varieties.

Field experiments conducted in 1963 gave similar results. The type of response in varieties indicated with curves (Figs 6, 7, 8 and 9) did not change, in fact, it became more explicit. The scores of the properties at the new resistant selection (Fig. 6) strongly decreased while those of the variety *MFB 104* (Fig. 7) increased to a higher degree than in 1962. Characteristically of all varieties, they developed longer ears as compared with the past year while plant weight and grain to ear ratio substantially decreased. Ear weight has shown the least change. The data seem to point out that environmental conditions changing year by year favour different yield components, i.e. the yield of the variety may be based on an other yield component each year. If, however, a yield component developed extremely, the other components are similarly modified according to circumstances. The scores of the properties in varieties *MK 42* and *M Korai* decreased in both years under the influence of the treatments, while those of *MFB 104* increased. According to the data Karathane treatment inhibits, in some susceptible varieties, the development of mildew and induces a provisional freedom of symptoms thus, resulting in

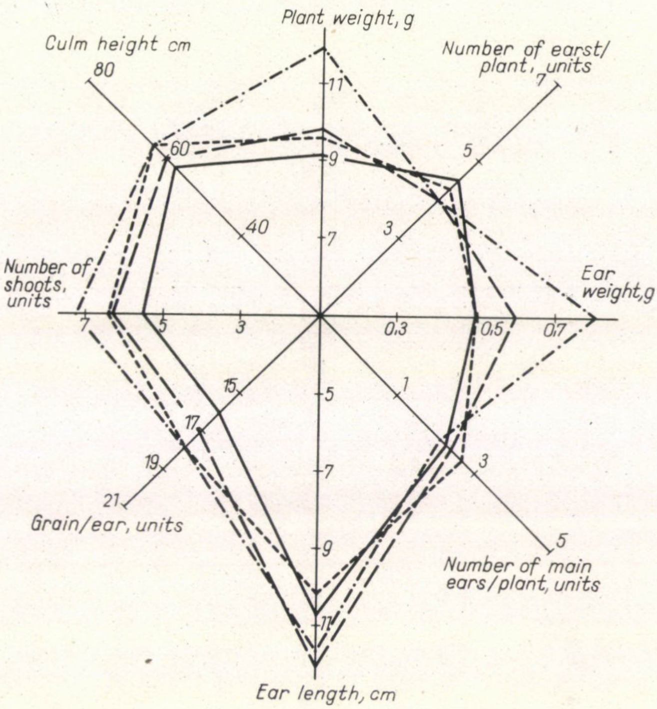

Fig. 7. Summer barley spraying experiment 1963. MFB 104 susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment -------- IV. treatment

a higher yield. In the case of the mildew resistant variety *MK 42*, on the other hand, it causes scorching spots, diminishes the scores of yield components and other important properties leading then to a diminished yield. The same thing was established in the case of the susceptible variety *M Korai* with the difference that no scorching spots appeared.

It is comparatively easy to form a judgment of the "infection picture" caused by mildew incidence, varieties having a rather characteristic response to the infection. Several scales of evaluation were elaborated to determine the degree of infection. The best known of these are the scales of Honecker (1934) and Hänsel—Zakowsky (1956, 1956). Their main feature is that no conidia capable of infection develop on the plants of varieties that can be ranged into the resistant classes *i*, 00 and 0 and the place of the infection is marked by "resistance spots" drying up. The plants of varieties belonging to the susceptible classes 1—5 bear no "resistance spots" but they are more or less covered by mildew thalli.

Nevertheless among the mutants of the variety *MFB 104*, varieties of the varietal collection and progeny of some crosses, also plants of the 00/1,

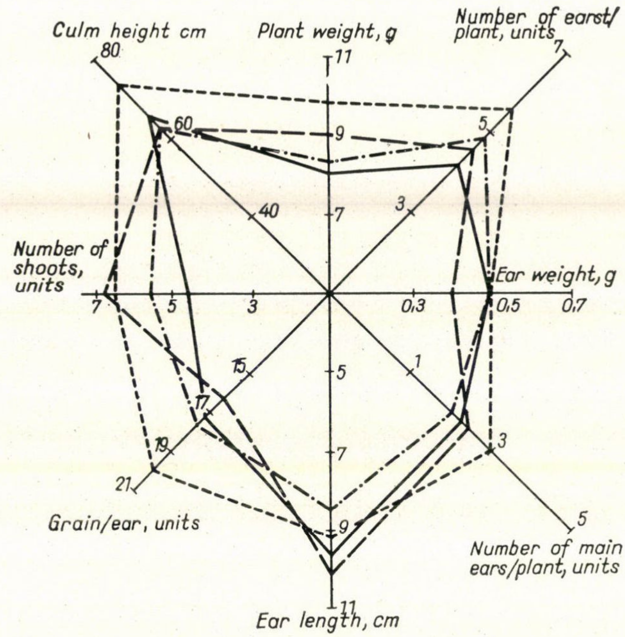

Fig. 8. Summer barley spraying experiment 1963. MFB 102 susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment -------- IV. treatment

00/2, 0/1 and 0/2 type were found. On these *plants of intermediary* infection type there were for a few days, beside the "resistance spots", also thalli developing conidia which dried off and perished within 5 to 6 days. In view of breeding, resistance of intermediary type proved to be worthless because these varieties when crossed with susceptible ones did not actually produce mildew resistant progeny.

A particularly high number of plants of intermediary infection type were found in the hybrid generations of the resistant winter × susceptible winter and resistant summer × susceptible winter type barleys. Presuming that from these combinations, in F_2 generation we succeeded by inoculation, at glass house in selecting resistant plants, the overwhelming part of these plants assumed, in the field and already in the F_2 or F_3 generation, the intermediary infection type or became susceptible. Therefore, it is far more difficult to bread a mildew resistant winter barley type than a summer one.

The appearance of an unexpectedly high number of intermediary type and susceptible plants in the F_2 and F_3 generations is, in our opinion, connected with the fact that the effectiveness of resistance to mildew depends largely on the environmental conditions. The mean evaluation value (84, 66) of the varietal collection consisting of 412 varieties sown among the winter barley e.g. substantially exceeded the value of the same varieties evaluated in the

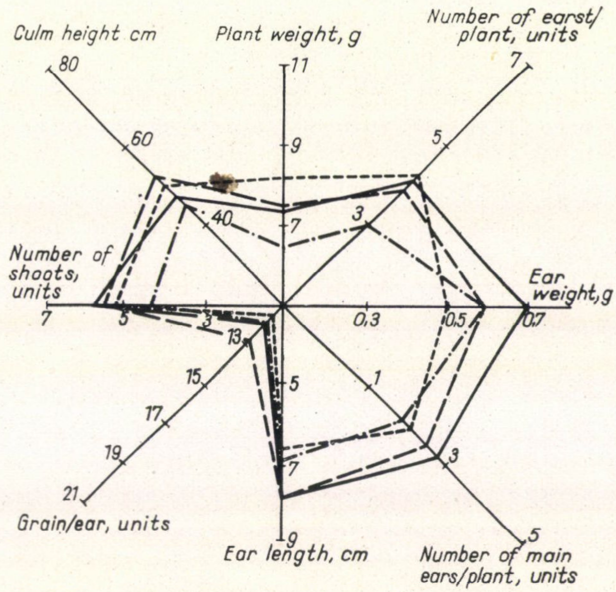

Fig. 9. Summer barley spraying experiment 1963. M Korai susceptible variety. Treatments I—IV see Fig. 2

——— I. treatment — — II. treatment —.— III. treatment -------- IV. treatment

varietal collection (59, 22). This difference may be mostly attributed to the fact that the mildew incidence attained its maximum on the varieties sown among the winter barley about two weeks earlier. Simultaneously with these

Table 2

Distribution of summer barley varieties according to classes of evaluation
Martonvásár 1960

(1) Denomination	(2) Treatment	Classes of evaluation (3)								(4) Total units
		i=0	00=0	0=0	1=20	2=40	3=60	4=80	5=100	
(5) Number of varieties, units	a) Among winter barley	11	1	—	4	11	58	91	236	412
	b) In the varietal collection	13	8	3	18	40	217	94	19	412
(6) Number of varieties, %	a) Among winter barley	2.7	0.2	—	0.9	2.6	14.1	22.1	57.4	100.0
	b) In the varietal collection	3.2	1.9	0.7	4.5	9.7	52.7	22.7	4.6	100.0

Note: General evaluation: among winter barley 4 = 84.6
in the varietal collection 3 = 59.2

essentially quantitative changes, however, qualitative changes were also observed. While in the varietal collection the proportion of the actually resistant varieties was 5.8 per cent, only 2.9 per cent from the same varieties sown among winter barley proved to be resistant (Table 2).

Between the new selection *MK 42* and its progeny from crosses realized with resistant and susceptible barley varieties no plants of the intermediary types of infection appeared either in the glass house or sown among winter barley. On these grounds it may be assumed that the new selection *MK 42* — disregarding its missing winter hardiness — may be a suitable crossing partner to produce a winter barley variety resistant to mildew.

Conclusion

Mildew *(Erysiphe graminis* D. C. f. sp. *hordei)* in recent years has caused increasing damages in cereals. The damage by mildew calculated on the grounds of the difference in yield between the mildew resistant new summer barley selection *MK 42* and the susceptible standard variety *MFB 104* appearing in 4 years of experiment in Martonvásár (2.01 q/cad.hold, 11.1 per cent) and one year of national variety trial (2.37 q/cad.hold, 26.4 per cent) has proved to be higher than estimated before.

At variance with earlier views, mildew exhibited its main damages not on the plots with developed, highly tillering dense stands and in years having higher yields than average but in the "mildew years" and those with crop yields below average (Table 1).

It is well known from a number of experiments that the degree of mildew incidence and the damage caused can be diminished by means of plant protection and farm technology. According to glass house and field tests the mildew resistant new selection *MK 42* responded to the increasing number of Karathane sprayings with scorching spots, reduction of yield and that of value scores of economically important characters (Figs 1, 2 and 6) whereas the susceptible variety *MFB 104* with the increase of crop yield and of the scores (Figs 1, 3 and 7). The response of *MFB 102* (Figs 4 and 8) and of *Martonvásári korai* (Figs 5 and 9) was not unequivocal. According to data the "Karathane susceptibility" of the non mildew resistant varieties is substantially different.

Breeding mildew resistant winter barley varieties is a difficult task, owing to the scarcity of suitable resistant parent varieties, the close connection between resistance and environment (Table 2) and the exceedingly great number of "intermediate infection type" and susceptible plants appearing in the hybrid generations. The new selection *MK 42* — apart from its missing winter hardiness — can be a good crossing partner also for the breeding of winter barley resistant to mildew.

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COMPARATIVE ANALYSIS OF SOME LINES OF THE HYBRID POPPY BC—2 FROM THE VIEWPOINT OF PHARMACEUTICAL INDUSTRY*

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The features of breeding value of the lines carried on in 1963 of the *BC—2* poppy were analyzed. The 10 lines examined were evaluated first of all from the point of view of seed weight, seed yield, capsule weight, capsule yield, thousand seed weight and so-called industrial alkaloid production and then, next year the best individuals or groups were carried on and studied for the properties referred to. It has been established that in some of the new "*A*" lines originating from the best individuals of the lines (e.g. 57/1964, 60/1964) the associate alkaloid content approaches that of the *SC* parent of higher performance and at the same time their production is favourable also for other properties.

Introduction

As a first result of alkaloid poppy experiments (SÁRKÁNY *et al.*, 1959) conducted on the initiative of the Alkaloida Chemical Factory and of the Central Planning Board 3 new selections reported to certification were — and with the selection method — produced from 1951, on a broader basis with an objective of breeding and under the name of *SB*-, *SC*- and *SD-morphin poppy* (SÁRKÁNY, SÁRKÁNY-KISS and DÁNOS, 1959). In the national variety trial of 1956 and 1957 from the 3 new selections referred to, *SC* with grey and brownish grey seeds with a rather strong stem and *SB* with lighter and/or darker steel blue coloured seeds distinguished themselves. Also for alkaloid production the first of these has been qualified under the name of *SC morphin poppy* as a free variety licensed for sale, while the second under the name of *SB* morphin poppy as preliminary certified improved variety and both have been taken into nation-wide cultivation (ALBEROWSKY *et al.*, 1963).

In the course of crosses conducted to obtain a good plant material for seed colour and beside morphin also for associate alkaloid contents (SÁRKÁNY *et al.*, 1959) among others we succeeded, in producing from *SB*$\times$*SC* the *BC* hybrid poppy which, beside other properties, proved to be advantageous also as to seed colour. On the strength of experimental results one of the materials found to be best was reported to certification under the name of

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BC—2 hybrid poppy seed (F_6-generation) (SÁRKÁNY, DÁNOS, SÁRKÁNY-KISS). — The new selection was evaluated in 1962 in our own breeding garden at Alsógöd in a 4 series comparative experiment and its performance being studied as compared with the *SB—SC* parents and the registered variety "*Hatvani zárttokú kék mák*" (blue poppy from Hatvan with closed capsules). After the positive results obtained the new selection *hybrid poppy BC—2* was included in 1963 and 1964 in a national trial with other new selections on the stations of the National Institute for the Qualification of Agricultural Varieties and Production Techniques.

Several lines *(I—XV)* of the *BC—2 hybrid poppy* and a mixture of lines respectively was set in an experiment also in Keszthely 1962 and the 10 best lines carried on further with selection breeding each year. In 1964 further "*A*" lines were included. In the present paper experience gained in our work conducted in 1963 and 1964 with the lines of the *hybrid poppy seed BC—2* is discussed.

Experimental Procedure

The 10 best lines of the *hybrid poppy BC—2* were — in 1963 — set up in the exhibition garden of the College of Agricultural Sciences at Keszthely. The experimental seed material was planted on a 450 sq.m. area *in 5 series* divided by paths, according to the block method (MUDRA, 1958), in a well cultivated soil on April 5th. In each plot on the average 8×20 i.e. 160 individuals were raised. — In 1964 again in Keszthely (but in the external breeding garden) 10 lines of the hybrid material *BC—2* were arranged similarly (plots 1—50). Besides (in the interior breeding garden) 14 new "A" lines (plots 51—64) and some progenies from the mixture of the best individuals (4—5) were established (plots 65—92). The latter are not dealt with in the present paper. The new "*A*" lines referred to were raised from the seeds of the best individuals of the 1963 stand examined for several features.

Weather was favourable in the 1963 season. The number of sunlit hours was above the mean of many years. At maturation an average temperature of +20°C prevailed. Most precipitation fell in the month of June (65.3 mm). Due to the drought in July the wall of the capsule was thinner than usual and, accordingly, lower values were obtained for capsule weight than in the previous years. — In 1964 the weather was particularly prior to flowering less favourable. The number of sunlit hours lagged behind the mean of many years. At maturation the medium temperature was 19.2° C. During the vegetation period there was a comparatively high amount of rainfall, most of it in June (88 m) and the month of July was also wetter than in the previous year (61 mm).

The *soil of the experimental area* was medium heavy. It was given farmyard manure in the previous year, head dressing in 1963 and 1964, respectively, and 80 kg/cad.hold (0.57 ha) "Pétisó"*. Previous crop was peas in 1962 and potatoes in 1963. Seeding was performed with machine in both years.

Care of plants consisted of scuffling and two hoeings. — For plant protection MELIPAX treatment was applied, and DDT dusting in 1964.

Flowering began mid-June in 1963 and end of June in 1964. Full inflorescence ensued in a week on the average. Individual isolation was commenced on the flowers or buds not open yet previously. Development of the plant material of the plots was continuously followed according to possibilities in both years and to establish the degree of the hybrid character a great many observations and measurements were carried out as to the exterior morphological and phenological properties both outdoors and after harvesting in the laboratory and the data obtained for the lines were generally evaluated also statistically. So among others the following features were surveyed: plant height, number of flowers or capsules in each individual, hairiness of flower and/or peduncule, colour of petals and character of the basic spot,

* Calcium carbonate-ammonium nitrate fertilizer manufactured in Pét, Hungary.

shape and hybrid character of the capsules, colour of developing and mature capsules, colour of ripe seed, seed yield per lines and thousand seed weight, seed weight per capsules and individuals, capsule weight per lines and individuals.

Methods and procedures applied to the determination of the contents of collected capsule material in morphine and in some associate alkaloids were as follows. Morphine examinations were carried out with polarography in the laboratory of the Alkaloida Chemical Factory for which we wish to thank also here. Examination of the associate alkaloids was conducted partly with PFEIFER's (1956) paper chromatography and partly with the volumetric analysis of GYÖNGY (1964). Besides we commenced also to apply the thinlayerchromatographic method of DÁNOS (1964).

From the mass materials of the plots from 5 replications each a minimum of two parallel measurements were carried out. So the means were calculated on the basis of at least 10 measurements. The mean data of the individual examinations derived from ten or more individuals.

Part of the data obtained were also statistically evaluated (SVÁB, 1961).

Results and Discussion

Morphological examination of the ten lines of *BC—2 hybrid poppy* was concentrated on the capsules supplying industrial raw material. The development of the shape of capsule was followed with a particular attention. This is suitable also for the purpose in view that the *SB* and *SC* parents exhibit a shape of capsule which characteristically differ from each other in several properties. Therefore, we endeavoured to establish to what proportion the hybrid lines exhibit the properties of one parent or the other or how far they are of an intermediary character. So we examined and fixed in drawing a total of 1280 capsules of the ten lines. The capsule shapes occurring in the hybrid material can be separated into 3 groups (Fig. 1.). The capsule shapes of the one group are showing more the properties of the *SB* parent, i.e. the fruit in mature condition is of a yellowish brown colour, flattened pear shape, with a cervical part withdrawing below and a cylindrical construction on the upper end. The disk of the stigma is archedly flat, up to the centre hardly sunk in. The number of the stigma rays not contacting each other is 12—14. The colour of the capsular fruit which remains closed in half-ripe (opium-ripe) condition is greyish green, somewhat downy from a waxy cover. — The capsule forms of the other group are more suggestive of the properties of the *SC* parent. In mature condition the fruit is also remaining closed, of rust-brown colour, longitudinal pear-shaped, tapering toward the cervical part. The crown of the stigma is concave, with an edge turning strongly upwards. The edges of the stigma rays are for the most part characteristically contacting sometimes covering each other. The number of rays is 14 to 17. The colour of the capsule fruit is yellowish green in half-ripe (opium-ripe) condition, at places of a violet hue from anthocyan. — The capsule shapes of the third group show intermediary forms between the previous ones. It is characteristic of this intermediary form that the properties of the parents are not so explicit as in the previous ones. Table 1 presents the percentual distribution per lines of the capsule shape. Summing up briefly it may be stated that more than 50 per cent

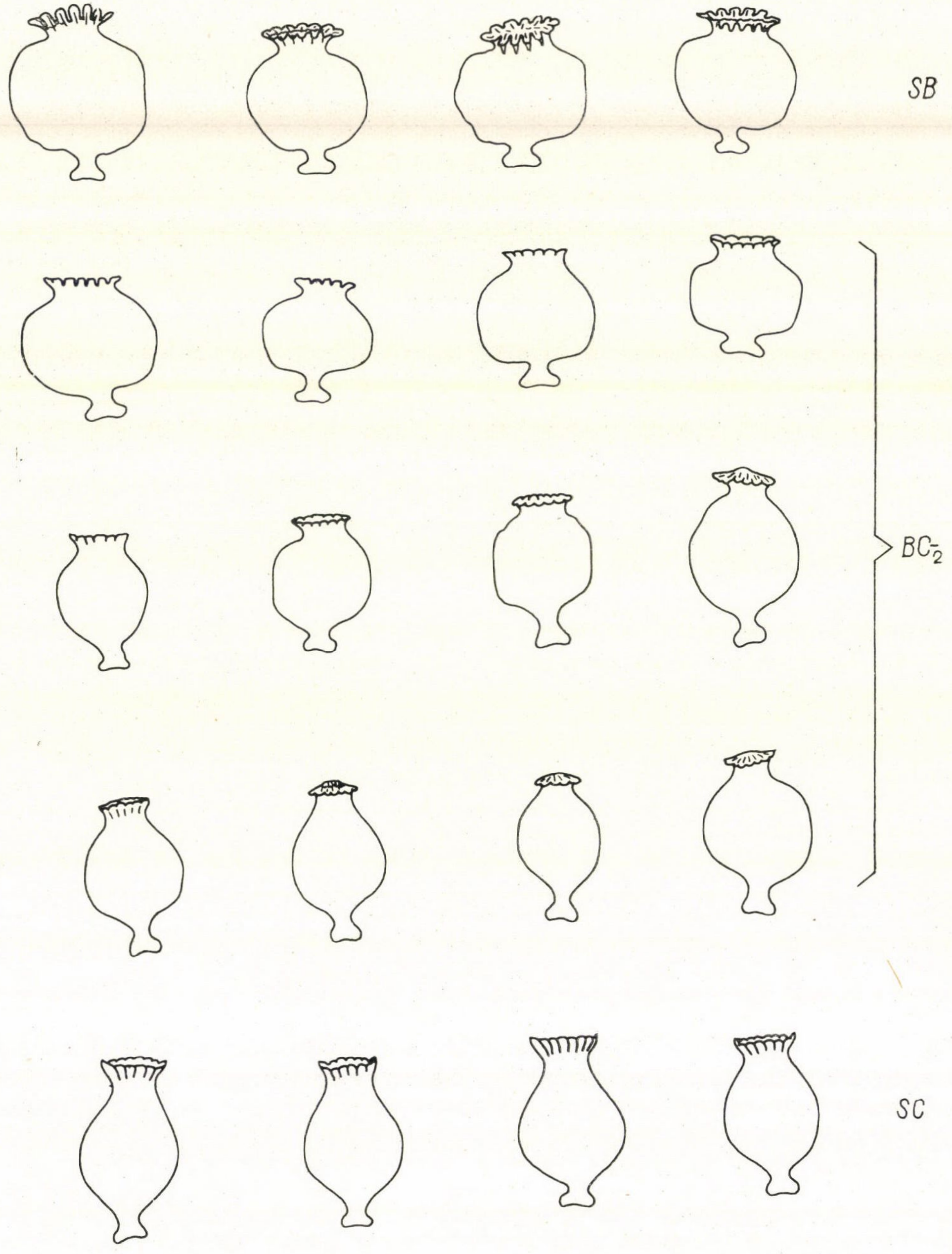


Fig. 1. Scheme of the capsule forms of the BC—2 hybrid poppy (Keszthely 1963) and capsule types of the parents (SB, SC)

of capsules in each line show a typical intermediary form that is it may be concluded on the dominant proportion of the hybrid character in the lines. The intermediary forms are least of all in the IX line: 44.1 per cent and most in IV: 60 per cent. From the capsule shapes suggestive of the parents those resembling the *SC* parent dominate up to 41 per cent except again for the IX line where the capsule form suggestive of the *SB* parent is more important: 29.4 per cent, while the form resembling *SC* amounts to 26.5 per cent.

Table 1

Groupment according to capsule form of the lines of BC—2 hybrid poppy 1963

Lines	Intermediary capsule forms		Capsule forms suggestive of SB		Capsule forms suggestive of SC	
	No.	%	No.	%	No.	%
BC—2/I	74	54.8	6	5.5	55	40.7
BC—2/II	60	51.4	15	12.6	44	37
BC—2/IV	85	60.6	6	4.4	49	35
BC—2/V	85	51.2	13	7.8	68	41
BC—2/VI	75	59.1	15	11.8	37	29.1
BC—2/VII	74	57.8	29	19.6	25	22.6
BC—2/VIII	76	53.5	11	7.7	55	38.8
BC—2/IX	45	44.1	30	29.4	27	26.5
BC—2/X	75	58.6	18	14.1	35	27.3
BC—2/XV	52	56	5	5.3	36	38.7

Further on we evaluated for each line seed weight and capsule weight, thousand seed weight and approximate seed yield as related to one individual or one capsule (Table 2). As to the capsule weight data obtained from 100 measurements each and also for the seed yield collected from 5 experimental plots per line, significant differences can be established among the lines. So e.g. for capsule weight the lines No. VI, VII and X exhibited the best values while for total capsule weight within the individual first of all the lines VII and X excel. — As to seed weight, either as related to one capsule or one individual, no significant difference was found among the lines. On the strength of thousand seed weight the lines No. II, V, VI, VIII and X are better than the rest.

When comparing the values obtained for the ten lines it appears that for all standards of value the line No. X is outstanding. In some properties the line V (seed yield), VII (seed weight), VI, VII and IX (capsule weight) distinguished themselves. One of the poorest line for several features was No. IV.

Table 2

Some value standards of BC—2 hybrid poppy lines
Keszthely 1963.

Lines	Seed yield in kg on a 45 sq.m. area *	Seed weight per capsule in g ***	Seed weight per individual in g	Capsule weight in g **	Capsule weight in g per individual	Thousand seed weight **
BC—2/I	*29.51*	2.08	6.24	1.36	4.08	0.426
BC—2/II	25.19	*2.16*	6.48	1.36	4.08	*0.458*
BC—2/IV	20.14	1.82	5.82	1.24	3.96	0.444
BC—2/V	*30.45*	2.02	*6.86*	1.27	4.31	*0.450*
BC—2/VI	23.97	2.07	6.00	*1.50*	4.35	*0.458*
BC—2/VII	28.45	*2.29*	*6.87*	*1.56*	*4.68*	0.432
BC—2/VIII	27.38	2.14	6.42	1.41	4.23	*0.466*
BC—2/IX	22.19	2.15	6.45	1.48	*4.44*	0.440
BC—2/X	*29.95*	*2.37*	*7.11*	*1.56*	*4.68*	*0.454*
BC—2/XV	21.29	2.07	*6.79*	1.38	3.86	0.434

* From the mean of 5 replications S. D. 5% = 4.7
** On the basis of 100 measurements each SD 5 = 0.13
*** F = 1.51, P 10% = 1.88

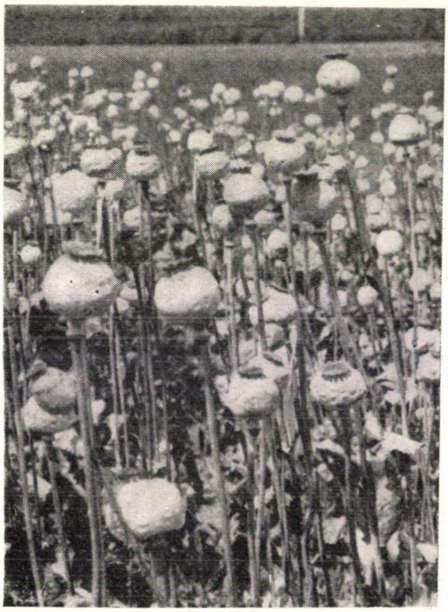


Fig. 2. Detail of a stand of BC—2 hybrid poppy with almost ripe capsules (Keszthely)

Now we are going to discuss the data pertaining to capsule and seed production of the new "*A*" lines set up in a series in 1964 which bear a purely informatory character. Mean values obtained for the 14 new "*A*" lines arranged in the small plots 51–64 (3 sq.m each) are presented in Table 3. According to these data the highest values for the properties examined were obtained for the line No. X (plot 63), which derives from an individual of the line *BC–2*/X

Table 3

Some value standards of the new "A" lines of the BC–2 hybrid poppy
Keszthely 1964
(Informatory mean data)

Plot number of lines	Origin	Seed weight per capsule in g	Seed weight per individual in g	Capsule weight in g	Capsule weight in g per individual	Thousand seed weight
51	BC–2/I.	1.97	6.9	1.60	5.60	0.427
52	BC–2/II.	2.76	10.00	2.37	8.60	0.471
53	BC–2/II.	2.36	7.41	2.65	8.32	0.490
54	BC–2/II.	2.32	7.65	1.92	6.33	0.547
55	BC–2/V.	2.19	5.47	2.11	5.27	0.433
56	BC–2/V.	1.64	4.92	1.27	3.80	0.479
57	BC–2/VI.	1.40	5.74	1.86	7.63	0.446
58	BC–2/VIII.	1.76	5.46	1.50	4.65	0.396
59	BC–2/VIII.	1.62	4.86	1.48	4.44	0.402
60	BC–2/IX.	2.68	7.50	2.39	6.69	0.460
61	BC–2/IX.	2.89	9.39	2.25	7.31	0.456
62	BC–2/X.	2.64	9.24	2.00	7.00	0.500
63	BC–2/X.	3.28	10.66	2.35	7.64	0.508
64	BC–2/XV.	2.47	8.64	1.60	5.6	0.435

exhibiting also a good performance in 1963. Good results were attained also by the stands of the lines II (plot 52), XI (plot 61) and partly of III (plot 53). As to thousand seed weight the material of the lines No. II and X (plots 54, 62, 63) was found most outstanding. — For the distribution of capsule shape — on the grounds of 450 analyses — the intermediary form appeared with a considerable dominance in line I (plot 51) and in an almost 50 per cent proportion at the stands of line No. III (plot 53), No. IV (plot 54), No. VIII (plot 58), No. IX (plot 59) and No. XI (plot 61); concerning similarity to the one parent (*SB*) or the other (*SC*) on the one hand line No. X (plot 60) and XIV (plot 64) and on the other hand line No. VI (plot 56), VII (plot 57) and VIII (plot 58) excelled. — As to seed colour in some of the lines more the medium blue (plots 51–53, 56–59) in others more the greyish blue seed colour (plots 60–63) was found to be characteristic. Sporadically also the bluish violet, darker blue and brownish-greyish-blue colours were encountered.

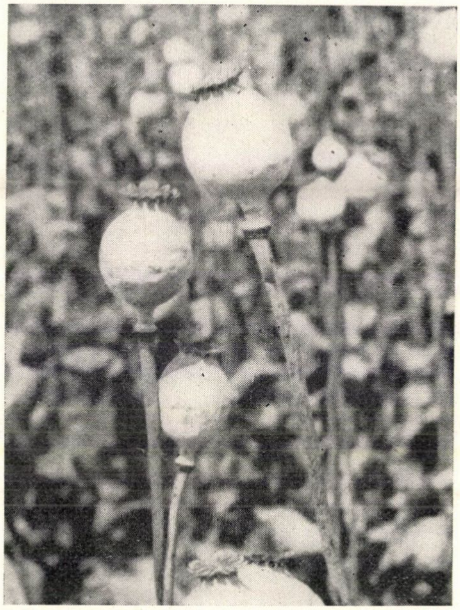


Fig. 3. Intermediary capsule forms in an almost ripe stand of the BC—2-hybrid poppy; Keszthely, 1963

Table 4

Morphine content of the 1963 lines of the BC—2 hybrid poppy

Lines	Morphine ‰	
	Individual means	Mass means*
BC—2/I	6.6	5.62
BC—2/II	6.7	5.63
BC—2/IV	7.5	5.74
BC—2/V	6.6	5.87
BC—2/VI	6.6	5.37
BC—2/VII	6.5	5.18
BC—2/VIII	7.2	5.41
BC—2/IX	7.3	5.76
BC—2/X	8.00	5.28
BC—2/XV	8.00	5.56

* F = 2.14, P 10% = 1.88

Results of alkaloid analyses refer partly to morphine content and partly to the developments in the individuals of the associate alkaloids important for the pharmaceutical industry (codeine, thebaine, papaverine + narcotin), and also to their total value within the ten lines; both mass materials and individual samples were evaluated for this purpose.

No significant differences were found among the lines as to morphine contents. These values ranged for the most part from 5.5 to 6‰ in the mass materials and lagged behind the values obtained from individual means which attain, e.g. in the lines X and XV even 8‰ (Table 4).

Table 5/a

Associate alkaloid examination results of the 1963 lines of the hybrid poppy BC—2 on the grounds of the volumetric analysis of Gyöngy

(Means of mass material)

Lines	Codeine ‰	Thebaine ‰	Narcotin ‰	Papaverine ‰	Total associate alkaloid mean ‰
BC—2/I	0.392	0.097	0.063	0.029	0.581
BC—2/II	0.403	0.145	0.075	0.052	0.674
BC—2/IV	0.553	0.079	0.105	0.064	0.801
BC—2/V	0.320	0.107	0.075	0.055	0.559
BC—2/VI	0.467	0.087	0.050	0.050	0.654
BC—2/VII	0.297	0.102	0.048	0.036	0.482
BC—2/VIII	0.409	0.097	0.046	0.032	0.584
BC—2/IX	0.423	0.086	0.060	0.073	0.642
BC—2/X	0.275	0.072	0.029	0.037	0.413
BC—2/XV	0.318	0.019	0.036	0.047	0.420

For the most important associate alkaloids the volumetric analyses from mass materials resulted in low values. The best was the line No. IV which proved in morphological respect to be poorest, followed by Nos VI and VII (Table 5/a).

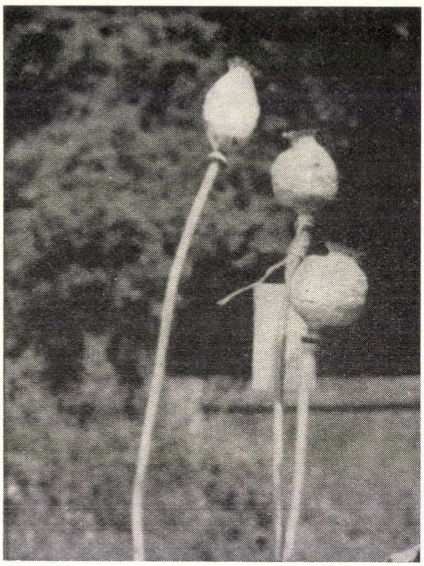
Also some individuals were lifted from the lines for associate alkaloid examinations conducted with chromatography and evaluating the material with relative scores from 0.1 to 3.00 on the strength of a comparison with a standard series. — Considerable differences were found among the lines as to associate alkaloid contents. Since well developed characteristic hybrid individuals were chosen, also the values of associate alkaloids were higher than those found for the mass material. On the strength of individual evaluation the high relative mean values were obtained in the lines Nos II, IV, VI, VIII, XV (Table 5/b). The lines II, IV and VI proved to be good both in individual evaluation and from the viewpoint of mass value.

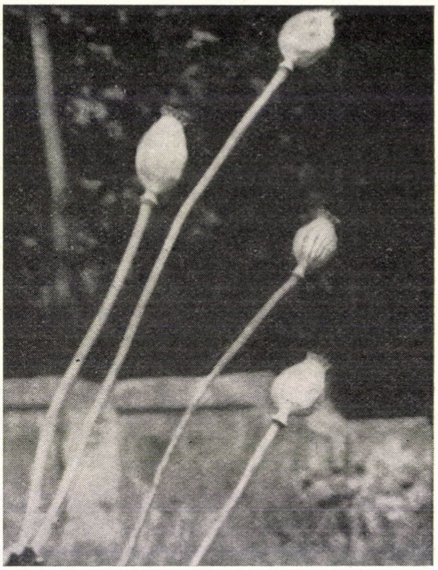
In 1964 on the basis of individual selection from the *BC—2* lines the best material was carried on in the form of new "*A*" lines. Line No. IV, however,

Table 5/b

Associate alkaloid examination results of the 1963 lines of the hybrid poppy BC—2 in relative values
(Individual means)

Lines	Codeine	Thebaine	Papaverine + Narcotin	Associate alkaloids examined, total
BC—2/I	0.8	0.4	0.6	1.9
BC—2/II	1.1	0.5	0.5	2.1
BC—2/IV	1.2	0.7	0.8	2.6
BC—2/V	0.5	0.4	0.7	1.6
BC—2/VI	0.8	0.5	0.6	2.3
BC—2/VII	0.7	0.4	0.5	1.7
BC—2/VIII	0.9	0.5	0.6	2.2
BC—2/IX	0.7	0.3	0.6	1.6
BC—2/X	1.3	0.6	0.7	1.2
BC—2/XV	0.9	0.7	0.7	2.5





Figs. 4 and *5.* 7 variant capsule forms of an individual of BC—2 hybrid poppy; Keszthely 1963

was eliminated owing to its low values for capsule and seed weight. Results obtained in 1964 for associate alkaloids with indication of the lines of origin are presented in Table 6. The progenies originating from the outstanding individuals of the lines II and VI partly retained their higher associate alkaloid character. — Very good results were obtained also from a new "*A*" line

Table 6

BC—2 "A" lines from 1964
Keszthely
Volumetric analysis according to Gyöngy

Plot № or mark of lines	Associate alkaloids					Associate alkaloids total ‰
	Origin	Codeine ‰	Thebaine ‰	Narcotin ‰	Papaverine ‰	
BC—2/51	BC—2/I	1.23	0.056	0.083	0.028	1.397
BC—2/52	BC—2/II	0.717	0.056	0.055	0.033	0.861
BC—2/53	BC—2/II	1.01	0.35	0.134	0.137	1.631
BC—2/54	BC—2/II	0.974	0.089	0.16	0.166	1.389
BC—2/55	BC—2/V	0.85	0.089	0.097	0.092	1.128
BC—2/56	BC—2/V	0.54	0.060	0.082	0.047	0.709
BC—2/57	BC—2/VI	1.52	0.218	0.625	0.6	2.963
BC—2/58	BC—2/VIII	0.727	0.188	0.038	0.356	1.301
BC—2/59	BC—2/VIII	1.41	0.093	0.025	0.037	1.565
BC—2/60	BC—2/IX	1.73	0.29	0.64	0.33	2.99
BC—2/61	BC—2/IX	1.29	0.109	0.028	0.101	1.528
BC—2/62	BC—2/X	1.12	0.115	0.064	0.078	1.377
BC—2/63	BC—2/X	0.645	0.216	0.044	0.099	1.004
BC—2/64	BC—2/XV	0.91	0.214	0.025	0.099	1.248

Table 7

Associate alkaloid content of parent SB
(1964 examination)

Volumetric analysis according to Gyöngy

	Codeine ‰	Thebaine ‰	Papaverine ‰	Narcotin ‰	Associate alkaloids examined, total ‰
1963 Ag (Alsógöd)	0.182	0.19	0.149	0.032	0.553
	0.55	0.117	0.057	0.014	0.737
	0.565	0.033	0.046	0.051	0.695
1964 Ag (Alsógöd)	0.312	0.161	0.025	0.017	0.515
	0.362	0.176	0.039	0.019	0.596
	0.425	0.124	0.159	0.09	0.798

originating from the line No. IX (plot 60). Lines carried on with individual selection generally behaved well in 1964.

Not for comparison's sake but just to indicate between what limits the associate alkaloid content ranges concerning the parents (*SB* and *SC*) the data of two consecutive years are presented. These entirely support our experience gained during many years, since in previous years, when the two parents were set up on the same area the character of the differences appeared the same as in the last two years (Tables 7 and 8). — The contents of the most important associate alkaloids ranged around 0.5‰ in both years in *SB* while the *SC* parent distinguished itself by a high, 2.4 to 3.8‰ associate alkaloid content.

Table 8

Associate alkaloid content of parent SC

(1964 examination)

Volumetric analysis according to Gyöngy

	Codeine ‰	Thebaine ‰	Papaverine ‰	Narcotin ‰	Associate alkaloids examined, total ‰
1963 M (Makó)	1.98	0.086	0.244	0.187	2.497
	1.89	0.8	0.50	0.028	3.218
	1.84	0.183	0.27	0.128	2.421
	2.56	0.46	0.57	0.28	3.870
1964 M (Makó)	2.23	0.036	0.41	0.03	2.65
	1.85	0.429	0.33	0.047	2.706

The mass material of the *BC—2 hybrid poppy* lines as shown produced a lower associate alkaloid content in 1963. The progenies of the best (*SC* capsule shaped) blue seeded individuals selected ("*A*" lines) approach the higher associate alkaloid production character of the *SC* parent. It should be particularly stressed that in the "*A*" line (plot 57) which appears as the progeny of line VII total associate alkaloid content was 2.96‰ in 1964. One of the progeny "*A*" lines of line IX (plot 60) also exhibited an outstanding associate alkaloid content: 2.99‰. From the new "*A*" lines only one originating from line II and another from line V gave a total associate alkaloid content of less than 1‰.

Comparing the associate alkaloid content of the new "*A*" lines with some standards of value (Table 3) it can be stated that the material of plot 60 deriving from line No. IX with an outstanding alkaloid content results in standards of value somewhat higher than medium and in this respect exceeds the features of the "*A*" line of plot 57 originating from line No. VI. Progenies originating from line No. X which disposes otherwise of good value standards (plots 62, 63) resulted more in lower total associate alkaloid contents.

The new "*A*" lines, after proper evaluation, will be carried on next year and set up with the two parents and with the registered variety "*Hatvani*" on the same place and under the same conditions. These new examinations will help us to decide how far the higher total associate alkaloid content found in 1964 is a characteristic and permanent feature of the lines involved. There is no doubt that it is worth while going on with further examination of the new lines showing a higher alkaloid content.

Conclusion

Ten lines of the *hybrid poppy seed BC—2* set up in several replications, the material of a total of 50 plots was studied and the practically most important features were subjected to a comparative investigation. In the course of this work some morphological characters were observed and seed colour, seed yield, thousand seed weight, capsule weight and individual capsule yield as well as the morphine and associate alkaloid (codeine, thebaine, narcotin, papaverine) content of the test material evaluated. It has been established that the lines are morphologically comparatively well balanced but differ from each other as to seed and capsule yield. Their alkaloid production exhibits also differences as though the morphine content does not show in the mass material of the lines significant differences, the associate alkaloid content differs in the lines examined. From the new "*A*" lines originating from the individual progenies of the best *BC—2* hybrid lines in some (e.g. No. 57/1964, 60/1964) the associate alkaloid content approaches the *SC* parent of higher performance and at the same time their production is also advantageous for other properties.

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THE BIOCHEMICAL PROCESSES OF VERNALIZATION

III. THE CHANGES OF ASCORBIC ACID OXIDIZING CAPACITY IN THE COURSE OF VERNALIZATION

By

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Investigations having been made on the ascorbic acid oxidizing capacity of the shoots and roots of young wheat plants at different levels of vernalization it has been established that the temperature optimum of the ascorbic acid oxidizing system is shifting with the progress of vernalization towards the lower temperatures and it attains 5°C at the 50 per cent vernalization level. This phenomenon can be explained by the synthesis or activation of new types of enzymes exhibiting high activity at lower temperatures. The phenomenon observed plays an important part in the development of winter hardiness and frost resistance of wheat plant. It is most probable that the dehydroascorbic acid reductase, which controls the SH content, assures the level of the coenzyme.

Introduction

In a previous study (DÉVAY 1962) we succeeded in establishing that, essentially, three processes supplementing each other take place during the vernalization of wheat: 1. The development of winter hardiness and that of the capacity to make preparation for winter time. 2. The synthesis of hormonal or other factors of the transition from vegetative into generative stage. 3. The influence of vernalization requirement and/or degree of autumnal character on the various processes. The author intends, in the present paper, to report on the development of the capacity to prepare for the winter and on results obtained in connection of winter hardiness with the degree of vernalization.

Material and Method

Investigations were conducted on winter wheat *Bánkuti 1201*. The experimental seed material had been swollen for 12 hours at 20°C and subsequently germinated for 24 hours at the same temperature. During this period the embryo had broken through the seed coat. Then vernalization had been conducted at 0°C in a refrigerator for 0, 12, 24, 36 and 48 days; these periods correspond to 0, 25, 50, 75 and 100 per cent degree of vernalization. After vernalization the germs were planted in wet sand for further examinations and raised on artificial light until their two-leaf stage (DÉVAY 1962). The young plants were washed out of the sand in due time and the ascorbic acid oxidizing capacity of shoots and roots determined from the average of twice 100 plants, at 0, 5, 10 and 20°C temperature.

The determination of the ascorbic acid oxidizing capacity in vitro

The shoot and root parts after having been carefully cleaned from sand, were homogenized in turmix homogenizator in 100 ml 0.15 *M*, pH 5.6 phosphate buffer and, subsequently, the homogenizate was put through a silk bolter tissue No. 8. Then 2 ml solution containing a total of 500 γ ascorbic acid and 10 γ copper sulphate was added to 2 ml homogenizate. The period of the reaction was 60 minutes. Once reaction period being over, the proteins were precipitated with an amount of 10 per cent ice-cold metaphosphoric acid in order to obtain 5 per cent final metaphosphoric acid concentration of the solution. The amount of ascorbic acid was subsequently determined with dichlorophenol-indophenolic titration. As a control we used, in all cases, a sample taken and titrated after 0 minute reaction i.e. at once, and a sample being kept for 60 minutes at the temperature of the reaction and not containing any enzyme, but the pure phosphate buffer, vitamin C and $CuSO_4$. From the sample we used as a measure of the ascorbic acid decrease the relative number of the γ ascorbic acid (1 mg protein) 60 minutes and established this as activity. The accuracy of the determination was, taking the serial deviation as a basis, ± 2.5 per cent on the average. The changes demonstrated were, in all cases, significant[—].

Results and Discussion

With our investigations we have been tracing the ascorbic acid oxidizing capacity of the shoots and roots of plants at different levels of vernalization. The results are presented in Figs 1—2. On the three dimension diagrams there has been illustrated the development of the ascorbic acid oxidation capacity both as a function of the degree of vernalization and that the temperature changes, between the limits of 0° and 20°C.

From Fig. 1 it clearly appears that the ascorbic acid oxidizing capacity is to change at various temperatures, with the progress of vernalization according to a maximum curve, though the site of the maximum is shifting. At higher (20°C) temperature the highest activity is shown by plants being not in the

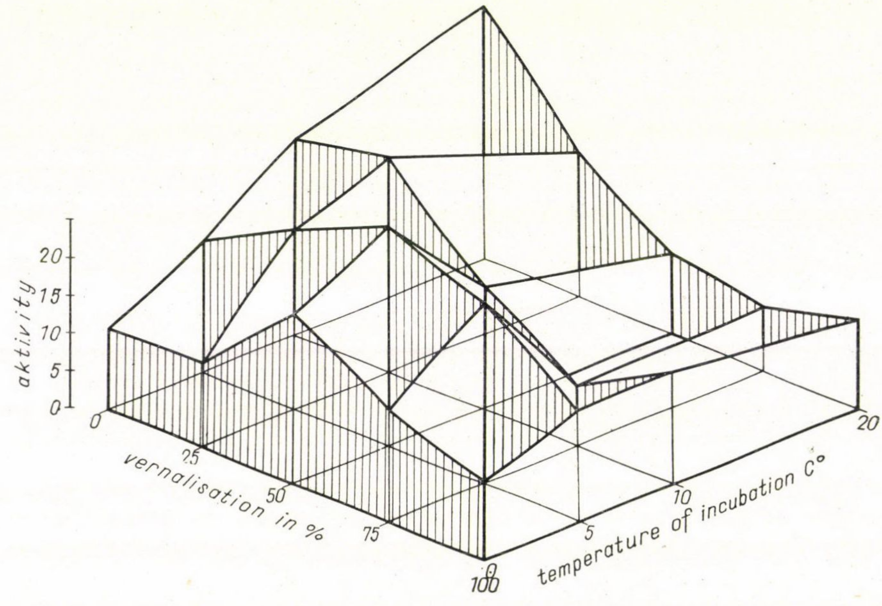

Fig. 1. The changes of ascorbic acid oxidizing capacity in the course of vernalization in shoots.

vernalization stage, while progressing towards lower temperatures, the site of the maximum is gradually shifting to the later stages of vernalization. The case seems to be similar when examining temperature dependence of the diminution of ascorbic acid at different levels of vernalization. The temperature maximum of the ascorbic acid oxidizing activity is shifting with the progress of vernalization towards the lower temperatures, indicating that one must

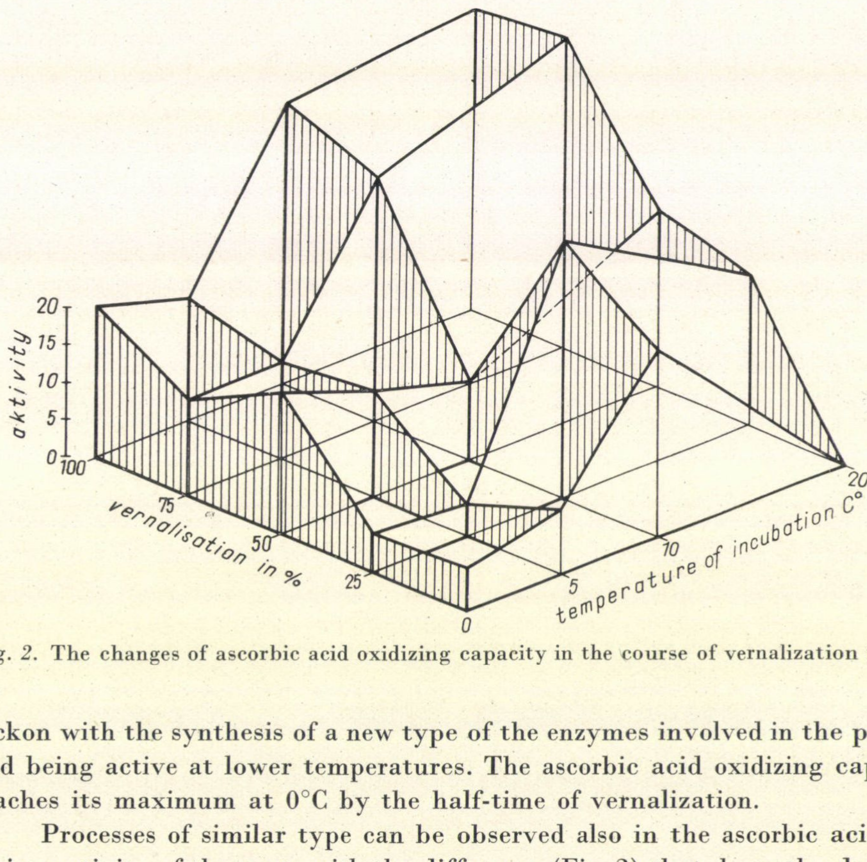

Fig. 2. The changes of ascorbic acid oxidizing capacity in the course of vernalization in root

reckon with the synthesis of a new type of the enzymes involved in the process and being active at lower temperatures. The ascorbic acid oxidizing capacity reaches its maximum at 0°C by the half-time of vernalization.

Processes of similar type can be observed also in the ascorbic acid oxidizing activity of the roots with the difference (Fig. 2) that, here, the development of the maxima occurs in other periods of vernalization. Particularly conspicuous is the first maximum developing in the first phase of vernalization at the 10° C temperature level.

It is well known that the SH content is a new field of investigation in the biochemistry of frost resistance (LEVITT, SULLIVAN 1961). It has been as well known for a long time, that, in the development of winter hardiness, two important factors are mainly involved: 1. the concentration of the cell sap and the sugar content of the plants, 2. the physico-chemical properties of the plasma. The first one is probably related to the changes of amilase activity. Results obtained in this domain will be reported elsewhere. The second point, the physicochemical condition of the plasma, depends on the number of the polar groups and, by implication, also on the SH content. This has subsequently led to the recognition that the SH groups play an important role in the development of frost resistance.

According to WAISEL, KOHN, LEVITT (1962) the GSH oxidation is not connected in the first half of vernalization, with the induction of flowering. Increased GSH oxidation, during vernalization, is not supposed to be related to the enhancement of the enzyme dehydro ascorbic acid reductase but to that of its co-factor, the dehydro ascorbic acid. As to the dehydro ascorbic acid content, it still depends on ascorbic acid oxidase activity. Therefore, it may be assumed that the ascorbic oxidizing enzyme observed by us and proving to be very active around 0—5°C is responsible for the high DHA level.

The preparation for the wintering and, by implication, the development of frost resistance must be composed in all probability, of the following steps:

1. The synthesis of new enzymes being active at low temperatures, which process takes place as part of the vernalization.

2. As a consequence to the appearance of the new type of enzyme, the DHA content of the tissues is increasing.

3. The DHA level, as a co-factor, is to regulate the SH content.

The development of new proteins, new enzymes with a low temperature optimum i.e. that, of the ascorbin oxidizing system in our case, is also supported by the fact that if the seeds to be vernalized are treated with 10^{-2} per cent acridine orange or dinitrophenol, or chloramphenicol of similar concentration, this phenomenon cannot be observed. The process is not influenced by the use of other respiration poisons e.g. sodium arsenate. The enzyme developed is, in all probability, ascorbic acid oxidase (Table 1) in view of the fact that 87 per cent of ascorbic acid diminution can be ascribed to the activity of the enzyme.

Isolation and analysis of the enzyme are being prepared.

Table 1

The proportion of the different ascorbic acid consuming systems in the shoot of the wheat plant at 50 per cent vernalization level

(on the basis of calculated ascorbic acid diminution) at 0°C

Ascorbin oxidase	87 per cent
Polyphenol oxidase	8 per cent
Citrochrome system	5 per cent

Conclusions

The ascorbic acid oxidizing capacity of the shoots and roots of young wheat plants at different vernalization levels has been investigated in vitro and it has been established that:

1. The ascorbic acid oxidizing capacity of shoot and root changes with the progress of vernalization in dependence on temperature.

2. The temperature optimum of the ascorbic acid oxidizing system is shifting with the progress of vernalization towards the lower temperatures and it attains 5°C at the 50 per cent vernalization level. This phenomenon can be explained by the synthesis or activation of new types of enzymes exhibiting high activity at lower temperatures.

3. Ascorbic acid oxidation can be ascribed, to 87 per cent, to ascorbic acid oxidase activity.

4. The phenomenon observed plays an important part in the development of winter hardiness and frost resistance of the wheat plant. The dehydro ascorbic acid reductase controlling the SH content presumably assures the level of the co-enzyme.

5. The development of the new enzyme requires DNA and energy, in consideration of the fact that acridine orange and DNP and chloramphenicol are inhibiting the process.

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DATA OF THE NITROGEN AND AMINO ACID METABOLISM IN WHEAT

By

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The composition and quantitative change of amino acids were studied in leaves and roots of winter wheat as influenced by different N-supplies. It has been established that in wheat shoots asparagine, alanine, glutamic and γ-amino butyric acid are present in majority. Under the influence of highly different N-supply levels, no quantitative divergency appears in the spectrum of amino acids. The amino acid contents of shoots indicate, in a sensitive manner, the rate of N-supplying; as much as 300 per cent differences could be proved between the variants. As to the values of dry weight, amino acid and N-composition a better parallelism has been found between them than in the case of concentration.

Introduction

It has not been quite known so far how the decreased N-contents of the soil influence — in the course of initial autumn development — the N-uptake of wheat and the protein synthesis respectively. Concerning protein metabolism as described by FARKAS (1963), many plant physiology problems have arisen recently which problems result from the peculiar organization of the plant. Though after germination the seedling has much space at its disposal, practically the N-contents of only a small area can be taken into consideration, the one covered with the network of the roots since the migration of the nutrient ions in the soil is very slow.

From the work of DÉVAY (1962) it has become evident that if seedlings are deprived of nitrogen in the first 12 days of their development, the number of heads will decrease even if they are afterwards given plenty of nitrogen. Wheats that had been sown in time and being well supplied, will have grown thick before the beginning of winter (DÉZSI—DÉVAY—NAGY—PÁLFI, 1960). The photosyzing surface being thus increased, it can store a larger quantity of organic substances in the root-system. Nowadays the importance of carbohydrates and free amino acids is well known in connection with vernalization and winter hardiness (DÉVAY, 1962; TELTSCHEROVA, 1962; TRUNOVA, 1963) as well as with disease resistance (FARKAS, 1963; KIRÁLY—FARKAS, 1957; SOLYMOSY—FARKAS, 1963).

In our present experiment we aimed at elucidating the behaviour of N-contents of wheat shoots in a culture medium with total and decreased N;

and whether there is any difference of quality in the free amino acid store of wheat shoots due to different levels of N supplying. We also wanted to know if there is any change in total amino acids of the wheat shoots according to the degree of N supply.

Materials and Method

As culture medium quartz sand washed up chemically was used. The variants in 6 liter culture dishes were set up in three repetitions; as culture fluids KNOP total applied were then that of 1/2 N and of 1/10 N contents. To the medium HOAGLAND A—Z microelement and 5 per cent ferric chloride were separately added. In order to equalize the concentration, instead of the calcium and potassium nitrate that had been withdrawn, corresponding quantities of calcium sulphate (FRENYÓ, 1959) were supplied.

The sowing of the *Bánkuti 1201* variety was performed on the 5th October, 1963. The wheat having been raised in sunshine, was thinned after 6 days of emergence to the usual plant distance as used in the field. Every day the culture was given alternately culture fluid and dist. water. The concentration of the culture medium had been checked up and adjusted weekly. Sampling of the shoots had been done on every 12th day — 100 shoots of each variant — althogether five times. In December, when hard frost set in, we washed out the roots, too.

Samples were fixed and dried at 65°C. They were ground to powder and then required quantities being destructed with sulphuric acid, the total nitrogen was measured photometrically after NESSLER reaction.

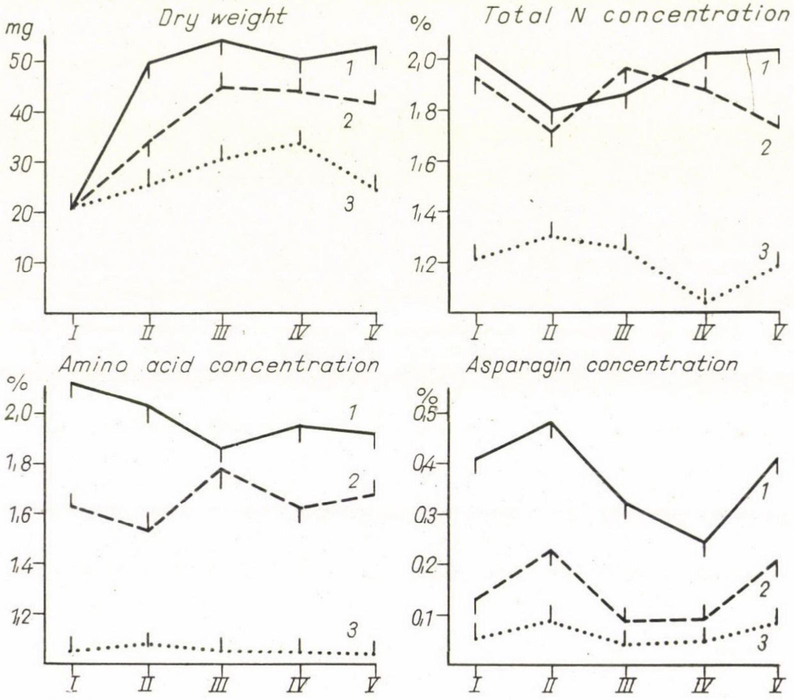

Fig. 1. Total N, total amino acid and asparagine concentration in wheat shoots raised at different N-levels expressed in the % of dry material. 1 = total N; 2 = 1/2 N; 3 = 1/10 N; I—V = the order of samples taken on every 12th day. The length of the vertical short-lines indicate the rate of the average error

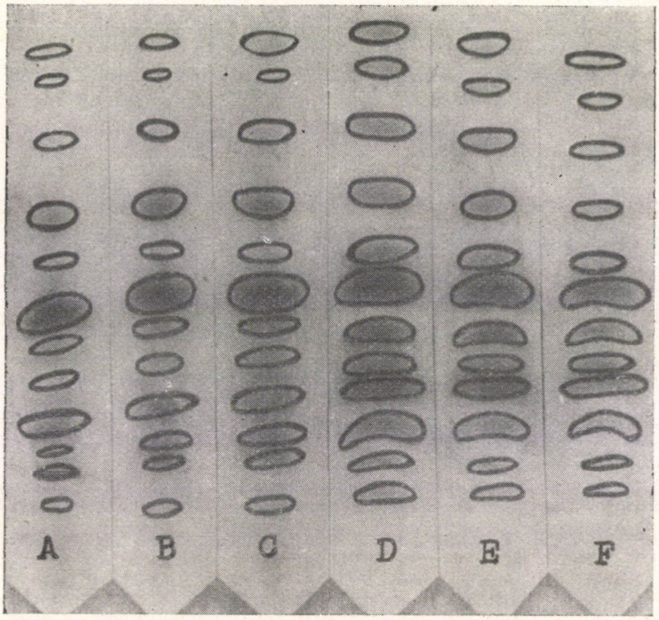

Fig. 2. Amino acids in the wheat shoots on the occasion of the first sampling. A = 1/10 N; B = 1/2 N; C = total N; D = universal standard with 50 g total amino acids; E = univ. stand. with 37.5 g total amino acids; F = univ. stand. with 25 g total amino acid contents

	Amino acids of the universal standard (D strip)
1. Leu	1.5 g
2. Phen	3.0 ,,
3. Val	1.5 ,,
4. γ-amb	1.5 ,,
5. Pro	5.0 ,,
6. Ala	5.0 ,,
7. Glu + Ser	6.0 ,,
8. Gly + Glu$-NH_2$	3.5 ,,
9. Asp	10.0 ,,
10. Asp$-NH_2$	8.0 ,,
11 Lys	1.0 ,,
12. Cys	4.0 ,,

The detection of amino acids was carried out with rising paper chromatography method starting from the air-dry weight.

The 70 per cent ethanol extracts were added on Whatman No 1 paper in four repetitions. The solvent was butanol—glacial acetic acid — water (2 : 1 : 1). With one-dimension evolvement retarded by cooling (at 0°C for 24 hours), prolonged and repeated runs, respectively, were also performed. In case of a two-dimension identification on Sch.-Sch. No. 2043b paper, we used the mixture of phenol—water (4 : 1), with ninhydrine development. As to the method those of "universal standard mixture" and of "quick eluational determination of total amino acid" have been applied (Pálfi, 1963; Pálfi, 1963; Szalai, 1957). The main point in this process is that the composition of the standard amino acid is similar to the amino acid supply of the plant extracts. On determining the total amino acid, one develops a series of standard-mixture concentration with the unknown extracts, on a paper without evolvement, with ninhydrine. The spots that have been fixed with a mixture of copper-salt, are photometered by alcoholic eluation. The extinction values of the eluated standard spots give the calibration curve.

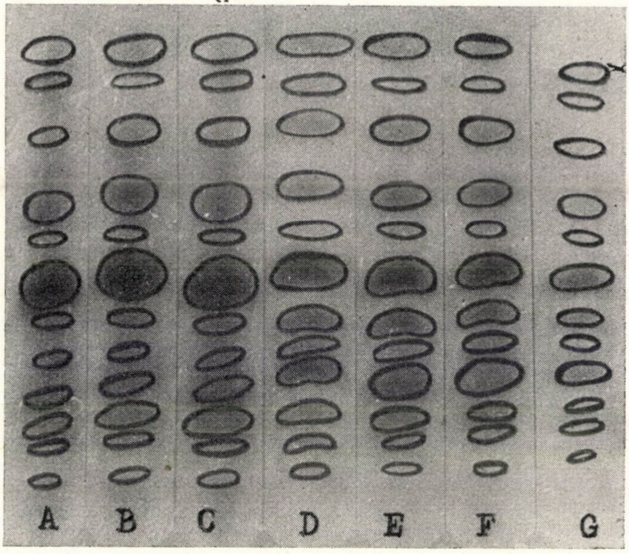

Fig. 3. Amino acids of the wheat shoots and of the roots on the occasion of the 5th sampling. A = shoot 1/10 N; B = shoot 1/2 N; C = shoot total N; D = univ. stand. with 50 g total amino acid; E = root total N; F = root 1/2 N; G = root 1/10 N

Amino acids of the standard (D)

1. Leu
2. Phen
3. Val
4. γ-amb
5. Pro
6. Ala
7. Glu + Ser
8. Gly + Glu$-NH_2$
9. Asp
10. Asp$-NH_2$
11. Lys
12. Cys

Experimental Procedure

Wheats once being given total nitrogen and 1/2 N portion, have developed normally. Wheat plants being raised on 1/10 of the N in the Knop culture fluid, have remained stunted and have not grown thick. In Fig. 1 the dry weight of the shoots shows distinctly the difference in N supplying. With total N concentrations expressed in the per cent of dry material, wheats raised both on total N portion and on half N portion, produced almost identical value (Fig. 1). However, the total N concentration of the wheat raised on one tenth of the normal N portion has considerably lagged behind the two other variants. With the total amino acid concentrations, the first and second treatments are equally different although with the total N concentration no difference has appeared (Fig. 1). The variant with greatly diminished N portion, shows considerably less values than the other two ones.

As to asparagine concentrations, it has already been proved in the course of experiments with rice (Pálfi, 1963; Pálfi, 1963), that its rate changes parallel with the total N concentration in the plant being cultivated under normal conditions. From Fig. 1 it can be seen that the asparagine quantity displays similar tendency.

When establishing the free amino acids, it had been evidenced that the great difference in N supply does not create *qualitative changes* (Figs 2, 3). From the chromatogram pictures it can also be established that the amino acids of the universal standard mixture are at the same level as the spots of the wheat extracts (Figs 2, 3).

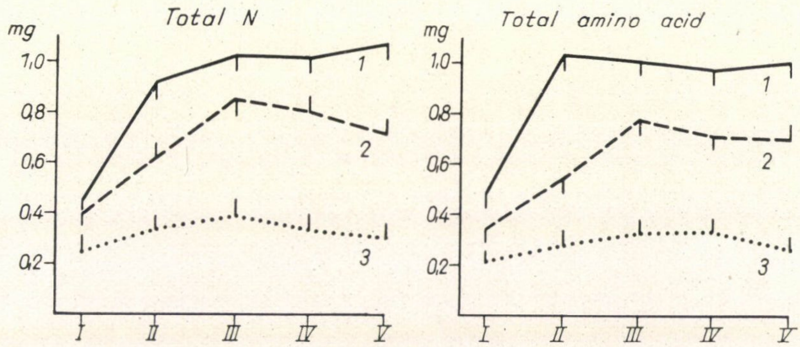

Fig. 4. Total N and total amino acids in the dry material of wheat shoots raised at different N levels, in mgs

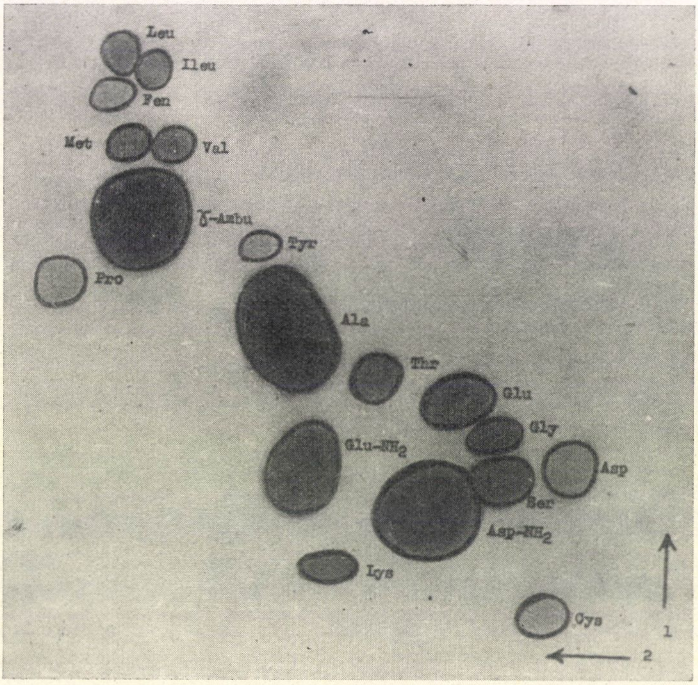

Fig. 5. Amino acids of wheat shoots on the occasion of the 5th sampling. 1. dim = butanol—glacial acetic acid—water (2 : 1 : 1); 2. dim. = phenol—water (4 : 1) Evolvement = 5° C, 24 hours

Out of young wheat shoots asparagine, alanine, glutamine, γ-amino butyric acid and glutamic acid could be evidenced in largest quantity (Figs 2, 3 and 5).

If the concentration data of the variants are referred to the total dry material per shoot, we shall obtain results being proportional to N supply (Pálfy—Dézsi, 1960). Fig. 4 shows that in the case of total N, treatments 1 and 2 produce considerably divergent results although our concentration data have not diverged considerably (Fig. 1). With the total amino acid curves in Fig. 4, the values of the variants being raised on total and 1/10 portion, differ as much as 300 per cent. The amino acids of roots that had been washed out were compared with the amino acid contents of the shoots. The results obtained have shown that the shoots contain considerably more γ-amino butyric acid, alanine and asparagine (Figs 3 and 5). The roots on the other hand, are remarkable for their high glutamine and glutamic acid contents (Fig. 6). The changes of amino acids in wheats in connection with supply will be further investigated.

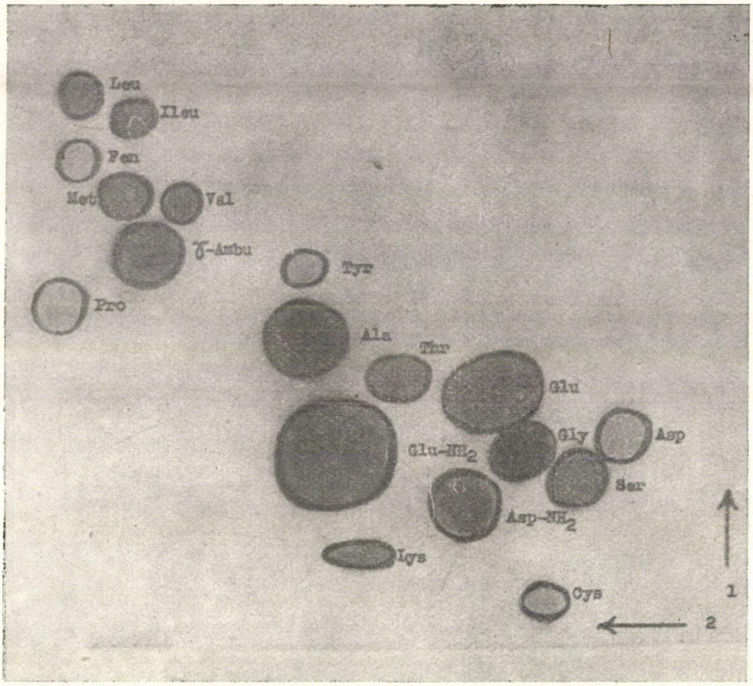

Fig. 6. Amino acids in the roots of wheat on the occasion of the 5th samplings. Evolvement same as in Fig. 5

Results and Discussion

When referring the evinced N concentrations to the total dry material in shoots of the variants, the differences obtained will be corresponding to the rate of N supply (Fig. 4). From this it can be concluded that the contents of the nutrients reveal the supply just as well as the concentration values (Gros, 1955; Lloyd, 1961; Schlichting, 1955). In wheat shoots there prevail — according to quantity — asparagine, alanine, glutamine and γ-amino butyric acid, though, the quantity of leucine and valine is still considerable (Figs 2, 3, 5 and 6). Similar statement has been made by Cocking and Yemm (1961) in the case of barley.

Between wheats raised on total N portion and on culture fluid with N contents reduced to the tenth, the difference concerning amino acid concentration, exceeds sometimes even the 100% (Fig. 1).

The brown spot produced by asparagine with ninhydrine will appear in an independent spot in case of one-dimensioned evolvement delayed through cooling (Figs 2, 3). When following with attention its quantity, it has become evident that in case of wheat seedlings, its concentration changes parallel with the rate of N supply (Fig. 1). It is true that in wheat shoots the glutamine is also present in considerable quantity, but, the concentration of asparagine is still more constant; a fact explained by the cyclic structure (DOBY, 1959). Owing to this asparagine is taking a better part in storing N and amino group, respectively. The intensity of protein synthesis might decrease in case of virus or fungus infection (HARPAZ—APPLEBAUM, 1961). Similar effect might be induced also by long-lasting damaging environmental circumstances (e.g. alkali soil). Under such circumstances the asparagine concentration might increase (PÁLFI, 1963). The latter case can be concluded to if both dry weight and total N contents in the examined variant is being decreased. The primary role of asparagine and glutamine in the N metabolism of wheat is also proved by the results of HELLEBUST and BIDWELL (1963), results obtained with radioactive isotope.

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WINTER WHEAT MANURING EXPERIMENT

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The effect of phosphorus and potassium fertilizer application was examined in two consecutive years in the relationship of different nitrogen dosage rates. Nitrogen fertilizer application proved to be unequivocally very effective, while phosphorus exerted a more moderate yield increasing effect only with a high rate of nitrogen fertilizer application. No potassium effect could be demonstrated in this experiment.

Introduction

The optimum ratio of active principle given with the chemical fertilizer depends on many factors. Recently the significance of nitrogen restoration has been largely increasing. In the field experiment with NPK chemical fertilizers on wheat conducted by PRASHAR and AINGH (1963) only the nitrogen fertilizer resulted in a considerable excess yield and showed some residual effect, whereas phosphorus and potassium had less influence on the yield. In the studies of SEN, BAINS and MATHUR (1962) maize subsequent to legumes and then wheat with one-sided nitrogen fertilizer application gave the highest yield. One-sided phosphorus fertilizer application and still more phosphorus and potassium was injurious and sometimes caused even a depression. SARKADI (1963) when evaluating 384 data obtained from 36 experiments conducted in various regions of Hungary in 1956—1962 established very little effect with phosphorus applied alone to wheat while with higher nitrogen dosage rates the nitrogen—phosphorus diagram decisively exceeded the nitrogen diagram. On the average of experiments phosphorus effect was about half of that of nitrogen. According to DEZSŐ and MARTIN (1961) in the environments of Debrecen on some grassland soils phosphorus was in many cases more deficient than nitrogen. ECK, TUCKER and SCHLEHUBER (1963) had examined through seven years the effect of seven different increasing dosage rates on five wheat varieties. During seven experimental years phosphorus effect was obtained in five cases while nitrogen effect only in three. The highest grain yield on the average of seven years was obtained with the combined dosage of nitrogen and phosphorus. West-European literature (SCHÜLZE, 1961; ANNE, DUPUIS and MAROCKE, 1956; BLACKETT, 1957; LINSER and PRIMOST, 1958; WID-

DOWSON, PENNI and WILLIAMS, 1961; etc.) has reflected in the last decade and in conformity with the latest results obtained in Hungary the decisive influence of nitrogen, on regularly fertilized soils and particularly in the case of the so-called intensive wheat varieties.

In chernosem forest rest soils of Martonvásár the nitrogen fertilizer application to wheat is the most important yield increasing factor while phosphorus and potassium effect was exceptional. As it is only evident that above a certain nitrogen level also phosphorus and potassium effect is to be present, our experiment has examined the possibilities of making phosphorus and potassium fertilizer application more effective.

Experimental Procedure

The experiment was conducted on grassland loam of medium cultural condition (according to genetical classification: chernosem with forest rests), after mixture of oats and vetches in the first year (1961—62), while in the second one (1962—63) after sweet sudan grass grown for green fodder as previous crops. The experimental soil has contained 3.5 per cent humus, 0.11 per cent total N, 64 mg total P per 100 g of soil, 8.2 mg available (according to EGNER) P, 600 mg total or 20 mg available K and thus it can be described as well provided with phosphorus and potassium.

During the winter 1961—62 with about average temperature from December 20 to March 25 the soil was seven times covered by snow, with two occasions of the most crucial cooling down. Except for November and January the vegetation period was characterized by a considerable deficiency of precipitation. In 1962—63, during an exceedingly severe winter that lasted from November 23 until end of March the experimental soil was covered with snow from November 23 to March 11 with short interruptions, but in January a cooling off below —20°C without snow cover occurred. Distribution of precipitation was highly unfavourable.

Table 1

Data of precipitation measured on the experimental area

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean 1901—1940	31	31	39	46	66	62	50	52	52	53	46	43
1961												
Precipitation mm	20	46	0	45	68	22	29	6	2	19	100	33
Deviation mm	—11	15	—39	—1	2	—40	—21	—46	—50	—34	54	—10
Deviation %	—34	47	—100	—2	4	—63	—41	—89	—97	—64	120	—22
1962												
Precipitation mm	34	16	34	44	32	16	44	1	30	6	187	31
Deviation mm	3	—15	— 5	—2	—34	—46	— 6	—51	—22	—47	141	—12
Deviation %	8	—47	—13	—5	—52	—74	—12	—97	—42	—89	305	—28
1963												
Precipitation mm	70	75	29	43	25	72	58	68	103	17	17	38
Deviation mm	39	44	—10	—3	—41	10	8	18	51	—36	—29	— 5
Deviation %	13	14	—26	—6	—62	16	16	31	98	—68	—63	—12

The winter precipitation that fell abundantly as snow on the soil was frozen to a depth of 70 cm. On the rapid melting in March it ran off the surface. Spring in both years was drier than average with a significant lack of precipitation especially in the month of May. Data of precipitation measured on the experimental area are presented in Table 1.

The 3×3×3 factorial experiment included in two replications, all possible combinations of the chemical fertilizer active agent quantities involved in Table 2. The 27 possible combinations form, according to the plan 6, 7 of COCHRAN and COX (1957) 3 incomplete blocks in each replication; in the first one W, in the second X components of NPK interaction have been confounded with the block effect (Table 3).

After harvesting the mixture of oats and vetches, in the first year of the experiment, the stubble was stripped with tractor disk and then rolled. On Sept. 19 1961 the experimental

Table 2

Experimental treatments

Active agent	Levels		
	0	1	2
	containing. the following amount of active agent kg/ha		
N	0	70	140
P_2O_5	0	70	140
K_2O	0	70	140

area was ploughed 20 cm deep with rolling as a closing operation. On October 6 the soil was disked and after having marked out the plots (plot size 28.79 sq.m.) the total amount of superphosphate and potassium salt and one third of "pétisó"* were spread out and harrowed into the soil. On October 24 the experiment was sown with the winter wheat variety Besostaya 1, using 550 germinating seeds per sq.m. 2/3 of the nitrogen fertilizer (pétisó) applied on March 30 as head dressing. Phosphorus and potassium fertilizer — in contrast to the general practice in Hungary — has not been ploughed in because, according to local experience, it is more effective when applied flatly or, moreover, given as head dressing in spring time.

On the area of the 1962—63 experiment after the harvesting of Sudan grass on July 10 the stubble was stripped and rolled. On Sept. 17 the soil was ploughed to a depth of 20 cm with subsequent disking and harrowing. Superphosphate and potassium salt in their total amount and 1/3 of the pétisó had been applied before sowing and the experiment was sown again with the wheat variety Besostaya 1, 550 germinating seeds per sq.m. on October 17th. 2/3 of the nitrogen fertilizer was given April 3, 1963.

In both years the crop was protected from insect pests by autumn dusting with contact poison. Except for a medium mildew incidence no damages occurred in the experiments.

The yield of the first year's experiment was harvested on July 25., that of the second year on July 10. with the "Massey Ferguson 603" harvester-thresher. The grain was stored in sacks and weighed in air dry condition. Straw yield has not been weighed. From the results of weighings and observations carried out in this experiment the present paper proposes to bring out only the data of grain yield per plot.

Results and Discussion

Grain yield data of the experiment for both years and on the average of the two experimental years are presented in Tables 4, 5 and 6 calculated in kg per hectare. Data of the analysis of variance are shown in Table 7.

*Calcium carbonate—ammonium nitrate fertilizer manufactured in Pét (Hungary)

Table 3

Treatment combinations (in parentheses) and grain yield data (kg/plot)

(in the upper row the grain yield data of 1961/62, in the lower row those of 1962/63)

I.			II.		
npk	npk	npk	npk	npk	npk
(111)	(220)	(201)	(202)	(112)	(121)
12.3	13.2	12.6	13.1	13.8	15.0
7.9	10.0	9.6	8.0	7.3	7.6
(102)	(101)	(112)	(221)	(211)	(022)
13.2	13.0	13.7	15.8	14.7	12.1
7.7	8.7	9.2	9.6	10.3	5.1
(010)	(021)	(100)	(122)	(002)	(212)
12.5	11.7	13.8	15.2	11.8	13.9
5.3	6.1	8.4	7.5	5.1	9.4
(022)	(000)	(210)	(020)	(021)	(011)
11.4	11.2	14.2	12.2	11.4	11.4
5.3	5.9	10.7	4.9	4.8	7.3
(120)	(012)	(121)	(100)	(222)	(110)
14.4	12.3	14.6	14.4	15.1	15.3
10.9	6.8	9.7	7.3	10.5	8.8
(212)	(202)	(011)	(210)	(200)	(201)
14.9	14.0	13.8	15.2	13.9	14.3
11.0	10.7	6.2	9.0	8.7	8.4
(001)	(122)	(020)	(012)	(010)	(000)
13.1	14.4	13.8	12.3	12.7	13.1
6.4	10.2	6.2	6.9	5.2	7.6
(221)	(211)	(222)	(001)	(120)	(102)
16.0	14.8	16.5	12.0	14.8	14.1
10.2	10.1	10.9	6.5	9.9	9.2
(200)	(110)	(002)	(111)	(101)	(220)
14.9	13.5	12.7	15.0	14.7	15.1
8.0	7.9	5.3	8.4	7.6	8.9

In the year 1961/62 out of the experimental treatments only the nitrogen effect was significant (on the P = 0.1 per cent probability level) (Table 7). The linear component of the nitrogen effect was also significant at the P = 0.1 per cent while the quadratic component at the P = 1 per cent probability level. This implies that with increased nitrogen dosage rates no yield increase

Table 4

Means of grain yield in 1961/62 (kg/ha)

		P 0	P 1	P 2	Mean
	0	4278	4342	4203	4275
N	1	4817	4840	5118	4925
	2	4794	5077	5309	5060
Mean		4630	4753	4877	4753

		N 0	N 1	N 2	Mean
	0	4371	4991	5008	4790
K	1	4249	4898	5106	4751
	2	4203	4886	5066	4718
Mean		4275	4925	5060	4753

		P 0	P 1	P 2	Mean
	0	4707	4828	4834	4790
K	1	4614	4747	4892	4751
	2	4568	4684	4904	4718
Mean		4630	4753	4877	4753

Least significant differences (LSD) kg/ha

	Between means of treatments	Between means of inner cells
P = 5%	209.3	376.5
P = 1%	281.9	511.8
P = 0.1%	382.7	688.4

of direct proportion can be expected but the yield function increases with increasing doses at a diminishing rate.

In contrast to the nitrogen effect in phosphorus only the linear effect is significant (P = 5 per cent) while the quadratic effect is zero. After all the combined linear and quadratic phosphorus effect presents no significant result at the P = 5 per cent probability level.

Tabele 5

Means of grain yield in 1962/63 (kg/ha)

		P 0	P 1	P 2	Mean
	0	2131	2183	1876	2063
N	1	2831	2866	3231	2976
	2	3092	3503	3479	3358
Mean		2684	2850	2862	2799

		N 0	N 1	N 2	Mean
	0	2032	3080	3202	2771
K	1	2159	2889	3369	2806
	2	1997	2958	3503	2819
Mean		2063	2976	3358	2799

		P 0	P 1	P 2	Mean
	0	2657	2715	2941	2771
K	1	2733	2906	2779	2806
	2	2663	2929	2866	2819
Mean		2684	2850	2862	2799

Least significant differences (LSD) kg/ha

	Between means of treatments	Between means of inner cells
P = 5%	196.5	340.5
P = 1%	267.1	462.8
P = 0.1%	359.4	622.5

The nitrogen × phosphorus interaction is not significant, except for one of its components the N_1P_1 (linear × linear) interaction component. When investigating in detail (Table 4) phosphorus given without nitrogen fertilizer had no yield increasing effect. At the single dose nitrogen level, however, phosphorus increased significantly the yield (P = 5 per cent) and in the case of double nitrogen dosis a yield increasing effect was obtained even at the P = 0.1 per cent probability level.

Table 6

Means of two years' combined grain yields (kg/ha)

	P 0	P 1	P 2	Mean
N 0	3204	3262	3039	3169
N 1	3824	3853	4174	3950
N 2	3943	4290	4394	4209
Mean	3657	3802	3869	3776

	N 0	N 1	N 2	Mean
K 0	3202	4035	4105	3781
K 1	3204	3893	4238	3779
K 2	3100	3922	4284	3769
Mean	3169	3950	4209	3776

	P 0	P 1	P 2	Mean
K 0	3682	3772	3888	3781
K 1	3673	3827	3836	3779
K 2	3616	3807	3885	3769
Mean	3657	3802	3869	3776

Least significant differences (LSD) kg/ha

	Between means of treatments	Between means of inner cells
$P = 5\%$	139.4	241.5
$P = 1\%$	186.5	323.1
$P = 0.1\%$	244.9	424.3

In 1962/63, similarly to the results of the previous year, the greatest effect was obtained by the application of nitrogen fertilizer being both the linear. Nitrogen effect component and the quadratic component was significant; the former at the $P = 0.1$ per cent, the latter at the $P = 1$ per cent probability level (Table 7).

In this year neither of the components of the phosphorus effect was significant whereas the nitrogen $\times$ phosphorus interaction on account of the high linear $\times$ linear interaction-component was significant (P = 5 per cent). From the data of Table 5 it appears that — similarly to the previous year — phosphorus fertilizer application in itself did not increase, but combined with simple and double dosis nitrogen did increase the yield at the P = 1 per cent probability level.

The two years together. The combined results (Table 7) indicate that in the course of two year examinations the effect of nitrogen fertilizer application was the highest, followed in order of magnitude by the nitrogen $\times$ phosphorus interaction. Finally the linear effect of the phosphorus application was also significant (P = 1 per cent).

Beside those mentioned, other effects of experimental treatments — at the P = 5 per cent probability level — were not significant.

Conclusion

In both years greatest increase of yield was obtained from nitrogen fertilizer application. On the two year average 70 kg/ha nitrogen active agent was responsible for a surplus grain yield or 781 kg/ha while the 140 kg/ha nitrogen dosage rate for 1040 kg/ha as compared with the yield of the control plots. In the case of the small dosis 11.16 kg while with high nitrogen dosis 7.43 kg grain yield was obtained per kg of nitrogen active agent. Thus the measure of the yield increase was not proportionate to the dosage: with the increase of the nitrogen dosis the positive effect followed a diminishing trend.

Phosphorus fertilizer application resulted in both years in a considerably more modest surplus yield but on the other hand the effect on the given range of fertilizer application was explicitly linear for the whole experiment, particularly in the first year.

In this experiment a noteworthy nitrogen $\times$ phosphorus interaction appeared. Phosphorus given alone was ineffective while supplying in high dosis it caused a reduction of yield being almost a significant one (in the 1962/63 experiment). On the other hand phosphorus given together with the high nitrogen dosis invariably resulted in a significant increase of yield.

The potassium fertilizer application both in each year and on the two year average was ineffective and did not present an interaction either.

The 3-factor NPK interaction was not significant in either of the two years.

It should be stressed that the area of the experiment presented had received regular phosphate and potassium fertilizer application and its soil was primarily not deficient in these nutrients. In cases when the soil is not saturated with phosphorus the restitution of this nutrient may be of great importance even in the case of lower nitrogen levels.

Table 7

Analysis of variance

Source of variation	DF	MS 1961/62		MS 1962/63		DF	MS Two years total	
Years	—		—		—	1		854.58***
Replications	5		0.84		1.29	10		1.06
Treatments:								
N_1	1	46.0136***		125.0669***		1	161.3766***	
N_2	1	6.6008**		7.0023**		1	13.6042***	
N	2		26.31***		66.04***	2		87.49***
P_1	1	4.5511*		2.3511		1	6.7320**	
P_2	1	0.0000		0.5926		1	0.2960	
P	2		2.28		1.48	2		3.51*
N_1P_1	1	4.3350*		5.1338*		1	9.4572**	
N_1P_2	1	0.0939		0.0235		1	0.0117	
N_2P_1	1	0.1089		1.8368		1	1.4157	
N_2P_2	1	0.8067		2.9167		1	3.4087	
NP	4		1.34		2.48*	4		3.57**
K_1	1	0.3803		0.1736		1	0.0204	
K_2	1	0.0008		0.0112		1	0.0032	
K	2		0.19		0.10	2		0.01
N_1K_1	1	0.6338		1.4017		1	1.9594	
N_1K_2	1	0.1901		0.2689		1	0.0035	
N_2K_1	1	0.0401		1.0756		1	0.7665	
N_2K_2	1	0.0704		0.9869		1	0.7955	
NK	4		0.23		0.93	4		0.88
P_1K_1	1	0.5400		0.0817		1	0.1012	
P_1K_2	1	0.0355		0.6422		1	0.1872	
P_2K_1	1	0.2006		1.0272		1	0.1584	
P_2K_2	1	0.0017		0.2674		1	0.1120	
PK	4		0.19		0.50	4		0.14
NPK (unconfounded)	8		0.87		1.11	8		1.28
Treatments (total)	(26)		(2.74)**		(6.07)***	(26)		(7.98)***
Years + treatments	—		—		—	26		0.83
Error	22		0.76		0.67	44		0.71
	53					107		

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ALKALOIDAL CONTENTS OF DATURA SPECIES SIGNIFICANT FROM THE THERAPEUTICAL POINT OF VIEW DURING ONTOGENY

By

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Datura species with hyoscyamine and scopolamine as main alkaloids were examined during ontogeny in 11 different developmental phases established by the author in various organs, for total alkaloid contents. It has been found that both the percentual and absolute alkaloid contents exhibit ontogenetical variability. Two or less often three alkaloid maxima were observed according to species and organs during ontogeny. This phenomenon permits to assume remobilization and occasional new development of the alkaloids.

Introduction

Most of the 25 species of the genus *Datura* (SAFFORD, 1921) contain mostly tropane alkaloids. From the extended relative literature only the comprehensive works of BLAKESLEE (1957) and GERASIMENKO (1953, 1961) should be referred to. Some *Datura* species are also important from the therapeutical aspect as e.g. *Datura stramonium* L., *Datura meteloides* Dun., *Datura innoxia* Mill. and *Datura metel* L.

A number of communications were published on alkaloidal contents and composition of *Datura* species. Generally, data given for total alkaloidal contents show a wide range. E.g. according to MORITZ (1962) the leaves of *Datura stramonium* may contain 0.2 to 0.5 per cent of alkaloids. Deviations in alkaloidal contents may be traced back on the one hand to individual differences (individual spreading) and on the other hand to the influence of environmental factors. These causes, however, do not explain in every case completely the differences arising in alkaloidal contents. Thus it appears both justified and necessary to examine the plant species, in the present case the *Datura* species, for alkaloidal contents during ontogeny on as many occasions as possible in morphologically well defined developmental phases. Possible changes in alkaloidal contents during ontogeny present the ontogenetical characters of the plant species. Investigations of this kind make us acquainted with the rhythm of active agent production in medicinal herbs, while from the practical aspect they point to the labile character of the active agent contents and to the necessity of the knowledge of these changes to obtain more compensated raw material.

According to SCHRATZ (1963) ontogenetical variability manifests itself in the evolution of the plant individual. — The recognition of this variability is rendered difficult by the fact that simultaneously with the progress of the development of the plant undoubted changes of environmental conditions occur as well. — The ontogenetical variability of endogenous origin is accompanied by modifications of exogenous origin. The single effect of the two factors may be summarized or compensated, which can disturb to an unknown degree, the ontogenetical behaviour. When comparing the data of two or more years the modifying factors result mainly from the influence of the environment. The run of the diagrams, however, makes us acquainted in a manifold comparison, with the progress of the development of the alkaloidal content examined.

In recent literature some data are found which refer to the developments of alkaloids during ontogeny. E.g. in *Hyoscyamus muticus* AHMED and FAHMY (1949), in poppy SÁRKÁNY and DÁNOS (1957) in *Datura stramonium* KOLODZIEJSKI and KULASINA (1959) carefully recorded, beside alkaloid examinations, the morphological developmental stages of the plants. When setting up the present investigations we endeavoured to indicate — in knowledge of the body organization of *Datura* spp. — as many morphologically well defined phases as possible in 2 years' replication, to study the developments of alkaloidal contents, in order to be able to record changes as densely as possible. Results are presented in the following.

Materials and Methods

The following *Datura* species were used for investigations:

4 varieties of *Datura stramonium* L. of the hyoscyamine type according to the systemization of DANERT (1954); these are: *var. stramonium* L., *var. tatula* Torr., *var. inermis* Jacq. and *var. Godroni* Dan.; and on the other hand *Datura meteloides* Dun. and *Datura innoxia* Mill. of the scopolamine type.

In 1959—60 preliminary studies were conducted concerning the body organization of Datura species and a plant material true to species selected for further examinations. At the same time also phenological observations were made (G. VERZÁR-PETRI—S. SÁRKÁNY 1960) which were later utilized in the expert collection of plant material.

11 kinds of developmental phases were found to be well defined and characteristic of the species examined from which the collections were carried out. These phases were the following: I — seedling, II — nursling with 2 leafs, III — 3—6 foliage leaf young plant, IV — development of 1. branching, V — flower opened in the 1. branching, VI — flower opened in the 2. branching, VII — green fruit developed in the 1. branching, VIII — green fruit developed in the 2. branching, IX — ripe fruit in the 1. branching, X — 3—4 ripe fruits, XI — more than 5 ripe fruits. Developmental phases are illustrated by Figs 1—3.

The plant material was raised in the Botanical Garden of the University in 1961 and 1962 under identical conditions, apart from meteorological differences. Collection was made from the developmental phase just prevailing according to the plant material, taking into consideration the diurnal fluctuation, in the same hour of the morning. In a serene, dry weather we collected according to requirements different numbers of individuals, several thousand from seedlings and at least ten from developed plants. The collected plants were processed immediately. After dissection to organs the enzymes were inactivated at 105°C to 15' and then the plant material dried to dry weight at 60°C.

Total alkaloid determination was carried out with volumetric analysis according to the prescriptions of the Hungarian Pharmacopoeia, deviating from these only in the preparation

Fig. 1. Datura meteloides Dun. in the III. developmental phase

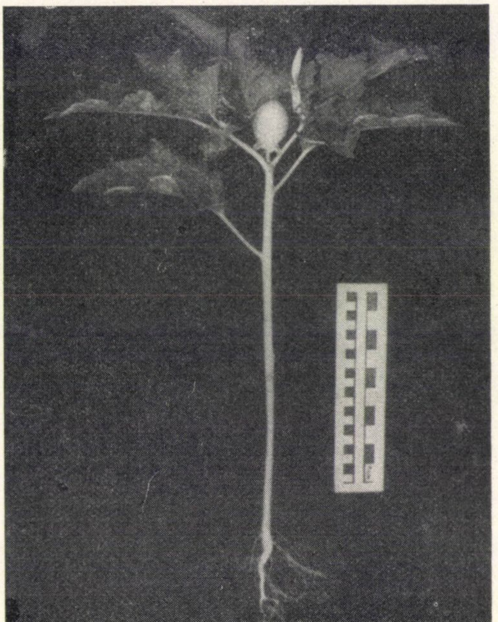

Fig. 2. Datura stramonium L. var. inermis Jacq. in the VII. developmental phase

of the extraction, giving preference to the ammonium digestion suggested by BERGER (1950) and to threefold cold chloroform shaking.

After having determined the green and dry weight of the collected plant material for each organ we calculated the absolute alkaloid content for the mean organ weights obtained from at least 10 measurements. Besides, we evaluated also the relative alkaloid per cent used generally in practice. The data have been tabulated and part of them graphically represented (see Tables 1—6 and Figs. 4—9).

Fig. 3. Datura stramonium L. var. tatula Torr. in the VIII. developmental phase

Results

Datura stramonium varieties

The roots of *var. stramonium* started to develop both in the 1. and 2. experimental year with a very low alkaloidal content (Table 1 and Fig. 4). In plants with two foliage leaves a rise can be observed both in percentual and absolute alkaloidal contents. With the strengthening of the plants and the start of the organization of the reproductive phase (Phase III, IV) the alkaloidal content in the root rises almost to its fourfold which decisively supports the view that in this phase there is a greatly increased metabolistic activity in the plant and the root is the place of renewed alkaloidal synthesis or accumulation. The start of flowering (Phase V) in the first experimental year resulted in a considerable reduction of the alkaloidal content of the root. This great reduction, however, was not verified by the second experimental year. In connection with this difference we may refer to the meteorological conditions since this phase was wetter in the first year than in the second. Thus the reduction of alkaloidal contents in the V phase is no characteristic feature of var. stramonium, but it may be traced back to the manifestation of the effect of meteorological, environmental or perhaps other factors. Simul-

Table 1

Developments of the alkaloidal content of Datura stramonium L. var. stramonium L. during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	Abs. alk. in mg
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	2. year	2. year
I.	0.089	0.103	0.001	0.133	0.168	0.003	0.133	0.140	0.005		
II.	0.129	0.156	0.003	0.153	0.160	0.005	0.096	0.105	0.012		
III.	0.498	0.530	0.84	0.140	0.250	0.06	0.257	0.260	0.84		
IV.	0.480	0.465	0.68	0.165	0.463	1.66	0.165	0.192	1.72		
V.	0.096	0.281	1.068	0.102	0.384	4.22	0.126	0.241	6.049	0.203	0.087
VI.	0.219	0.225	1.26	0.213	0.220	4.26	0.165	0.180	5.40		
VII.	0.185	0.180	3.43	0.136	0.135	7.50	0.286	0.209	2.62		
VIII.	0.563	0.395	9.27	0.105	0.176	17.95	0.551	0.534	54.46		
IX.	0.205	0.228	3.19	0.173	0.176	10.91	0.235	0.234	14.50	0.199	0.57
X.	0.150	0.155	4.74	0.101	0.321	32.74	0.198	0.223	13.83		
XI.	0.63	0.120	3.74	0.050	0.187	22.66	0.095	0.179	14.17	0.215	2.88

taneously with flowering and the formation of the green fruit the alkaloid level establishes itself around 0.2 per cent. A new maximum (less sharply in the 2. year) is felt at the start of maturation while later the alkaloid level decreases again.

In the stem the total alkaloidal content is during ontogeny invariably lower than in the root; it amounts to 0.16 per cent on the average. An increase can only be observed in flowering (Phase V, VI). By the end of the vegetation

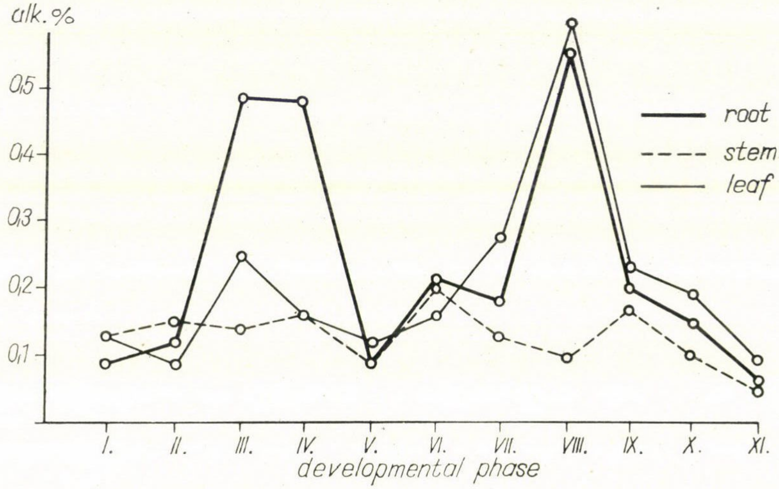

Fig. 4. Developments of the total alkaloidal contents of Datura stramonium L. var. stramonium L. in the vegetative organs during ontogeny (1. experimental year)

the alkaloid level in the stem decisively diminishes. In the 2. year the reduction was less explicit. The compensated alkaloid values which can be otherwise observed in the stem support the view that no alkaloid accumulation of varying measure occurs in this organ.

In the leaf the total alkaloid content is highly fluctuating. It begins with 0.13 per cent to attain 0.551 or 0.534 per cent by the start of maturation of the fruit. This maximum coincides with the root maximum. Later on, a considerable reduction of alkaloidal contents can be observed in the foliage leaf. During the same time (Phase VIII) when comparing the absolute alkaloid content of the leaf with that of the root it can be found that the alkaloidal content expressed in weight (mg) in the leaf is sixfold of that found in the root. Thus it proves very useful to compare the relative and absolute alkaloidal contents in the vegetative organs. The volume of the foliage strongly influences the absolute alkaloidal content of the leaf placing then the leaf as alkaloid source above the root.

Total alkaloidal contents of flower and fruit agree with literary data and somewhat increase with the maturation of the fruit.

Table 2

Developments of the alkaloidal content of Datura stramonium L. var. tatula Torr. during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	2. year	2. year
I.	0.270	0.282	0.0090	0.205	0.223	0.003	0.189	0.236	0.00826		
II.	0.280	0.282	0.012	0.225	0.220	0.016	0.176	0.250	0.01625		
III.	0.138	0.145	0.044	0.207	0.195	0.086	0.278	0.209	0.418		
IV.	0.213	0.190	0.315	0.147	0.149	0.557	0.165	0.218	2.040		
V.	0.222	0.128	0.576	0.239	0.249	3.013	0.184	0.123	3.087	0.325	1.79
VI.	0.142	0.091	0.637	0.135	0.202	4.352	0.220	0.280	9.510		
VII.	0.123	0.105	2.520	0.161	0.178	11.570	0.501	0.396	44.596		
VIII.	0.232	0.225	9.450	0.193	0.188	24.816	0.255	0.315	40.320		
IX.	0.281	0.290	10.440	0.141	0.168	16.80	0.267	0.302	36.844	0.289	34.10
X.	0.213	0.262	24.0516	0.093	0.196	14.308	0.226	0.419	71.900		
XI.	0.202	0.223	0.92	0.067	0.120	20.88	0.190	0.200	15.720	0.466	70.18

Total alkaloidal content of the seed (2. experimental year): 0.231 per cent.

In the organs of *var. tatula* the total alkaloidal content is more balanced as compared with the rhapsodic character observed in var. stramonium (Table 2, diagram 5). Alkaloidal contents given as per cent of dry weight are only temporarily higher in the root than in the leaves. The development of the root, in contrast to var. stramonium, begins with a high alkaloid synthesis. Already before flowering a slight maximum occurs. Later, with the progress

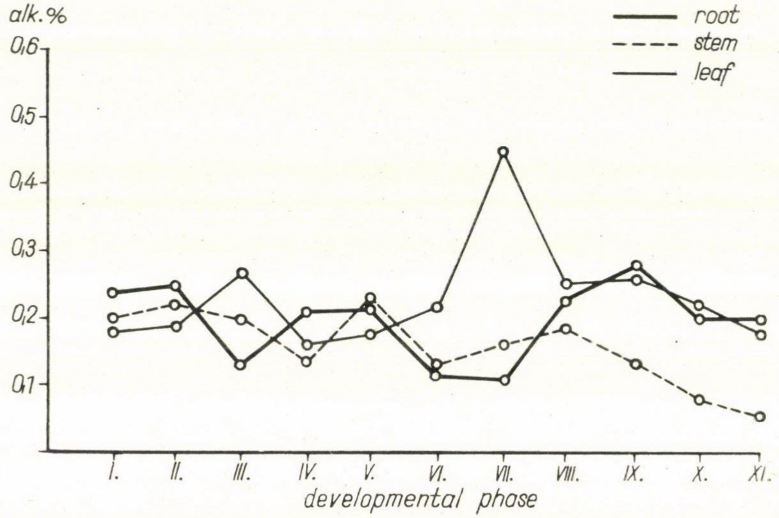

Fig. 5. Developments of the total alkaloidal contents of Datura stramonium L. var. tatula Torr. in the vegetative organs during ontogeny (1. experimental year)

of the maturation of the fruit (Phase IX), another maximum appears. Thus the two maxima at the time of flowering or maturation, respectively, are observable also in the var. tatula and as a third maximum that found in the seedling may be added. Percentual alkaloidal content of the stem lags behind that of the root. A fluctuation can be observed also here. The moderate maxima coincide with those of the root. The absolute alkaloidal content of the stem is highest in the VIII developmental phase.

The leaf mirrors, particularly in the 1. experimental year, the reversed developments of alkaloidal content found in the root. There is a maximum in the leaf when a minimum is found in the root (III, VII phase). In the 2. experimental year the maximum occurring at the ripening of the fruit repeats itself in a milder form. The first maximum fails to come about and thus has no ontogenetic significance.

The absolute alkaloidal content gradually increases in all organs. Also in this variety it is highest in the leaf, attaining its maximum in the X. phase (71.9 mg).

Table 3

Developments of the alkaloidal content of Datura stramonium L. var. inermis Jacq. during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year
I.	0.103	0.105	0.001	0.104	0.110	0.003	0.192	0.235	0.019		
II.	0.112	0.120	0.005	0.120	0.138	0.007	0.240	0.267	0.053		
III.	0.168	0.185	0.06	0.46	0.145	0.072	0.187	0.167	0.43		
IV.	0.280	0.295	0.413	0.162	0.306	1.07	0.165	0.282	2.23		
V.	0.427	0.405	3.40	0.170	0.123	2.16	0.186	0.189	6.64	0.206	0.79
VI.	0.179	0.241	1.59	0.083	0.478	10.61	0.247	0.146	4.18		
VII.	0.098	0.349	10.05	0.072	0.223	11.60	0.202	0.175	18.20		
VIII.	0.191	0.200	4	0.268	0.320	21.12	0.435	0.287	22.71	0.280	12.32
IX.	0.265	0.283	4.98	0.192	0.240	15.36	0.315	0.285	23.03	0.401	12.35
X.	0.202	0.225	4.05	0.059	0.230	15.53	0.232	0.286	23.60	0.229	14.54
XI.	0.192	0.220	3.78	0.062	0.160	10.24	0.237	0.235	14.85	0.217	8.59

Total alkaloidal content of the seed: 0.273%.
(2. experimental year)

The alkaloid content of flower and fruit is comparatively high: 0.3—0.46 per cent.

In the root of *var. inermis* (Table 3, Fig. 6), similarly to var. stramonium, two rather sharp maxima can be observed. These occur in Phase V (beginning of flowering) and in Phase IX (beginning of maturation). The difference against the former varieties is that here the first maximum is more important. Between the developments of absolute and percentual alkaloid

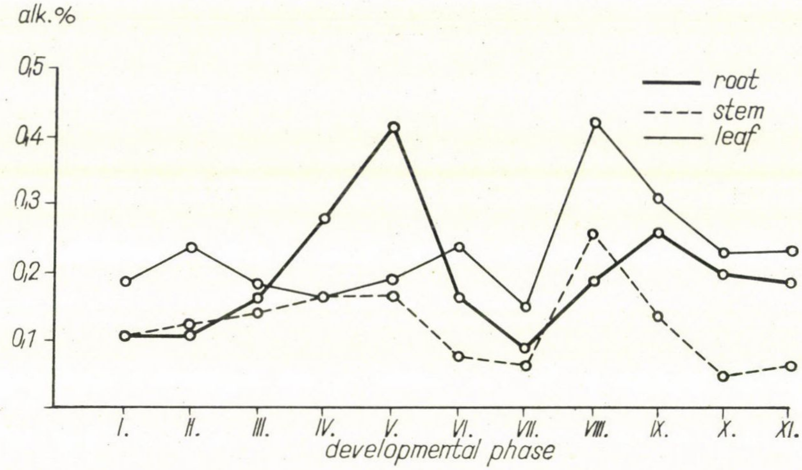

Fig. 6. Developments of the total alkaloidal contents of Datura stramonium L. var. inermis Jacq. in the vegetative organs during ontogeny (1. experimental year)

contents there is a definite difference in the VII phase which requires further examination.

In the first experimental year the alkaloid content of the stem attains 0.22 per cent only in the III and VII developmental phases. The data of the second year are somewhat higher.

In the leaf the total alkaloidal content shows a similar trend in both experimental years. Two maxima can be observed, at the beginning of flowering (Phase VI) and at maturation of the fruit (Phase VIII) of which the second is more important.

The absolute alkaloidal content of the vegetative organs is again the highest in the leaf, amounting to 98 mg in the X phase.

The alkaloidal content of the flower is 0.2 per cent while that of the fruit through 0.28—0.40 per cent diminishes to 0.21.

In *var. Godroni* (Table 4, and Fig. 7) the total alkaloidal content similarly to var. stramonium shows a more considerable fluctuation in the vegetative organs. In the root the two maxima also occur together with a final third one. The second maximum is decisively more considerable. The alkaloidal content

Table 4

Developments of the alkaloidal content of Datura stramonium L. var. Godroni Danert during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	Abs. alk. in mg
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	2. year	2. year
I.	0.093	0.126	0.008	0.076	0.150	0.0045	0.142	0.201	0.014		
II.	0.194	0.245	0.020	0.102	0.123	0.006	0.302	0.295	0.059		
III.	0.208	0.203	0.07	0.225	0.255	0.23	0.287	0.306	0.98		
IV.	0.383	0.390	1.01	0.146	0.203	1.28	0.206	0.223	3.35		
V.	0.355	0.365	2.92	0.282	0.285	6.13	0.394	0.425	21.97	0.235	0.75
VI.	0.248	0.270	4.49	0.136	0.140	5.74	0.205	0.215	12.36		
VII.	0.175	0.226	5.31	0.220	0.220	23.98	0.221	2.234	13.81		
VIII.	0.582	0.450	15.08	0.186	0.200	21.9	0.232	2.240	18.12		
IX.	0.279	0.302	11.17	0.096	0.106	13.78	0.395	0.457	59.41	0.246	18.20
X.	0.371	0.400	21.2	0.156	0.150	36.75	0.353	0.402	98.49		
XI.	0.269	0.276	35.47	0.050	0.120	39.61	0.153	0.203	67.5	0.236	81.42

Total alkaloidal content of the seed (2. experimental year): 0.215 per cent.

of the stem lags behind that of the root, similarly to the other varieties. The alkaloid maximum of the leaf follows, with a slight difference, the alkaloid maxima of the root. In comparison of the two years the change of the total alkaloidal contents is in close agreement.

The absolute alkaloidal content is again the highest in the leaf, attaining 98 mg (Phase X), similarly to var. inermis.

The alkaloidal contents of the flower and fruit are 0.23 — to 0.24 per cent, comparatively lower.

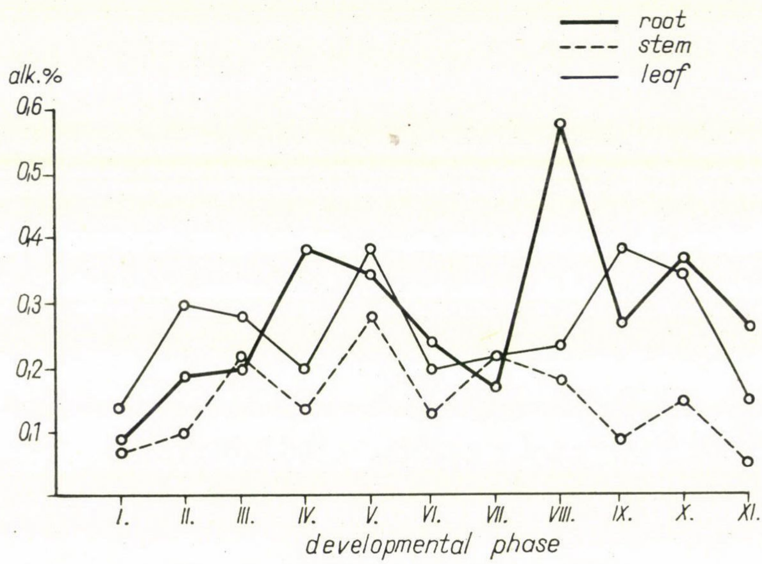

Fig. 7. Developments of the total alkaloidal contents of Datura stramonium L. var. Godroni Danert in the vegetative organs during ontogeny (1. experimental year)

In *Datura meteloides* the alkaloidal content during ontogeny (Table 5, Fig. 8) was averagely about 0.3 per cent in roots and leaves while in the stem a lesser amount, about 0.2 per cent could be demonstrated. Even in the root of the young seedling the total alkaloidal content is rather high. It decreases before flowering, then rises again for a short time at the maturation of the fruit. In the stem the total alkaloidal content at first runs parallel with the root but with the beginning of flowering (Phase V) contrarily increases, to gradually decrease later on. Its values always lag behind those of the root. The alkaloidal content of the leaf follows, until flowering, (Phase V) a definitely opposite trend to that of the root, but from this point on it runs parallel with the same.

The observable developments of total alkaloidal contents in Datura meteloides offer evidence of a very intensive alkaloid forming activity in the young seedling, especially in the leaf. The alkaloid level of the root follows an opposite trend. During the time when it is high in the leaf, before flowering,

Table 5

Developments of the alkaloidal content of Datura meteloides Dun. during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	Abs. alk. in mg
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	2. year	2. year
I.	0.293	0.315	0.003	0.205	0.234	0.0037	0.297	0.265	0.0053		
II.	0.275	0.304	0.009	0.227	0.260	0.03	0.327	0.304	0.012		
III.	0.253	0.260	0.026	0.162	0.203	0.08	0.305	0.315	0.32		
IV.	0.169	0.202	0.32	0.117	0.120	0.29	0.347	0.390	1.72		
V.	0.211	0.215	6.88	0.212	0.245	14.26	0.418	0.484	36.59	0.460	0.92
VI.	0.250	0.260	8.94	0.127	0.150	9.30	0.263	0.307	41.99		
VII.	0.219	0.219	10.25	0.117	0.137	17.21	0.381	0.305	39.41		
VIII.	0.305	0,305	12.57	0.141	0.142	25.16	0.317	0.306	19.16		
IX.	0.152	0.187	8.23	0.048	0.080	14.40	0.165	0.184	12.14	0.273	28.39
X.	0.138	0.165	9.74	0.073	0.115	23.46	0.212	0.200	16.00		
XI.	0.147	0.180	14.65	0.102	0.104	39.10	0.250	0.223	20.16	0.246	79.29

Total alkaloidal content of the seed (2. experimental year): 0.239 per cent.

it shows a decrease, while it increases in the stem, proving that a considerable transporting activity is going on there. There is no doubt that the onset of the reproductive phase closely influences the alkaloid level of the plant.

The absolute alkaloidal content lags behind that of the stramonium varieties. The absolute alkaloidal content of the root is the least to the end while at the beginning (at the flowering) it is higher in the leaf, later in the

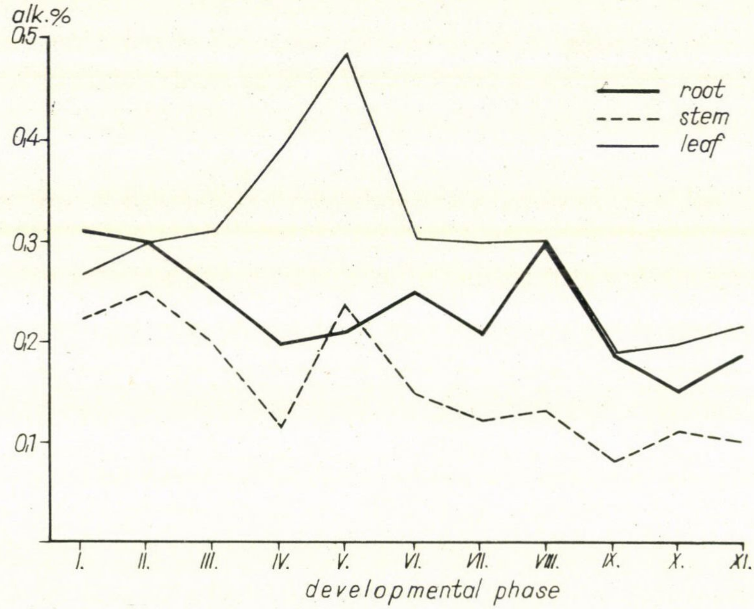

Fig. 8. Developments of the total alkaloidal contents of Datura meteloides Dun. in the vegetative organs during ontogeny (2. experimental year)

stem (maturation of the fruit). The trend of the absolute alkaloid content is really in close connection with the progress of the development of the plant. The shoot axis continuously grows, increases and develops branchings. The leaves are of comparatively smaller size and begin soon (Phase IX) to dry.

In the *Datura innoxia* (Table 6, Fig. 9) the total alkaloidal content in the seedling age is strikingly high in the root — 0.6 per cent — in both experimental years. The high alkaloidal content lasts until the III developmental phase and with the reproductive organization suddenly falls. Simultaneously with the organization of fruit the alkaloidal content of the root increases again and moreover, in the VII developmental phase an explicit maximum can be observed. In Phase IX also another mild maximum occurs. As a result 3 alkaloid peaks evolve in the root of *Datura innoxia*. At the stem the total alkaloidal content is less than half, with a rhythmic fluctuation during ontogeny, which, however, does not follow the changes of alkaloid demonstrable in the root but develops partly parallel with the alkaloidal content of the leaf.

Table 6

Developments of the alkaloidal content of Datura innoxia Mill. during ontogeny

Developmental phase	Root			Stem			Leaf			Flower or fruit	
	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent		Abs. alk. in mg	Total alkaloidal content in per cent	Abs. alk. in mg
	1. year	2. year	2. year	1. year	2. year	2. year	1. year	2. year	2. year	2. year	2. year
I.	0.601	0.625	0.006	0.302	0.252	0.013	0.259	0.305	0.0061		
II.	0.648	0.660	0.020	0.349	0.294	0.015	0.208	0.253	0.037		
III.	0.645	0.603	1.15	0.123	0.153	0.052	0.110	0.154	0.15		
IV.	0.295	0.346	0.55	0.215	0.202	0.78	0.180	0.200	1.8		
V.	0.085	0.250	3.05	0.121	0.143	4.92	0.264	0.270	18.47	0.223	35.54
VI.	0.367	0.302	6.28	0.096	0.105	5.63	0.317	0.325	18.85		
VII.	0.636	0.704	24.78	0.046	0.050	4.16	0.193	0.210	21.21		
VIII.	0.337	0.352	12.14	0.152	0.152	22.12	0.267	0.304	33.70		
IX.	0.425	0.464	36.47	0.107	0.123	33.21	0.208	0.228	46.19	0.145	18.27
X.	0.368	0.395	36.34	0.196	0.215	64.20	0.228	0.265	53.03		
XI.	0.177	0.213	17,04	0.110	0.120	21.91	0.165	0.202	30.99	0.196	11.99

Total alkaloidal content of the seed (2. experimental year): 0.281 per cent.

In the leaves the alkaloidal content is rather high again in young plants. During the III phase, i.e. earlier than in the root it decreases, then gradually rises again and earlier than in the root, as early as in the IV phase it attains the maximum, which fully coincides in both experimental years.

The two maxima found in the stramonium varieties cannot be observed in the leaves of *Datura innoxia*. The alkaloidal content of the flower is 0.22

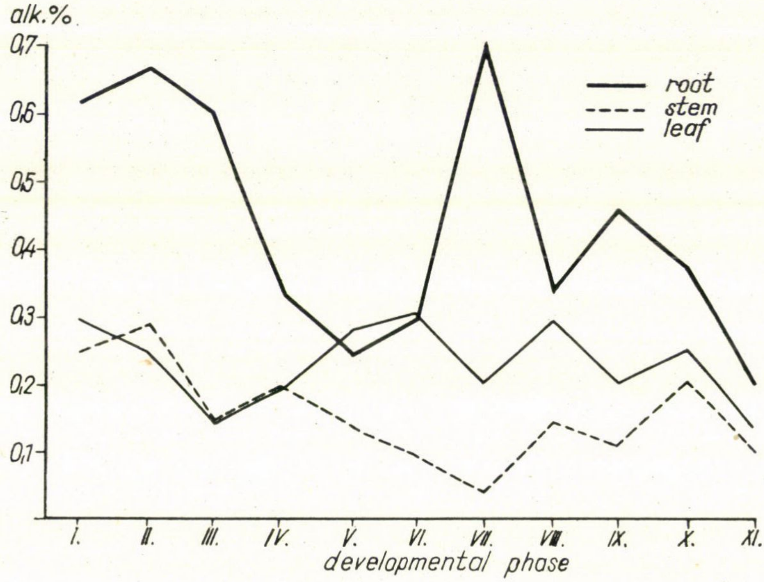

Fig. 9. Developments of the total alkaloidal contents of Datura innoxia Mill. in the vegetative organs during ontogeny (2. experimental year.)

per cent, that of the fruit in green condition 0.14 per cent, in ripe condition 0.19 per cent. The alkaloidal content of the ripe seed is 0.28 per cent.

The absolute alkaloidal content is the highest in the stem: 64.2 mg in the Phase X. The absolute alkaloidal content of the leaf is at the same time as high as 57 mg. In the root the maximum (IX phase) is 36.47 mg.

Conclusion

4 varieties of *Datura stramonium* L., *Datura meteloides* Dun. and *Datura innoxia* Mill. were examined within two years' replication for percentual and absolute alkaloidal contents in 11 phases of ontogeny established by the above-mentioned institute.

The per cent of total alkaloidal content in the various organs fluctuates on a wide range, between 0.2 and 0.8 per cent. From the organs examined generally the root has the highest alkaloidal content; there is somewhat less in the leaf and least of all in the stem.

As to absolute alkaloidal content generally the foliage is leading except for the thick-stemmed species *D. innoxia* Mill., *D. meteloides* Dun. where the absolute alkaloidal content of the shoot axis is significant.

For the Datura species examined it may be considered as generally valid that in the course of ontogeny at the various organs 2 or 3 alkaloid maxima arise. The maxima occur in flowering (or immediately before flowering) in Phase IV, V and later when the fruit begins to mature (Phase VIII, IX). A possible third alkaloid maximum may be observed by beginning of ontogeny (roots of *Datura stramonium* L. *var. tatula* Torr.) or at its end (roots of *Datura innoxia* Mill.).

The maxima observed in the various organs may occur simultaneously (*Datura stramonium* L. *var. stramonium* L. *var. inermis* Jacq.) or with a time interval (*D. stramonium* L. *var. tatula* Torr., *var. Godroni* Dan., *D. meteloides* Dun. and partly *D. innoxia* Mill.).

The intensive changes in alkaloid contents observed during ontogeny indicate a high grade and rapid rate of transporting activity and the maxima arising testify as well for alkaloid formation occurring on several occasions.

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APPROXIMATE QUANTITATIVE DETERMINATION OF LINALOOL IN CORIANDER OIL BY WAY OF LAYER CHROMATOGRAPHY

By

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I have elaborated a thin-layer chromatographic procedure for the approximate quantitative determination of the linalool content in coriander oil. The advantage of the method lies in the fact that the linalool content of volatile oils can be determined within one hour and a half.

Introduction

According to the data of GILDEMEISTER (1961), *Oleum coriandri* contains 60—70 per cent of linalool. That unsaturated tertiary alcohol is a very important aroma-substance being used especially in the perfume industry and in cosmetics; it is also applied as scent matter in soap manufacturing (GUENTHER 1957).

The main point of the method as applied by me, had been described by HEINDBRINK (1964); among others, he had determined the linalool content in Lavander oil, however, only reference had been made to his intention to report on it in a subsequent paper. Coriander oil has not been studied by him.

Materials and Methods

In my analyses I have used commercial coriander oil. The characteristic data of the volatile oil were the following: specific weight: 0.868, optical rotation: +9.65, refraction index 1.466, acid number: 2.0, ester number: 16.8, ester number after acetifying: 140.7. As test material pure linalool was used that had been obtained, through MEDIMPEX, from the firm Dragoco. For the chromatographic procedure 20×20 cm glass sheets were used; for 5 sheets a suspension of 20 g Kieselgel-G Merck and 45 ml water was prepared. After activating at 100° C for half an hour, and a subsequent cooling, the solution was dripped with a certified pipette of 0.1 ml. Of the oil solution drops of identical concentration were applied on each sheet, while of the linalool solution the drops were of increasing concentration. As solvent and as plating substance, benzene was equally used. The distance of plating was 10 cm. Plating was performed in two ways: a) plating in the generally used chromatography vessel; b) plating without using a closed chromatograph vessel — a method as suggested by WASICKY (1963); viz., placing two sheets into a glass tray having the width of a test-tube. This doing in such a way that the sheets faced each other with their smeared surface; a 2 mm wire bridle that had been bent twice in right angle, was installed between them. The glass sheets were fastened together with clips. Following the evaporation of the benzene, the sheets were placed in a vessel filled with bromide fumes; after being bromized for 3—5 minutes, they were placed under a heat-radiator so that the distance from the radiator was about 10 cm. A wire screen was placed under the sheets to prevent their eventual cracking. After cooling, the spots were assayed.

Assaying was performed in two different ways: a) On a sheet transilluminated from below, the spots were measured with the aid of a transparent plastic pattern. The pattern was made in a manner that the holes on the start line were 1.5 cm from the lower edge; through these holes the place of droppings could be marked with a needle. On the upper part of the sheet there were holes of different size, their diameters ranging from 3 mm to 15 mm. With the aid of these the size of the spots can be measured. b) The cooled sheets were transilluminated from below; a glass plate being placed on them, the spots were stencilled to a tracing paper and then measured with a planimeter.

The results obtained were illustrated graphically; the concentration was applied on axis X, while the values of the linalool solution that had been gained either by planimeter or by the pattern-method, were applied on axis Y, and from this the linalool content of the oil could be concluded to.

Results and Discussion

As it can be seen from the Table, when applying identical concentration on different sheets, the spots obtained are not of entirely identical size; it will be advised, therefore, to follow the method suggested by STAHL (1962) according to which it seems appropriate to apply to every sheet a test material of increasing concentration, too.

Table 1

Linalool content of coriander oil as measured with the pattern method

Spot diameter of the linalool-test in solutions of various dilutions					Diameter of the linalool spot of the oil	Measured oil in γ	Linalool per cent of the oil
62 γ	92 γ	125 γ	156 γ	187 γ			
11	12	13	13.5	14	13	181	63.5
10.5	11.5	13	14	14.5	12.5	181	63.5
12	12.5	13	13.5	—	12	90.7	68.3
62 γ	78 γ	94 γ	125 γ	156 γ			
10	11	11.5	13	14	11	90.7	68.3
9.5	10	10.5	11.5	12	10.5	90.7	68.3
10	10.5	11	12	12.5	10.5	90.7	68.3
9	9.5	10.5	11.5	12	9	83.8	83.4
10	10	11	11.5	12	10	83.8	83.4
9	10	10.5	—	12	9	83.8	83.4
62 γ	94 γ	125 γ	156 γ	181 γ			
10	10.5	—	12	12.5	10.5	97.5	79.8
9	10	11	12	12	9.5	97.5	82
8	9	9.5	10	10.5	8.5	97.5	82
9.5	11	11.5	12	12.5	10.5	121	64.4
9	10	11	11.5	—	9.5	97.5	79.8

In the present case plating without the use of a closed chromatography vessel suggested by WASICKY (1963), can be applied because the plating substance consists of one component only. The results are identical with those obtained in the customary plating runs performed with the use of a chromatography vessel. As advantage of the method it may be mentioned that only little plating substance is needed, on the other hand, its disadvantage is that the evaporating benzene used as substance, is very nocuous.

I have used a 10 cm plating method as, according to WALDI (1963), separation is most effective in the lower one third of the sheet. When the quantity of linalool is decided upon in a way that the concentration ranges from 60—62 γ to 180—187 γ, the spot-size will be proportional to the linalool concentration. However, when raising the quantity above 200 γ, the spot will not be round any more. With higher concentration, besides linalool 3 more components can be discerned in the volatile oil; one below linalool and two above it. One of these takes place at the front line. Since I have aimed at the quantitative determination of linalool, I have not followed with attention the other components, and have applied both linalool and the oil in a concentration that has rendered it possible to obtain round spots.

Under the influence of bromizing, with the spots of solutions having higher concentration, there becomes a yellow spot discernible; when, however, placing it under the heat radiator, the spot will increase, and on the layer that has remained colourless up till then, the spots, too, will become visible in about 5 minutes. The colour will then turn from yellow to brown. After cooling, the size of the spot will remain, however, the colour gets faded. This shade is now permanent; on heating it gets darker again but on cooling it will become lighter once more.

The assays were not performed in a separate, special room, and the relative humidity of the air in the laboratory was changing. It is well-known that the relative humidity of the air influences the Rf value not only on the alumina layer (GEISS and SCHLITT 1963), but also on Kieselgel-G (DALLAS 1965), submitting it seems — therefore — to be unnecessary because there is only one spot and the test material, too, runs along with it.

On basis of the average of the results obtained with the plastic pattern method, the linalool content of the examined coriander oil was 73.3%. Six sheets were measured with planimeter and thus the average was 72.6%. According to the statistical determination of error, in case of performing measurements with plastic pattern, the measuring accuracy is $= \frac{5}{6}$ a.e. $\pm$ 6.5%.

Conclusion

As can be seen from the above, the method may be applied for quick, approximate assaying. Its advantage lies in the fact that no special equipment is needed and, if sheets are prepared before, the maximum time for determining the linalool content of the volatile oil is not more than one hour and a half.

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EXAMINATION OF YIELD COMPONENTS BY PATH ANALYSIS, IN A FERTILIZER EXPERIMENT WITH WINTER WHEAT

By

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The yield components of a winter wheat experiment lasting two years were examined by the aid of the so-called "path analysis", taking into consideration the effects of treatment with fertilizers and of other, environmental influences. Though sampling error was great (51 per cent), it could clearly be demonstrated that the number of ears is hardly affected by fertilizing. The weight of grains per ear, however, was influenced (to 37 per cent) by nitrogen dressing.

Introduction

The yield components of winter wheat are differently affected by the treatments: certain characteristics scarcely change, others respond sensitively.

On examining the internal connections among features the method of path analysis has been used. The advantage of this procedure is that the direct effect of independent components (causes) and the correlation among them (if such exists) may be portrayed in a single diagram. The result of the path analysis is, therefore, exceedingly expressive and multi-variable connections can much better be illustrated by it than by the usual regression analysis. In the latter the expectable value of means is disintegrated, in the former the variances are resolved. The "path coefficient" itself is that part of the dispersion of Y, which depends on the variability of the x_i characteristic component (cause). Its important trait is that certain part of the entire process may expressively be represented even without respecting some parts of the main process. Therefore, the application of the path analysis is advantageous, if (as in many cases) the regression function chosen does not adequately meet the real biological state or if errors are great. Against the favourable attributes mentioned above stands the drawback that path analysis can only be applied for additive models and is unserviceable for expressing the effect of interactions.

The present paper is an example for using the path analysis when treatments (fertilizers) of the experiment as well as its environment (the blocks) are also included into the causal system. As it does not lay claim to draw far-reaching conclusions, only literature data pertaining to the analysis are quoted.

The method of path analysis, elaborated primarily by WRIGHT (1921, 1934, etc.) is chiefly applied in genetics. The handbooks of LI (1955), KEMPTHORNE (1957) and LE ROY (1960) describe the procedure in detail. According to literature it is also frequently used in field experiments. If beside total yield also other features — mostly yield components — are surveyed these may be dealt with in a "path diagram". The data of a winter wheat fertilizing experiment to be described below were elaborated so that the effect of treatments had also to manifest itself in the path diagram. Such evaluation of factorial experiments by path analysis is not habitual in literature.

Experimental Procedure

The effect of nitrogen fertilizers on the Soviet winter wheat variety Besostaya-1 was examined by KOLTAY in Martonvásár, applying collaterally P and K fertilizers. Originally an $n \times p \times k$ factorial experiment arranged in incomplete blocks was set up and doses were given on three levels ($n = p = k = 3$). But NPK interaction components confounded with incomplete blocks were generally unimportant, therefore from the aspect of elaboration the experiment may be looked upon as a random block of 2 replications. The conditions of the experiment performed in 1961/62 and 1962/63 as well as the analysis of total grain yield were described by KOLTAY (1965).

Beside measuring the grain yield of plots also other characteristics were surveyed, here only the number of ears per plot and total grain weight per ear are discussed. The wheat was harvested and threshed by combines, grain yield stored in sacks in a barn and its quantity per plot established by weighing it in air dry state. The number of ears and the grain weight per ear were obtained for each plot on the strength of samples. Immediately before harvest (July 25, 1962 and July 10, 1963) eared sample plants were collected from 2 current metres in each plot and from these was the number of ears per plot established. Subsequently from this eared sample plant material 10 specimens per plot, i. e. 40 specimens per treatment combination (thus altogether 1080 plants in the whole experiment) were selected by balloting and elaborated assessing the value of grain weight per ear. Theoretically the following connection exists:

$$\text{total grain yield} = \text{ear number} \times \frac{\text{grain weight}}{\text{ear}}$$

As in path analysis an additive model must be applied, the following connection was used

$$Y_1 = Y_2 + Y_3,$$

where Y_1 = the logarithm of grain yield per plot,
Y_2 = the logarithm of ear number per sample,
Y_3 = the logarithm of grain weight/ear per plot.

The value of the first yield component was obtained by measurement, that of the others by sampling. When speaking hereinafter — for reasons of brevity — simply about grain yield per plot, number of ears per sample or grain weight per ear, always the logarithm of these values are to be understood. Y_2 and Y_3 are naturally not independent from one another, because both yield components were collectively affected more or less by the different influences of N, P and K fertilizers (treatments), blocks and years (a case of correlated causes).

Results and Discussion

The result of variance and covariance analysis pertaining to the data of the experiment comprising a two-year-old material is presented in Table 1. In its Head I "Source of variation" the effect of years and full blocks has not been divided, but are evidenced jointly as the cause of variation (B) brought about by environment. Consequently, the analysis is essentially identical with the randomized block design of four complete blocks ($b = 4$). Treatments contain all main effects and two-factor interactions. But the NPK effect of third degree, being in reality confounded with certain incomplete block impacts (KOLTAY, 1965), was recorded under the designation "Other causes". The mean square data (MS) of total yield (Y_1) does naturally not correspond with those previously published (KOLTAY, 1965), because the latter were gained on the basis of original values, whereas in the elaboration described here their logarithms were used. Due to this reason and as a consequence of transformation also significance data differ slightly from those to be read in KOLTAY's paper.

Mean squares of variance analysis and data on significance are contained in the three columns of Head III in Table 1. All mean squares (MS) have naturally positive values. The last three columns of Table 1 (Head IV) evidence

Table 1

Analysis of variance and covariance for data of KOLTAY's *experiment*

I	II	III			IV		
Source of variation	DF	Y_1	Y_2	Y_3	Y_1Y_2	Y_1Y_3	Y_2Y_3
		MS			MP		
Environment (B)	3	0.52741[3]	0.05070[2]	0.02487[2]	+0.15779	+0.10320	+0.02886
Treatments:							
N	2	0.20156[3]	0.00528	0.10428[3]	+0.03164	+0.14094	+0.02347
P	2	0.00434	0.00104	0.00398	−0.00131	−0.00370	−0.00037
NP	4	0.00767[1]	0.00720	0.00215	+0.00178	+0.00420	−0.00164
K	2	0.00011	0.00666	0.00723	−0.00053	+0.00085	+0.00269
NK	4	0.00186	0.00396	0.00088	+0.00090	+0.00024	+0.00185
PK	4	0.00088	0.00380	0.00384	+0.00174	+0.00072	+0.00140
Other causes	8	0.00222	0.01172	0.00174	+0.00098	+0.00105	−0.00124
Error	78	0.00262	0.00862	0.00416	−0.00032	+0.00182	+0.00012
Total	107	0.02110	0.00938	0.00627	+0.00499	+0.00704	+0.00135

[1] Significant on the $P = 5\%$ probability level
[2] Significant on the $P = 1\%$ probability level
[3] Significant on the $P = 0.1\%$ probability level

the results of covariance analysis. The signs of mean products (MP) were always indicated. The lowermost row of Table 1 displays the estimated values of total variance and covariance respectively (MS and MP) pertaining to the logarithms of the data on grain yield per plot, ear number per sample and grain weight per ear. If path analysis is conducted only on the basis of these three factors (the yield and its two components), then nothing else but this undermost row is needed, i.e. variance and covariance analysis may be omitted. Most authors do so.

1. Path analysis without considering the treatments and other effective reasons

This is the simplest and most frequently applied procedure by which total correlation coefficients existing among the characteristics are calculated and on their basis path coefficients established. In case of the three features mentioned above the following correlation coefficients are obtained: $r_{12} = 0.355$; $r_{13} = 0.613$; $r_{23} = 0.176$. These values may directly be gained from the lowest row of Table 1. E. g.

$$r_{23} = \frac{0.00135}{\sqrt{(0.00938)\,(0.00627)}} = 0.176$$

etc. It is evident that in this case the logarithm of total grain yield is closer correlated to the grain weight per ear ($r_{13} = 0.613$) than to the number of ears ($r_{12} = 0.355$). The case of correlated reasons is shown by the path diagram of Fig. 1. Customarily the line provided with two arrows indicates the correlation coefficients, while those with one arrow imply the "pathes". The unknown values of path coefficients marked with the letters u, v and w may be cal-

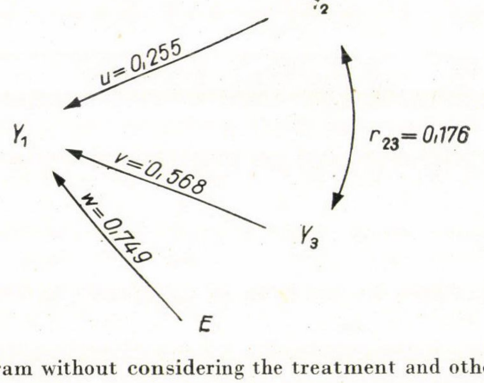

Fig. 1. Path diagram without considering the treatment and other effective reasons

culated from the following three equations:

$$r_{12} = u + r_{23} \cdot v \tag{1}$$

$$r_{13} = v + r_{23} \cdot u \tag{2}$$

$$1 = u^2 + v^2 + 2 \cdot u \cdot v \cdot r_{23} + w^2 \tag{3}$$

In the present case the correlation coefficients of the equations equal the values described before. Fig. 1 demonstrates clearly the components of correlations.

Number of ears versus total yield	$r_{12} = 0.355$
Direct effect of ear number	$p_{12} = 0.255 = u$
Indirect effect via grain weight per ear	$r_{23} \cdot p_{13} = 0.100 = r_{23} \cdot v$
	Total : 0.355

Both effects were positive, the direct one proved stronger in the present case.

Grain weight per ear versus total yield	$r_{13} = 0.613$
Direct effect of grain weight per ear	$p_{13} = 0.568 = v$
Indirect effect via number of ears	$r_{23} \cdot p_{12} = 0.045 = r_{23} \cdot u$
	Total : 0.613

The indirect effect was unimportant.

However, the variability of total grain yield per plot cannot in practice be fully established on the strength of ear number per sample and grain weight per ear, because grain yield was actually measured, while the value of both other factors assessed by sampling. Therefore, in the path diagram also a "Sampling error", as variability reason, was inserted. The path value of sampling error computed by equation (3): $w = 0.749$ is very high; 56 per cent of the variance of total yield ($0.749^2 = 0.561$) may be traced back exclusively to this reason (Fig. 1). Under given experimental conditions the total yield of the wheat variety Besostaya-1 depended much more (to 32 per cent) on the total weight of grains per ear than on the number of ears per plot (6 per cent). Indirect effects (2. $u.v.\ r_{23}$) participated merely with 5 per cent.

2. Path analysis taking treatments and other effective reasons into consideration

The correlation between both yield components: the number of ears per sample and the grain weight per ear was low: $r_{23} = 0.176$. Paying respect to the different effective reasons of the experiment we may continue to interpret also this correlation. Regarding only the simple influences Table 1 was somewhat transformed by drawing interactions into the rest; thus its degree of freedom (DF) amounted to 98. By this reduction for the logarithm of ear number per sample (Y_2) and for the logarithm of grain weight per ear (Y_3) the estimated variances (MS) and covariances (MP) according to Table 2

Table 2

Alternative analysis of covariance

Source of variation	DF	Y_2	Y_3	Y_2Y_3
		MS		MP
Environment (B)	3	0.05070	0.02487	+0.02886
N	2	0.00528	0.10428	+0.02347
P	2	0.00104	0.00398	−0.00037
K	2	0.00666	0.00723	+0.00269
Rest (E)	98	0.00843	0.00373	+0.00006

Table 3

Components of variance and covariance

Y_2	Y_3	Y_2Y_3
$\sigma^2_{b_2} = 0.00188$	$\sigma^2_{b_3} = 0.00092$	$\sigma^2_{b_{23}} = 0.00107$
$\sigma^2_{n_2} = 0.00015$	$\sigma^2_{n_3} = 0.00290$	$\sigma^2_{n_{23}} = 0.00065$
$\sigma^2_{p_2} = 0.00003$	$\sigma^2_{p_3} = 0.00011$	$\sigma^2_{p_{23}} = -0.00001$
$\sigma^2_{k_2} = 0.00018$	$\sigma^2_{k_3} = 0.00020$	$\sigma^2_{k_{23}} = 0.00008$
$\sigma^2_{e_2} = 0.00843$	$\sigma^2_{e_3} = 0.00373$	$\sigma^2_{e_{23}} = 0.00006$
$\sigma^2_{T_2} = 0.01067$	$\sigma^2_{T_3} = 0.00786$	$\sigma^2_{T_{23}} = 0.00185$

were obtained, in constructing of which generally the symbols and presentation used in Table 1 were applied.

The values of variance and covariance components figured out from the data recorded in Table 2 are summarized in Table 3. The way of calculating the right variance and covariance components on the strength of MS and MP values is chiefly detailed in the books by KEMPTHORNE (1957) and LE ROY (1960). Regarding the basic data as "basic population", in accordance with the variance and covariance analysis of "multi-way classification" ($b = 4$, $n = p = k = 3$) the following equalities subsist (KEMPTHORNE, 1957):

$$MS \text{ environment } (B) = \text{n.p.k. } \sigma_b^2 = 27 \cdot \sigma_b^2$$
$$MS \text{ nitrogen } (N) = \text{b.p.k. } \sigma_n^2 = 36 \cdot \sigma_n^2$$
$$MS \text{ phosphorus } (P) = \text{b.n.k. } \sigma_p^2 = 36 \cdot \sigma_p^2$$
$$MS \text{ potassium } (K) = \text{b.n.p. } \sigma_k^2 = 36 \cdot \sigma_k^2$$
$$MS \text{ rest } (E) = \sigma_e^2 = \sigma_e^2$$

For MP values similar equation may be stated, but instead of variances adequate covariances are to be applied. Variance components thus computed

Table 4

Coefficients of correlation

X	Y_2	Y_3	Y_2Y_3
	$r_{T \cdot X}$		$r_{X \cdot X'}$
B	0.4198	0.3420	0.813
N	0.1186	0.6074	1.000
P	0.0530	0.1183	−0.182
K	0.1299	0.1595	0.388
E	0.8889	0.6889	0.011
	$r_{T_1T_2} = 0.38872$	$r_{T_1T_3} = 0.63270$	$r_{T_2T_3} = 0.20156$

are shown in the first two columns, corresponding covariances in the third column of Table 3. On summing up the calculated values of each column total variances and covariances respectively are obtained (LE ROY, 1960).

The different "paths" and correlation coefficients may be reckoned from Table 3 and are presented in Table 4. Correlation coefficients displayed in the last column were established in the following way. On the basis of MS and MP data from Table 2 the correlation coefficient between the blocks Y_2 and Y_3 has the following value

$$r_{B.B'} = \frac{0.02886}{\sqrt{(0.05070)\ (0.02487)}} = 0.8127.$$

(The same result may also be obtained by using the variance and covariance components of Table 3, but it would involve more rounding errors.) The "paths" figuring in the first two columns of Table 4 were e. g. calculated as follows

$$r_{T_2B.} = \sqrt{\frac{0.00188}{0.01067}} = 0.4198;$$

the values needed were taken from Table 3. The lowermost row of Table 4 contains the correlation coefficients worked out on the basis of total variances and covariances

$$r_{T_2T_3} = p_{T_2B}\, r_{BB'}\, p_{B'T_3} + p_{T_2N}\, r_{NN'}\, p_{N'T_3} + p_{T_2P}\, r_{PP'}\, p_{P'T_3} +$$
$$p_{T_2K}\, r_{KK'}\, p_{K'T_3} + p_{T_2E}\, r_{EE'}\, p_{E'T_3} = 0.20268.$$

Apart from the rounding error this value equals the directly calculated result:

$$r_{T_2T_3} = \frac{0.001846}{\sqrt{(0.01067)\,(0.00786)}} = 0.20156.$$

The connections are shown.

Conclusion

Considering also the effect of treatments (full analysis) in the fertilizing experiment conducted with the winter wheat in question, the sampling error proved to be great (51 per cent) as to the logarithms of grain yield per plot (Y_1), ear number per sample (Y_2) and grain weight per ear (Y_3) (Fig. 2). Sampling errors of such degree are not unknown in literature. It can be seen clearly that despite of the great sampling error other parts of the diagram may undisturbedly be evaluated.

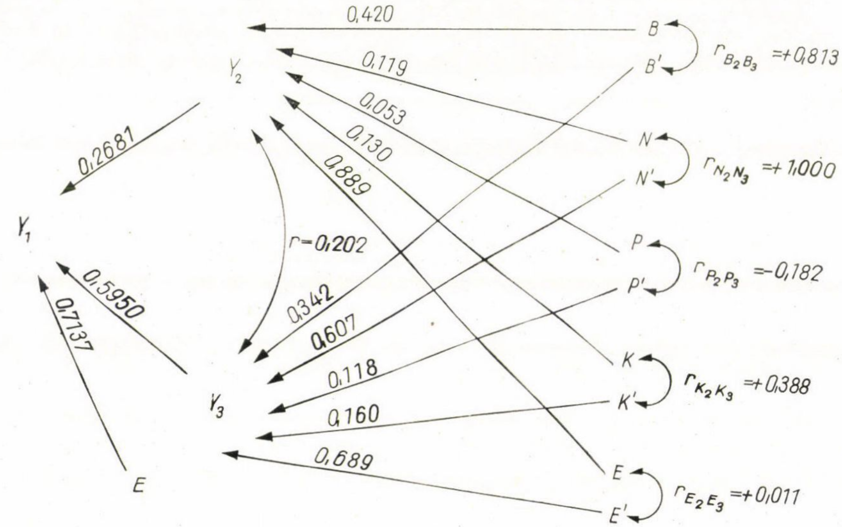

Fig. 2. Path diagram considering the treatment and other effective reasons

Out of direct effects 35 per cent of variability in Y_1 have been caused by the logarithm of grain weight per ear and 7 per cent by that of ear number per sample. The value of indirect effects $(2. u. v. r_{23})$ was only 6 per cent. The correlation between grain weight per ear and ear number per sample manifested itself as $r_{23} = 0.202$; this can be traced back to the different (block, N, P, K and other) effects and may entirely be explained numerically by path analysis. The positive correlation between ear number per sample and grain weight per ear is uncommon; it usually is negative in variety experiments. The difference may be attributed to the effect of fertilizer.

In the experiment reported here the variance of ear number logarithm may be ascribed to different effects, viz. 18 per cent to the blocks, 1 per cent to N, 0.3 per cent to P, 2 per cent to K and 79 per cent to other causes. The number of ears has hardly been influenced by the applied fertilizer doses, this seems chiefly to be an inside variety property: the winter wheat Besostaya-1 produces one ear per plant and seldom an after-ear.

The logarithm of grain weight per ear has given quite a different result. The great effect of nitrogen treatment is conspicuous. From total variance 12 per cent was due to blocks, 37 per cent to N, 1 per cent to P, 3 per cent to K and 48 per cent to other reasons (Fig. 2). By the latter also the interactions are represented.

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FIELD TESTS ON RESISTANCE OF WHEAT VARIETIES TO STEM AND LEAF RUST IN MARTONVÁSÁR 1960–1964

By

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Investigations of the resistance of wheat varieties to stem rust *(Puccinia graminis* Pers. f. sp. *tritici* Erikss. et Henn.) and leaf rust *(Puccinia recondita* Rob. ex Desm. f. sp. *tritici* [Erikss.]) were conducted in Martonvásár 1960–64 in provocatory field tests with uredospore populations including the prevalent domestic races, under microclimatic conditions particularly suited for these pathogens. The varieties involved were examined for 2–5 years. Resistant to both rusts proved to be: *Pembina, Rafaela, Pergamino Goboto, Klein Petiso* ; to stem rust only: *Lee, Selkirk* ; to leaf rust only: *Besostaya 1, Skorospelka 3b, Skoplje, Klein Aniversario, No. 10* (Bulgarian), *Mida, El Gaucho, Kärn II, Fertődi 249, Rannaya 27, Osetinskaya 3, Mocinave, Feranol Pinto, Atlas 50, Bledsoe.*

Introduction

Cereal rusts belong to the pathogens in which, since specialization has been demonstrated, and differential test sortiment utilized with the aid of infection types developing on wheats in seedling condition, the greatest number of physiological races were isolated. Until 1962 as many as 297 stem rust races were determined — STAKMAN *et al.* (1962) — but since that time their number exceeded 300 and that of the recorded leaf rust races is nearly 200 — HASSEBRAUK (1963). — It is well known that the rust races can be ranged into rust groups. For instance, from the two leaf rust races being most important at present in Hungary the race No. 20 belongs to group 9 while No. 77 to group 21.

Resistance in early age established in the glasshouse in no way warrants that the variety in earing or in the subsequent developmental phase would be resistant on the field too; this has been demonstrated also with various progenies from crosses. It has been as well known for many years that varieties susceptible to some important races in seedling age are as developed plants resistant to the same races — CAMPOS *et al.* (1953). — According to examinations conducted by BÓCSA (1964) not a single variety or line kept in glass house proved to be during the seedling stage resistant to the leaf rust No. 77 considered as the most dangerous in Hungary so far. In spite of this fact in the field, in developed plant condition, under the influence of inoculation — when the spore material doubtlessly included the race No. 77 — several resistant varieties and lines were found — MANNINGER (1962, 1964). It is to be noted that SOPINA (1960) in the Soviet Union and supported by the investigations carried out in the VIZR in 1958/59 reports already on the wide spreading of leaf rust race No. 77, which had occurred before the war only in Armenia.

Materials and Methods

The objective of experiments on resistance to stem rust (*Puccinia graminis* Pers. f. sp. tritici Erikss. et Henn.) and leaf rust (*Puccinia recondita* Rob. ex Desm. f. sp. tritici [Erikss.]) initiated in Martonvásár 1960 was to demonstrate, with provocatory field methods, differences in resistance among species, varieties, lines and hybrid populations and to promote the breeding of varieties with field resistance. Naturally, according to Hungarian requirements resistance of winter wheat varieties are being preponderantly dealt with, but in view of the search for sources of resistance and of theoretical research work regular experiments with summer wheat have also been set up year by year.

Since 1960 the round plot ("head hill") seeding method recommended by the Institute for Agricultural Experiments in North-Eastern Hungary (Kompolt) has been employed and fulfilled expectations also here. Concurrently, since 1962 and owing to the small amount of the available seed samples, sowing in drills has also been employed repeatedly. The susceptible varieties sown to the centre of the round plots or to the longitudinal sides of the 1.2 m wide blocks have been infected with the injection method (for detailed description see MANNINGER, 1962), in view of our practical objectives with uredospore populations containing the most important Hungarian races. The stem rust races No. 21, 40 and 17 as well as the leaf rust races 20 and 77 were obtained by the courtesy of BÓCSA. Maintenance and propagation of these races and/or of the rust populations collected by us are being conducted in Martonvásár.

Since it is also important to take into consideration the natural infection, in summer 1964 stem rust from natural infection was collected in Martonvásár. From these samples HASSEBRAUK determined the races 17 and 21.

In autumn 1964 by the assistance of KLEMENT from the Research Institute of Plant Protection the preservation (lyophilisation) of part of the uredospore material until the next inoculation period was effectuated. In the current year we intend to complete the inoculum material with the stem rust race No. 14.

The winter wheat experiments are established under particularly favourable microclimatic conditions — along a brook, on an area delimited from the one side by a forest in rather deep situation — in separate stem and leaf rust breeding gardens separated by broad machine seeding. Both for stem and leaf rust, in 4 series each generally every year 1000—1600 round plots and 800—1000 drill plots are maintained with the insertion of 2 standard varieties. The exceedingly strong incidence has made possible a strict selection in every year so far. Only such material is included in next year's experiment that proved to be susceptible at least for one of the two rusts. Exception is made in the case of varieties and lines outstanding for mildew resistance or other economically important characters.

Results and Discussion

Resistance of wheat varieties in the experiments sown in autumn

1960/61: out of 143 varieties 4 were resistant to stem rust, 8 to leaf rust.
1961/62: out of 175 varieties 9 proved to be resistant to stem rust, 41 to leaf rust.
1962/63: out of 84 varieties 20 were resistant to stem rust whereas out of 86 varieties 23 to leaf rust.
1963/64: out of 74 varieties 11 showed resistance to stem rust, 23 to leaf rust.

In the 2., 3. and 4. experimental year the following varieties were resistant

(those examined also in spring sowing marked separately)

In 1961, 1962, 1963 and 1964

to both rusts: *Pembina* (1961 only in spring sowing, 1962, 1963 and 1964 both in autumn and spring sowing);

to stem rust only: *Lee* (1961, 1963 and 1964 only in spring sowing, 1962 both in autumn and spring sowing);

to leaf rust only: *Besostaya 1*, *Skorospelka 3b*, *Skoplje*, *Klein Aniversario* (also in 1960 spring sowing).

In 1961, 1962 and 1963

to stem rust: *Selkirk* (1961 in spring sowing only, 1962 and 1963 both in autumn and spring sowing);

to leaf rust: *No. 10* (Bulgarian).

In 1961 and 1962 Mida to leaf rust.

In the material tested only in 1962 and 1963

to leaf rust: *El Gaucho*, *Kärn II*.

In the material tested only in 1962, 1963 and 1964

to both rusts: *Rafaela* (1963 and 1964 in autumn and spring sowing), *Pergamino Goboto* (in 1964 also in spring stem rust experiment), *Klein Petiso* ;

to stem rust only: —

to leaf rust only: *Fertődi 249*, *Rannaya 27*, *Osetinskaya 3*, *Mocinave*, *Feranol Pinto*, *Atlas 50*, *Bledsoe*.

Varieties exhibiting at least medium resistance to both kinds of rust during several years (which is perfectly satisfactory from the practical point of view) are considered particularly valuable. From the varieties listed, however, the winter hardiness of someones that are very important from the aspect of resistance such as *Pembina*, *Rafaela* and *Pergamino Goboto* is not satisfactory. Moreover *Rafaela* in the 1964 spring experiments exhibited susceptibility to leaf rust.

Resistance of lines and hybrid progenies

From the various lines and hybrid progenies included in the experiment, the most resistant ones are to be mentioned separately. Resistance to stem and leaf rust was exhibited for several years by some *Besostaya 4* and *Besostaya 1* lines, *Besostaya 1* × *San Pastore* and reciprocals, as well as *Besostaya 1* × *Produttore* F_3 progenies and *T. timopheevi* containing Czech lines, further 10 American lines synthetized from the varieties *Frontana*, *Newthatch*, *Kenya 58*, *Lee 3*, *Klein Titan*, *Thatcher*, *Timstein*.

From the crossings started in summer 1963 the partners were chosen in a way that the one parent should be a variety or line that had proved to be resistant to rust in experiments for several years while the other parent reliably winter hardy under conditions prevailing in Hungary, stiff-strawed and early as far as possible. Examination of the progeny of crosses concerning resistance to rust is still being in progress.

In our provocatory experiments with consistent selection of lines and further extension of sources of resistance we hope to promote the breeding of rust-resistant wheat varieties.

The wheat variety of the future must be resistant to the most various rust races. Considering the great multitude and variety of the rust races the solution of this problem is rather difficult.

The breeder naturally endeavours to unite in his varieties as many favourable properties as possible. Various methods relying on the present state of science and on breeders' experience make presumably this synthesis possible already.

May I quote, after this reassuring statement the words of LEVINE (1959) who died a few years ago: "No one country, big or small, is in a position to solve completely, all by itself, the vexatious cereal rust problems. For the most effective desirable results, the investigators would need a common technical language, uniform diagnostic methods and coordinated research procedures."

Conclusion

The resistance of wheat varieties and lines to stem rust and leaf rust was examined in 1960—64 in provocatory field tests. Artificial injection infections were carried out on susceptible varieties sown in round plots on the centre while in drills on the longitudinal sides of 1.2 m wide blocks with uredospore populations.

Generally 1000 to 1600 round plots were sown every year in 4 series and 800 to 1000 drill plots in 1 series each separately for the stem rust and leaf rust experiment.

From the many varieties and lines exceedingly few proved to be resistant to both kinds of rust or to stem rust only. Resistance to leaf rust exhibited a comparatively more favourable picture.

Resistant to both rusts were: *Pembina*, *Rafaela*, *Pergamino Goboto*, *Klein Petiso* ; to stem rust only: *Lee*, *Selkirk* ; to leaf rust only: *Besostaya 1*, *Skorospelka 3b*, *Skoplje*, *Klein Aniversario*, *No. 10* (Bulgarian), *Mida*, *El Gaucho*, *Kärn II*, *Fertődi 249*, *Rannaya 27*, *Osetinskaya 3*, *Mocinave*, *Feranol Pinto*, *Atlas 50*, *Bledsoe*.

Out of lines and hybrid progenies resistance to stem and leaf rust was found during several years in some *Besostaya 4* or *Besostaya 1* lines, *Besostaya 1* × *San Pastore* and reciprocal, *Besostaya 1* × *Produttore* F_3 progeny and *T. timopheevi* containing Czech line, further 10 American lines synthesized from the varieties *Frontana*, *Newthatch*, *Kenya 58*, *Lee 3*, *Klein Titan*, *Thatcher*, *Timstein*.

In order to enhance reliability of yield, varieties that are practically resistant to rust in developed plant condition are needed.

As pointed out by our results, the breeder must include in his experiments a great variety of ground material (species, land races, varieties, hybrids, lines) to find the few that are really resistant.

It is not possible to examine a large varietal collection, several thousands of lines and progenies of crosses, for each rust race. Therefore the correct method is, in our opinion, field inoculation with rust populations containing the prevalent races.

For strict selection in field experiments microclimatic conditions particularly favourable for the development of rust are indispensable.

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THE APPLICATION OF MODERN GENETIC PRINCIPLES IN ORDER TO RENDER THE PRODUCTION OF HUNGARIAN SPOTTED CATTLE MORE ECONOMICAL*

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Up to the beginning of this century the selection for breeding had been based on conformation of the animal, — a view accepted throughout Europe. Much attention was paid to the external features like colour and the distribution of same, to the formation of certain constitutional characters, etc. This evaluation and selection for breeding based in several respects on "formalism", and playing a rather important role in Hungary between the two world wars and being met with, to a certain extent, even in these days, generally affected the rate of genetic progress adversely. The trend to obtain uniform character of types and of colour might be attributed also to the erroneous notion as if greater uniformity of shape and colour between individual animals entailed higher uniformity and less diversity regarding internal characteristics, too. In addition to this, cattle breeding was, in many cases, a sort of hobby the chief aim of which seemed to be uniformity in perfect shape and colour. This trend was supported, in some degree, by the shows at which qualifying was based principally on the type of the animal. However, there is no doubt that it is much easier to gain certain uniformity in particular properties showing themselves in morphology and colouring than regarding the internal properties, like production and related features which cannot be judged by conformation only.

The work of registering and that of milk recording started widely after World War I, doubtlessly contributed to providing more realistic bases for selection in this country, too. Examining, however, the results it may be established that in spite of the network of milk recording set up with considerable financial sacrifice, the milking ability of our cattle stock did not develop at the rate required. Though it seems to be rather difficult to form an opinion on the formation of milking capacity because the insufficient feeding of the stock renders very difficult the realistic evaluation of the development of milking capacity, the view may — however — be ventured that in spite of outstanding individual results, especially the average milking ability of the

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Hungarian stock has not considerably improved in the last 30—40 years. To a certain degree, this is supported by the fact that the butterfat per cent which is less influenced by environment, has not changed either, though butterfat was recorded as well as milk production. This lagging behind displayed in milk production is mainly due to the fact that the spiritual inheritance of Ujhelyi could not be realized enough in practice, and that the crossbreeding with the Swiss Simmenthal cattle for the transformation of type, was performed too formally instead of relying upon the excellent qualities of individuals and families of the Hungarian spotted cattle. *Regarding the important properties of economical milk production as milk production per unit of live weight, the concentration of milk, the formation of udder for efficient machine-milking as well as early maturity, our stock will not quite meet the claims made to an up-to-date stock.*

On the other hand, besides certain negatives showing themselves in milking ability, it has to be established that, due to grading with the Swiss Simmenthal breed and the selection according to type, the cattle stock has improved both in growth-rate and general character of type. The excellent meat producing capacity being appreciated on the world-market can also be attributed to the above-said.

Speaking now of the modern types of cattle and the breeding trend to be followed, it has to be established that these seem to be very difficult problems not only of general agricultural practice but, besides the scientific research of animal husbandry, it is also a problem particularly of genetics, farm and general economics as well. In other animals, due partly to the smaller generation interval, partly to their greater prolificacy, it was much easier to produce a type that could best meet man's requirements; as an example it might be mentioned that in the last decade the "Hungarian mangalica" pig has been replaced within short time, by the Yorkshire pig. The most conspicuous example, however, is offered by poultry hybrids and the way they have ousted, all over the world, the local breeds. While in cattle breeding, due to slow multiplication and change of generations as well as to the technical difficulties of establishing the real economic merit of animals, the situation is much more complex.

From time immemorial the change of man's demands has been the stimulus to turn out new animal products. Therefore, it might be of interest to speak about the subject of the International Congress on Animal Breeding held in 1961 in Hamburg referring to the above, and dealing with the demand for animal products in the coming 15 years (Kirsch). No doubt, this reflects primarily the demands of the western European countries, however, the tendency may be accepted for the other European countries, too.

According to this forecast, in connection with the demand for animal products, it has to be reckoned with the following: Marked increase appears in poultry meat and eggs, and increasing demand in beef. Slightly increasing demand in pork, butter, cream, cheese and powdered milk; the demand in consumption-milk will be stagnant. At the same time we have to reckon with a decrease in the consumption of cereals, potato and margarine. Certainly, there will be some deviation from the above prediction in different countries, depending on the circumstances and customs of respective peoples — thus e.g., in Hungary the low level of milk consumption *has* to be raised. On the other hand, pork fat will play an important role in Hungarian food supply for some time ahead. According to all indications, with the increase of living standards, the tendency of the above-mentioned prediction seems to be, at least in its outlines, pertinent.

In the field of meeting the increasing demand for animal products, cattle breeding and, first of all, milk production have a very important role. Besides meeting the demand in certain products of cattle breeding, *a decisive problem is still the prime cost of the products.* In this connection it will be interesting to note that in the prime cost of beef production far less differences seem to appear than in milk production.

In our times, however, it is not enough to deal with the problem as to which commodities will be in greater demand. In further future — with the rather quick increase of mankind — we have to reckon with a more and more increasing competition — at least in some parts of the world — between man and certain farm animals for the available vegetable food. This competition will be the least poignant for those vegetable foods which are rich in cellulose and which cannot be utilized directly by man (PHILLIPS). For this reason, the ruminants will be in an advantageous position because, among other reasons, by way of the microorganisms existing in their digestive system, they are able to transform to meat and milk even those non-protein, nitrogen containing compounds (amides) that other animals cannot utilize at all or, only to a limited extent.

While previously increase in turning out animal products was generally tried to be solved by raising the number of animals, in our days countries disposing of developed animal husbandry endeavour to increase the production by improving the productivity of the stock. By this means they increase the productivity per unit of live weight and decrease the fodder proportion needed for maintenance. The reason of this change of trend is, among others, that in most countries, and to those belongs Hungary, too, the available arable land is limited. *So, the future task will be to render animal production more intensive. The main trend and effort of our stock breeding will most probably be for long decades ahead to produce, in return for the fodder grown on a given area, the largest quantity of best-quality of animal products.* Thus the problem of energy requirement needed with certain types of animal and with turning out animal products, has risen rather explicitly. From this point of view it is to be noted that *the energy requirement of milk production is relatively low.* A good cow will transform about 30—50 per cent of the nutritive value in the fodder consumed, into human foods. On the other hand, the young cattle as well as the beef cattle show but 10—18 per cent of transformation, while hens transform about 20—30 per cent in the course of egg laying. The transforming capacity of the pig falls between that of beef cattle and the cow.

The prognostic of future briefly outlined, the transformation data as well as the quality of the cattle being able to produce the most important foodstuffs from fodder-plants rich in fibres and unfit for human consumption show that the *importance of the cow will probably greatly increase in the future*, the cow transforms the fodder by three times more efficiently than the beef cattle although the latter, too, utilizes much ruffage. On the other hand, there is no doubt that when trending to obtain the maximum milk from the given unit of starch-value and protein, the problem of the future type of cow should be put in another light, and many circumstances have to be examined more exactly in the light of figures.

Passing on to the discussion of the genetic aspects of productivity, it seems to be advisable to take for basis the generally accepted principle that the cattle with dual-purpose and being apt to meet domestic demands, yields in 2/3 parts milk and in 1/3 parts meat products. No doubt, the priority is that of milk.

The capacity of milk production and that of meat production (daily gain in weight) do not show negative correlation (Mason, Groenewold, Langlet, etc.). It might be supposed that where there *is* some slight positive correlation between the two traits, the favouring of the larger frame-type, which produces also more milk, will show more gain in weight. In other words, more weight gained in youth means a bigger cow, a fact that might, however, influence milk production unfavourably if this latter does not increase proportionately with the weight of the animal.

Consequently, it is open to question whether, especially in case of dual-purpose animals, the aiming at a greater growth rate is reasonable beyond certain limits. Our experiences gained in the course of crossbreeding of smaller types seem to prove that through increasing the weight of cow by 50 kg, the daily gain during fattening will increase by about 50 g. (See Table 1.) Similar experiences were obtained by Timotity and co-workers when examining the Hungarian spotted types. The average growth rate of cows belonging to different breeds seems to support the above.

In practice, a growth rate of about 1000 g obtained in cattle fattening meets the requirements concerning the cost of production. The bull calves of cows of about 550—650 kg live weight, will meet that demand without any special breeding work. If aiming at a daily gain in weight that considerably exceeds 1000 g, one has to reckon with a bigger type of animal which, regarding milk production, could be considered economical only with certain reserves. Milk production of cows of 700—800 kg live weight ought to exceed considerably that of smaller types, in order to maintain their productivity at an economical level. Besides, it seems that too big body of the animal involves calving difficulties, large-shaped cows also produce only one calf, and require at the same time much forage for maintenance. In the case of big types, one has to reckon also with the fact that under limited forage supply, milk production will decrease quicker since the *requirements for maintenance enjoy preference over milk production.*

Table 1

Live weight of cow (kg)	550	600	650
Daily gain (g) of heifers	470	516	562
Daily gain of fattened bulls (g)			
50% Jersey blood (end weight 448 kg)	927		
25% Jersey blood (end weight 515 kg)		1002	
Hung. red. packed (end weight 560 kg)			1037

In cattle breeding the quality of meat does not seem to be so much a matter of the type. Experiences in practice show all over the world that the largest quantity of meat is being provided by dairy breeds; neither shows the meat quality in every case superiority if beef breeds are compared with, dual-purpose or dairy breeds although regarding this problem, much subjective prejudice can be met with. This is proved not only by crossbreeding performed all over Europe; it seems to be sufficient to refer to those model-experiments which were carried out in Hungary (1954, Horn *et al.*) and later on, the large-scale experiments of Bárczy *et al.* (Szuromi). According to these, no considerable superiority in the meat production of the progenies could be proved in the course of crossbreeding the Herefored or Angus or, recently, the Charollais with the Hungarian spotted cattle. There might be some advantage in somewhat better muscularity, bone-ratio or slaughter-weight, however, in growth-rate the crossbreds all lagged behind and did not justify crossbreeding.

As an other noteworthy circumstance can be considered the fact that in Great Britain where the quality of beef is an important factor, in 1961 only 20 per cent of the cattle came from beef herds alone. The remaining 80 per cent were solely dairy especially Frisians and other milking breeds or progenies of crossbreeding with beef cattle. As it can be seen, high quality meat can be produced through dairy and beef cattle as well as of dual-purpose breeds. This is proved not only by the excellent meat producing ability of the Hungarian spotted cattle, but also by the research work done in recent years; according to the opinion of consumers, the meat quality of the dairy breeds

(Frisian, Jersey, etc.) has been found better than that of certain beef cattle types (FLOCK). When meat production is the aim, the animals should be well-muscled. Today, however in the limelight is not so much the size of the fatted animal, but rather *the time* during which we can hit this target. This means early maturity and certain growth-rate in the early phase of development. This property can generally be found in many dairy or dual purpose breeds; the precondition of high milk yield means a great capacity of food consumption, — a fact that, of course, has advantageous influence on the results of fattening.

Table 2

Live weight of the cow kg	Cow being kept on 1000 kg starch value	
	Cow	%
750	0.782	100.0
700	0.830	106.1
650	0.856	109.5
600	0.913	116.8
500	0.944	120.7

On basis of the abovesaid, it seems that the demands in meat production are best met by such types of cattle the bull-calves of which reach around 800—1000 g gain per day reckoned from their birth under normal field conditions; being fattened up to 450—550 kg live weight, these animals are adequately ripe, and produce — while being fleshy — just as well lean meat. *The Hungarian spotted bull-calves serve very well these purpose while meeting, at the same time, the export requirements, — a factor being very important for Hungary.* A further essential requirement is to produce bull-calves as cheap as possible and in adequate number. EDWARDS, of the Milk Marketing Board says: "incubators" are needed to produce beef calves for fattening. These incubators can, of course, only be cows. To this it might be added that heavy cows handicap calf producing and having more requirements for maintenance: they are inefficient "incubators". Table 2 demonstrates how the quantity of fodder needed for the production of the calf changes with the increase of the weight of the cow. In other words: with a given quantity of fodder, less cows of big body size can be kept, consequently less calves can be produced for fattening purposes. This means that the potential capacity for meat production in a stock with big body size, is less.

It deserves attention to consider the effect of early maturity on the capacity of meat production. In case of stocks of the same number, *early maturing effects meat production in as high a percentage as raising period is* *abbreviated by. As much less heifers can be kept for replacement, and the feed thus saved may be utilised for fattening purpose* (DUNAY).

Speaking of certain problems of milk production, it has been an old aim of breeders to establish the economy of milk production. "Economy" means here and first of all labour, fodder cost and other expenditure for producing one unit of dairy product which is, essentially, the prime cost of milk production. Since the most important item of expenses — about 50—70 per cent — is that of feeding, it is well understandable that the rate of economical milk production of dairy cows should principally depend on the quantity of fodder used for obtaining one unit of milk or dairy product.

Unfortunately the measuring of fodder used for producing milk, meets in practice, with almost insoluble difficulties. All efforts made to establish and to fix the fodder consumed in the course of milkrecording performed in order to disclose the quantity of the nourishing substance consumed against the milk produced by the cow — have not justified expectations. The herd-book data referring to the utilization of fodder, have remained but formal and today, in practice, no much importance is attached to them.

The herd-book control can establish three properties being important from the point of view of economy of milk production: *the milk-yield, the production of butterfat through the control of butterfat per cent, and the live weight of cows,* (measurements from which the live weight can be computed). To conclude on economical milk production, we might rely upon these three available data.

Before dealing with the three above properties from an economical point of view, it is to be mentioned that the fodder requirements of cows both for their maintenance and for production, do not show considerable individual differences. Thus, most *healthy cows utilize the same amount of fodder in order to maintain the same unit of live weight, and to produce one kg milk of identical concentration.*

As referred to previously, the three above-mentioned factors established during milkrecording, have a decisive influence on the economical efficiency of milk production. The first of them is the amount of the yearly milk-output. Its relation to the expenses of feeding is shown in Table 3.

In this Table it is well demonstrated how the fodder-requirement needed for 1 kg of milk, decreases — though always at a slower rate, — with the increase of the yearly milk output. While with a yearly production of 2000 kg milk 844 g starch-value is needed per kg of milk, — this figure will decrease to 494 g in the case of a yearly output of 5000 kg of milk. This means a decrease of about 40 per cent. When, however, the production of 5000 kg is raised by further 3000 kg to 8000 kg, the starch value needed for the production of 1 kg of milk decreases to 406 g, a phenomenon which, on the other hand, shows a fodder-utilization that is being reduced by 10 per cent only. Taking into con-

Table 3

Starch value requirements for producing 1 kg milk in case of different yearly milk production

Milk prod. kg	Live weight kg	Starch value for maintenance kg/year	Total starch v. needed for producing 1 kg of milk kg	Total starch v. required for producing 1 kg of milk %
2000	650	1168	0.844	100
3000	650	1168	0.649	77
4000	650	1168	0.552	65
5000	650	1168	0.494	59
6000	650	1168	0.455	54
7000	650	1168	0.427	51
8000	650	1168	0.406	48

Table 4

Fodder requirement for producing butter from milk of different fat per cent, reckoning with a yearly output of 3500 kg milk
(live weight 650 kg)

Yearly milk production kg	Fat %	Fat kg	Starch value requirement kg	Starch value requirement in fodder needed to produce 1 kg butter kg	Fodder requirement for butter production %
3500	3.0	105	1955	16.0	100
3500	3.5	123	2043	14.3	89
3500	4.0	140	2131	13.0	81
3500	4.5	158	2218	12.1	76
3500	5.0	175	2306	11.3	71
3500	5.5	193	2393	10.5	66

sideration the excess work and fodder as well as the stress of the constitution, the economical level of production seems to be, for the time being, around a production of 4000—5000 kg.

A next possibility to decrease the production cost is the increasing of the *fat per cent* or the concentration of milk. (I.e. with butterfat the protein content of milk generally also increases, though not in a direct ratio.) Table 4 demonstrates how the fodder requirements decrease for producing 1 kg of butter in the course of a yearly milk production of 3500 kg with different fat per cent.

From Table 4 it can be seen that cows with identical milking capacity though yielding milk of but 3 per cent fat contents, require for butter production by about 30 per cent more fodder than those yielding milk of a fat content of 5 per cent. Similar tendency shows itself in the fodder-expenses needed for producing good quality cheese as well as other dairy products; thus, the prime costs can be decreased efficiently through the concentration of milk.

The third factor that is available through the data of the herd-book and can be used for rationalizing the aims of breeding — is the live weight

Table 5

The trend of feeding expenses in milk production depending on live weight

Live weight kg	Milk production kg	Starch value needed to produce 1 kg milk kg	Starch value requirement of 1 kg milk %
500	3500	0.552	100
550	3500	0.563	102
600	3500	0.573	104
650	3500	0.594	108
700	3500	0.604	109
750	3500	0.625	113
800	3500	0.646	117

with which a cow or the stock produces the milk, the butterfat or protein. (See Table 5.)

Besides the motives outlined above, there arises also the requirement with the modern type of cattle according to which the cow has to be productive also on highly mechanized farms. Therefore, *such constitution is needed that transforms the fodder into meat, milk, butter, etc. most efficiently while requiring the possibly* least labour and adapting itself to modern ways of *management.*

If we look for the type of cow that can meet the manifold requirements, it would be instructive to compare the financial value resulting from the milk production of different types of cows or, *more exactly, the financial income per unit of live weight.* In order to demonstrate this relationship, Table 6 shows a calculation regarding two price-systems paid to the producer. These are the milk price systems of two European countries that play the most important role on the world market: i.e. Denmark, and the Netherlands; the former has the most leading position in world's butter-market, the latter has a conspicuous role in world's cheese-market. In Denmark butterfat is being appreciated above all, while Netherlanders are chiefly interested in protein due to their developed cheese-export. *Both price-systems serve to support competitive* *milk production on the world market and therefore, I am of the opinion that they deserve to be paid attention to.*

It should be noted that the Dutch price-system that has been introduced in Friesland, is based on the milk-protein test; in our days the milk of 350,000 cows is regularly examined in the Netherlands, and milk is being paid not

Table 6

Breed	Milk kg	Fat kg	Fat %	Protein kg	Protein %	Amount paid for the milk of one cow (Danish crown)	Value of milk of one cow according to the Dutch price system	Live weight kg	Value per 100 kg live weight expressed in the percentage of Danish-red in Denmark, blackspotted type in German Fed. Rep.	
									Danish crown	Dutch value index
Denmark (1960/61)										
Danish-red	4465	190	4.3	158	3.5	985	179	570	100	100
Black-spotted low-land	4587	187	4.1	158	3.4	966	177	650	86	87
Shorthorn	3809	149	3.9	128	3.4	771	142	600	74	76
Jersey	3410	205	6.0	150	4.4	1090	187	400	158	149
German Fed. Rep. (1960/61)										
Black-spotted low-land	4367	167	3.8	145	3.3	855	160	640	100	100
Red-spotted low-land	4220	156	3.7	137	3.2	798	150	600	100	100
Angeln	3891	176	4.5	142	3.7	916	165	500	137	132
Jersey	3101	187	6.0	137	4.4	994	170	400	186	170
Fleckvieh	3602	145	4.0	123	3.4	748	138	650	86	86
Brown swiss	3639	139	3.8	120	3.3	713	133	600	89	89

only on the basis of fat per cent, but also on that of protein per cent (POLITIEK). This means that the price of milk is made up by the fat and protein per cent in the ratio of 2 : 1. The quantity of liquid and other constituents of milk are not taken into consideration. The Danish price-system has a preference for the production of butterfat.

In order to approach a cow type producing milk in the most economic way, it seems reasonable to examine, on basis of these price-systems, the production value of cows in countries where different types having different milk concentrations are being bred. Starting from this point of view, the data of the herd-books of two countries have been used. The one of them is Denmark, the other the German Federal Republic. In both countries the cattle stock consist of different breed types producing milk of different concentration.

In Denmark and in the German Federal Republic where stock are under milk recording, the production and the values paid according to the two price-systems, are absolute; *however, the price of milk related to 100 kg live weight,*

shows the superiority of types, first of all that of the Danish Jersey, which produces milk of higher concentration. (See Table 6.) While in Denmark the Danish red, a most predominant breed which gained world wide fame even in productivity has only brought in 985 Danish crowns, the Jersey cow as much as 1090 crowns, the ratio of which, according to the Dutch price system, is 179 : 187. Even greater is the difference if the values paid for milk refer to 100 kg live weight and, taking the production of the Danish-red cows for 100 per cent, we shall obtain with the Jersey cows, according to the two price systems, 157.7 per cent and 148.7 per cent, respectively. If this calculation is made on basis of the *Brody—Ragsdale* formula which had been elaborated with regard to the decreasing demands for maintenance — the difference will be 22 and 15 per cent respectively to the credit of the Jersey type. Here, however, the standardization for milk of 4 per cent (FCM) lessens the effectiveness with the price system.

When examining the controlled stocks of the German Federal Republic the difference to the credit of the Danish Jersey is even greater than in Denmark. As against the black and white breed prevailing here (100%) the Danish Jersey produced — for 100 kg live weight — 186 per cent according to the Danish milk price system, which figure, on basis of the Dutch price-system, was 170 per cent. According to the *Brody—Ragsdale* index there equally shows itself a difference of 35 and 24 per cent, respectively, to the credit of the Danish Jersey.

It would, however, be proper to raise the question whether it is right only on basis of the milk production level to decide on the dairy types to be bred. No doubt that especially in Europe, considerable claims must be put forward concerning meat production, too. Thus, breeding — beyond certain limits — such types the bull-calves of which are less suitable for fattening purposes, can be advised with reservations and only to a more limited extent. Such breed is the Danish Jersey and others that are single-purpose dairy types.

However, it seems instructive to consider that the efficiency of milk production points to the direction of the reasonableness of the concentration of milk.

Several new aspects are encountered in modern cattle breeding. Since in up-to-date animal husbandry the stress is not only on the problem whether certain traits can be developed or not, a factor of more importance is the *time* factor, — with each breeding objective the time has also to be taken into consideration during which the aim can be attained. Another feature of today's animal breeding is the trend towards developing such populations that do not show much diversity in their qualities being at the same time, productive on high level. From an economic point of view, ***not so much the production of certain individuals is essential but the genetic security through which we might obtain populations of determined productivity, almost in series.***

The area available for growing fodder crops is rather limited, yet more and more dairy products and beef must be produced; consequently a cow type maturing as early as possible and yielding yearly 6—10 times its live weight (550—650 kg) in milk standardized to 4 per cent (FCM), seems to be economical.

This type of cow has also to produce calves which can be fattened with good results; its udder must be suitable for mechanized milking. Such a type can be attained by developing a stock which primarily produces concentrated industrial milk or an other producing a great quantity of less concentrated milk for liquid milk consumption. The question might be raised how to approach the outlined aims in shortest way. In modern genetics a quicker rate of development might be secured by way of applying three guiding principles:

1. Through reduction and rationalization of the number of characteristics which serve as basis of selection.
2. By means of increasing selection pressure.
3. Applying rational crossbreeding.

The most difficult task requiring the utmost care, is *to reduce the number of characteristics* that form the basis of selection. It is not only a question of focussing our energy on developing economically important qualities, but also of combining, as far as possible, those which are in positive correlation with one another. *Through each new trait with which we increase the number of properties that serve as basis of selection, the time required for attaining a given level, will be increased to the square.* This requirement speaks also in the favour of ignoring all kinds of formalism; qualities which are not bearing upon efficient production must not be taken into consideration.

The second guiding principle is the raising of *selection pressure*, a concept which means the number of recorded or progeny tested animals out of which the individuals for breeding can be selected. The larger the number of individuals from among which we can select those with best hereditary qualities and *the less the per cent of individuals intended for further breeding, the greater is the selection pressure. At the same time, the selection differential raises and consequently, the work of breeding becomes more effective.*

By applying the third guiding principle: crossbreeding, the gene-reserve of a given stock can be rendered richer with new genetic elements. Since the aim of this paper is to discuss how to improve the Hungarian Fleckvieh breed by way of pure breeding, crossbreeding will not be discussed.

On the forthcoming pages suggestions will be made concerning the possibilities of how to rationalize the qualities to be selected for, taking into consideration the available genetic conditions for improving the milking — calving — meat-producing capacities and, in general, the efficiency of production of the Hungarian spotted breed.

It is a well-known fact that the heritability of *milk production* is rather low ($h^2 = 0.2-0.3$). A rich number of domestic papers and even more of those written abroad prove that the genetic variation in milk production in dairy and dual-purpose breeds is very great. Therefore, the standpoint according to which the development of milk production through reasonable selection were an undertaking promising but little result — seems to be wrong. This is being definitely underlined by many foreign results (VAN VLECK, LE ROY, JOHANSSON, etc.).

With the genetic improvement of *fat per cent*, the situation is, in certain respects, inverse. Though the heritability of this trait is high ($h^2 = 0.6-0.7$), the variability within the breeds is less than in milk production. In this field in some countries and especially by breeding lowland breeds, considerable progress has been attained. The main motive for this seems to be the fact that the centre of interest was the fat per cent, and the quantity of milk was often neglected. Consequently, certain concessions were made regarding the quantity of milk production.

As to *fat quantity* the situation is about the same as with milk quantity. There is much variation in butterfat production at a low h^2 value. At the same time, in almost every European country the basis of payment for milk, is the production of butterfat. Also in Hungary, since the 1st of January 1964 the trading contracts have been concluded on basis of butterfat kg. Thus, it is the produced fat quantity that is in closest correlation with the economy of milk production.

As to the *protein* contents of milk, rather numerous examinations were carried out both in this country (CZAKÓ, VERESS, HEROLD, HORN, DOHY, DUNAY, etc.) and abroad. For the increase of total protein contents in milk — apart from the initiation of the Netherlands, — no material concern has been realized so far. The suggestion of some experts (HANSSON, JOHANSSON) concerning the selection for the *fat-protein-ratio* is, for the time being, not promising in practice because the variation in these properties within the breeds is very small; thus, considerable improvement could be hoped for only after very long time.

There is no doubt that with protein per cent the situation is, to a certain degree, similar to that of fat per cent. Its h^2 value is high and shows even less variation than the fat content. If, on a given occasion, it is necessary to select either for the fat-free solids or directly for the protein contents, both can be realized as soon as the different scientific and economic problems have been, in this respect, cleared up. However, for the time being we cannot reckon with the general introduction of protein tests, neither can we expect to reward suitably the protein as long as it is not attractive enough for the milk industry.

For developing the method of selection to be followed, it is essential to investigate what connections the different correlations calculated with in the Hungarian spotted breed show regarding the phenotypic and genoetic correlations being important from an economic standpoint.

The correlations established with the Hungarian spotted breed clearly relate to the fact that the most efficient possibility of selection is that for the quantity of butterfat. This is being suggested by most experts of importance especially in Europe, on basis of investigations carried out in recent years (Johansson, Haring, Heidhues, Hartmann, Winnigstedt, etc.), and those who have dealt with the problem in connection with the Hungarian spotted breed (Herold, Veress, Horn, Dohy, Sebestyén, Munkácsi) are of the same opinion.

It is true that selection for butterfat kg may result, to some extent, in a reduced increase of milk concentration, i. e. that of fat per cent, nevertheless the quantity of milk will primarily increase as a result. And yet, selection on basis of butterfat is considerably more advantageous than laying stress on quantity of milk; in this connection negative correlations will reveal themselves as shown in the Table 7; with other words, we have to reckon with constant thinning of milk both in the case of fat — and of protein per cent.

In order to keep up meat production, it has to be taken into consideration besides increasing of calving capacity to keep also growth rate at a proper level. In view of this it is advised to carry out such selection, too, in the course of which individuals with poor daily gain will get excluded.

For this reason when evaluating bulls, the daily gain has to be controlled. From the stock of the raising stations 30 per cent of those with poorest growth rate should be rejected. The sires of fattened bull-progeny groups that have not reached in the course of central progeny tests a daily gain of 1000 g, and of those which do not gain 850 g daily, under average farming conditions, should not be qualified.

Other qualities like the scoring for conformation, milk production, fat per cent, quality of udder, milkability, would be listed with minimum value in the course of classifying stock cows appointed for bull production. Therefore, it would be advisable to keep up this system, under the stipulation that animals being under the average as to protein content of their milk (those with a protein content per cent below 3.3 per cent) ought to be excluded from this category of cows.

A further crucial index of efficient milk production is the milk produced per unit of live weight. The realization of this principle was suggested as early as 1940 by Gaines ("The lactational drive"), while Brody (1945) proposed the exponent 0.73 of FCM kg/live weight for establishing efficiency.

On the other hand, Mason suggested the ratio of lactation and withers height because according to his data, the height of withers is the most constant value and reflects in a sure way body weight.

Table 7

*Correlation between properties connected with milk production in the Hungarian spotted cattle**

Properties	Value of the correlation coefficient (r)	Author and the year of the test
Quantity of milk — butterfat % ..	−0.150	Farkas (1936)
Quantity of milk — butterfat % ..	−0.20	Horn (1942)
Quantity of milk — butterfat % ..	−0,195 $P < 1\%$	Horn (1960)
Quantity of milk — butterfat % ..	−0.39 (genotypic)	Sebestyén (1964)
Quantity of milk — butterfat % ..	−0.16 (phenotyipic)	Sebestyén (1964)
Quantity of milk — butterfat quant.	+0.977 $P < 1\%$	Horn (1960)
Quantity of milk (FCM) — butterfat quant.	+0.917 $P < 0.1\%$	Horn (1960)
Quantity of milk (daily) — butterfat quant. (daily)	+0.910	Herold—Veress (1963)
Quantity of milk — live weight	+0.39 $P < 0.1\%$	Czakó et al. (1963)
Quantity of milk — live weight	+0.64 (genotypic)	Sebestyén (1964)
Quantity of milk — live weight	+0.26 (phenotypic)	Sebestyén (1964)
Quantity of milk — heart girth	+0.208 $P < 0.1\%$	Dunay—Dohy (1961)
Quantity of milk — heart girth	−0.25 (genotypic)	Sebestyén (1964)
Quantity of milk — heart girth	−0.06 (phenotypic)	Sebestyén (1964)
Quantity of milk (FCM) — index of relative milk production	+0.86 — +0.95 $P<0{,}1\%$	Dohy—Dunay (1963)
Quantity of milk (per milking) — rate of milking	+0.70 $P < 0.1\%$	Dohy (1958)
Quantity of milk (lifetime production) — udder conf.	+0.215	Horn (1942)
Quantity of milk — udder score ...	−0.149 (genotypic)	Sebestyén (1964)
Quantity of milk — udder score ...	−0.12 (phenotypic)	Sebestyén (1964)
Quantity of milk — total score	+0.32 (genotypic)	Sebestyén (1964)
Quantity of milk — total score	+0.25 (phenotypic)	Sebestyén (1964)
Butterfat % — butterfat quantity ..		Horn (1960)
Butterfat % — protein %	+0.189 $P < 0.1\%$	Herold—Veress (1963)
Butterfat % — protein %	+0.302 $P < 0.1\%$	Horn et al. (1963)
Butterfat % protein % (Hing. spot. × Jersey)	+0.261 $P < 0.1\%$	Horn et al. (1963)
Butterfat quantity — protein quantity	+0.916 $P < 0.1$	Herold—Veress (1963)
Butterfat quantity — protein quantity	+0.91	Herold—Veress (1964)
Butterfat quantity — protein quantity	+0.976 $P < 0.1\%$	Horn et al. (1963)
Butterfat quantity — protein quantity (Hung. spot. × Jersey)	+0.906 $P < 0.1\%$	Horn et al. (1963)
Butterfat quantity — total jury score	+0.42 (genotypic)	Sebestyén (1964)
Butterfat quantity — total jury score	+0.07 (phenotypic)	Sebestyén (1964)
Butterfat quantity — udder conf. ..	+0.22 (genotypic)	Sebestyén (1964)
Butterfat quantity — udder conf. ..	+0.11 (phenotypic)	Sebestyén (1964)
Cingulum — index of relative milk production	−0.395 $P < 0.1\%$	Dohy—Dunay (1963)

* In the Literature as enumerated also the papers dealing with other breeds.

It seems that under very favourable conditions, and with very uniform breeds the height of withers is characteristic for live weight. However, in the Hungarian spotted breed these two conditions are not yet given. On the other hand, the heritability of live weight as well as heart girth that is in close correlation with the former, is high ($h^2 = 0.37-0.41$ MASON, SHEFFER, TOUCHBERRY, etc.). Because of the low heritability of milk yield, due to the positive correlation between live weight and milk production, the selection for milk yield alone or for fat quantity only, would increase live weight at a greater rate than the relative milk production. Therefore, the selection carried out solely on absolute milk or fat production, or for the production of FCM impairs, to a certain extent, the relative milk yield and efficiency of milk production. Most probably, this refers especially to the Hungarian spotted breed because in this breed live weight shows particularly great variations, more than in other breeds.

On basis of the above briefly outlined views, it seems to be difficult today to take a definite attitude concerning the optimum live weight of the cow, and even when accepting the argument that under well-balanced, advantageous feeding conditions it is reasonable to keep also herds with bigger body — *there can hardly be divergence of opinions that one of the basic stipulations of economic milk production is high milk yield related to live weight and thus, it is of crucial importance in evaluating efficiency of milk production.*

In this connection, the method of the Finnish breeders is very noteworthy: according to this, they express the economic milk production by way of showing, with certain cows, how many kilos of 4 per cent standardized milk (FCM) are produced per 1000 Scandinavian feed-units required for maintenance. Practically this means how much milk is produced by the cows per unit of live weight. As a result of applying this principle, it could always be provided for the milk production of the stock to become more and more economical. Milk yield referring to the unit of live weight as a standpoint for selection is very important also because nowadays we are aware of the fact that selection for milk or that on butterfat production as well as selection referring to the daily gain during fattening tends to raise live weight all the time. This, on the other hand, lowers efficiency of milk production and the calving capacity (per unit of fodder) being important from point of view of meat production. *To ensure the balance, i.e. that between milk production and the economic character of same as well as calving capacity, it is only possible if, in the course of selection, milk production referred to one unit of live weight becomes prominent, thus preventing less efficient types getting to unjustified preference.*

The importance of milkability increases through the spreading of machine milking. Fortunately, this trait shows close correlation with the quantity of milk yield. Thus, in case of selection for butterfat kg, we may reckon with the improvement of milkability, as well, as this appears also from the investigation of JOHANSSON, FOOT, DOOD, DOHY, etc.

From Table 8 it can be seen what positive and negative effects may result when selecting for butterfat kgs, yield of milk standardized to 4 per cent per unit of live weight, and for daily gain.

Table 8

Selection	Effect	Trait
1. Selection for butterfat quantity	greatly increases	1. Milk quantity
		2. Protein quantity
		3. Total solids of milk
		4. Utilization of fodder
		5. Rate of milking
	increases	1. Body weight
		2. Udder conf.
	does not affect, or slightly enhances	1. Butterfat %
		2. Protein %
	probably decreases	1. Milk production related to live weight
	decreases	1. Calf-producing capacity*
2. Selection for daily gain in weight	increases	1. Live weight
		2. Utilization of fodder during fattening
	decreases	1. Milk production related to live weight
		2. Calf-producing capacity*
3. Selection for milk standardized to 4% fat (FCM), related to 100 kg live weight	greatly increases	1. Econ. prod. of milk and dairy products
	enhances or does not affect	1. Calf-producing capacity*
	probably decreases	1. Body weight

* Related to a given quantity of nutrients.

According to the information obtained from Table 8, as well as on basis of the phenotypic and genetic correlations established with Hungarian spotted cows, and also found in world literature — it is advisable to rationalize the work of selection. Since in future besides increasing yield, the principle of efficient production must prevail in a much more definite way — only such method might meet the requirements that can grant the suitable balance in estimating partly the absolute production, partly the economic character, developing, in both direction, the capacities parallel.

In herds being under milkrecording and when evaluating the progeny groups, on basis of the abovesaid, the backbone of selection would be the quantity of fat, and the production of FCM per 100 kg live weight, in a manner that weighting would be 50—50 per cent. Evaluating this way this would give the "Economical Value Index of Production". The weighting of 50—50 per cent is reasonable when starting from the theoretical concept that with the rate of increase in milk production based upon the selection for fat quantity, live weight would increase in approximately the same ratio. Therefore, if selection is aiming only at butterfat and milk quantity, then in case of the Hungarian spotted cows, more efficient milk production could be but partly carried out and at the same time, calf-producing capacity of the stock would decrease.

It deems advisable to compare the "Economic Value Index of Production" with the production of a standard Hungarian spotted cow. Regarding this, it is suggested that this type of cow should be the one of 650 kg live weight, producing 4000 kg milk with a fat content of 4 per cent (615 kg FCM per 100 kg live weight). This production would represent the 100 per cent.

On the basis of the principles outlined, if the progenies of an "A" bull having an average weight of 500 kg, produce 3000 kg milk, and 120 kg 4 per cent butterfat, the value index gained on basis of butterfat production will be:

$$\frac{X^{\text{fat kg}} \times 100}{A^{\text{fat kg}}} = \frac{120 \times 100}{160} = 75\%$$

where $X^{\text{fat kg}} =$ the average butterfat production expressed in kg of the cow or progeny group in question

$A^{\text{fat kg}} =$ fat-yield of the standard cow taken for basis of the comparison

The efficiency index obtained on basis of FCM/live weight:

$$\frac{X^{\text{kg FCM/live weight}} \times 100}{A^{\text{kg FCM/live weight}}} = \frac{600 \times 100}{616} = 97\%$$

where $X^{\text{FCM/live weight}} =$ milk yield standardized to 4 per cent fat content of the cow or progeny group in question divided by live weight

$A^{\text{FCM/live weight}}$ = milk production standardized on 4% fat content, of the standard cow that serves as basis of comparison, divided by the live weight.

The "Economic Value Index of Production": $\frac{75+97}{2} = 86\%$.

Thus, a basic gauge of the level and economic production can be established to which the individual animals being under milk recording can be compared ; at the same time progeny groups and their sires can be evaluated. It has always been a problem to reduce to the same denominator the production of animals chosen for breeding at different age and weight, and producing milk of different quantity and concentration, and being of different live weight. This problem can be solved by availing ourselves of the suggested "Economic Value Index of Production". Animals taken into breeding at different age, show up in live weight; this is automatically expressed by the "Economic Value Index of Production". In connection with live weight possibility for compensation is attainable here, cows and progeny groups with great live weight but excellent production will be highly valued. Only those types will not come up to standard the yield of which lag far behind their body weight and the production of which is not economical.

Of course, there is no doubt that the suggested method can be improved in several relations; however, until further data are available, it may be used for evaluating individual cows and progeny groups. The relative grading of the progeny groups at the testing stations can be performed in such a way that in addition to the absolute "Economic Value Index of Production", the grade of the bull in question can be expressed by the percentage related to the average of the performance at the progeny testing station, and this might be listed after the index of the progeny group (i.e. 85—120%).

A further advantage of relating to the mutual basis is that bulls with determined index might be used, depending on their absolute level, in herds having different production level. Thus, in a stock with an average production of 160 kg butterfat and 650 kg live weight, evidently, it will be advised to use a bull with a value index higher than 100 per cent.

Finally, the "Economic Value Index of Production" grants possibilities for making comparison between breeds that differ regarding early maturity, milk-production, milk-concentration as well as live weight, and, in certain respects, renders the objective comparison of breeds and bulls possible even on an international level.

The principles briefly outlined require in some respects a new outlook. There is no doubt, however, that the application of present genetic experiences in practice might give considerable impetus to rendering the production of especially dual-purpose cattle breeds more efficient.

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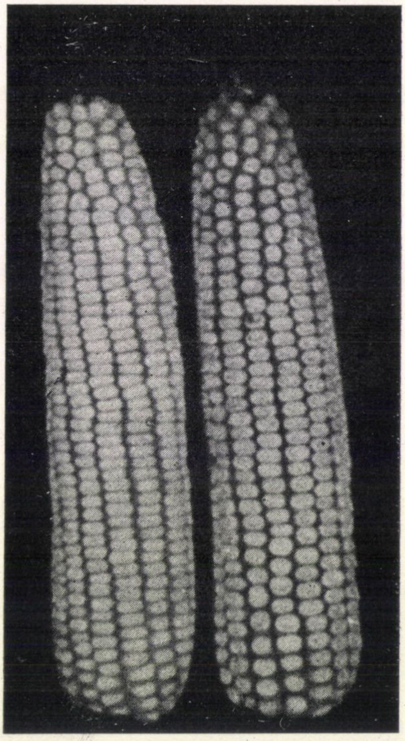
VARIA

Varieties registered

State certified plant varieties



Hybrid maize Martonvásári 40
(Mv 40)

Origin: Crossing of 5 yellow and 1 white early inbred dent corn lines.

Beginning of breeding: 1952, in the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár.

Breeders: Endre Pap, István Kovács, Károly Fehér and László Szentirmai.

Year of qualification: 1959.

Characterization of the plant: Inbred dent hybrid corn of short vegetation period, rapid development, medium growth, medium standing ability, with one or two ears, productive as related to earliness, variegated.

Vegetation period: Belongs to maturity class 300; ripening date 340.

Morphological description

Foliage: Medium abundant; leaf blade relatively broad and short.

Stalk: Medium high, of medium thickness. Somewhat susceptible to lodging.

Tillering: Medium.

Male inflorescence: 5—20 July, under conditions prevailing in Hungary.

Maturation: First half of September under conditions prevailing in Hungary.

Ear: Medium size; length 18—20 cm; at the apex of husks small leaf blades. Ears grow generally on peduncles of 10—15 cm. Liable to produce several ears. Ears are not completely compensated since the hybrid originates from multiple cross.

Kernel row: 14—18, the rows are practically straight and perfectly closed.

Cob: Medium thick; colour meat-red.

Shelling rate (%) 85—86.

Kernel: Medium long, dent corn, on which sometimes only a shallow cupule is seen. Colour variegated: abt. 15—20 per cent of the kernels are white, the rest yellow and of mixed colour. Thousand kernel weight 310—320 g; hl weight 72 kg.

Growing region: Can be grown as a main crop where the conditions of growing hybrids with maturity class 300 are present. In the region of maize varieties with maturity class 100 and 200 it can be grown as maize for silage. In places where also late maize varieties are ripening, Mv 40 may be grown as a second crop.

Origin: Crossing of two yellow inbred dent corn lines and the white Mindszentpuszta variety

Beginning of breeding: 1950, Martonvásár (Agricultural Research Institute of the Hungarian Academy of Sciences)

Breeders: Endre Pap and István Kovács, Martonvásár

First preliminary state certification: 1961

Characterization of the plant: High yielding, well earing, medium maturing hybrid maize for silage; large bulk of green material; very good response to irrigation

Vegetation period: Belongs to maturity class 400; ripening date 430

Morphological description:

Foliage: Abundant; leaf blade medium broad and long

Stalk: Medium thick, high

Tillering: Very good

Male inflorescence: Second decade of July,

Maturation: For kernels, second half of September under conditions prevailing in Hungary

For silage, second half of August, under conditions prevailing in Hungary

Ear: Producing 1—2 ears. The ear is well covered by husks. The husks frequently terminate in leaf blade.

Peduncle 5—10 cm. The ears are projecting. Length of the ear: 20—23 cm. The ears are well covered

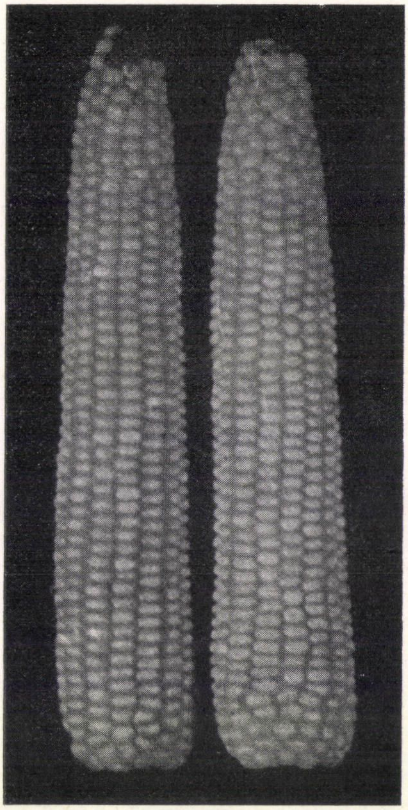
Number of kernel rows: 14—16

Colour of cob: meat-red

Shelling rate (%) 85

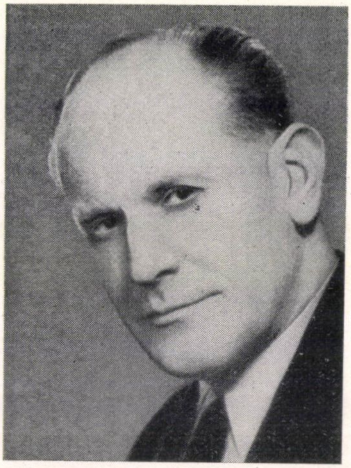
Kernel: The colour is variegated: 3/4 of the kernels being yellow, 1/3 white. The kernel is smooth or with shallow cupule. Thousand kernel weight 330 g

Growing region: As maize for silage it can be grown in the region of hybrids with maturity classes 200, 300, 400 and 500, respectively.



Hybrid maize Martonvásári 26
(Mv 26)

CHRONICA



ALADÁR PORPÁCZY
1903—1965

In the person of Academician, Director, University Professor, Kossuth Prize-winner and holder of two degrees of the Order of Labour Aladár Porpáczy, an initiator of horticultural research work passed away from our ranks. He was one of those who, in this country, first took active part in fruit improving as organizer and founder of this kind of scientific work.

In the past decades he was one of the most prominent personalities of horticultural science and of agriculture in general. Noble human qualities, indefatigable zeal to work, creative optimism, the possession of youthful intellectual faculties, and his unswerving pursuance of the new and true, have made him a great man.

His activity displayed right up to his last days, leads us to believe that his death has deprived us of many creative years.

He was born in 1903, in Pápa. He continued his grammar school studies and made his final examination in that town. He then served as a probationer with Gyula Magyar, the most progressive horticultural researcher. After taking his degree at the School for Horticulture and Viticulture, first he had started his educational work here and later continued this at the Magyaróvár Agricultural College. Educating had been a recurrent passion throughout his whole life. In 1931 he was invited to become head gardener of the Esterházy Estate in Fee Entailed, being in this position up to 1945. In his soul he had borne the marks of various people, of friends and of his schools from previous times. However, his restless mind wanted to get acquainted with new ideas. It was in this period that he wrote articles and books in order to fill in the gaps in education. Besides meeting the requirements of his job, he found time for research work and for getting absorbed in the problems of his scientific field. He closely co-operated with neighbouring plant breeders thus getting much inspiration which formed the basis of his later work.

After the liberation in 1945 his activity became even more intense. In order to improve his faculties, the regime provided opportunities which, previously, had not been granted to him. Only a man with his qualities could have availed himself of the opportunities to such a degree as he did. By establishing the State Horticultural Experimental Station in 1945, he created the first institution of the kind. In 1946 he organized a specialized secondary school and later a technical college under the most difficult circumstances. Thus, he has established the first specialized school after the liberation. In 1949 he gave up, for some time, special training and devoted himself to the thorough reorganization of the horticultural experimental station thus establishing horticultural research work and modern fruit improvement on a new basis. In 1950 together with the Agricultural Experimental Station, he had brought about such a wide-ranging institute the results of which soon became public property. From this time on his fame got more and more known; due to his practical and theoretical results, he rose to the rank of the most outstanding experts. In 1955 he was elected to be a corresponding member of the Hungarian Academy of Sciences. From the year 1957 he had been entrusted with the management of the Sopronhorpács Experimental Station, too. Between 1959 and 1963 he became university professor of the Pomiculture Chair at the School for Horticulture and Viticulture. It was at that time that he was awarded 1st grade of the Order of Labour. In 1961 he organized the Fertőd High-Degree Pomiculture Technicum, and again he became closely connected with educational work.

In 1963, on the occasion of his 60th birthday, he was awarded the gold-grade of the Order of Labour as a reward of the Government for his scientific work.

Besides these manifold activities, he devoted part of his time to research and educational work, too. His fruit varieties became acknowledged one after the other. The most outstanding work of his literary activity is the book: "Theoretical Problems of Modern Pomiculture", meeting in the most up-to-date approach the highest requirements. The book has been published in several languages thus gaining more appreciation for scientific work done in Hungary.

His theoretical knowledge and his results are appreciated all over the world. Reference is often made to his principles and to his science throughout Europe.

His accuracy, love of work, kindness have been widely known. He loved his country, his people, and identified himself with all those principles that were to contribute to the welfare of humanity.

His death, ensuing after a long illness, caused sincere grief to every true friend and scientist.

It is with great regret that we had to take leave of the deceased at a relatively early age.

However, his love of learning, his humaneness and modesty will survive as an example for us all.

We will remember his creative optimism that had always lent him new power to his work.

A great man of Hungarian horticultural science passed away but we will always keep his memory.

F. Beke

RECENSIONES

GY. MÁNDY *et al.*: *A burgonya* (The potato). Publishing House of the Hungarian Academy of Sciences, Budapest 1964.

Special literature on potato in Hungary has dealt up to now almost exclusively with production problems. The present work published recently is treating, as a sort of compendium the potato, except for the growing of the plant, its botanical physiological, biochemical and genetic relationships. Knowledge pertaining to agricultural botanics of potato has been elaborated in 20 chapters. This comprehensive study is most welcome and necessary to complete the scope of knowledge of experts dealing with potato, first of all as related to botanics.

Here the origin of potato is discussed from new viewpoints and a characterization is supplied of the resistance of wild species (resistance both to climate and diseases). The work deals in detail with interior and exterior morphology of potato, with the germination of potato seeds, the sprouting or chitting of tubers and with the results of experiments carried out with "rindite".

A most important part of the book is the physiology of metabolism in potato discussed in chapter 8. No such comprehensive discussion of the physiology of metabolism in potato has been presented to the Hungarian reader so far. In this chapter the author deals with mineral nutrition of potato, photosynthesis, photoperiods, respiration (respiration of cells) and alkaloid synthesis.

In the chapter on "The potato and its environment" the authors have developed in detail the influence of edaphic and climatic factors as well as of physiographical and agrotechnical effects on the production of potato.

An other important part of the book is the chapter on plant pathogens and animal pests of potato. The chapter on "The significance of resistance in the control of potato diseases" deserves special interest since Hungary, as it is well known, is liable to the breakdown and degeneration of potato.

60 per cent of new potato varieties all over the world originate from crosses with wild species and therefore the chapter of the book on "Chromosome conditions and genetics of potato", which is a detailed study of the subject is very useful and necessary. Here the authors discuss in detail the resistance of potato to pathogens and pests from the point of view of genetics.

The book contains data indispensable also for the practical specialists in its following chapters: "Yield data of potato", "Biological problems of the storage of potato" and "Economic significance and uses of potato".

The varietal systematics of potato are treated in a completely new elaboration. The key of determination of the cultivated Hungarian and most important foreign varieties may supply an important aid for specialists engaged in the production of potato tubers. The book is completed by very ample References.

Thus a long needed book came into the hands of practical and theoretical specialists filling a gap in Hungarian agricultural literature and in which the latest results of research on potato can be found.

B. Koch

E. Guzsal: *A háziállatok szövettana* (Histology of domestic animals). Publishing House for Agricultural Books, Budapest 1963.

We may be hardly mistaken when stating that in the world literature no other book is available discussing the theme in such details and presenting such a rich choice of histological sections (477 pictures). Although it is a textbook of the University of Veterinary Sciences, the illustrative presentation of the material of knowledge makes it very useful also for veterinary practitioners and generally for those engaged in histological studies.

Gy. Mándy: *Szántóföldi növények nemesítése táblázatokban* (Breeding of field crops in tables). Publishing House for Agricultural Books, Budapest 1963.

A number of shorter and more extensive works appeared in foreign countries on the breeding of field crops which are dealing with problems of and data on the breeding of various plants. It involves, however, a considerable difficulty for the reader that these works must be studied with painstaking care whenever quick information is wanted in some question or other. This is where the present work intends to afford help. Data on the breeding of sixty most important agricultural crops are discussed in a tabellary composition and elaborated according to uniform viewpoints. Thus for each plant the questions concerning the origin of the plant, its chromosome conditions, species and generic hybridization, flowering biology, fertilization, castration, isolation, heredity, mutations, breeding purposes and methods are exposed. As an advantage of tabellary elaboration the reader obtains answers to a number of questions and all this in a very word-bound but fully intelligible manner.

Gy. Mándy: *Kertészeti növények nemesítése táblázatokban* (The breeding of horticultural plants — in tables). Publishing House for Agricultural Books, Budapest 1964.

In this book data and other knowledge concerning the breeding of about 60 vegetables and fruits, medicinal herbs and ornamental plants are found. The tabellary form using columns has a number of other advantages beside short and concise presentation: it is easy to survey and to handle, warrants the uniformity of discussing the individual species, at the same time practically compelling the author to make public property a great many of scattered and hardly available data not only to breeders but to all gardeners-specialists who are interested in further training.

M. Mohácsy, P. Tomcsányi, S. Peregi: *A gyümölcs útja a fától a fogyasztóig* (The pathway of the fruit from the tree to the consumer). Publishing House for Agricultural Books, Budapest 1964.

The book deals with the up-to-date large-scale manipulation of fruit produced for the market. Its objective is to promote that a uniform, faultless commodity true to name and with a tasteful exterior should reach through the organs of the trade the table of the consumer and all works necessary for it should be inexpensive and economically efficient. The pathway leading to this objective is modern technology, new methods of labour organization, maximum mechanization: machines for harvesting, grading and moving of the produce. Moreover it is necessary to clearly understand the biological processes taking place in the fruit from the beginning of ripening through storage to consumption.

INTERNATIONAL LACTIC ACID PRIZE

It is announced that, subject to the undermentioned conditions, prizes will be awarded for the two best and worthy papers submitted on the following subject:

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Professor Dr. A. T. Phillipson, Department of Veterinary Clinical Studies, School of Veterinary Medicine, Cambridge, England

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РЕЗЮМЕ

УЛУЧШЕНИЕ ПРОДУКТИВНОСТИ *TRITICALE*

А. КИШШ

Было определено, что для улучшения продуктивности первичного ***Triticale*** наилучшим методом является выведение вторичного ***Triticale***.

В то время как первичный гексаплоидный *Triticale I* за прошедшие 15 лет совершенно не улучшился, потомки, полученные в результатае скрещивания ***Triticale*** 56 хром. × 42 и 42 × 56 хром. гептаплоидов, создали чрезвычайно продуктивные вторичные гексаплоиды. В результате ежегодно проведенных скрещиваний и исследований потомков было определено, что оптимальный геномный уровень ***Triticale*** не октоплоид, а гексаплоид.

До сих пор наиболее продуктивным гексаплоидом является ***Triticale 30***, который происходит от скрещивания ***Triticale* «F»** (2n=56) и ***Triticale I*** (2n=42). Родитель ***Triticale* «F»** представляет собой **T. aestivum** L. F. 481 (2n=42) × S. **cereale** (2n=14), а **Triticale I — T turgidum var. buccale** Alef. (2n=28) × **S. cereale** L. (2n=14). Эта линия в 1964 г. на площади 4,5 кат. хольдов на бедном по качеству песчаном черноземе дал урожай выше, чем пшеница, рожь и озимый ячмень.

В 1965 г. ***Triticale 30*** выращивали в кечкеметском колхозе «Золотой колос» на площади 30 кат. х. и в Сельскохозяйственном Опытном Институте в междуречье Дуная и Тиссы на бедной песчаной почве на площади 5 кат. х. Насколько нам известно, это первый случай в мировой практике, когда ***Triticale*** перешла с опытных делянок на производственные поля.

Кечкеметская ***Triticale*** выносит песчаную почву также хорошо, как и рожь. В противовес ржи у нее есть большое преимущество, которое заключается в ее резистенции против мучнистой росы, листовой и стеблевой ржавчин. Содержание белка в ржи, озимой ячмене и кукурузе недостаточно. ***Triticale 30*** на песчаной почве может служить источником ценного белка, как концентрированный корм и хлебный злак. Общее содержание белка 18—20% (рис. 1), таким образом чрезвычайно бедные запасы белка в стране улучшатся и сократятся годовые потребности в импорте, которые составляют примерно 50 000 вагонов.

СОДЕРЖАНИЕ КАРОТИНОИДА В ЗЕРНЕ МУТАНТОВ КУКУРУЗЫ

А. ФАЛУДИ-ДАНИЕЛЬ, Ф. ЛАНГ

Нами исследовалось содержание каротиноида и его локализация в зерне линий кукурузы, содержащих γ-каротин и ликопин. На основании абсорбционных спектров каротиноидных экстрактов, полученных из зерна нормальной кукурузы и мутантов, были сделаны выводы о синтезе полного блока каротиноидов.

Вначале было найдено, что содержание каротиноида в зерне нормальной кукурузы и мутантов почти одинаковое, но как было показано в зародышах мутантов по сравнению с зародышами нормальной кукурузы на общее содержание каротиноидов приходилась большая часть.

Количество каротиноида, приходящееся на один фактор, в нормальных зародышах меньше, а в мутантах намного больше, чем в эндосперме.

На протяжении периода хранения зерна содержание каротиноида значительно снижается, поэтому для сравнения сортов наиболее пригодными являются свежие созревшие зерна.

ПАРТЕНОКАРПИЧЕСКАЯ МЕТАКСЕНИЯ У БАКЛАЖАНА (SOLANUM MELONGENA L.)

Дь. ПАЛ, Ж. ОСВАЛЬД

На баклажане исследовалась степень влияния пыльцы разлиных сортов, видов и родов на партенокарпическую метаксению. В случае партенокарпической метаксении влияние опыления проявляется на материнском растении на развитие плода (метаксения) и в таком случае образуются бессемянные плоды.

Определено, что на баклажане при отсутствии оплодотворения образование бессемянных плодов и их число представляет собой сортовой признак. Чужеродная пыльца, в зависимости от вида и рода вызывает образование партенокарпических плодов в различной степени, но при опылении внутри рода и между родами прямой зависимости от степени родства не обнаружено. Пыльца видов, относящихся к одному и тому же роду и к другим родам, вызывала образование партенокарпической метаксении в большей или меньшей степени независимо от отношения растений к данному или другому роду.

СРАВНИТЕЛЬНОЕ ИЗУЧЕНИЕ ПОГЛОЩЕНИЯ БРОМИДА ИНТАКТНЫМИ ПРОРОСТКАМИ И СРЕЗАННЫМИ КОРНЯМИ

З. БЁСЁРМЕНИ

Сравнение поглощения бромида интактными проростками и срезанными корнями приводит к выводу, что причина, лимитирующая поглощение в обоих случаях одна и таже, а именно: аккумуляция, происходящая в клетках симпласта корня.

Этот процесс двойной; его можно разделить на процессы, насыщающие растворы на низкую и высокую концентрации. В растворах с отношением хлорида : бромида = 1:1 компетиция изменяется в зависимости от концентрации, максимума достигает при концентрации 1 моль. экв./л. Транспортировка в побеги растет пропорционально концентрации (как % общего поглощения), но интересное переходное снижение проявляется при концентрации 0,1—0,3 моль. зкв./л.

Концентрация поглощения бромида и кривые компетиции не дают основы для суждения о природе или кинетике аккумуляции, происходящей в вакуоли или секреции, выделяющейся в сосуды если такое можно предполагать. Возможность легкой транслокации аккумулированного в корнях Br^{82} показывает, что между вакуолью и симпластом происходит быстрый обмен Br.

В исследованном случае низкое содержание соли не влияло на процессы K_m- поглощения I; по сравнению с растениями с высоким содержанием соли сокращалась скорость поглощения при любой исследованной концентрации. У растений с низким содержанием соли транслокация Br происходит в небольшой степени. Это повидимому следствие начинающегося недостатка N (и P). У растений с недостатком N при азотном удобрении скорость поглощения Br (при любой концентрации) и % транслокации быстро растут. Оба действия можно задержать одновременным применением хлорамфеникола.

ВЛИЯНИЕ РАЗЛИЧНЫХ СПОСОБОВ ВЫРАЩИВАНИЯ РАССАДЫ КОЛЬРАБИ НА ЕЕ РАННЕСПЕЛОСТЬ И РЕНТАБЕЛЬНОСТЬ

П. САЛВА

В овощеводстве Венгрии среди скороспелых культур кольраби является одним из первых, находящимся в широком производстве, овощей богатых витамином. Различные способы выращивания рассады способствуют более ранней уборке кольраби. В статье обсуждается часть результатов исследования, полученных в течение последних четырех лет. При выращивании рассады различными способами выяснилось, что выращивание рассады в питательных кубиках ускорило созревание на 7 дней и увеличило валовую доходность на 91% по сравнению с традиционным выращиванием рассады путем посева семян вразброс.

СЕЛЕКЦИЯ *SOLANUM LACINIATUM* (AIT) С ПОМОЩЬЮ ОБЛУЧЕНИЯ

П. ТЕТЕНИ

В 1960 г. семена *Solanum laciniatum* (AIT) были подвергнуты облучению изотопом Co^{60} в дозах 26, 34, 44, 58, 72 KR. LD_{50} наблюдалось у потомства семян, получивших облучение в дозе 44—58 KR; появились морфологические изменения и ненаследуемые модификации; в большой степени наблюдалось сбрасывание плодов, которое проявлялось и в последующих поколениях. Исследование самоопыленных линий, проведенное в течение 5 лет, подтвердило сигнификантное увеличение отклонения содержания дрога, появление максимумов в 28—31% и наследование определенного уровня гликоалкалоида. Произведенный после облучения позитивный отбор создал отклонения, в пределе вида, по химическому составу в такой степени, что смеси отселектированных линий по содержанию гликоалкалоида оказались сигнификантно выше контроля на 26—43%.

УСЛОВИЯ ОПЛОДОТВОРЕНИЯ СОРТОВ ЯГОДНЫХ РАСТЕНИЙ

А. ШЕЛЯХУДИН, Ш. БРОЗИК

Ягодные растения (земляника, крыжовник, малина, черная и красная смородина) будут приобретать все большее и большее значение. Условия оплодотворения находящихся в производстве сортов в общем не выявлены, есть сведения об условиях оплодотворения отдельных сортов и видов. В пределе некоторых видов имеется много самоопыляющихся сортов. Но есть частично или полностью самобесплодные сорта, даже в отдельных случаях встречаются взаимносовместимые сорта.

Межсортовое оплодотворение во всех случаях вызывает более высокое завязывание. Поэтому и у самоопыляющихся сортов можно показать влияние сортов-опылителей, способствующих повышению урожая.

Посадка сортов, которые хорошо взаимно оплодотворяются, целесообразна и рентабельна для хозяйства.

Отдельные сорта, склонные к партенокарпии, и без оплодотворения обеспечивают урожай.

Приведенные выше вопросы выяснения взаимоотношения сортов изучались в течение 6 лет на 24 сортах земляники, 10 сортах малины, 10 сортах крыжовника, 14 сортах красной смородины и 21 сорте черной смородины.

ИЗУЧЕНИЕ ХАРАКТЕРА ОЗИМОСТИ — ЯРОВОСТИ У СОРТОВ ОЗИМОЙ ПШЕНИЦЫ. II.

Й. МЕШ

Несколько тысяч сортов пшеницы изучали при осеннем и весеннем посевах по характеру озимости-яровости на основании зимней гибели и данных по выходу в трубку-колошению. По отношению к изученным признакам наблюдали большое обособление среди сортов, особенно в весеннем посеве. На основании анализа данных с определенностью удалось показать качественное и количественное разделение сортов по характеру озимости—яровости.

Эта дифференциация дала возможность разбить сорта по характеру озимости — яровости на типы и по устойчивости этих типов.

БИОХИМИЯ ЯРОВИЗАЦИИ

IV. Изменение активности рибонуклеазы в течение яровизации

М. ДЕВАИ

Исследовали изменение активности рибонуклеазы в течение яровизации у озимой пшеницы Банкути 1201. Растения брались в виде проростков. Определено, что биохимический механизм яровизации частично связан с обменом веществ нуклеиновой кислоты. Очень активная форма РН-азы, принимающей участие в обмене веществ РНК, синтезируется и при низкой температуре (0° С) уже в первые часы процесса яровизации. Эту

РН-азу мы обозначили РН-аза 1. На основании температурных условий ее образования и условий торможения можно предположить, что она непосредственно принимает участие в обмене веществ процесса яровизации. Энзим удалось изолировать. Кроме системы РН-азы 1 в проростках пшеницы действуют и другие системы РН-аз. Изучение их находится в процессе исследования.

ВЛИЯНИЕ МИНЕРАЛЬНЫХ УДОБРЕНИЙ НА ИЗМЕНЕНИЕ ТИПОВ ДЕРНИНЫ

И. ВИНЦЗЕФФИ

Ряд типов дернины удобряли минеральными удобрениями различными способами и исследовали их изменение. Различные удобрения изменяли урожай дернины и ее состав. Количественное (урожай травы) и качественное (ботанический и химический состав растений) изменения при различных типах дернины проявились в разной степени.

ВЛИЯНИЕ МОЛИБДЕНА НА СИНТЕЗ НУКЛЕИНОВОЙ КИСЛОТЫ В ЛИСТЬЯХ СОИ

Б. И. ПОЖАР

Раствор аммония с молибденом в концентрации 50 ppm значительно стимулирует синтез нуклеиновой кислоты в листьях сои, при поглощении из раствора или при опрыскивании листьев. В случае опрыскивания листьев влияние микроэлемента оказывается более благоприятным на включение фосфата нуклеиновой кислоты, чем при подаче через корни. Обработка молибденом способствует повышению уровня лабильного кислотного фосфата, наряду с поглощением общего фосфата. Так как влияние опрыскивания листьев увеличивает в большей степени синтез и накопление фосфата нуклеиновой кислоты, чем при поглощении корнями из раствора, поэтому с большей вероятностью можно предположить, что процесс редукции нитрата тесно связан с непрерывной фотосинтетической транспортировкой водорода. В течение фотохимического распада воды начавшаяся транспортировка водорода связана с редукцией нитрата переносом редуцированного никотинамидаденина-динуклеотидфосфата. Неприменным условием увеличения синтеза нуклеиновой кислоты, в свою очередь, является редукция нитрата.

10-ЛЕТНИЕ (1955—1965) ОПЫТЫ ПО ХИМИЧЕСКОМУ ИСТРЕБЛЕНИЮ СОРНЯКОВ В СОРГО

Э. КЮКЕДИ

Исследование по химическому истреблению сорняков в сорго проводилось в Научно-исследовательском институте сельского хозяйства Венгерской Академии наук. Всего испытано 13 гербицидов. Применялись дозы от 1,75 до 15 кг/га. Время опрыскивания осенью производилось в ноябре, а весной после обработки почвы, в апреле до всходов и после всходов. Исследование проводилось в посевах сладкой суданской травы, суданской травы Mv Hybar 301, сахарного сорго Early Sumac, американского гибрида NK 120 — зернового сорго, сортов зернового сорго Hybar Mv 101 Mv Hybar 102, и Early Hegari.

На основании исследований выяснено, что 2,4-Д лучше применять на посевах суданской травы в возрасте 4—5 листьев (1,75—2,0 кг/га) опрыскиванием травостоя. Другое время не является удовлетворительным для опрыскивания. Суданскую траву можно с успехом выращивать после кукурузы на зерно и на силос, которая обрабатывалась Атразином или Хунгазином ПК. Суданская трава сильно реагирует на гербициды содержащие Триазин, поэтому надо избегать свежее опрыскивание этими гербицидами. Афалон, Арезин и Кармекс нельзя применять даже в малых дозах на посевах суданской травы.

ПОЛОЖЕНИЕ РАСТЕНИЕВОДСТВА И АНАЛИЗ ФАКТОРОВ ЕГО РАЗВИТИЯ

Г. ЛАНГ

Среди факторов, влияющих на урожай полевых культур, особое значение имеют сорта, имеющиеся в производстве, севооборот, обработка почвы, орошение и удобрение.

Исследуя эти факторы приходим к выводу, что новые селекционные сорта по сравнению с имеющимися в производстве сортами, сами по себе только в небольшой мере могут повысить урожай. В прошедшее время, в основном, широкое распространение в производстве гибридной кукурузы способствовало увеличению урожаев.

Севооборот, в первую очередь, зависит от соотношения площадей, занятых растениями, находящимися в производстве. Изменить сложившееся в стране соотношение культур еще нет возможности, это можно будет сделать только соответственно с увеличением средних урожаев. Так при имеющемся в настоящее время уровне производства, создание такого состава культурных растений, который мог бы значительно повлиять на плодородие почвы, почти невозможно.

В Сельскохозяйственной Академии в Кестхее и в ряде научно-исследовательских институтов, проведенные опыты показывают, что только на некоторых типах почв более глубокая обработка, чем та, которая проводилась до сих пор, приводит к повышению урожая. В благоприятном случае пропашные культуры после глубокой обработки дают повышение в урожае более, чем на 20%. На протяжении последующих лет у следующих культур можно ожидать повышения урожая только на 5%. Так в конечном счете, производительность всего севооборота под влиянием глубокой обработки повысится самое большое на 8—10%.

Орошение само по себе только редко, чаще всего в сочетании с интенсивным удобрением дает положительный результат.

Навоз, полученный в хозяйствах, является важным фактором поддержания плодородия почвы. Количество навоза значительно повысить, в то же время, нет возможности, т. к. оно, в первую очередь, зависит от поголовья крупного рогатого скота.

Среди наиболее важных средств повышения средних урожаев считаем минеральные удобрения. В опытах по применению минеральных удобрений, проведенных с пшеницей, кукурузой, сахарной свеклой, картофелем, силосной кукурузой, затем на пастбищах и лугах, было достигнуто довольно значительное (20—100%) повышение урожая. Достигнутые по стране в течение последних трех лет повышенные урожаи, в первую очередь, можно приписать внесению большого количества минеральных удобрений.

Между фактором применения минеральных удобрений, с одной стороны, и благоприятно действующими на величину урожая рядом других факторов, как-то: применение в производстве продуктивных сортов, установление оптимальной площади питания, правильная обработка почвы, рациональное использование навоза, с другой стороны, имеется существенная принципиальная разница. Последние факторы повышают урожай без больших добавочных затрат и, главным образом, представляют собой использование внутренних источников хозяйства. Использование же минеральных удобрений, с другой стороны, значительно повышает производственные затраты и обеспечить их можно только из источников вне хозяйства. Поэтому очень важно изучать факторы, влияющие на действие минеральных удобрений, и особенно те способы, с помощью которых результаты, полученные на опытных делянках, можно было бы перенести на поля хозяйств с почвой не вполне соответствующей по качеству почве опытных делянок.

ВЛИЯНИЕ СРЕДЫ И ОТБОР

Ш. РАЙКИ

В опытах по генетическому превращению незимующих яровых в зимостойкие озимые, расширение вариации по колошению — от яровости до озимости —, как это неоднократно было установлено, нужно приписывать, в основном, влиянию среды, а не отбору.

В посевах зернового и сахарного сорго только гербицид 2,4-Д ввиду кратковременного действия менее пригоден. Лучше всего их сеять после кукурузы, обработанной гербицидами Атразин или Хунгазин ПК, и в случае необходимости опрыскивать Атразином 1,75—2,0 кг/га, Пропазином или 2,4-Д. В случае свежего опрыскивания на черноземных почвах Атразином или Пропазином нельзя применять дозу выше 3 кг/га. Наименее опасным является опрыскивание травостоя.

Считаем, что среди испробованных гербицидов непригодными для борьбы с сорняками в сорго являются Афалон, Арезин, Кармекс. Гербициды Аметрин, Прометрин в увеличенной дозе уничтожают посевы сорго, гербициды А-1798, А-1802, А-2099 и Рандокс в данном случае вызывают временное пожелтение сорго.

Сделанные нами выводы относятся к опытам, проведенным только на черноземах.

ИЗМЕНЕНИЕ ПИГМЕНТА В ЛИСТЬЯХ ЯЧМЕНЯ

Д. ЛАСТИТИ, М. ХОРВАТ

У сорта ячменя MFB в изолированных и интактных листьях исследовалось изменение содержания пигмента.

Часть растений в течение 7 дней выращивали в темноте. Через 7 дней изолированные и интактные листья получали освещение. Исследование этиолированных растений проводилось на свету (8000 lux, F 30).

Другая часть растений в течение первых 7 дней выращивались на свету, а затем помещались в темноту. Исследование этих растений также проводилось на свету. Контролем служили растения, которые и выращивались, и исследовались на свету.

Третья часть растений выращивалась на свету, затем часть изолированных и интактных листьев помещались в водопроводную воду, а другая в 10 мол. раствор кинетина. Растения во время исследования были на свету.

Во всех вариантах у изолированных и интактных листьев сравнивались общее содержание пигмента и компоненты.

Определено, что у изолированных листьев ячменя общее содержание пигмента в зависимости от времени уменьшалось по сравнению с содержанием пигмента у интактных листьев, как на свету, так и в темноте. Наиболее определенное снижение показывал хлорофилл *a*. У листьев, обработанных кинетином, уровень общего пигмента и содержание хлорофилла *a* достигал более высокой величины, чем у интактных листьев.

ПАТОГЕННОСТЬ ВОЗБУДИТЕЛЕЙ КОРНЕЕДА СВЕКЛЫ

I. Метод селекции на устойчивость

Э. КИШШ

Результаты проведенных в ящиках опытов указывают на необходимость помещать инфекционный материал на 1 см ниже уровня семяложа.

Патогенность возбудителей болезней не проявлялась в полной мере при заражении семян агаро-споровой или мицелий-споровой суспензией (табл. I.).

Метод искусственного заражения почвы зарекомендовал себя удобным приемом в селекции свеклы на устойчивость к корнееду при внесении инфекционного материала по вышеуказанному способу.

Метод приготовления инфекционного материала: агаро-грибная суспензия поглощалась раздробленными семенами сахарной свеклы, предварительно стерилизованными и высушенными при комнатной температуре, полученная таким способом масса измельчалась и перемешивалась. Приготовленный по описанному методу инфекционный материал высевали в почву под семяложе.

Сорта различно относятся к отдельным возбудителям корнееда (рис. 3). Сорт Клейнванцлебен Поли, отличающийся в общем высокой резистентностью, оказался весьма восприимчивым к заражению **Phoma betae**.

В среднем по одиннадцати сортам, испытывавшимся в течение двух лет, поражаемость ростков отдельными возбудителями корнееда характеризуется, соответственно по годам, следующими показателями (в процентах): **Pythium de Baryanum** — 46,7 и 36,0; **Aphanomyces laevis** — 43,3 и 21,4; **Phoma betae** — 18,4 и 29,2 и, наконец, **Fusarium sps.** 16,6 и 13,1.

Exegi monumentum aere perennius
(HORATIUS)

It is with the deepest regret and grief that the Editorial Board of the Acta Agronomica announces the death of

Kossuth-Prize holder Academician; emeritus Professor of fifty years' standing; the late departmental head of the Agricultural Research Institute of the Hungarian Academy of Sciences; holder of the "Medal of Merits in Socialist Work", etc.

DR. JÁNOS SURÁNYI

who passed away, after long suffering, on the 8th of November, 1965 in the 79th year of his life.
The burial of our well-remembered co-worker took place in the Farkasréti-Cemetery in Budapest, on the 15th November.

The Editorial Board of
Acta Agronomica

IMPROVEMENT OF THE FERTILITY OF TRITICALE

By

Á. Kiss

AGRICULTURAL EXPERIMENT INSTITUTE IN THE REGION BETWEEN THE DANUBE AND THE TISZA RIVERS, KECSKEMÉT

Knowledge on the production of secondary *hexaploid Triticale* and the results obtained are presented here. It has been established that the optimum genome level of *Triticale* is not the octoploid with 2n = 56 chromosomes produced earlier but the hexaploid with 2n = 42 chromosomes produced lately. The secondary *hexaploid Triticale* 30 produced by the author develops on sandy soils similarly to rye but more protein is obtained from the unit area.

Introduction

The problem of the generic hybridization between wheat and rye had initially been dealt with by botanists who studied first of all the development of species and the degree of relationship between wheat and rye.

Wilson presented in 1875 to the Botanical Society of Edinburgh the first sterile wheat-rye hybrid produced by himself. The first stabilized wheat-rye hybrid of transitory character was produced by the German plant breeder Rimpau in 1890. Since then both botanists and breeders have reported all over the world on a number of wheat-rye hybrids. Botanists, geneticists and cytogeneticists have been principally interested in evolutional problems, while breeders have been led by practical purposes.

Some of them aimed at producing between the two cereal genera a new species that could have combined the favourable characters of wheat and rye. The more important pertinent literature is given by a number of authors (Aufhammer et al. 1961, Kappus 1964, Kattermann 1935, Kiss—Rédei 1953, Kiss 1958, Kiss 1965, Konstantinov 1963, Krolow 1962, 1963, Lapchenko 1963, Mahalin 1963, Lindschau—Oehler 1935, Meister 1921, Müntzing 1939, 1963, Nakayima 1951, 1952, 1954, etc., Pisarev 1955, Pisarev—Samsonov 1958, Pisarev—Zilkina 1963, Riley 1960, Rimpau 1891, Sanchez-Monge 1956, 1958, Schneider 1954, 1955, Taylor—Quisenberry 1935, Tschermak 1913, Vettel 1958, 1959, 1960, a, b, etc.).

Review of the Literature

The amphiploids of the wheat-rye hybrids have attracted attention of plant breeders and geneticists, and rightly so. The fact itself that the sum of the genomes of two genera can be united in a third species has raised the idea that the hereditary substance of the new stabilized hybrid would probably be richer and more varied, consequently, the organizatory and genetic value of the new plant higher.

The *Triticalia* produced up to now have satisfied the requirements of botanists and geneticists but not the objectives of the plant breeders. In the field of practical utilization these hybrids have caused a great deception. The *Triticalia* produced lately show almost the same drawbacks as the first ones produced 75 years ago and those obtained subsequently (Kiss 1954, Lindschau—Oehler 1935, Müntzing 1939, Pisarev 1956, Sanchez-Monge 1956, Tschermak 1913, Vettel 1958). It was surprising to find that the first *Triticalia* produced did not improve in the course of years either upon the influence of selection or on hybridization or mutational induction (Kiss 1958, Leiser 1954, Pisarev 1956, Schneider 1955, Vettel 1958).

Müntzing (1939) regards the most efficient way of the improvement of fertility in the method of crossing the very fertile wheat mother varieties with self fertilizing rye varieties tolerating inbreeding and subsequently polyploidizing the sterile hybrids. Such selection of the parent partners was adopted by a number of authors (Oehler 1941, Kiss—Rédei 1953). This selection of the parent partners did not bring about the desirable result either (Kiss 1958). Since wheat and rye in nature had not produced during their co-existence of several thousand years a viable, fertile, stabilized hybrid, some authors came to the conclusion that the production of such stabilized hybrids was completely illusory (Forlani 1954, Heinisch 1964 oral communication, Tschermak 1913, Meister 1921, Strampelli 1904, (cit. Dionigi 1955)).

Between the wheat and rye genera the genetical incompatibility is so great that the production of high productivity *Triticalia* is impossible from the very outset. Wheat is closely flowering and self fertilizing while rye open flowering and cross fertilizing, which means that wheat gets fertilized, for the most part, by its own pollen while rye requires the pollen of the neighbouring plant individuals. In the case when the stigma of the rye gets fertilized by its own pollen, the progeny will be aborted and largely sterile. Now when uniting the hereditary substance of wheat and rye, the stabilized wheat-rye hybrid obtained will be self-fertilizing as the wheat and will be, to a very little degree, able to receive the pollen from foreign individuals. This feature acts detrimentally on the fertility character of the rye in the hybrid, the consequence of which is the high grade of sterility of the *Triticale* progeny (Kiss 1953, Müntzing 1963, Schneider 1954, Stebbins 1951).

Most authors explain the high grade of sterility in the old and new *Triticalia* also by the abnormal division in meiosis, the primary cause of which is the genetical and biological incompatibility referred to before (Krolow 1962, Müntzing 1948, Nakayima 1951, 1952, etc., Schneider 1954, Vettel 1960 a, b). According to TISCHLER (1946) and STEBBINS (1951) the newly developing plant species must first of all go through a long period of selection. Hereby the chromosomes of the new species gradually exchange so far that they reach complete homology, moreover, at the production of gametes of the new species only bivalents arise. KAPPUS (1964) points out that the sterility of the present *Triticalia* may be brought about by unknown causes so that in the breeding of wheat-rye hybrids the practical result entirely depends upon chance.

The explanations referred were verified by experience and by our own experimental data. On the grounds of the theories presented we arrived at a point where it seemed to us that the work directed to the breeding of *Triticale* should be abandoned, as the practical objective set out at the beginning of the work seemed unattainable (KISS 1958).

As a matter of fact no fertile *Triticale* have come into being either in nature during the course of many thousand years. Although spontaneous wheat-rye hibrids were found by several workers these were sterile and could not be taken into consideration from the view-point of plant production (LEIGHTY-SANDO 1928, MEISTER 1921, TAVČAR 1941).

All of the *Triticale* produced by plant breeders struggled with the disturbances of fertility. The Soviet professor PISAREV alone published in 1956 reassuring data, explaining the weak fertilization and the skrinking and wrinkling of the grains by the deficiency of the trace element boron. In the material of the octoploid *Triticale* AD 20/1 he had produced with the use of boron, lines setting, in 1954, 56.2 on the average and maximally 82 grains per main ear. The grain yield of the *Triticale* per spikelet does not touch two. The best strains of SCHNEIDER (1954) set 1.29 grains per spikelet, while the hybrids of KAPPUS (1963) 1.33 and the *Triticale* of AUFHAMMER et al. 1.47 maximum 1.74 grains.

Most breeders were engaged in the improvement of the fertility of the octoploid *Triticale* produced from the hybrid of the common bread wheat *(Triticum aestivum)* and of rye. LEISER, in 1954, aimed at producing strains of higher fertility from the various lines of *Triticale* "Rimpau". In 1961 AUFHAMMER, FISCHBECK and SCHNEIDER reported on the hybridization of various *Triticale* lines with each other. RUDORF (cit. AUFHAMMER et al. 1961) obtained a minor improvement by the crossing of the fertile hybrids among each other. LEISER (1954) when crossing the *Triticalia* of KATTERMANN could not select individuals more fertile than the starting parent partners. Several workers recommended to use for the production of *Triticale* wheat partners readily crossing with rye.

On the First International Wheat Genetics Symposium held in Winnipeg, Manitoba, Canada, 11—15 August 1958, the idea was raised that perhaps the hexaploid *Triticalia* might prove to be more valuable than the octoploids (JENKINS 1958, MÜNTZING 1958, SHEBESKI 1958, SANCHEZ-MONGE 1958).

JENKINS (1958) regards the hexaploid *Triticale* material of O'MARA and that deriving from Spain suitable for further breeding. MAC KEY (1958) considers the *Triticale* of SANCHEZ-MONGE as a raw breeding material which must be further improved by the convergent method. SANCHEZ-MONGE (1958) recommends for practical use the hybridization of the hexaploid *Triticale* and of common wheat.

PISAREV (1956) proved that the crossability of the wheat and rye partners did not involve higher productivity of *Triticale*. VETTEL (1959) suggests, beside the combination and selection breeding, the use of the mutation method. In his experiment he found few mutants the productivity of which was better than that of the initial form.

According to Swedish experiments (MÜNTZING 1963) *Triticale* attains, on good clay soil, 65 per cent of the productivity of wheat (the wheat variety Skandia II = 100%) while on sandy soil 96—98 per cent. The *Triticale* of VETTEL (1959) approximated the wheat variety Derenburger Silber on a clay soil with loess to 60—65 per cent only. According to the written communication of MAYER (1965) the German *Triticale* of Hadmersleben attained in 1964 only 28.5 per cent of the yield of the wheat variety Eros. According to the oral communication of DOBBEN (1965) the Dutch *Triticale* produced after 1944 did not work well in practical farming either and at present are found only on plots of collections. Similarly the Italian, French and Austrian *Triticalia* are only grown in varietal collections.

Since the practical value of *Triticale* produced up to now is insignificant, several workers tried to bring about neocombinations (MÜNTZING 1963, PISAREV 1955, PISAREV—ZILKINA 1963, SANCHEZ-MONGE 1958, SCHNEIDER 1954, VETTEL 1959) and mutations (VETTEL 1959, KISS 1958).

Material and Method

From the literary data outlined it appears that *Triticale* research has a past of almost 90 years (WILSON in 1875 produced the first sterile hybrid) but up to the present day no such material has emerged that stood the test in practical farming. After the attempt made by GYŐRFFY in Mosonmagyaróvár (1948 ined.) the optimum genome level of *Triticale* was studied by the author since 1951 in Martonvásár and since 1957 in Kecskemét (KISS—RÉDEI 1953, KISS 1954, 1958). During the last 15 years we have not succeeded in producing between the diploid wheat and diploid rye a tetraploid ($4\times = 28$) *Triticale*.

In 1951 the first hexaploid *Triticale* was produced from the hybrid between *Triticum turgidum* var. *buccale* ($4\times = 28$) and *Secale cereale* L. ($2\times = 14$) (Fig. 1). Although great hopeswere attached to the fertility of this *Triticale* of lower grade of polyploidy, it did not prove more fertile at all than the known foreign octoploid Triticalia. Our *Triticalia* produced from the cross between *T. aestivum* L. ($6\times = 42$) and rye ($2\times = 14$) were rather varied but did not exceed in fertility the *T. "Rimpau"*, thus our initial attempt was unsuccessful. The hybrids produced exhibited the same disadvantages as the foreign *Triticalia* and there was no hope that these drawbacks could be eliminated in one way or the other.

Our research work was led, however, not only by the objective of breeding but also by the viewpoint of evolutionary genetics. Crossing experiments were conducted not only with the practically valuable wheat and rye varieties but also with the practically worthless wheat and rye species *(T. turgidum* L., *T. carthlicum Nevski*, *T. durum Desf.*, *T. timopheevi Zhuk.*, *T. monococcum* L., *Secale vavilovi*, *S. sylvestre Host.*, *S. montanum* L., *S. africanum* L., etc.) The most valuable hybrids were obtained from the crosses between *T. turgidum* L. and *S. cereale* L. The inclusion of all other wheat and rye varieties into the hybridization and polyploidization experiment involved so many bad and disadvantageous characters (fragility of the ear, shrunk and shrivelled grains, low fertility, etc.) that in the following they were disregarded.

Result and Discussion

The production of new wheat varieties with rye properties showed a somewhat quicker result but difficulties presented themselves also here. It was quite a surprise that from the *Triticale* × wheat crosses already in the second and third generations fertile wheat was readily obtained. The difficulty appeared when we tried to fix rye property in these hybrids. The rye character generally disappeared as soon as after the second back-cross with wheat. From the wheat-rye hybrid the rye genome fell out entirely. Isolation of the rye genome was often experienced in the meiosis studies and in the control of progenies.

It was easy to fix in the wheat progeny the hairiness of the culm below the ear characteristic of rye. These lines did not distinguish themselves by great fertility in any of the cases and it may be supposed that the rye chromosome (or chromosome particle) containing the hairiness improves neither fertility nor sand tolerance in the hybrid.

We did not succeed at all in producing rye with wheat-cytoplasma from the *Triticale* × rye crosses, although Lein (1943) reported on such result. From these experiments it appears that *Triticale* can be easily transformed into wheat but its retransformation to rye encounters difficulties.

In the experiment we continued to lay the greatest stress on the improvement of the stabilized wheat-rye hybrids. It was surprising to find that our hexaploid *Triticale* No 1 did not improve almost at all in the past 15 years. From the examinations it could be established that the hybrid raises many flowers in each main ear (90—110, mean 98) but sets few grains (33—39, mean 37). The number of the grains in the spikelets of the main ear did not attain two in any of the experimental years. In the average of the years the extreme values ranged from 1.18 to 1.43, the mean being 1.29.

Since the score of the hybrids produced from the *Bánkúti* and *Fleischmann* wheats studied before and of the foreign *Triticalia* was not higher either, an attempt was made to hybridize the present *Triticalia* among each other. As transformation of polyhaploid hybrids with 14 and 35 chromosomes into dihaploid was not successful, the hexaploid × hexaploid, octoploid × octoploid and hexaploid × octoploid and/or reciprocal crosses were thoroughly investigated.

It should be noted here that attempts to produce valuable neocombinations from the crossing of *Triticalia* of a 42 × 42 or 56 × 56 chromosome polyploidy level were unsuccessful. All the more surprising and novel were the progenies of the crosses of various polyploidy levels.

In the investigation of the yield components of *Triticale* hybrids the greatest stress was laid on the grain to main ear, grain to main spikelet ratio and on grain setting per ear as evaluated from the total number of flowers. In the course of selection it appeared that the ear to plant and grain to plant ratio supplied reliable data only together with the productivity of the spikelet and with grain size. The actual conditions of tillering may make appear eventually an entirely worthless line as productive and another one as not

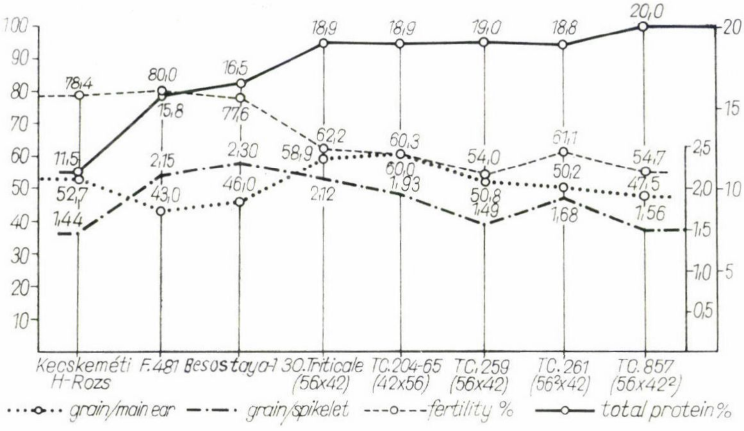

Fig. 1. Grain yield per ear of Triticale hybrids in the average of the years 1960—64

productive. Since in the beginning, owing to poor grain setting and high degree of sterility, we could work with a low number of individuals only, we evaluated, also in the later generation, the individuals of hybrids raised on plots of 1 $^1/_2$ to 2 sq.m. and sown at a spacing of 10 $\times$ 10 cm. After the second and third generation 4 $\times$ 100 plants were already analysed. Fig. 1 presents the mean values obtained in the years 1960—64. For better orientation also the scores established on the experimental plots for the wheat and rye parents are indicated (Fig. 1). From the Figure it appears that grain yield per main ear of the *Triticale 30* plant individuals raised with a 10 $\times$ 10 cm spacing has attained and even exceeded the grain yield of the rye *Kecskeméti "h"* and of the wheat varieties *F 481* and *Besostaya 1.*

In the case of *Triticale* the improvement of fertility is still the objective of the first order. While the hexaploid *Triticale* 1 in the mean of the years 1960—64 showed only 36.5 per cent fertility, the hexaploid secondary *Triticale* 30 from the hybrid between the 56 chromosome *Triticale "F"* and the 42 chromosome *Triticale 1* exhibited, in the average of the last 5 years, a fertility of 16.2 per cent. In no other newer hybrid has been observed a higher average fertility. It has been found that in the last one or two years the fertility evaluated from the total flowers has rapidly increased. Evaluating the data of the last year (1964) the fertility of *Triticale 30* has come very near to that of the rye (71.4 per cent in this year, while *Triticale 30* attained 69.5).

It is worth while to compare minimum and maximum values of the mean of the last 4 or 5 years because from these one may conclude whether there is hope for an improvement of the grain yield per ear (Table 1).

Table 1

Minimum and maximum grain yields per ear of the hexaploid Triticale hybrids in 1960—64

(Controls: wheat, rye and the most fertile German *Triticale* Hadmersleben)

Serial No.	Line or variety	2n	Number of grains per main ear										$\bar{x}$
			1960		1961		1962		1963		1964		
			min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	
1.	Rye Kecskeméti "h"	14	38	80	26	75	36	80	36	79	39	53	54.64
2.	Wheat F 481 . . .	42	16	69	18	70	16	73	15	68	32	63	41.22
3.	Besostaya 1.	42	—	—	23	70	22	65	21	60	38	67	43.75
4.	Triticale 1.	42	17	50	21	48	18	49	14	51	27	43	37.20
5.	Triticale 30.	42	26	59	25	63	28	60	24	63	32	99	54.86
6.	Triticale "Hadmersleben"	56	24	65	20	61	28	56	28	59	29	62	44.66
7.	2/B×Triticale 30.	42	—	—	0	2	13	36	22	49	32	68	40.97
8.	(AD×TT)×Triticale 1.	42	—	—	0	4	7	18	20	47	30	64	35.43
9.	Ko Tc.×Triticale 1.	42	—	—	0	7	6	34	16	61	33	72	37.57
10.	Ko Tc.×Triticale 30.	42	—	—	2	7	21	53	18	63	35	112	53.80

2/B = Triticale "Bánkúti" Ko Tc. = Triticale "Korai"
AD = AD20/1 Triticale "Pisarev"
TT = Triticale "Taylor"

The 56 chromosome *Triticale* Hadmersleben under serial number 6 shows a good seed-setting, however, under the conditions prevailing in Hungary its fertility is very poor. As a consequence of its late ripening its thousand grain weight hardly reaches 20 g. Under serial numbers 7—10 only a few newer hexaploid × octoploid hybrids are presented. Since these hybrids derive from parents of different polyploidity level, the seed setting of the F_1 generation is very poor. In the third and fourth generation high fertility hexaploids were obtained from these hybrids in every case while the fertility of the aneuploids was poor. Since 1952 from hexaploid and octoploid *Triticale* crosses in no case

Fig. 2. The hexaploid *Triticale* 1

have we succeeded in regaining from the segregating population the octoploid parent type. This made us well conclude that in the case of *Triticale* the

Table 2

Machine seeding experiment of Triticale 30, 1961—63
(Plot size 28.77 sq. m., 6 replications)

	1961	1962	1963	$\bar{x}$
Rye Kecskeméti "h"	18.76	16.10	15.44	16.77
Triticale No. 30	14.22	13.90	12.50	13.54
S. D. 5%	1.35	0.88	1.20	
Difference to the benefit of the rye variety Kecskeméti "h"	4.54	2.20	2.94	3.23

Fig. 3. Triticale experiment with machine seeding 1960—61

Fig. 4. Triticale experiment with machine seeding 1961—62

optimum polyploid level is not the 56 chromosome octoploid but the 42 chromosome hexaploid form.

It is surprising that the very first hexaploid *Triticale 1* has exhibited no improvement at all during the last 13 years while its hybrid progenies (secondary hexaploids) yielded the most productive progenies. *Triticale 30* caught our attention in 1960. Its F_1 and F_2 generations were in 1958 and 1959 still rather sterile but in the F_3 generation we could already lift out individuals the grain yield per ear of which came very near to that of the rye. Although in the first four years values always lagged behind the rye Kecskeméti "h" in 1964, the mean value of the 100 "elite" ears lifted out from F_7 cought up with it already and even surpassed (63.1 grains per main ear).

Triticale 30 was the first to be recommended for a farm-scale trial. The comparative experiments with machine seeding were carried out in 1961—1963 (Figs. 2 and 3).

Until 1963 even this *Triticale* did not attain the productivity of the rye Kecskeméti "h" best adapted to the sandy soils between the Danube and the Tisza rivers (Table 2).

In 1964 *Triticale 30* was grown on the 4.5 cad. hold field of the Agricultural Cooperative Aranykalász. The result was 12.07 q grain yield per cad. hold and this was the first case when *Triticale* yielded more than rye. In the same farm rye yielded 8.84 q grain per cad. hold, winter barley *Béta* 8.22 q and the wheat variety *Besostaya 1* 8.49 q. It should be noted, however, that rye was grown on 10 cad. hold, winter barley on 62 and the wheat *Besostaya 1* on 70 cad. hold.

In 1965 *Triticale 30* is grown in the cooperative farm on 30 cad. hold. Besides, in the Szarkás station of this Institute on poor sandy soil an informative experiment with chemical fertilizer application is conducted on a 5 cad. hold area.

According to our experience the hexaploid *Triticale 30* tolerates the sand soil as well as does rye, but in years with mildew, leaf rust and stem rust incidence it does not get infected with these diseases while rye is susceptible to all three. In 1964 there was a heavy incidence of mildew and leaf rust which damaged first of all the rye.

Specialists expect a good deal of this new plant on sand exactly on account of its drought tolerance and resistance to diseases. *Triticale 30* and its improved derivatives may play an important part in the production of fodder rich in protein. The protein content of rye, fodder barley and maize is not satisfactory and the missing proteins are substituted for by other fodders rich in protein. This emergency situation further deteriorates the adverse protein balance of the country and increases the amounts of fodder which must be imported. *Triticale 30* with its 18 per cent protein contents enhances the value of the poor sandy areas. Since the quality of its flour is nearer to rye, its production is recommended first of all for protein fodder and in the second place for bread-grain. Its healthy rich foliage renders it also suitable for green fodder, and can be used as green manure and silo fodder, too.

Conclusions

Production of secondary hexaploid *Triticalia* has been found to be the best method for the improvement of the fertility of primary *Triticalia.*

While the primary hexaploid *Triticale 1* has not improved at all during the last 15 years, exceedingly fertile secondary hexaploids have been produced from the progeny of heptaploids from the crosses of *Triticale* with 56 × 42 and 42 × 56 chromosomes. From the annually reiterated crossing and progeny analysing experiments it has been established that the optimum genome level of *Triticale* is not the octoploid but the hexaploid level.

Our most fertile hybrid so far is *Triticale 30.* In 1964 this line yielded more on sandy grassland soil of poor quality — per unit area — than wheat, rye and winter barley.

In 1965 *Triticale 30* is grown in the co-operative farm Aranykalász of Kecskemét on 30 cad. hold and on the poor sand of this Institute on 5 cad. hold. As far as we know this is the first case in world-wide relation that *Triticale* has been carried out from the experimental plots on to farm fields: In autumn 1965 it will be planted on about 300 cad. hold.

Triticale 30 tolerates sand as well as does the rye. As compared with rye it has the great advantage of being resistant to mildew, leaf and stem rust. The protein contents of rye, winter barley and maize are not satisfactory. *Triticale 30* may become a valuable fodder and bread grain. Its total protein content amounts to 18—20 per cent (Fig. 1) and thus it may improve the rather poor protein balance of the country and help to reduce fodder importations amounting at present to 500,000 tons annually.

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THE FORMATION OF CAROTENOID CONTENT IN THE GRAINS OF MAIZE MUTANTS

By

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The carotenoid content and its localization in the grain crop of ζ-carotenic and lycopenic maize strains has been studied.

From the absorption spectra of the carotenoid extract produced from normal and mutant grains the total block of carotene synthesis of the mutants has been concluded.

In the beginning the carotenoid content of the normal and mutant grains had been found nearly identical however, in mutant embryos, as compared with the normal, a higher proportion of the total carotenoid content could be detected.

The carotenoid yield for one factor is somewhat lower in normal embryos, and considerably higher in the mutants than in the endospermium.

Introduction

Maize is the only corn fodder that contains carotene in high quantity, possessing also of considerable provitamin-A potency (SMIRNOVA—IKONNIKOVA 1958).

The carotene composition of maize grains might be very diverse in the strains. In comparative variety-experiments 0.2—60 μg/g values have been obtained for the total pigment content (QUACKENBUSH—FIRCH—BRUNSON—HOUSE 1963). The qualitative distribution of carotenoids might also be considerably different; in general, they contain relatively high quantity of phytoene, α- and β-carotene, zeaxanthine and lutein (SHARMA 1961). Of these, α- and β-carotene as well as zeaxanthine display vitamin-A activity; phytoene is indifferent; lutein, however, has an influence on the quality of certain animal products (PALMER 1915). The carotenoids are not evenly distributed in the grains: the carotenoid content of the embryo is lower than that of the endospermium, a fact that affects the quality of flour-milling products (BLESSIN—BRECHER—DIMLER 1963).

Growing conditions bear but little influence both on the carotenoid concentration and the qualitative composition since these are determined, primarily, by genetic factors (QUACKENBUSH—FIRCH—BRUNSON—HOUSE 1963); however, they are being changed by storage conditions (DAHLE 1965, QUACKENBUSH 1963).

In the present paper we want to report on comparative investigations performed with the grains of carotenoid mutant strains. Our deal is to compare the carotenoid content in grains of various genotypes, and to examine the topographic distribution of carotenoids.

Material and Methods

Our material consisted of two inbred strains of Zea mays L. with grains of dark-yellow and lemon-yellow, and dark-yellow and red endospermium, respectively, in the ratio of 3 : 1. Their pericarp is colourless, thus the characteristic colour of the grains can be attributed to the carotenoid content of the endosperm. In both strains, the dark-yellow grains produce normal seedlings while the grains of lemon-yellow and red endosperm yield seedlings of a pigment content below the normal level and being extremely light-sensitive. Both contain, instead of the carotenoids characteristic of the normal leaves, ζ-carotene or lycopene (FALUDI—F. DÁNIEL 1961).

The ζ-carotene strain was placed at our disposal by the Agricultural Research Institute of the Hungarian Acad. of Sci. (Martonvásár), while the lycopene-strain by Prof. A. Bianchi, these being now propagated at the Biological Station (Alsógöd) of the Eötvös Loránd Univ.

The carotenes were cold-extracted with a mixture of acetone-petroleum-ether (b. p. 60—80° C) and the extract was rendered acetone-free through washing with water then dried with Na_2SO_4. The carotenes and xanthophylls were separated by shaking with methanol of 95% and the methanol phase, being distilled in N_2, was carried over into petroleum-ether The gasolenic solutions were spectrophotometered. The quantity of carotenoids was calculated from the values measured on the absorption maximum of the main components (β-carotene, or lutein, ζ-carotene, lycopene).

The homozygous dominant grains $(\zeta^+)\zeta^+ - ly^+(ly^+)$ had been taken from non-segregating ears produced by self-fertilization. The ζ-carotenic grains being homozygous for mutation, were well separated from the normal ones within the time-course of the investigation and the lycopenic ones marked (ζ/ζ-ly/ly).

The localization of carotenoids was compared on the 7—8th week after pollination since, according to the evidence of our informative experiment, this was the time when the expressivity of the various genotypes was the most pronounced.

The effect of storage was compared with grains being in the late-waxy ripeness (15 weeks). The grains were stored on the ears, at room temperature, in scattered light.

The data are the means of 3 parallel analyses, their standard deviation scattering being of 15—20%.

Results

The absorption spectrum of the carotenoid extract of normal and mutant grains taken from ζ-carotenic and lycopenic strains, is shown in Fig. 1.

From Fig. 1 it can be seen that the shape of the spectrum curve referring to the normal grains, indicates a carotene-lutein mixture. The spectrum of the mutants sharply deviates from the normal. In the ζ-carotenic grains practically pure ζ-carotene is present. The lycopenic grains chiefly contain lycopene, however, by way of chromatographic separation, a small amount of xanthophyll that has not been identified in particulars, can be revealed, too.

In the course of quantitative analysis of the carotenoid content, we compared the quantity produced in one grain and from this the proportion localized in the sporophyton. The data are shown in Table 1.

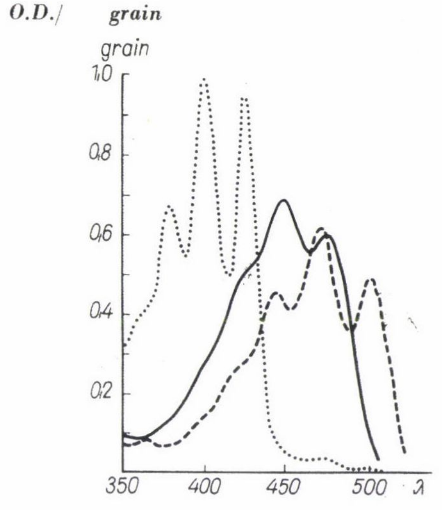

Fig. 1. Absorption spectrum of the carotenoid extract of normal and mutant grains
———— = normal, — — — = lycopenic, . . . = ζ-carotenic

Table 1

Carotenoid content of normal and mutant grains

Material	*Carotenoid* 10^{-9} M/grain	% for embryo	Efficiency of genefactor*	
			endosperm	embryo
ζ^+/ζ^+	8.0	8	11.1	7.2
ζ/ζ	9.9	27	11.2	31.6
ly^+/ly^+	10.0	5	16.3	11.3
ly/ly	8.8	45	13.3	39.1

$$*\frac{10^{-9}\ M\ \text{carotenoid/g endospermium}}{3}$$

$$\frac{10^{-9}\ M\ \text{carotenoid/g embryo}}{2}$$

From the data of the table it can be established that the carotenoid content of the normal and mutant grains is practically equal. However, in the topographic distribution of the carotenoids are great differences: the mutant embryo contains a considerably larger share of the total carotenoid content of the grain than the normal.

When comparing the carotenoid concentration calculated the weightunit in the endosperm and the embryo, it can be seen that the carotenoid concentration for each normal factor is higher in the endosperm than in the embryo. In the homozygous recessive individuals the situation is the opposite: the carotenoid accumulation to one factor in the embryos is almost the treble of the value measured in the endosperm.

On the basis of literary data and on visual observations, it seemed as if the carotenoid content would change in the course of storage. In order to approach the problem, we compared the carotenoid extract of grains that had been stored for different periods. The qualitative carotenoid composition did not change, the quantitative data are presented in Table 2.

Table 2

The effect of storage on the carotenoid content in grains of various genotypes

Material	Storage, month	*Carotenes* 10^{-9} M/grain	Xanthophylls 10^{-9} M/grain	Total carotenoid 10^{-9} M/grain	*Mutant* normal
ζ^+/ζ^+	0	2.5	3.3	5.8	0.36
ζ/ζ		2.1	0.0	2.1	
ζ^+/ζ^+	10	0.3	0.7	1.0	0.90
ζ/ζ		0.9	0.0	0.9	
ly^+/ly^+	0	1.2	4.1	5.3	0.50
ly/ly		2.4	0.3	2.7	
ly^+/ly^+	10	0.8	2.1	2.9	0.10
ly/ly		0.3	...	0.3	

From the Table it can be established that the carotenoid content has decreased in the course of storage. The rate of change is different in the various strains and this has an effect, at least, quantitatively, on the expressivity of the differences; e.g., the lycopenic characteristics that can be easily visually detected at the beginning of waxen ripening, are hardly visible in the ripened grains. After longer storage the grains that have originally been red, fade to ivory-white, while the carotenoid content of the normal ones decreases only by the half.

Discussion

From the qualitative differences of the carotenoids in normal and mutant grains, it can be concluded that the formation of carotenoids being characteristic of the normal grains, is inhibited in the mutant ones. The block of the biosynthetic chain in the mutants is complete because in these not even the traces of carotenes illustrative of the normal grains, could be revealed (FALUDI—F. DÁNIEL 1961).

The carotenoid yield falling to one factor is nearly the same in the normal and mutant endosperms, — in the normal embryo it is lower, while in the mutants it is considerably higher. Consequently, the statement of MANGELSDORF — FRAPS (1931), according to which the factor-number and the carotenoid content are proportional, does not hold in respect of these factors that determine the carotenoid synthesis.

The higher carotenoid content of mutant embryos might be explained by the fact that the cells of the embryo are considerably smaller than those of the endosperm, — thus in the weight-unit of the embryo we have to reckon with more cells, i.e., with more factors (SPRAGUE 1955).

In order to explain the low carotenoid content of the normal embryos, a complementary hypothesis postulating some inhibiting mechanism, would be needed. The intensive carotenoid production as experienced in mutant embryos, cannot be explained even by the lack of dormancy being in connection with the vivipary that is closely related to the carotenoid-forming irregularities of the ζ-carotenic grains (ROBERTSON, 1955) because neither are the lycopenic grains, in spite of their high carotenoid content, germinating on the ear. To understand the phenomenon, further investigations are required.

From the changes ensued under the effect of storage, it can be concluded that regarding vitamin-A activity, the freshly matured grains are the most valuable.

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PARTHENOCARPICUS METAXENIA IN EGG-PLANT (SOLANUM MELONGENA L.)

By

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We have been studying in egg-plant *(Solanum melongena* L.) to what extent the pollen of plants of different varieties, species and genera causes parthenocarpicus metaxenia. In the case of parthenocarpicus metaxenia the effect of pollination appears in the female plant, in its fruit formation *(metaxenia)* and in such cases seedless fruit *(parthenocarpicus)* will develop. We have established that if fertilization does not occur, the formation of seedless fruit and the number of these are properties of variety. The extraneous pollen causes, depending on varieties and genera, parthenocarpicus metaxenia of different rate, however, in crossings within the genus and in intergenera crossing, i. e. depending on the degree of relationship, no correlation can be experienced. The pollens of congeneric species and those belonging to other genera might produce slight and high-degree parthenocarpicus metaxenia irrespective of whether they originate from plants of the same or of some different genus.

Introduction

The basic problems of the fertilization conditions of eggplant varieties have been studied by several authors; in spite of this, there are numerous problems concerning the fruit development which have not yet been elucidated. The process of fertilization was studied by MAGTANG (1936) and BAILEY—MUNSON (1891). The latter authors established the fact that even if no fertilization had occurred, fruit-development would start on egg-plants: in such cases seedless fruit would be produced.

JASUDA (1933) studied the formation of seedless fruit produced without fertilization. He stated that the ovary of the egg-plant started to develop if pollination was performed with the pollen of *Petunia violacea* Lindl. On such occasions parthenocarpicus fruit would develop. On having used the pollen of tomato — *Lycopersicon esculentum* Mill., with similarly emasculated flowers — no such fruit was produced at all, or if so, only to a very little degree; this may be interpreted by the fact that in the stigma of the egg-plant the pollen-tube of tomato grows more slowly, while that of petunia grows more quickly.

According to the investigations of JASUDA (1933), the pollen cells of *Petunia violacea* Lindl. start the formation of the fruit from the ovary in *Solanum melongena* L., whereas in *Solanum gilo* Raddi they do not. His investigations have proved that the pollens of petunia grow more quickly in the stigma of *Solanum melongena* L. than in that of *Solanum gilo* Raddi. This has also been proved by having the pollens of *Petunia violacea* Lindl. germinated on various culture media because the value of germinating per cent of the pollens became higher and also the growth of tubes if an extraction made of the pistil of *S. melongena* L. was added to the culture medium. The investigations of JASUDA (1933) showed that when the pollen-tubes penetrated the pistils deeply, and even in the case when fertilization did not occur, there developed from the ovary a seedless fructus. When, on the other hand, the increase of the pollen-tubes on the pistil was inhibited, no seedless fruit was produced. In the course of our investigations the problem for us was whether the pollens of plants of different varieties, species and genera had an effect on the development of the *fructus* forming from the ovary; if so, how did it depend on the grade of relationship.

Materials and Method

The material of our investigations consisted partly of two varieties of egg-plant, partly of several species of the genus *Solanum* as well as the species of several genera in the family *Solanaceae*.

Taking for a basis the system of FILOV (1940) the examined egg-plant varieties were the following: The Common Purple egg-plant (*Solanum melongena* L. ssp. *occidentale* Haz. var. *bulgaricum* Fil.), as well as the Common White egg-plant (*S. melongena* L. ssp. *subspontaneum* Fil. var. *leucoum* Alef.). Out of the species of genus *Solanum* the *S. tuberosum* L., *S. gilo* Raddi, *S. abutiloides* Bitt. et Lille, *S. heterodoxum* Don., *S. dulcamara* L., *S. luteum* Mill., *S. nigrum*, L., *S. laciniatum* Ait., *S. rostratum* Dun., *S. giganteum* Jacq., *S. sinaicum* Boiss, *S. ribesiforme* A. Voss were included in our investigations.

Among the different genera of the family *Solanaceae* the *Nicandra physaloides* (L.) Gaertn., *Lycium halimifolium* Mill., *Atropa bella-donna* L., *Physalis peruviana* L., *Datura meteloides* Dun., *Capsicum annum* L., *Lycopersicon esculentum* Mill., *Petunia atkinsiana* Don., *Datura stramonium* L., *Saracha umbellata* G. Don. were examined.

In our investigations the following treatments were applied:

1. Emasculation and isolation. The flowers of both the Common White and the Common Purple egg-plants were emasculated as early as in their bud-stage — before fertilization would have occurred, — and isolated.

2. Crossing within the variety. The flowers being in the bud-stage, of both the Common White and the Common Purple egg-plants have been emasculated before self-fertilization and in both cases pollination was performed with the pollen of another individual belonging, however, to the same variety.

3. Intervarietal crossing. Between the Common White and Common Purple egg-plants direct and reciprocal crossings were made. In the first case the Common Purple egg-plant was the female and the Common White egg-plant the male plant and vice versa.

4. Interspecifific crossing. Crossings have been carried out between the Common White and the Common Purple egg-plants as well as the species of the genus *Solanum*. As female plant the Common White and the Common Purple egg-plant, as male plant on the other hand, various species of the genus *Solanum* have always been used.

5. Intergeneric crossing. Crossings have been carried out between the Common White and Common Purple egg-plant as well as the genera *Atropa*, *Capsicum*, *Datura*, *Lycium*, *Lycopersicon*, *Nicandra*, *Petunia*, *Physalis*, *Saracha* of the family *Solanaceae*. As female plant the Common White and Common Purple eggplants have always been used, while as male plant we have used the species belonging to the different genera of the family *Solanaceae*.

In each of the five treatments our investigations were made on 20 individuals. The flowers had been emasculated as early as in the bud-stage, they had been isolated and then pollination was carried out; isolating was then repeated. After the development of the fructus had started, the isolators were removed. When the first frosts set in, the fruits were gathered and the data were worked up. We determined, in per cents, the number of parthenocarpicus fruit as related to the number of crossings, the weight, length and width of the fruit.

The following problems were set for us:

1. Are all egg-plant varieties being examined by us, inclined to develop parthenocarpicus fruit?

2. How is the number of parthenocarpicus fruit on individual plants influenced by emasculation, self-fertilization, open pollination within and between varieties, in crossings between species and genera; does the effect of extraneous pollen depend on the grade of relationship?

Results

a) *Examination of emasculation.* The flowers of the Common White and Common Purple egg-plants have been emasculated as early as in the bud-stage. After emasculation the flowers were isolated; therefore, neither self, — nor extraneous pollination could occur. The isolators were removed only after the partial development of those fruits in which the development of the fructus had started from the ovary. In the case of flowers in which the formation of the fructus has not started, the pedunculus at the base will separate, together with the flower and will fall off. While those with which the formation of fructus has started, continue to develop.

The fruits being biologically ripe according to colour, were picked, and then it was established that no seeds could be found in them proving that emasculation had been successful. The number of parthenocarpicus fruit is expressed in the percentage of pollinated flowers; the values obtained are shown in Table 1. From the relevant data it can be seen that the wild type of the Common White egg-plant is not inclined to produce parthenocarpicus fruit, viz., if fertilization did not occur, no fructus would form from the ovary. The culture-type of the Common Purple egg-plant on the other hand, is apt to produce parthenocarpicus fruit, namely, with this variety even in the absence of fertilizing, the formation of the fructus will start from the ovary.

b) *Examination of self-pollination.* On the Common White and Common Purple egg-plants the flowers were isolated in their bud-stage, thus only self-pollination could occur with them. The biologically ripe fruit as indicated by the colour, was picked and then established the number of fruits in which there were seeds to be found and the number of those without seeds. The number of parthenocarpicus fruit has been expressed in the percentage of pollinated flowers and the obtained values are shown in Table 1. The data of Table 1 referring to self-pollination show that both egg-plant varieties are

Table 1

Number of seedless fruits taking shape in crossings within variety

Treatment		Number of seedless fruits, %	Average weight of fruits, g	Length of the fruits, mm	Width of the fruits, mm
Emasculation	P	20.00	293.6	139.2	91.9
	W	—	—	—	—
Self-pollination	P	29.41	211.6	121.6	70.5
	W	13.01	102.7	67.6	40.7
Open pollination	P	31.42	206.3	119.6	70.6
	W	8.40	91.6	62.7	41.6
Crossing within the variety	P×W	25.00	240.0	139.2	74.3
	W×W	—	—	—	—
Inter-variety crossing	P×P	30.00	196.9	129.9	71.2
	W×W	—	—	—	—

P = Common Purple egg-plant
W = Common White egg-plant

likely to produce parthenocarpicus fruit in case of self-pollination. In the case of self-pollination the Common Purple egg-plant produces parthenocarpicus fruit to a greater extent than does the Common White egg-plant.

c) *Examination of open pollination.* The flowers were neither emasculated nor isolated, only marked and when the fruits became biologically ripe, the data were worked up. We established in how many of them there were seeds to be found, and how many of them were seedless. The number of parthenocarpicus fruit has been expressed in the percentage of marked flowers, and the results are shown in Table 1. The data in Table 1 referring to free pollination, show that in both egg-plant varieties one can find parthenocarpicus fruit. On the Common Purple egg-plant big fruits develop without seeds while on the Common White only very small fruits are produced also without seeds. On the Common Purple egg-plant the percentage of parthenocarpicus fruit is high while in the Common White variety they appear in lower percentage. In the case of open pollination, — as compared to self-pollination, — the number of parthenocarpicus fruit has increased on the Common Purple egg-plant, while with the white variety it has decreased.

d) *Crossing within the variety.* On the Common Purple and Common White varieties crossing was performed between two-two individuals of the same variety. The flowers had been emasculated and isolated in the bud-stage, after which pollination was carried out with the pollen of the other individual belonging to the same variety. After pollination, the flowers were isolated again. The number of parthenocarpicus fruit is expressed, related to the pollinated flowers, in percentage, and the data obtained are shown in Table 1. The data of Table 1 show that in the case of crossing within the variety, under the influence of the pollen of extraneous individuals, on the Common White egg-plant no parthenocarpicus fruit will be produced. On the other hand, with the Common Purple egg-plant, as a result of the pollen of the other individual, the number of such fruit decreases as related to the emasculated and isolated flowers.

e) *Intervarietal crossing.* Direct and reciproc crossings were made between the Common White and Common Purple egg-plant varieties. The flowers had been emasculated as early as in the bud-stage, and the Common Purple egg-plant used as female plant was pollinated with the pollen of the male plant: the Common White egg-plant. Similarly to the previous results, these are expressed in percentage in Table 1. From the relevant data in Table 1 it can be established that if the Common Purple egg-plant is used as female, and the Common White egg-plant as male-plant, seedless fruit will be produced in great quantity and in the same value as produced by self- and open pollination of the Common Purple egg-plant. If the female plant is the Common White egg-plant and the male plant the Common Purple egg-plant, no such fruit will be produced.

When examining the average weight and the sizes of the fruit, it has been found that when the quantity of seedless fruit is large, the average weight of the fruit is less — during the same growing period — than in the reversed case when, on the other hand, the weight of the fruit is greater. Viz., the two properties change reversely.

f) *Interspecies crossing.* Crossings were carried out between the varieties Common White and Common Purple of the species *Solanum melongena* L. and several species of the genus *Solanum.* As female plant the two varieties of the egg-plant, while as male plant various species of the genus *Solanum* were always used. The flowers of the female plant were emasculated in bud-stage, then isolated and at last pollinated with the pollen of the male plant. After pollination the isolators were replaced on the flowers. The number of seedless fruit is expressed in percentage of pollinated flowers and seedless fruits. In the course of our investigations no seed-setting was experienced, thus, emasculation had been perfect because no self-pollination occurred, nor have we found hybrid seeds between the species in our present investigations. The results obtained in these examinations, are shown in Table 2.

The data in Table 2 show that the wild type of *Solanum melongena* L. is not inclined to produce seedless fruit as a result of extraneous pollination. If the culture type of the Common Purple egg-plant is used as female plant, the pollen of the different species of the genus *Solanum* will cause the production of seedless fruit to a great extent. According to the effect challenged by the pollen of various *Solanum* species, the number of seedless fruit changes in the Common Purple egg-plant. The least quantity of seedless fruit is produced when pollination is carried out with the pollen of *Solanum gilo* Raddi,

Table 2

Number of seedless fruits developing in interspecific crossings

Combination in crossings	Number of seedless fruits, %	Average weight of fruits, g	Length and width of fruits, mm	
$\frac{P}{W}\times$ *S. tuberosum* L.	20.00 —	323.3 —	138.0 —	80.0 —
$\frac{P}{W}\times$ *S. gilo* Raddi	5.00 —	242.6 —	174.9 —	77.8 —
$\frac{P}{W}\times$ *S. abutiloides* Bitt. et Lille	10.00 —	122.1 —	111.7 —	62.2 —
$\frac{P}{W}\times$ *S. heterodoxum* Don.	30.00 —	173.8 —	118.5 —	73.6 —
$\frac{P}{W}\times$ *S. dulcamara* L.	20.00 —	202.1 —	113.3 —	67.1 —
$\frac{P}{W}\times$ *S. luteum* Mill.	20.00 —	114.3 —	95.3 —	61.9 —
$\frac{P}{W}\times$ *S. nigrum* L.	65.00 —	294.1 —	140.3 —	83.0 —
$\frac{P}{W}\times$ *S. laciniatum* Ait.	45.00 —	329.8 —	136.6 —	88.3 —
$\frac{P}{W}\times$ *S. rostratum* Dun.	30.00 —	276.5 —	141.5 —	86.2 —
$\frac{P}{W}\times$ *S. giganteum* Jacq.	35.00 —	438.7 —	186.5 —	97.5 —
$\frac{P}{W}\times$ *S. sinaicum* Boiss.	20.00 —	21.6 —	13.6 —	9.8 —
$\frac{P}{W}\times$ *S. Ribesiforme* A. Voss.	35.00 —	208.4 —	132.3 —	77.6 —
Average	27.92	228.9	125.2	72.1

P = Common Purple egg-plant
W = Common White egg-plant

while to the greatest extent, when the pollen of *Solanum nigrum* L. is used. The average weight of seedless fruit also depends on the species the pollen of which is used.

The growth of the fruit is the least when the pollen of *Solanum sinaicum* Boiss. is used while the highest growth was observed in the case of using the pollen of *Solanum giganteum* Jacq. The length and width of seedless fruit change parallel with the average weight.

g) *Intergeneric crossing.* Crossing was carried out between two varieties of *Solanum melongena* L., the Common White and the Common Purple egg-plants and species belonging to the different genera of the family *Solanaceae.* As female plants the two egg-plant varieties were always used while as male plant a species belonging to various genera of the family *Solanaceae.* The flowers

Table 3

The development of seedless fruits in intergeneric crossings

Combinations in crossings	Number of seedless fruits, %	Average weight of fruits, g	Length of the fruits in mm	Width of the fruits in mm
$\frac{P}{W}$ × *Nicandra physaloides* (L.) Gaertn.	40.00 —	267.3 —	109.7 —	86.4 —
$\frac{P}{W}$ × *Lycium halimifolium* Mill.	10.00 —	179.6 —	123.9 —	74.3 —
$\frac{P}{W}$ × *Atropa bella-donna* L.	35.00 —	206.9 —	112.5 —	72.4 —
$\frac{P}{W}$ × *Physalis peruviana* L.	35.00 —	449.0 —	161.1 —	90.6 —
$\frac{P}{W}$ × *Datura meteloides* Dun.	20.00 —	139.5 —	114.6 —	67.7 —
$\frac{P}{W}$ × *Capsicum annuum* L.	15.00 —	309.7 —	158.0 —	92.9 —
$\frac{P}{W}$ × *Lycopersicon esculentum* Mill.	30.00 —	344.6 —	138.0 —	83.0 —
$\frac{P}{W}$ × *Petunia atkinsiana* Don.	60.00 —	216.5 —	119.1 —	74.9 —
$\frac{P}{W}$ × *Datura stramonium* L.	35.00 —	195.3 —	118.6 —	74.3 —
$\frac{P}{W}$ × *Saracha umbellata* G. Don	40.00 —	273.5 —	137.3 —	88.8 —
Average	32.00	258.2	129.3	80.5

P = Common Purple egg-plant
W = Common White egg-plant

of the female plants were emasculated in the bud-stage then isolated; and then pollinated with the pollen of the male plant. After pollination the flowers were isolated again. In the course of our investigations no seed-set has been experienced which shows that emasculation had been made perfectly since no self-pollination occurred and in our present investigations no hybrid seeds could be found between the genera. The number of seedless fruits is expressed in the number of seedless fruits and of pollinated flowers. The results of the investigations are shown in Table 3.

From the data in Table 3 it can be established that the wild-type *Solanum melongena* L., the Common White egg-plant is not inclined to produce seedless fruit when being pollinated with the pollen of species belonging to the various genera of the family *Solanaceae*. The culture-type Common Purple egg-plant on the other hand, produces seedless fruit to a large extent if pollination has been done with the pollen of species belonging to various genera of the family *Solanaceae*. As a result of using the pollen of species belonging to

Table 4

The ratio of the numbers of fruits with and without seeds

Treatment	The ratio of			
	fruits containing seeds		seedless fruits	
	in %			
	P	W	P	W
Emasculation	—	—	20.00	—
Self-pollination	70.59	86.99	29.41	13.01
Open pollination	68.58	91.60	31.42	8.40
Crossing within the variety	75.00	100.00	25.00	—
Inter-variety crossing	70.00	100.00	30.00	—
Inter-species crossing	—	—	27.92	—
Inter-genera crossing	—	—	32.00	—

P = Common Purple egg-plant
W = Common White egg-plant

the family *Solanaceae*, with the Common Purple egg-plant the number of seedless fruit changes depending on the species. The least formation of seedless fruit occurs when pollination has been carried out with the pollen of *Lycium halimifolium* Mill., while it is the highest when the pollens used have been those of *Petunia atkinsiana* Don. The average weight of seedless fruits depends also on the genus of the male plant. The growth of the fruit was the least if the male plant had been *Datura meteloides* Dun., and it was the greatest if it had been *Physalis peruviana* L. The length and width of the seedless fruit change parallel with the average weight of the fruits.

The percentage value of fruits with and without seed, obtained through emasculation, by different ways of pollination and crossings, are shown in Table 4. From the summarized data of Table 4 it can be concluded that on egg-plants the pollen of flowers of different varieties, species and genera, causes parthenocarpicus metaxenia of different rate. In the case of parthenocarpicus metaxenia the effect of pollination appears on the female plant, in its fruit-formation (metaxenia), when seedless (parthenocarpicus) fruit is produced. We have established that if no fertilization occurs, the formation and number of seedless fruit is a trait of the variety.

Extraneous pollen causes — depending on species and genera, — parthenocarpicus metaxenia of different rate, however, no correlation can be observed in crossings within the genus and between genera, i.e. correlation depending on the grade of relationship. The pollens of species within the genus and those belonging to other genera, are capable of developing low- and high-degree parthenocarpicus metaxenia quite apart from the fact whether they are from plants belonging to the same or to some other genus.

Conclusion

Of the egg-plant varieties examined by us the Common White produces seedless fruit only in the case of self- and open pollination; in these two kinds of pollination the forming of the fructus starts from the ovary without the ovules getting fertilized. The number of seedless fruit is higher with self-pollination than with open pollination. No seedless fruit was produced in crossings within the variety and in the case of intervarietal, interspecific and intergeneric crossings. Fruits containing seeds were gained at different rate, with self-pollination, open pollination and with crossings within the variety and between varieties. When the flowers had been emasculated and isolated in their bud-stage, no seedless fruits were produced, — a proof that emasculation had been perfect. Similarly, in our crossings between species and genera no fruits were produced which contained seeds showing that the Common White egg-plant does not cross with other species and genera examined by us.

The Common Purple egg-plant produces seedless fruit with all kinds of pollination; in the case of self-pollination, open pollination, with crossing within the varieties, intervarietal, — specific and — generic crossings and even when emasculation has been performed; in the latter case no pollination occurs. Fruits containing seed were obtained, of different values, through self-pollination, open pollination, by way of crossings within and between varieties. When emasculating and isolating the flowers in their bud-stage, no fruits were produced that contained seeds. With crossings between species and genera no seed-containing fruits developed thus we might say that the Common Purple egg-plant does not hybridize with such other species and genera that have been studied by us.

Acknowledgement

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A COMPARISON BETWEEN THE BROMIDE ABSORPTION BY EXCISED ROOTS AND INTACT PLANTS

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A comparison between the bromide uptake of excised barley roots and barley seedlings has offered the conclusion that the limiting step, viz., the accumulation in the symplast of the root cells is the same in both cases.

This is a process of dual character and can be divided into a process which saturates at low (L), and the other (s) at high (H) concentrations. The competition between chloride and bromide in 1 : 1 $Cl^- - Br^-$ solutions depends on the concentration and reaches a maximum at 1.0 m. equiv. /l concentration. The transport into the shoot (as per cent of the total uptake) increases proportionally with the concentration, but a transient decrease appears at the 0.1—0.3 m. equiv./l concentration range.

The concentration and competition curves of bromide uptake by intact seedlings do not offer information about the nature or kinetics of the accumulation in the vacuole, or about the secretion into the bleeding sap (if this can be considered a separate process). The quick translocation of the previously accumulated Br^{82} from the roots indicates an easy exchange between the two pools (symplast and vacuole).

In the case described the low salt content of the plants did not affect the K_m of process L, but decreased the rate of uptake in the whole concentration range investigated. The low salt plants had a diminished rate of bromide translocation, which can probably be ascribed to an initial stage of N (and P) deficiency. The addition of N to the N-deficient plants rapidly increases the rate of bromide uptake and its translocation. Both effects can be inhibited with chloramphenicol given simultaneously.

Introduction

The ion absorption of the excised roots as well as of intact seedlings has been examined on a fairly extensive scale in the last few years. However, the problem has frequently been confined — in the latter case — to the examination of relations between absorption and transpiration. The discussion has mainly been focused on trying to find out whether the whole stock of ions accumulated by active processes in the roots is available for further transport into the shoot, and whether this stock is the only source of this transport, or transpiration is also capable of evoking passive uptake.

At present, because of methodical reasons, we cannot answer the question whether an uptake process is active or passive in the strict sense of the term, but the question whether this absorption is of mediated or non-mediated character can well be decided, so in the following discussion we confine ourselves to investigating whether the step(s) constituting the absorption of the intact seedlings is of the former or the latter type.

The ion uptake is heterogenous in two respects. Firstly, it is apparent that some independent processes are taking part in the absorption of individual ions at different concentration ranges. Secondly, the mediated steps are divided between the surface of the cell and the surface of the vacuole (or subcellular organelles). A further active (or mediated) process is frequently supposed to have a role to play in the transfer of ions into the xylem.

Few attemps have been made to consider these two kinds of heterogenity. BANGE (1959, 1961) distinguished two separate steps in the K uptake of maize, with both of them having different preference for Na. He has suggested that the mechanism which is specific to potassium transports the K^+ ions directly into the xylem. At the same time the non-specific K—Na absorption system is supposed to forward the ions into a pool (vacuole ?), which is only indirectly connected to the xylem through the specific potassium system. However, according to FRIED et al. (1961), the Rb absorption of the barley corresponds well to the scheme according to which an intermedier of the mediated transport is distributed between the secretion into the vacuole or into the xylem. In this respect the behaviour of the two parallel mediated absorption processes of the Rb^+ ion is identical.

The question arises how it is possible to apply these hypotheses of cation absorption to anions. Can the picture be different according to the ion, to plant species or to what extent is it dependent on experimental conditions? What evidences can be offered by a kinetic analysis of the process about the participating mechanisms?

Methods

Plants

The "Herta" barley variety has been used, and the germination of the seeds initiated in a way usual in experiments with excised roots (BÖSZÖRMÉNYI 1965).

The seeds after disinfection with $HgCl_2$ solution were being washed in running tap water for 1—2 hours and then soaked in distilled water for a day at 25°C with continuous aeration.

These pre-soaked seeds were germinated on stainless steel net covered with a layer of gauze and wetted with 2×10^{-4}M $CaSO_4$ solution. The solution was in shallow plastic trays with the frames placed on them. The trays were continually aerated and left in a controlled dark room (25°C) till the fourth day.

In the morning of the fourth day the roots were in favourable growing condition for the transplantation to perforated plastic discs which subsequently were arranged over nutrient solution in large plastic trays. Table I contains the composition of the WOODFORD—GREGORY nutrient solution, and the N or P-deficient solutions constructed from it As a minor deviation from the original composition the iron has been given as Fe-EDTA in the rate of 1 mg/l. The depth of the nutrient solution layer was 4 cm and one unit with 12 plants was placed on each square decimeter. A continuous moderate aeration was given.

During the growing, the temperature stood at 25°C, the photo-period was 16 : 8 hours day-night cycle with about 10—15,000 lux and the relative air humidity about 70 per cent. After two weeks the plants had three leaves and a well-developed root system of a length of about 30 cms. The fresh weight of one unit varied between 8—10 grams in the different series and the root system accounted for 35—40 per cent of this weight.

In some experiments a part of the variants were given different nutritional treatments. The plants grown on complete nutrient solution had a high salt content. A relatively low salt

Table 1

The composition of the nutrient solutions
(mg/l)

	Complete	N-deficient	P-deficient
$Ca(NO_3)_2 \cdot 3\ H_2O$	22.2	—	22.2
KNO_3	28.0	—	28.0
$MgSO_4 \cdot 7\ H_2O$	24.0	24.0	24.0
KH_2PO_4	20.4	20.4	—
$CaSO_4 \cdot 2\ H_2O$	—	21.5	—

plant material had been prepared by exchanging the nutrient solution with 2×10^{-4}M $CaSO_4$ on the sixth day. The growth of these low salt plants was almost the same in the day of the experiment as that of the control high salt group (fresh weight: high salt plants 8.4 g/unit, low salt plants 7.0 g/unit), and their leaves showed only an incipient chlorosis.

In a further experiment N and P deficient material was grown on the respective nutrient solutions from the day of transplantation. As indicated by the fresh weight, the growth of the P deficient plants (7.1 g/unit) lagged behind the control (9.0 g/unit) but their roots were longer. The leaves were dark green, a symptom of initial P deficiency. The growth of the N deficient material was very low (3.75 g/unit) with characterisitc pale green leaves.

In a final experiment N deficient plants were grown (3.1 g/unit). In the morning of the day preceding the experiment a series was transferred to complete nutrient solution, another one to complete nutrient solution supplemented with 1.16 g/l chloramphenicol. (A third series remained as control on the N deficient solution.) After a 24 hour treatment there was no difference in the fresh weight of the variants, and only the greening of the younger leaves was noticeable on the first variant.

Experimental conditions

At the beginning of an absorption experiment the roots of the units taken from the nutrient solutions were rinsed with 2×10^{-4}M $CaSO_4$ solution. The volume of the solutions for the uptake was 830 ml, and besides KBr (and KCl) they contained 5 m. equiv./l Ca^{++}. The experimental plants were transferred to the surface of the solutions together with the perforated plastic discs. The solutions were continuously aerated at 25°C during the one hour absorption period. At the end, the roots were cut through on the upper surface of the discs and washed with running distilled water for one minute. The basis of the shoots was also rinsed and the empty seed-coat removed.

In the comparison between intact seedlings and excised roots the shoots were removed the same way but before the absorption period and the roots with the discs were used as units. No bleeding sap was observed.

Changes in this experimental method were only made in cases when the time course of the absorption was studied (for 6 hours) or when attention was focused on the further translocation of labelled bromide (potassium) on inactive solutions. In the latter case the timetable of the variants was: 1 or 4 hours absorption from labelled solutions, or 1 or 4 hours on inactive solutions after one hour uptake from labelled solution.

Determination of the radioactivity

To measure Br^{82} (or K^{42} in one experiment) the roots and shoots were pressed separately into test tubes and their radioactivity was measured with a well-type scintillation detector. To obtain evenly dense preparations the shoots were withered with infrared lamps before filling the tubes.

Results

The main characteristics of the bromide absorption

The study of the bromide absorption of excised barley roots and their segments has indicated two absorption processes (L and H) which saturate at different concentrations. (In some cases we demonstrated a system [M] which was intermediary between systems L and H and according to some new data [Elzam et al., 1964] system H itself is also a complex one.)

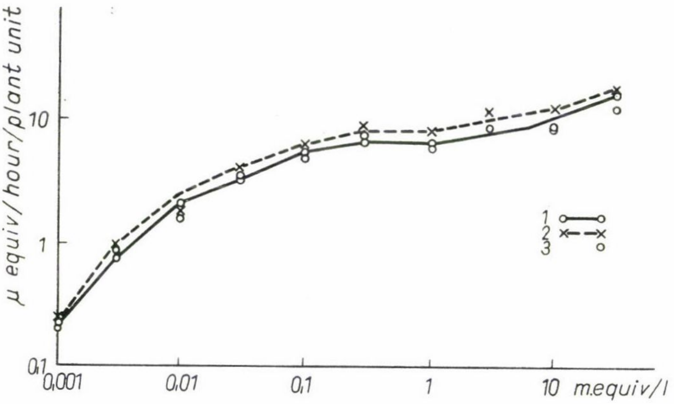

Fig. 1. The comparison of the bromide absorption of barley seedlings and their excised roots (1 = excised roots, 2 = intact seedlings, 3 = bromide accumulated in the roots of intact seedlings)

An important result of the experiments performed with intact plants is that these two main stages of the concentration curve are always recognizable (Fig. 1). The experimental units consisting of intact seedlings are never so homogeneous as the samples prepared from excised roots, consequently, and because relatively few concentrations have been used, it is not possible to resolve the supposed high concentration processes. According to the data the bromide uptake of excised roots is approximately identical with the bromide fraction accumulated in the roots of intact seedlings.

The use of intact seedlings instead of excised roots has not influenced the general pattern of the concentration dependence of the chloride-bromide competition. The competition in 1 : 1 Cl—Br solutions is the strongest at a medium concentration and then it decreases in both directions (Fig. 2). It is a minor quantitative deviation that with excised roots maximum competition takes place at a lower concentration as against intact seedlings in the reported experiment. The competition curve is practically identical when it is calculated for the root or the shoot fraction. Competition in the actual experiment begins to decline at a somewhat lower concentration in the root fraction than in the shoot, the present data are — however — insufficient to decide whether this slight difference is significant or not.

The distribution of the bromide between shoot and root is in accordance with expectations for the quantity of the transported bromide (as the per cent

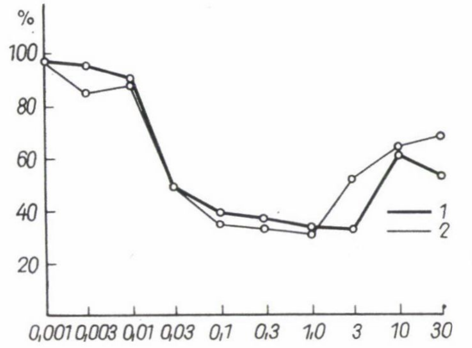

Fig. 2. The competition between chloride and bromide in the bromide uptake of barley seedlings. The accumulation in the roots or in the shoot from 1 : 1 chloride—bromide solutions is expressed as per cent of the accumulation from bromide solutions of equal concentration. (1 = root, 2 = shoot)

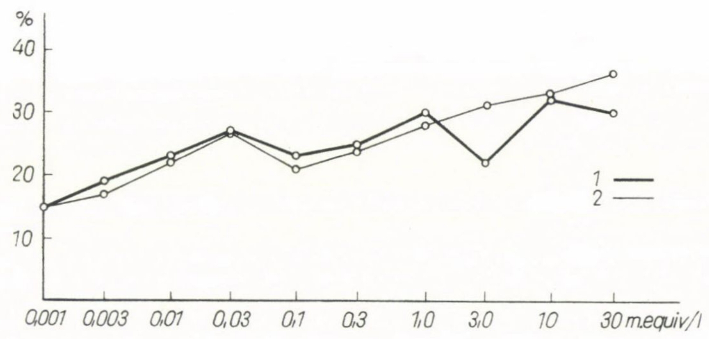

Fig. 3. The bromide content of shoots of barley plants on bromide (1) and on 1 : 1 chloride—bromide solutions (2) after one hour uptake, as the per cent of the total uptake

of the total uptake) depends on the concentration. However, a more careful consideration of the data has revealed a depression between 0.1—0.3 m. equiv./l in every experiment (Fig. 3). In this range, which is just above the saturation of system L, the rise in the rate of translocation fails to reach that of the total uptake. Perhaps system M which has been localised in this concentration range by excised roots plays also a role in these peculiar translocation curves.

The effect of nutritional factors on the bromide uptake

The general custom of growing experimental plants for a week in dense stands in darkness to provide excised roots is unfavourable for the investigation of the effect of nutritional factors. For this purpose the intact seedlings offer a better material, and it is surprising that this field is so unexplored except

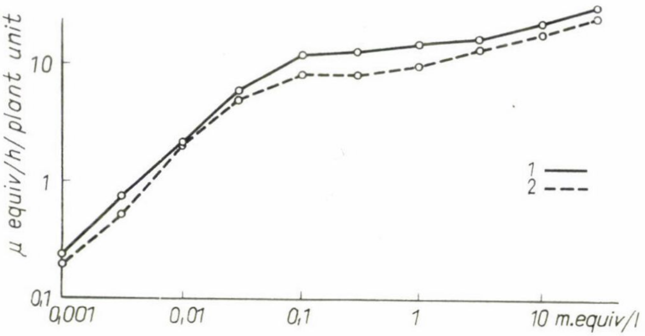

Fig. 4. The bromide absorption of high salt (1) and low salt (2) barley seedlings

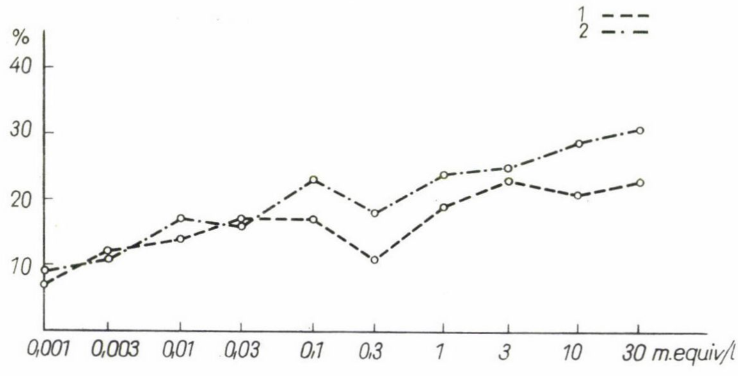

Fig. 5. The bromide content of shoots of high salt (2) and low salt (1) barley seedlings, as the per cent of the total uptake

for a few experiments with "high salt" and "low salt" plants. Naturally different qualitative and quantitative effects depending on the sort of plant material, or on the ion under investigation can be expected, and a stimulation of ion uptake by low salt plants (Broyer—Hoagland 1943) cannot be expected in every case.

In our experiment the rate of bromide absorption by high salt plants has surpassed bromide absorption of the low salt plants at every concentration (Fig. 4). However the K_m of system L did not change. The rate of bromide translocation of the low salt plants (Fig. 5) is lower than that of the control plants. This difference can clearly be observed above 0.1 m.equiv./l concentration. Both curves are characterized by a translocation minimum at 0.3 m. equiv./l.

One factor of the complex nutritional effects which arises in a pretreatment on diluted $CaSO_4$ solution can be the deficiency of the macro-nutrient elements. Of the possible cases the N and P deficiency have been selected. None of them has affected the general pattern of the concentration curve or

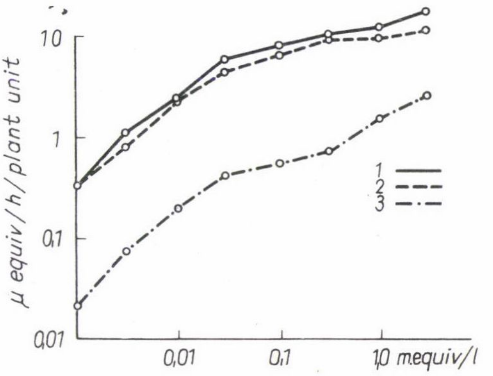

Fig. 6. The bromide absorption of barley seedlings grown on complete (1), P-deficient (2), and N-deficient (3) nutrient solutions

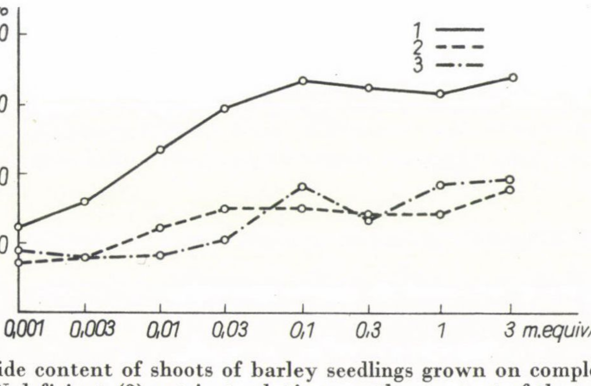

Fig. 7. The bromide content of shoots of barley seedlings grown on complete (1), P-deficient (2), and N-deficient (3) nutrient solutions, as the per cent of the total uptake

the K_m of process L (Fig. 6). A comparison between the V_{max} values presents some difficulties because there is no adequate basis for the calculations (neither the fresh nor the dry weight is fully acceptable). What can be positively said is that P deficiency did not reduce the bromide uptake, and probably N deficiency increased the relative contribution of system H to the total uptake at high concentrations.

The translocation curve of all variants shows the minimum between the limits 0.3—1.0 m.equiv./l (Fig. 7). Both N and P deficiency sharply decreased the percentage of bromide translocated into the shoot; this is especially noticeable in the case of P deficiency because it did not affect the total absorption of the seedling.

We tried to improve the comparison by a further experiment in which the changes in the characteristics of N-deficient plants were observed after N fertilization. The rate of bromide uptake is higher in the whole concentration

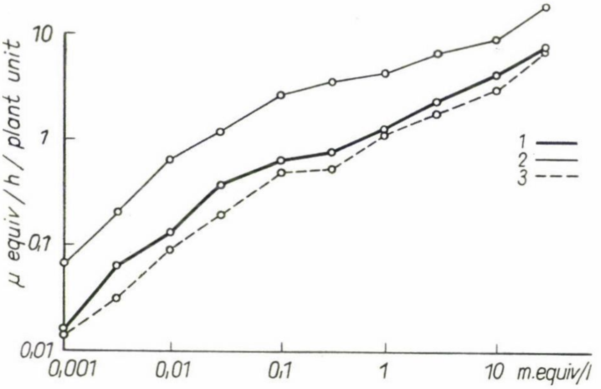

Fig. 8. The bromide uptake of barley seedlings grown on N-deficient nutrient solution (1 = control, without pretreatment, 2 = 24h pretreatment with complete nutrient solution, 3=24h pretreatment with complete nutrient solution supplemented with 5 mM chloramphenicol)

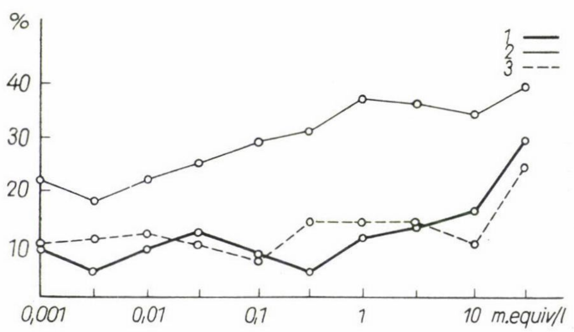

Fig. 9. The bromide content of the shoots of barley seedlings grown on N-deficient nutrient solution, as the per cent of the total uptake. (Explanation as on Fig. 8)

range, but this is particularly well expressed in the V_{max} of system L (Fig. 8). System H seems to be stimulated to a lesser extent. The stimulation of bromide absorption was inhibited by chloramphenicol given simultaneously.

N fertilization also has increased the per cent of the bromide transported into the shoot, and this effect has also been hindered by chloramphenicol (Fig. 9).

The translocation of the bromide or potassium pool of the roots

Two aspects of translocation have been considered in the study of the bromide and potassium content of the roots: 1. the behaviour of the labelled ion content in the leakage or exchange with the external solution, and 2. the behaviour of this content in translocation into the shoot.

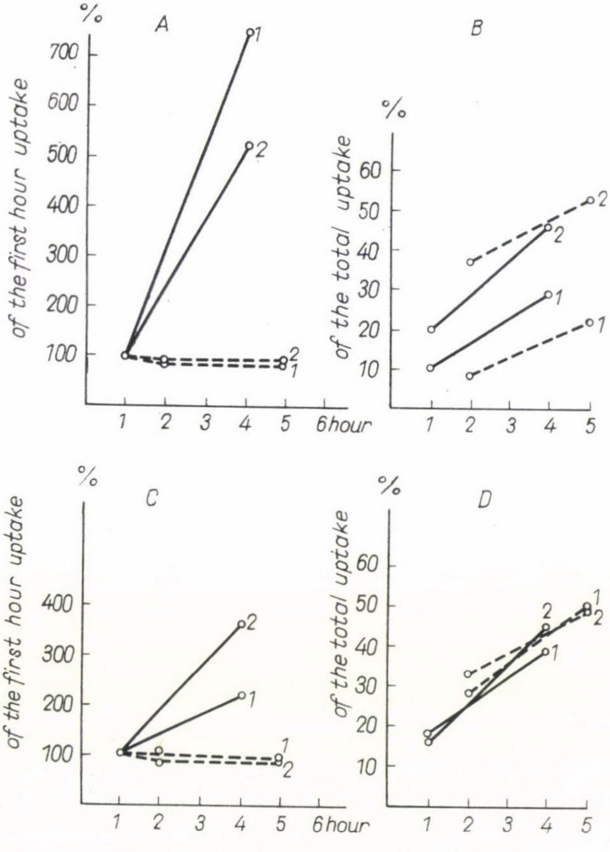

Fig. 10. The time-course of potassium[42] (*A*) and bromide[82] (*C*) uptake and exchange by intact barley seedlings and of potassium[42] (*B*) and bromide[82] (*D*) transported into the shoots (——— 1 = uptake from 0.01 m. equiv./l labelled solution throughout, ---- 1 = exchange on 0.01 m. equiv./l inactive solution after one hour uptake from 0.01 m. equiv./l labelled solution; 2 = as 1 but one m. equiv./l)

The leakage and exchange of both ions into the outer solution is very slight (Fig. 10 A, C). If a conclusion can be drawn from the limited data on the comparison between the two ions, we could say that the leakage (+ exchange) of the potassium ion is probably greater. This compares favourably with expectations, because in the case of potassium the Donnan free space may also contribute to the process.

The rate of translocation of the labelled bromide has been about equal at both concentrations as illustrated in Fig. 10 D, and this rate has not undergone remarkable changes during the interval investigated. During this time no limit was found which, by a lower rate of translocation, might have indicated a separate pool.

The rate of potassium translocation (as per cent of the total uptake) from 0.01 m.equiv./l solution is lower than from 1 m.equiv./l (Fig. 10 B). Probably the rate of translocation of the previously accumulated K^+ is somewhat lower than that of the simultaneously accumulated K^+. This indicates the existence of two potassium pools in the roots. However, a much more detailed comparison is required to find a quantitative interpretation in the behaviour of the ion content of the roots.

Discussion

The mechanism of the transfer of ions across the root and their access to the xylem gives a special feature to the ion uptake of intact plants. In this connection four questions are to be answered:

a) the transfer of ions from the external solution into the plant cells (symplast, protoplasmic free space)

b) the accumulation of ions in the vacuole

c) the transfer of ions into the xylem (bleeding sap)

d) the transport of ions across the tissues from the epidermis to the xylem

According to our present knowledge different carrier-mediated processes are dominating in the process of ion absorption into the plant cell (but see MENGEL 1964). The investigation of the absorption as the function of concentration has proved that the process is heterogenous. At first the cation absorption (FRIED—NOGGLE 1958), then the anion absorption (BÖSZÖRMÉNYI—CSEH 1958, 1964, BÖSZÖRMÉNYI 1965) were resolved into two processes. Recently ELZAM et al. (1964) have described three H processes and BÖSZÖRMÉNYI (1965) presented evidence of another process (M). Processes L and H are typical in the cells of the different root zones (BÖSZÖRMÉNYI 1965).

ARISZ and his co-workers emphasized (e.g. 1953) on the basis of a long series of experiments that in *Vallisneria* leaves, besides the absorption into the symplast, there was a separate accumulation step into the vacuole. They maintained that both processes were active, and associated with different metabolic pathways. Some similar cases are described concerning the Algae and Charales (e.g. MACROBBIE 1964) in which some ions are secreted into the vacuole by a separate process. We have no right to doubt that in the (root) cells of the higher plants a part of the absorbed ions are also used for the accumulation into the vacuole. According to HELDER (1964, personal communication) the chloride : bromide discrimination of the vacuole process is different from the discrimination of the absorption process which delivers the ions into the cells.

Since the publication of CRAFT—BROYER's paper (1938) the majority of authors agree that the ions are transferred into the xylem vessels by the same mechanism that plays a role in their absorption from the external solution and the secretion of ions is a consequence of the different conditions at the two places. WIERSUM (1947) wrote: "We might arrive a good description of absorption by accepting a different accumulation level (as a result of both leakage and active accumulation) between cortex and stele. As the latter cells have the lower capacity for retaining salts, they ooze away into the xylem where they can give rise to the phenomena of exudation or carried off by the transpiration stream." The idea, that the primary accumulation process of the cell is capable of creating accumulation through a tissue is supported by CHRISTENSEN's work (1962) on artificial tissue "membranes" constructed from the free cells of animal tissue cultures. He has demonstrated that the different factors which stimulate or inhibit the carrier-mediated amino acid absorption of the free cells may bring about concentration differences between the two surfaces of the "membrane".

However, another hypothesis (e.g. SUTCLIFFE, 1956) can also be found in the literature according to which the transport of ions into the bleeding sap is carried out by an independent secretion system. This opinion is based on the observation that the excised roots showed smaller preference to potassium in absorption from mixed Na—K solutions than the translocation into the shoot of intact seedlings. (We notice here that SUTCLIFFE, under the influence of a contemporary hypothesis, considered the cytoplasm a part of the apparent free space and therefore he supposed only two absorption steps (one into the vacuole, the other into the bleeding sap). His evidence, however, is not convincing because a vacuolar accumulation which has a different discrimination may cause such changes in the pool of the protoplasmic non-free space, which would explain a shoot accumulation different from the original discrimination (HELDER 1964, personal communication).

The fourth problem, that is, the transport across the root tissues can similarly be divided into two parts: *a)* transport through the tissues and *b)* transport in the cells. It is generally accepted that the water-free space of the cell walls is accessible for the ions by diffusion and so ions from this solution are taken up by the cells of the deeper layers. The transport from cell to cell through the plasmodesma is presumably slower, but in spite of this fact it is supposed to play a role in the reutilisation of the ions from the vacuoles.

The difficulties of finding an explanation to the intracellular transport are not clearly surveyed. E.g. FRIED's scheme (FRIED et al., 1961) about the ion absorption of intact seedlings includes the supposition that the carrier-ion complex leaves the plasmolemma membrane, wanders to the tonoplast or to the

$$\begin{array}{c} M + R \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} MR \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} M_{root} + R' \\ k_3 \Big\uparrow\!\!\Big\downarrow k_{-3} \\ M_{shoot} + R' \end{array}$$

membrane close to the xylem and there it breaks down and liberates the ion. According to this interpretation there is no free ion in the cytoplasm, consequently, in the strict sense of the word, no accumulation takes place in this compartment. This supposition is contrary to the general spirit of the carrier theory.

According to ROBERTSON's well-known hypothesis (1951) the ions are transported in the protoplasm by subcellular components (e.g. mitochondria) between the plasmolemma and tonoplast or into the direction of the xylem vessels, so the subcellular components act as carriers. It is obvious that some ions are accumulated in the mitochondria (or in other subcellular components), yet the role of this process is disputed in the ion absorption of the cells.

Of course our own experimental material is not sufficient for answering all these questions; however, it makes possible to form somewhat an attitude and it also reveals the problems that require further work.

In FRIED's et al. estimation (1961) both the L and H systems contribute to Rb accumulation in the roots and to the translocation into the shoot, because the concentration curves of both processes show the characteristic dual saturation. Our observations about the concentration curve of bromide uptake have been similar. The data we have obtained are more detailed in the H range than theirs, yet they are not detailed enough to determine the supposed H or M process (ELZAM et al., 1964, BÖSZÖRMÉNYI 1965).

Practically identical Cl : Br competition curves have been obtained with excised roots and in both fractions of the intact seedlings. On the basis of this observation the conclusion may be drawn that both absorption processes contribute to the root accumulation as well as shoot translocation also in the case of chloride. In this respect the Cl : Br ion pair differs from the Na : K pair studied by BANGE—VLIET (1961). It is possible that this difference stems from a speciality of the Na : K pair, but it may also have a methodical reason because the determination of Na absorption is difficult with flame-photometry from a low concentration solution.

Quantitative and qualitative similarities between the bromide uptake curves of excised roots and intact seedlings indicate that the rate of absorption is limited by the same process, viz. the transfer of ions from the external solution into the plant cell (protoplasmic non-free space).

We used short absorption or translocation periods, because the rate of absorption decreased after one hour at the lowest concentrations. This phenomenon may be connected with the physiological condition of the plants transferred from a nutrient solution to diluted experimental solutions. Short experimental periods might explain why the Cl : Br competition in the root or shoot accumulation was identical. A different competition could also prove a specific accumulation step into the vacuole (HELDER) or into the bleeding sap (SUTCLIFFE). However, these two opinions are not necessarily conflicting as they affect different ions.

We would point out that such discrimination is possible even if the same absorption system is supposed to operate in all the three functions. CHRISTENSEN (1962) demonstrated that in the active amino acid accumulation of animal cells the individual amino acids lose different parts of their affinity to the carriers on the inner side of the membrane. (This decrease in the affinity is the energy consuming step of the accumulation.) Every combination of the influx and efflux is possible and this flux-ratio determines the final accumulation. The process of absorption and discrimination may be quite similar in the inorganic ion absorption of plants.

Similarly, we may refer to the general literature on the problem (WILBRANDT 1956) that in the initial absorption an ion which has higher affinity to the carrier can surpass another one with lower affinity, but it will reach the final accumulation equilibrium later than the previous one. Considering that the volume of the vacuole is limited (but the bleeding sap is not) it would come close to a state of equilibrium earlier and the discrimination of the ions may be reversed in the two stages, even if the carrier systems are identical.

Beside the differences in the discrimination, the time curves of translocation (+ exchange and leakage) are regarded as evidences of the existence of two (or more) ion-pools and their interconnecting transport processes. In the case of the K ion transport (BANGE—VLIET 1961, BOWLING—WEATHERLEY 1964) in plants transferred to distilled water or to diluted $CaSO_4$ solution the further potassium transport into the shoots was found to decline rapidly. According to our data the previously accumulated Br^{82} was translocated on inactive bromide solutions without a change in the rate over a relatively long time. This result is not contrary to the previous ones because in this case the exit from the vacuole may be an exchange and not a net leakage.

When discussing the effect of nutrition on the ion absorption and translocation a distinction must be drawn between the case when the plant is well supplied with the investigated (or a related) ion (see e.g. HODGES—VAADIA 1964) and when its nutrition varies in the main nutrients, with variants not differing from one another in the elements whose absorption is under consideration. This was the case in our experiments. Such experimental design may be followed in the case of the halide ions, which are essential, but only in small internal concentration.

According to BROYER—HOAGLAND (1943) the high salt content increases bromide absorption; we, however, found the opposite effect. These deviations are not surprising if we take into account the enormous qualitative and quantitative variability in the nutritional state of plants. Characteristic and comparable results can only be expected if the terms and methods of assessing the nutritional condition are used accurately (ULRICH 1952). We can only speak about a relatively high (luxurious) or low (deficient) nutrition if the critical internal concentration of the individual elements are known. Further, it has to be considered (PREVOT—OLLAGNIER 1961, BÖSZÖRMÉNYI 1958) that the critical concentrations of the individual elements are mutually interdependent.

Growth (and development) as a result of nutrition are changing and therefore it is difficult to find a reference basis for a comparison between the V_{max} values or even to decide whether the rate of absorption increased or decreased. It is safer to study the K_m or the relative participation of the different absorption processes in the total uptake. (In our case the K_m of system L was stable.)

It seems to be an important observation that N and P deficiency decreases the bromide translocation into the shoot. This effect is completely different from the cases in which the saturating ion and the investigated ion were the same (e.g. on absorption-translocation curves). N and P deficiency may influence the ion absorption in a variety of ways [e.g. the carriers are probably proteins (or nucleic acids?), the membrane contains phospholipids, P deficiency may have a strong effect on energy supply, etc.], therefore it is not surprising that the N fertilization of the deficient plants increased the ion absorption. These data are too preliminary to authorize us to suppose that the N fertilization increased the quantity of proteinous carriers, but they are not against it either.

The chloramphenicol as an inhibitor of the protein synthesis may affect this process. However, when interpreting the chloramphenicol effect, it must be born in mind that it can inhibit respiration (BALOGH—BÖSZÖRMÉNYI—CSEH 1963), it may have an uncoupling effect (HANSON—HODGES 1963, HANSON—STONER—HODGES 1964), it also affects other metabolic processes (BALOGH, BÖSZÖRMÉNYI—CSEH 1961, PEAUD LENOEL—DE GOURNAY 1962, HÖFNER 1963), and finally, according to ELLIS (1963) a chloramphenicol isomer inhibiting the salt absorption of higher plants does not inhibit the protein synthesis of microorganisms. At present, therefore, it is still to be decided whether the N nutrition and the chloramphenicol affect the absorption processes directly or indirectly. Further studies should be made as to the time-course of the phenomenon, and the associated metabolic events.

Considering the four questions raised in the introduction to this chapter, we suggest the following scheme (partly based on our experiments) as the most probable and simplest working hypothesis:

$$
\begin{array}{lll}
 & & + R_1' \underset{k_{-2}}{\overset{k_2}{\rightleftarrows}} MR_i \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} M_{\text{bleeding sap}} + R_1 \\
M + R_1 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} MR_1 \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} M_{\text{cytoplasmic pool}} & & \\
 & & + R_2 \underset{k_{-3}}{\overset{k_3}{\rightleftharpoons}} MR_2 \underset{k_{-4}}{\overset{k_4}{\rightleftharpoons}} M_{\text{vacuole pool}} + R_2'
\end{array}
$$

Summarizing the main points of the scheme: The root contains two ion pools with a rapid exchange between them. Probably the same carriers, which act in the absorption of ions into the cytoplasmic pool play a role in their transfer into the bleeding sap. If there is a difference between the discrimination of the ions accumulated in the roots or shoots, this may be ascribed to various reasons, but most probably to the secretion into the vacuole. All concentration dependent absorption processes contribute to the translocation into the shoot.

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THE STUDY OF EARLY KOHLRABI GROWING

I. EARLINESS AND PROFITABILITY OF KOHLRABI AS AFFECTED BY VARIOUS METHODS OF PLANT RAISING

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Kohlrabi is one of the first mass vegetables rich in vitamins in the outdoor vegetable production of Hungary. Earlier picking of kohlrabi can be promoted by various methods of raising the seedlings. The present paper deals with part of the results obtained in the last 4 years. A comparison of various methods revealed that as against the traditional plant raising with broadcast seeding the cultivation with nutrient blocks increased earliness by 7 days and resulted in a 91 per cent increase of the gross earnings.

Introduction

After the long winter period human organism increasingly requires the consumption of the so-called fine vegetables, rich in vitamins, partly in order to render the diet more varied and partly in view of maintaining health. This is why growers all over the world endeavour to produce large quantities of vegetables for early marketing.

In the early production of vegetables, owing to its many favourable properties, the share of kohlrabi (*Brassica oleracea* L. var. *gongylodes* L.) is outstanding. To promote early kohlrabi production in Hungary this Institute has bred the variety Szentesi fehér (white) well adapted to the conditions prevailing in this country and ripening earlier than the foreign varieties; it has also conducted a number of experiments to elaborate proper cultural practices for early growing and to assure its profitability. Importance of early growing is stressed by the fact that 39 per cent of the total produce is exported which percentage could be further raised by still earlier picking.

One of the greatest deficiencies of early kohlrabi production in Hungary was that in absence of modern cultural practices and farm technology the favourable given climatic conditions and the suitable variety could not be made use of sufficiently. So e. g. in the main early kohlrabi producing region of the country, in the surroundings of Szentes, where 65.7 per cent of yield of early kohlrabi and 86.6 per cent of the exports is produced, traditional methods are in many cases employed even to-day although from the viewpoints of hygiene, nutrition and rentability it is an urgent necessity to assure as early maturation as possible both on the level of the country and of world economics.

Taking these considerations into account, a broad farm technology experiment has been conducted concerning early kohlrabi growing in the centre of the Szentes region. — In the following an account will be rendered of the 4-year period of this research work, of results obtained with the various methods of plant raising as to the increase of earliness, quality and rentability.

On the strength of the experience gained from research work and of literary data it appeared suitable for the purpose in view to search possibilities of increasing earliness and profitability by the most adequate method of container or nutrient block plant raising (SZALVA 1963). It was verified by a number of studies that the use of seedlings raised in containers or nutrient blocks increased, as compared with the traditional plant raising method, earliness by 7—15 days and profitability by 50—120 per cent (BECKER—DILLINGEN 1929, EDELSTEIN 1951, FILATOV 1952, 1953, FRIEDRICH—KEINER 1953, CHASE—POUNCY 1955, ZATYKÓ 1957, SOMOS 1960, SZALVA 1961, 1963, KOVÁCS 1963).

The kohlrabi plant raising in containers or nutrient blocks has been a successful farm technological achievement (LAUENSTEIN—MARX 1952, FRIEDRICH—KEINER 1953, HAHN 1953, GOETSCH 1955, SZALVA 1955—56, 1960, 1961, 1963, REINHOLD—KRÜGER 1956, LAUENSTEIN 1958, VOGEL 1958, SKAPSKI 1959, EITELGÖRGE 1959, PHILIPP 1963). — On the grounds of data found in literature we could start our experiments supported by a certain knowledge. In consequence of the character of variety and the given conditions of the region, however, we had to rely mainly on our own experience.

Material and Method

Experiments were conducted with the Szentesi fehér kohlrabi variety bred by ourselves which had obtained preliminary state certification in 1961. *Description of the variety:* Tuber white, 5—6 cm in diameter, somewhat flattened globular, foliage thin (6—7 leaves); significantly frost tolerant (not injured even by a frost of —7°C), of short vegetation period (marketable on the 38—44th day from planting), early ripening (Fig. 1). In connection with this variety we should think of elaborating the most suitable early cultivation method, too.

Six different methods of container and/or nutrient block raising were examined (Fig. 2) and in addition three methods of hotbed seeding which were used as a control. The experimental treatments were the following: 1. nutrient block raising, 2. sod block raising, 3. clay pot raising, 4. paper pot raising, 5. corrugated iron raising, 6. pressed earth ball raising, 7. hot bed seeding at a spacing of 5.5 × 5.5 cm., 8. hotbed seeding at a spacing of 4 × 4 cm, 9. 6 g seed broadcast on an area under a hotbed window each.

Composition of the nutrient block: 50 per cent hotbed soil +50 per cent farmyard manure compost. This mixture had been matured for 2 months and then formed into blocks of 5.5 × 5.5 × 6 cm with manual press. Sod blocks were made of natural road side turf in similar dimensions as the nutrient blocks. They were produced still before the strong autumnal frosts and stored until use on a moist place. The dimensions of the clay pot were also the same as of the nutrient block. The paper pot was made in the Institute in a rectangular form with sticking and lined with paraffine. The corrugated iron moulds were also made in the Institute. For each treatment the soil mixture prepared for the nutrient block was used. The earth ball was prepared immediately before planting by pressing the earth with the hand to the roots of the plants.

In all four experimental years (1961—64) seeding (into hotbeds) was carried out in the second half of January *(Table 1)* and the seedlings planted during the month of March.

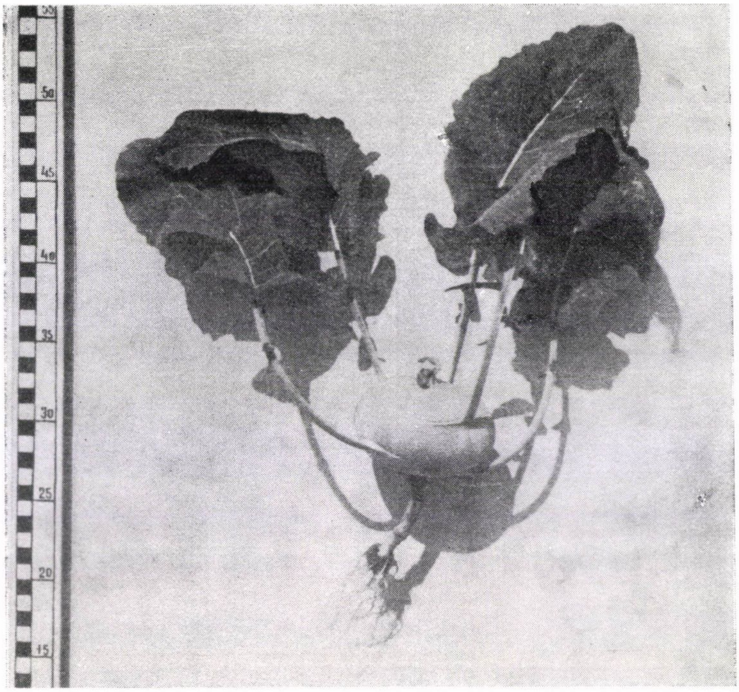

Fig. 1. The experimental test plant "Szentesi 21 korai fehér kalarábé" (early white), the first Hungarian-bred variety. At present most adapted for the purposes of early growing

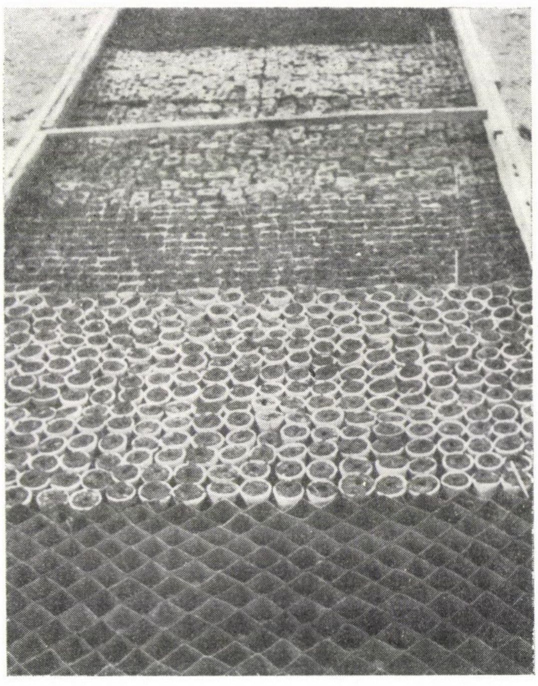

Fig. 2. The placement of all containers together in the hotbed. The photo shows also the place of the treatments sown into the smooth hotbed soil in the upper part of the hotbed

Table 1

Major experimental data of farm technology

Treatment	1961	1962	1963	1964
Seeding in hotbeds	20. I.	18. I.	22. I.	25. I.
Irrigation with 14°C water in which Pétisó* was diluted	6. III. 11. III.	6. III. 10. III. 19. III.	8. III. 20. III.	27. II. 5. III. 12. III.
	16. III.	4. IV.	28. III.	31. III.
Protection from pests (with 20 per cent Nikerol)	20. III. 29. III.	10. IV. 21. IV.	17. IV. 25. IV.	17. IV. 25. IV.
Number of irrigations	4	6	5	7
Precipitation, mm	102	33.1	30.6	57.1
Ploughing summer and autumn	20 cm deep	20 cm deep	20 cm deep	20 cm deep
Manuring ripe farmyard manure in winter	250 q/c. h.	250 q/c. h.	250 q/c. h.	250 q/c. h.
Head dressing 25 per cent Pétisó	4 q/c. h.	4 q/c. h.	4 q/c. h.	4 q/c. h.

* Calcium carbonate-ammonium nitrate fertilizer manufactured in Hungary

Treatments were placed into randomized blocks with 10 replications. Each plot was of 1 sq m size (with 16 plants planted in 25 × 25 cm spacing, one plant each). The plants were raised with the usual cultural practices with irrigation *(Table 1)*. Since the trial grounds in Szentes are immediately at the bank of the river Kurca, irrigation was carried out with the water of the river.

The soil of the trial grounds is medium heavy (black) loam *(Table 2)* with satisfactory nutrient supply, good water conductivity and sufficient salt contents.

Weather developed favourably for the growing of kohlrabi during the vegetation period in all four years. Data of the meteorological factors are shown in *Table 3*.

Picking was begun when the tubers reached a 5 cm diameter. Quality was determined according to the national standard (MSz 3594—57 I. grade).

Experimental Results

Earliness of the experiments is manifestly demonstrated by the data on *treatment* and *picking*. Differences between the container and broadcast (control) raising of plants were consistently appearing. The data *(Table 4)* show that in the *container plant raising a 7 day earliness can be reckoned with safety*.

Table 2

Major analytical data of the soil of the trial grounds
Szentes (1964)

	Analyses	0—20 cm	20—40 cm	40—60 cm	60—80 cm
1.	Sticky point	51.5	51.0	49.6	51.6
2.	Capillary water raising 5 h. 20 h.	121.1 232.1	121.4 235.0	127.5 248.2	109.6 219.6
3.	pH in water	7.5	7.5	7.5	7.6
4.	Total humus %	2.7	1.5	1.1	1.1
5.	Calculated total N mg/100 g	156.7	90.6	66.6	62.4
6.	Alkalinity as soda %	w. t	w. t	w. t	w. t
7.	Carbonic chalk $CaCO_3$ %	t	0.28	0.41	0.38
8.	Total salt %	0.12	0.14	0.14	0.13
9.	Physical structure	medium heavy black loam	medium heavy black loam	brownish black loam	yellowish grey loam

Indication: w. t. = weak traces
t. = traces

Effect of treatments was also measured on developed seedlings before planting *(Table 5)*. It was shown that plants with stocky stems, well- developed leaves and stout tubers had been obtained in the container and nutrient block treatments.

No substantial differences in the developmental state of the seedlings had appeared yet between the container and nutrient block treatments but the latter showed a somewhat more favourable appearance as against the other treatments. The less favourable appearance of the plants raised in clay pots, corrugated iron and with pressed earth balls has been obvious.

The effect of the different raising of plants on earliness has been manifest. Taking into account the results and values of the first 3 days of picking *(Table 6)* as well as the amount and value of total picking it can be established that the best results have been obtained with the nutrient block and sod treatments *(Table 6, Fig. 3)*. With the nutrient block plant raising method higher results can be obtained both numerically and as to total earnings than with any other container raising method. With the nutrient block plant raising the double amount of early yield, threefold early total income and nearly double total earnings (105 236 Ft/cad. hold*) can be obtained as compared

* 1 cad. hold = cadastral hold = 0.57 ha

Table 3

Half-month data for the major meteorological factors of

Period	Air temperature °C	Radiation minimum °C	Soil temperature*		
			°C	on soil surface	at a 5 cm depth
II. 1—15.	—1.1	—7.8	—5.2	—2.1	—1.8
16—28.	—0.2	—4.2	—3.3	—1.4	—0.9
III. 1—15.	3.1	—1.6	—0.9	1.2	3.7
16—31.	6.5	—0.9	1.8	3.2	4.3
IV. 1—15.	11.5	2.8	5.9	9.8	9.9
16—30.	15.4	4.0	8.1	16.9	13.2
V. 1—15.	15.3	6.5	7.8	17.4	17.6
16—31.	17.4	8.7	13.2	19.4	20.9

* = 3-year mean

with the broadcast control, and thus the success of the nutrient block plant raising method different as it is from the traditional one has been verified.

Through extending the test to the examination of quality, from the percentual distribution of the tuber yield it clearly appears (Table 7) that also the best quality has been assured by the nutrient block plant raising method. Here substandard quality has been found occurring to the lowest percentage; nearly half as much as in the next best method of treatment but three times less than in the traditional broadcast control.

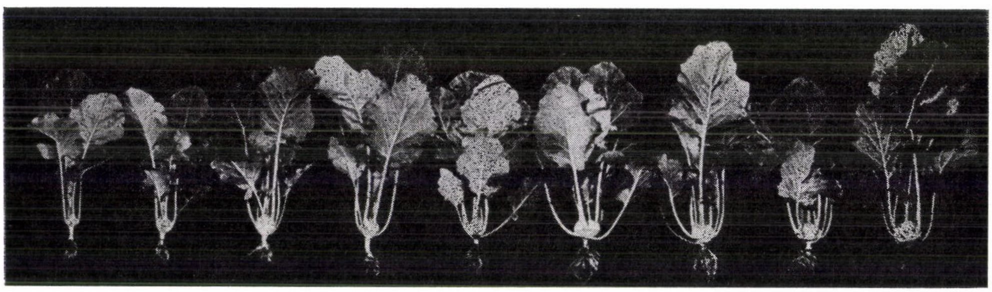

Fig. 3. Plants of the container, nutrient block and other treatments 5 weeks after planting out. The difference between the treatments is well visible and the lagging behind of the control is particularly manifest. The treatments in the order as discussed before: nutrient block, sod block, clay pot, paper pot, corrugated iron, pressed earth ball, sown 5.5 × 5.5 cm, sown at 4 × 4 cm, control (6 g seed broadcast)

the experimental period in Szentes, mean of the years 1961—64

Number of frosty days		Number of sunlit hours		Precipitation minimum mm	Mean* humidity %
rad. min. below °C	min. temp. below 0°C	hours	daily mean		
11.2	13.7	35.3	2.3	25.2	85.0
10.5	9.7	44.0	3.3	9.9	78.0
10.2	9.2	64.7	4.3	17.2	85.0
8.2	5.0	58.3	3.6	17.0	79.0
0.7	0.0	86.2	5.7	9.0	74.0
0.2	0.0	119.1	7.9	21.7	57.0
0.2	0.2	117.9	7.8	8.5	65.0
0.0	0.0	138.6	8.6	25.3	65.0

Table 4

Mean data of treatments and picking
(1961—64)

		Date, period
Mean seeding date		21. I.
Period of emergence, days		7
Plant raising, weeks		8
Mean date of planting out		27. III.
Mean date of first picking, days	container and nutrient block-plant raising	3. V.
	control	10. V.
	earliness of container and nutrient block plant raising	7
Last picking	container and nutrient block plant raising	16. V.
	control*	22. V.
Picking period, days	container and nutrient block plant raising	13
	control	12
Period of tuber development, days	container and nutrient block plant raising	37
	control	44

* Control = broadcast

Table 5

Major characteristic data on plants raised in containers, nutrient blocks and otherwise, directly before planting out, in the mean of the years 1961—64

Treatments	Stem length/ from soil surface to tuber mm	Stem thick-ness mm	Leaf length/ leaf stalk + leaf blade cm	Tuber dia-meter mm	Foliage leaf number units	Description of the plant
1. Nutrient block	5	3.0	19	8	5	Beautiful dark grass green; with sound and vigorous foliage leaves and roots
2. Sod block	5	3.0	20	8	5	Beautiful dark grass green; with sound and vigorous foliage leaves and well-developed roots
3. Clay pot	7	3.0	19	8	5	Beautiful dark grass green; with sound and vigorous foliage leaves and well-developed roots
4. Paper pot	5	3.0	20	8	5	Beautiful dark grass green; with developed foliage leaves
5. Corrugated iron	9	2.6	19	7	5	Beautiful dark grass green; with developed foliage leaves
6. Pressed earth ball	9	2.6	19	6	5	Beautiful light grass green; sound foliage leaves and roots
7. Seeded at 5.5×5.5 cm	8	2.5	19	6	5	Beautiful, sturdy, light green; sound foliage leaves and root system
8. Seeded at 4×4 cm	10	2.5	18	6	4—5	Light green, with beautiful developed foliage leaves and root system
9. Control 6 g broadcast	15	2.2	17	4	4—5	Light green, with beautiful sound foliage leaves and root system, somewhat lanky stem

Table 6

Indices of earliness and profitability in the various plant raising experiments, in the mean of the years 1961—64

System of plant raising (treatment)	3 first pickings as related to all pickings in iron treatment				As related to the C. of the 3 first pickings		Total picking		
	units/cad. h.	units %	Ft/cad. h.	Ft %	unit % increase	Ft % increase	units/cad. hold	Ft/cad. hold	Ft % increase
1. Nutrient block	53.812	61.7	72.875	69.2	214.3	341.3	87.188	105.236	91.1
2. Sod block	53.665	64.2	73.978	72.3	213.4	348.0	83.591	102.369	85.9
3. Clay pot	49.781	61.3	69.330	70.7	190.8	319.9	81.146	98.057	78.1
4. Paper pot	42.874	51.7	56.612	61.7	150.4	242.9	82.872	91.755	66.6
5. Corrugated iron	44.170	53.9	56.595	62.7	158.0	242.7	82.009	90.233	63.9
6. Pressed earth ball	32.657	41.3	35.281	48.9	90.7	113.7	79.131	72.102	30.9
7. Seeded at 5.5×5.5 cm	33.667	43.1	37.975	53.2	96.6	120.0	78.123	71.363	29.6
8. Seeded at 4×4 cm	31.940	40.6	35.409	50.1	86.5	114.4	78.700	70.712	28.4
9. Control 6 g broadcast	17.121	21.9	16.512	30.0	—	—	78.124	55.060	—
S 5%	804	—	1.377	—	—	—	653	1.706	—

Table 7

Percentual qualitative distribution of tuber yields at the various plant raising methods

Method of plant raising (treatment)	Planted out units/cad. h. (100%)	Mean of the years 1961—64					Total unsuitable
		good	bursted	run to seed	stretched degenerate	deficiency	
Nutrient block	92.080	94.7	1.6	3.1	0.6	—	5.3
Sod block	92.080	90.9	4.8	3.2	0.3	0.8	9.1
Clay pot	92.080	88.4	4.3	6.2	0.5	0.6	11.6
Paper pot	92.080	89.9	3.3	5.5	0.5	0.8	10.1
Corrugated iron	92.080	89.1	3.9	6.1	0.6	0.3	10.9
Pressed earth ball	92.080	86.1	2.4	9.4	1.5	0.6	13.9
Seeded at 5.5×5.5 cm	92.080	84.9	3.3	9.7	2.0	0.1	15.1
Seeded at 4×4 cm	92.080	85.5	4.4	7.3	2.3	0.5	14.5
Control 6 g broadcast	92.080	84.9	6.4	4.2	3.6	4.9	15.1

Conclusions

In Hungary 65.7 per cent of early kohlrabi production and 86.6 per cent of exports are supplied by the vegetable growing region of Szentes.

The growing of early kohlrabi at some places is still conducted according to traditional methods. With the aim of elucidating this problem an experiment was set up in the centre of the Region at Szentes to find out the best cultural practices for the growing of early kohlrabi. — In this experimental series during the years 1961—64 several container, nutrient block and some traditional plant raising methods were included in which the value of the proceedings was estimated according to earliness, quality and profitability.

From the data of the experiment it has appeared that with nutrient block and container plant raising 7 days earlier picking can be achieved. The nutrient block method, though augmenting but slightly the number of tubers to be marketed, has substantially increased the income by assuring a great amount of early tubers of good quality.

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IRRADIATION OF MEDICINAL NIGHTSHADE

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In the year 1960 the seeds of medicinal nightshade *(Solanum laciniatum* AIT) were treated with Co^{60} isotope, 26, 34, 44, 58, 72 KR ray doses. In the treated generation LD_{50} is between 44 and 58 KR; the occurring morphologic divergences are non-hereditary modifications; the "shedding" of the crops is increased and can be discovered in later generations, too. Five year-examinations of the self-fertilized lines have proved the significant increase in the scattering of active constituents, the appearance of 28—31‰ maxima, the inheritance of a specific glycoalkaloid level. The chemical divergency brought about within the species through positive selection following irradiation, is of such a degree due to which the improved strain-mixture shows a glycoalkaloid content by 43% and 26% significantly more than the control.

Introduction

The acclimatizing of the species *Solanum laciniatum* AIT was started, upon the initiative of TUZSON, in the year 1952 and has been successfully carried out in these ten years (FÖLDESI 1965, a). This rendered possible the domestic manufacturing of steroid hormone, and the production of solasodine was started in the Alkaloida Chemical Factory in Tiszavasvári (ANONYMUS, 1962).

To ensure economical production is partly the task of technology; it partly depends on the glycoalkaloid content of the basic material. Though the age-group and the applied agrotechnique bear influence on it, the reaction latitude is determined by the inherited properties of the plant. However, the heritability of alkaloid content in the medicinal nightshade and the prospects of breeding have not been known by us.

The breeding of the plant had been encumbered by a methodological obstacle: the applied chemical method was a wearisome, preparative process (TUZSON—KISS, 1954) with the aid of which only the analysis of samples taken from larger quantities, i.e. from several individuals, was possible.

Hungarian cultivation has started from a single berry, and this fact has caused a second obstacle. Since the species is autogamic and even in its country of origin the facultative extraneous pollination ensues maximum for 8—10% (BAYLIS, 1963), consequently the progenies might be considered — among others in glykoalkaloid content — equilibrated.

In his summary FÖLDESI (1965, b) reports on the fact that the first experiments in the institute — from 1958 to 1960 — did not yield results partly because of the methodological difficulties and even more because of the high-degree homogeneity of the plant material. FÖLDESI also gives account on the findings that the kolchicin treatments — analogously with the experiences gained by SZTARIJ—NOVÁCSEK (1959) and STARY-KYBAL (1961) — have not brought about advantageous alteration in glycoalkaloid content.

Therefore, it seemed to be a more feasible way of improvement to get the inherited properties of the plant relaxed. Distant or some other crossing methods deemed advantageous, however, because of the diversity to be expected in hybrid progenies, they would have yielded results sometime later only. Though we have started on this method, too (FÖLDESI 1965, c), the irradiation treatments which had been applied successfully to other drug plants — though with different direct aims (TÉTÉNYI—MOLNÁR, 1962) — seemed to be quicker and better means to serve the purpose. Our irradiation experiments with *Solanum laciniatum* have been started simultaneously, however, the objective of improvement required a longer process, the observation of several generations; thus — apart from the particulars submitted already in the Ph. D. thesis (TÉTÉNYI, 1963) — the summarization could be given but now.

Material and Methods

As material of the experiments started in 1960, the produced seeds were used. The treatment of samples consisting of 50 seeds, was performed with Co^{60} isotope.* The applied ray doses were: 26, 34, 44, 58, 72 KR. The seeds and plants were given the usual agrotechnics (in the garden of our Institute in Buda). The treated materials were subjected as "pure" lines in families originating from self-fertilization, to examination, to comparison (in our plantation Budakalász).** Though self-fertilization could, in general, be assured by isolation, it still occurred that in want of isolated seed, the seed-progenies of the individual had been obtained from unisolated seeds having been most probably originated from self-fertilization.

In the chemical analyses from the preparative process we first went over to the amphiindication process of SZÁSZ et al. (1961), and then to the titrimetric method of Mrs. VALOVITS (1964). Both processes were suitable for the exact analysis of small quantity measured drug. Sampling was performed by the cutting of 25 cm shoot-tips measured along the ruler.

In the years 1961 and 1964 we had also tried FERENCZY's (1961) microbiological quick method based on zone of inhibition correlated with concentration. Due to method-technical or perhaps, to biological reasons, being the agreement now faultless in dry drugs the promising method is still not reliable.

* We avail ourselves of the opportunity to express our thanks to Gy. Hardy, Director, to J. Dobó, Head of Department and I. Somogyi, Research Worker, in the Synthetic Materials Res. Inst., for carrying out the irradiation treatments.

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Results and Discussion

Physiological and morphological changes

The emergency of the plants was similarly unequal in all doses. After the development of the cotyledons the differences however became immediately visible. Out of the highest dose not a single plant could be raised, they had

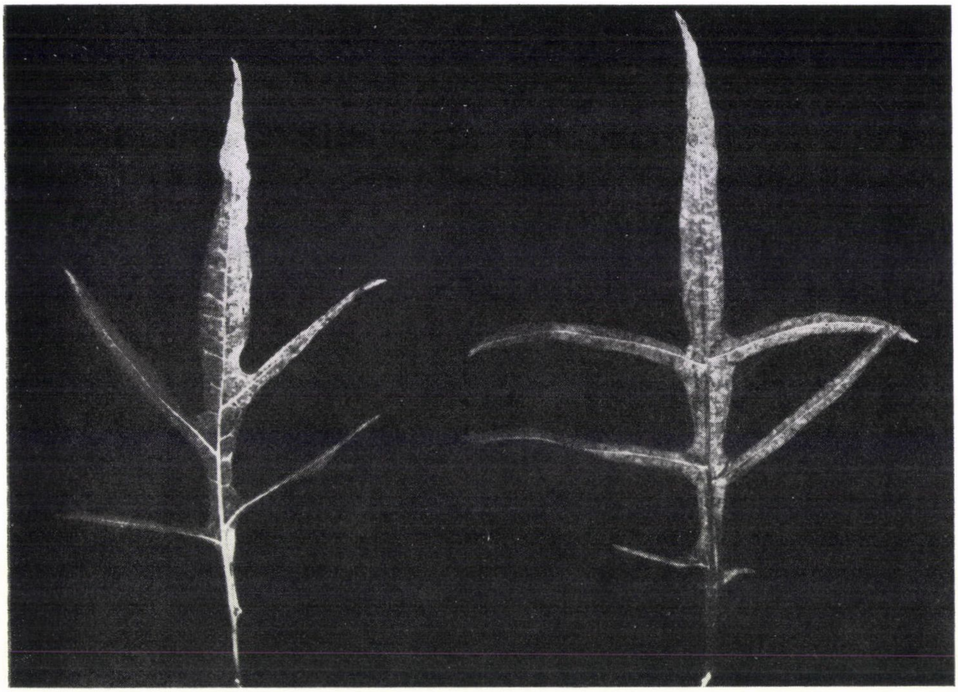

Fig. 1. Leaves of ray-treated plants

perished as early as in the embryo stage. Of the 58, 44, 34 KR treatments, viable plants in gradually higher percentage (44, 54, 76%) could be obtained, however, in the same ratio as the control, only the 26 KR treatment has produced plants (82 and 84% respectively). Thus, LD^{50} falls between the doses of 58 and 44 KR.

In the structure of the plants only in few cases could be detected numerically less or excess branchings. There were also stunted or long-spun plants especially in treatments with higher dosis. In the majority of plants treated with 58 KR the leaf-blades have shrivelled almost to the nervation (see Fig. 1). In the other treatments only with a smaller share of the plants appeared deformities and interlacings. The morphologic alterations had been characteristical of the treated generations only, in the next generation they entirely disappeared.

Under the influence of treatment in some individual plant — independently of its stunted or long-spun habitude — flowerage occurred one week earlier or three weeks later than in the control. As general phenomenon could be observed the high degree of "shedding" in seed-setting. (With KR 58, e.g. 37% of the plants did not produce fruit.) The cause of this was not pollen-sterility: according to our investigations the pollen was having tube even in the case of 58 KR treated plants — but the cause was that the turning into productivity had been disturbed. It is a well-known fact that the plants of species are liable to display "shedding" in the absence of normal circumstances; sudden rainfalls throw off the balance between fruit formation and growth, and the flower clusters in the first branching will partly or entirely, get shedded. With our treated plants the analogous phenomenon has appeared not only in the first but also in the second and even in the third embranchement. Thus, we were compelled, in several cases, to have the selected plants over-wintered; next year, in 1961 we had to transplant them again in order to obtain seed. Since we aimed at producing isolated seed, it is possible that the cause of sterility experienced even in the second breeding year, was self-incompatibility occurring periodically. Unfortunately, "shedding" was not confined to the treated generation but appeared also with the plants of the R_2, R_3 generations, too, causing sometimes the loss of the most valuable individuals. In the course of years "shedding" has somewhat decreased, and free pollination as well as cloning offer expedients.

Chemical alterations

In the R_2 strains treated with 26—58 KR irradiation, the glycolalkaloid content expressed in solasodine, generally decreased in 1961, however, the scattering as compared with the control increased (Table 1). The mean-values of the treated strains being less is *not*, but the increase of the mean scattering at $P_{5\%}$ level *is* significant. It can also be established that with both determinations, levels of the same tendency will be obtained.

Scattering could be observed also in later generations, since e.g., in the negative trend, with R_3 1962 there was also such a strain (from the 34 KR treatment) that, having 8.99% glycoalkaloid content (expressed in solasodine), had contained active constituent in a quantity corresponding only with 53% of the control (16.8%). Though the control grown in our country when being sent back to its original home, proved (according to experiments carried out there) to be of the best active constituents content (BROOKER,

Table 1

Data on the agent content of ray-treated R_2-generation and of control strains (1961)

		Treated strains	Control strains
Number of strains		14	12
Limit values	(b)	21.6—23.75 mm	22.55—24.1 mm
	(a)	4.3— 6.7‰	5.95—7.47‰
Mean value	(b)	22.76 mm	23.62 mm
	(a)	5.69‰	6.65‰
Scattering	(b)	0.229 mm	0.136 mm
	— *difference* F-test	*2.82*	
	(value of Table at $P_{5\%}$ level)	*2.76*	

b = biological method (FERENCZY, 1961)
a = amphi indication method (SZÁSZ et al., 1962)

1962) — in our experiments there occurred from the generation R_2 on, individuals and strains having the highest glycoalkaloid content experienced so far.

Such active agents could not be revealed so far even in berries, not to speak of shoots.

Literature — in connection with the ray treatment of other plant species — gives account of similar results. STUBBE (1959) examined the glycoalkaloid

Maximum (glycolalkaloid content expressed in solasodine)		
individual value		strain value
1962	29.1‰*	28.0‰*
1963	24.9‰	24.8‰
1964	30.6‰**	26.2‰**

* Data of the Drug Factory in Kőbánya; — for the performing of control analyses we express our thanks to Mr. K. SZÁSZ, Head of Department and co-workers.
** Data of the Alkaloida Chem. Factory in Tiszavasvári; —for carrying out the control analyses we wish to express our thanks to Mrs. VALOVITS et co-workers.

content of more than 100 plants after irradiation. The agent content of some of them decreased to 36—44% of the original level, while others well exceeded the average. There existed such plant with which the agent content increased to 282% i.e. almost to three-fold. SCHREIBER et al. (1961) when analysing materials add that, unfortunately, it was always the stunted plants with which the alkaloid content was higher.

STEINEGGER (1958) experienced considerable scattering in the analyses of *Datura stramonium* L. carrying out irradiation treatments up to the X_4

generation. The active constituent content of some plants could scarcely be proved by paper chromatography (0.00—0.07%), while that of others considerably increased (0.86%). STEINEGGER—ZBINDEN (1961) evaluating the ray treatment of ***Datura stramonium***, proved that only 1.5% of the plants had changed, they chiefly decreased. As against 0.372—0.462% alkaloid content of the control, there had been plants with a minimum alkaloid content of 0.018—0.037%. Though the alkaloid content (X_2, X_3 generations) of some plants is more than that of the control, however, in such cases either the plant

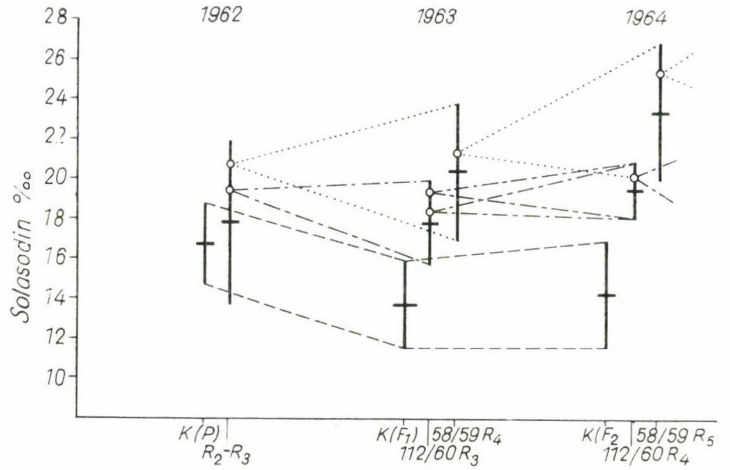

Fig. 2. The course of selection for agent content in ray-treated strains (R_3—R_5 generation

Key to the signs used: Control
Ray-treated strain mixture K — — —
Agent content of selected strains 58/59, 112/60
Average and P_5%-level limit values +

is small — and its alkaloid content is therefore little — or, if it is of normal growth, it could be established that the chromosome-set was duplicated.

By separating continuously individual plants (strains) of ***Solanum laciniatum*** AIT having high agent content, we could submit in 3 strain-mixtures super elite seeds for propagation in 1965. On the basis of progeny test, we traced back the three strain-mixtures and the similarly maintained control families; then the glycoalkaloid data, expressed in solasodine, were averaged, i.e., the significancy of differences for several years as repetitions, were examined.

Our data are summarized in Table 2. as it being of interest, we have also submitted particulars. From the Table it can be seen that to the advantage of the treated strains, as compared with the control, significant, positive deviation exists. The deviation from the control with the 58/59 strain is probable for 1%, while with the two other strains branching from the same origin, this is 5%.

The data prove, in three years' average, the efficiency of the treatment and of the subsequent selection — this is being shown in Fig. 2. — as well

Table 2

The formation of glycoalkaloid content, expressed in solasodine, of the strain mixtures and of the control

Symbol of the strain mixture	58/59	112/60	Control
1962			
a.	1	1	3
b.	2.09	1.94	1.68
1963			
a.	3	5	2
b.	2.05	1.76	1.39
1964			
a.	6	9	4
b.	2.34	1.96	1.44
average glycolalkaloid content in 3 years (%)	2.16	1.887	1.503
in the % of the control	143	126	100
P_5%	0.288		
1%	0.478		

a. = the number of strains in the strain-mixture,
b. = average glycoalkaloid content in the strains (expressed in solasodine) in the % of dry material

as the production of strain-mixtures with active constituent exceeding the control by 26% and 43%, respectively. The produced strains are healthy, of good growth, and it can be hoped that in herb-yield, too, they will not lag behind the control. To prove this, experiments will be carried out in 1965.

From the experiments follows also that agent-content is a hereditary peculiarity and the genetic fixedness of quantitative deviation — the existence of *chemocultivar* level taxons — has been proved by our experiments.

Conclusions

In 1960, in a five-year investigation of treated generation and self-fertilized progenies of *Solanum laciniatum* seeds irradiated with Co^{60}, the following could be established:

LD^{50} of the ray-treated seeds is between the doses 44 and 58 KR. 72 KR is lethal to 100%. In the R_1 plants there could be established some slight divergencies in habitude and leaf-blade, however, in the subsequent seed progenies these could not be evinced any more. With R_1 plants "shedding" of the fruit appears in the 2nd and 3rd branchings as well. The cause of it is not pollen sterility, and — though in less degree — it can be observed also in later generations.

The scattering of active constituent in R_2 generations is significantly greater than the control. The maximum of glycoalkaloid content expressed in solasodine, with individuals (29—31% and with strains [25—28‰] greatly exceeds the values established anywhere so far [20‰ max.]). The chemical quantitative deviation brought about by selection following the ray-treatment, and the specific glycoalkaloid level are hereditary. The glycoalkaloid content of the produced improved strain mixtures is significantly higher, by 43% and 26%, respectively, than that of the control material.

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CONDITIONS OF FERTILIZATION IN BERRY-PRODUCING VARIETIES

I. GENERAL PART

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Berry-fruits (strawberry, raspberry, gooseberry, black and red currant) obtain an ever increasing importance in our days.

The fertilization conditions of the cultivated varieties are generally not clarified; research work is related to certain varieties or species. Within the species there are many self-fertilizing varieties, but also partly or totally self sterile varieties are found and in some cases interincompatibility occurs.

Cross fertilization, in all cases, results in more important fruit setting. Therefore, even in self-fertilizing varieties yield increasing effects can be demonstrated with pollinating varieties.

To plant varieties readily fertilizing each other is a paying proposition and suitable for the purpose in view.

The parthenocarpic inclination of the single varieties may result even without fertilization in a high safety of yield.

It was attempted to clarify the above-mentioned issues in a 6 year investigation separately for 24 strawberry, 14 raspberry, 10 gooseberry, 14 red currant and 21 black currant varieties.

Introduction

The planting of berries is carried out in Hungary at an ever increasing rate and will reach 15,000 cad. hold* by 1965. Production has been restricted up to now to house gardens and small farms, while in our days more and more large-scale plantings are developed, even on the world-wide scale. Simultaneously with the planting of extended surfaces new problems arise: such as, among others, the problem of fertilization.

This latter is fully justified to be examined for several reasons.

— In the old small farms and house gardens many varieties had been involved and the knowledge of fertilization conditions constituted no problem.

— many new varieties are produced now the properties of which are not yet sufficiently known

— in order to assure rentability of production all properties of the varieties must be investigated.

On the strength of such practical considerations we conducted evaluation of the varietal collections from 1958 in two series, while having elucidated the fertilization conditions of the berries.

* 1 cad. hold = cadastral hold = 0.57 ha

From 1958 to 1962 the varieties of present production were dealt with whereas from 1963 the newer varieties which had excelled in the evaluation of varieties and seemed most valuable.

Our objective has been to clarify free and self fertilization conditions of the varieties and to find the best pollinating varieties and varietal combinations.

In this work we considered the results obtained in this field both in Hungary and abroad which have led to the following conclusions.

Thorough research concerning berries had generally begun only in the 18—19th centuries and became more intensive in the 20th. These fruit species were included in mass production on account of their high biological value. Their cultivation is being conducted in comparatively intensive cultures requiring much manual work; this is why the increase of their productivity is a predominating question.

Deeper research work had been initially and first of all concerned with breeding which led, as soon as in the 19th century, to significant results in France, England, Holland and the USA; in our present collections there are still certain varieties bred at that time.

On dealing with the varieties in detail the attention of breeders and also of growers has been attracted that there are important differences among varieties as to fertilizing ability. This has prompted research workers to study more intensively flowering biology, genetics, fertilization conditions of berries and the soil, water and ecological effects by which these are influenced. Today a series of literary publications are already available from which the results of extensive research work conducted in our century in Germany, England, the Soviet Union and USA are particularly important.

Literature on this wide and complicated problem can be discussed — in part I and II — only in connection with our investigations and according to fruits, since 5 berry fruits are involved and the data are often contradictory.

Conditions, Material and Methods

Examinations were conducted in the Research Institute of Horticulture from 1958 to 1964.

The soil of the trial grounds can be characterized according to TERTS (1957) as follows.

The soil is of grassland origin, moderately alkaline (pH 7.5—8.5) at places neutral (pH 6.5—7.5) the $CaCO_3$ changes from weak to strong (5—25% or even more). Humus condition is favourable, generally 3—8% in the upper horizon or even more in some places. Its heaviness varies between light and medium heavy loam, its structure is friable.

The climatic and precipitation conditions have evolved as follows.

The temperature on the average of many years is 11.6%, somewhat higher than the fifty year mean of Budapest. Although the annual mean precipitation is about 600 mm, its distribution is very uneven. The area is exposed to the influence of strong north-western winds and therefore soil moisture is not lasting.

Varieties chosen for study of fertilization showed the following distribution:

Species	1958	1959	1960	1961	1963	1964
Strawberry	16	20	21	11	18	20
Raspberry	12	13	12	12	11	8
Gooseberry	9	12	11	10	—	5
Black currant	8	8	8	9	—	16
Red currant	9	7	11	10	—	7
Total	54	60	63	52	29	56

The selection was conducted according to such viewpoints that varieties generally widespread in Hungary (in farms and house gardens) and, further, varieties valuable from other viewpoints of growing (early-late flowering, ripening, etc.) even chosen for detailed evaluation should be involved.

The names of the varieties selected are recorded in the Tables showing the results of fertilization in detail.

Methods

When starting the studies of fertilization, attention was paid to the many kinds of methods discussed in literature in connection with similar examinations of berries. From these only such methods were applied that, in our opinion, are simple, reliable and promising best results.

In the different phases of fertilization studies we have been working according to the following methods:

Isolation

According to data found in literature, in berries several kinds of isolation methods are employed: Klämbt (1958) employed parchment and linen (molino) bags, Maliga (1949) parchment, Mohácsy—Porpáczy (1957) cellophane, cotton wool, Tóth (1959) vaseline, parchment and tulle bags, etc.

Isolators were placed on parts of the shrubs facing various points of the compass. Each combination was placed as far as possible on the same shrub so that the number of flowers determined for each combination should be in several bags. Hereby we also wanted to satisfy the requirement that the combinations placed in several bags should, as replications, render the results more exact. Thus from strawberry 5—10, from raspberry 15—20, from gooseberry 20—30, from black currant 20—30 and from red currant 20—30 flowers were isolated in a bag.

We consider isolation with parchment bags as most suitable because the isolator thus safely closes the stigmata from the tiny insects as well as from the wind and other possibilities of pollination. This is supported also by the investigations of Maliga (1949) and Tóth (1959) while as a contrast Klämbt (1958) found the tissue (molino) bags somewhat better.

The use of cellophane and tulle isolators often employed by some breeders both in Hungary and abroad (Mohácsy—Porpáczy 1957, Tóth 1959, Rudloff—Schanderl 1950) was not found satisfactory since according to our experience the cellophane under the influence of the sun behaves as a glass surface and may cause scorching while the tulle may make it possible for small insects to penetrate and possibly wind pollination to take place.

The disadvantage of parchment paper is its stiffness which, in windy weather, may cause injuries to the stigmata.

Castration

In general it should be noted that we found the universally employed method of research workers engaged in similar studies or in breeding as suitable who, to assure the unchanged microclimate of the flower only remove the stamina from the flowers as done e. g. by

CSERNENKO (1957) who considers this method for the best. We must, however, on the strength of experience gained in the practice, draw the attention to the difficulties which, with berries, do not always make possible to use this method and sometimes may influence the results.

When employing this method we found out that with strawberry and raspberry at their castration in the bud phase the stamina were still very undeveloped and their removal was rather difficult owing to the strongly bowering sepals; thus the safety of the work may suffer or the hazard of the injury of the stigmata arise. With gooseberry, black and red currants the employment of the method had also caused difficulties. The small size and the closed condition of the bud and the anthers hindered the rapid performance of the work. At some currant varieties, as Heros, the bud easily gets torn off while being castrated. A similar difficulty was encountered with the variety Heros by KLÄMBT (1958).

For these reasons we employed in the succeeding years the method of radical castration and thus the reliability of the work was greatly increased.

Within the single berry fruit species we have generally chosen the most developed buds for castration thus in strawberry the buds of first and second order, in exceptional cases (frost or other damages) those of the third order. The other buds have been removed from the inflorescence. DARROW (1927) similarly established that the first flowers were the most developed ones but in contrast to our opinion he found that the stamina of the first flowers of the strawberry were not regular since they attained the pollen mothercell condition as soon as in autumn and were often damaged by the weather e. g. by frost. This was observed also by REUF—RICHEY (1926) as reported by BAUER (1960—1961).

With raspberry the uppermost buds of the inflorescence were best suited for castration while the lower and side buds were equally removed.

As to gooseberry the well visible buds emerged from the flower buds are best suited for castration while with black and red currant the basal flower buds are the most developed and best suited for castration. We have generally castrated these buds but in exceptional cases at rapid flowering that accelerates castration we have used also the buds situated in the middle of the inflorescence. These latter must not however be over- or underdeveloped. According to our experience the stigmata of the undeveloped buds owing to lesions during castration and lack of the necessary humidity cannot further develop but dry out. In the case of overdeveloped buds on the other hand the anthers may open and spread the pollen so that fertilization ensues. This can — of course — disturb the evaluation and lead to false consequences.

Pollination

The buds marked out for the collection of pollen were in each case isolated to exclude mixing with foreign pollen. The flowers opened in the bag were continuously picked, the anthers pinched off, rubbed to powder and dried in a shaded and well aired place. BULLMANN (1961) with reference to Dutch literature states on the conservation of the pollen of berries that at air temperature in a dark room the pollen can be kept viable for 24—48 hours. In a sealed bottle, mixed with thalmuc, at 10% relative humidity, on −1 −6°C the strawberry pollen is viable for 9—10 months. He also states that the mixed pollen has a good effect.

We placed the dried pollen in phials, in an exsiccator from which it has been employed in due time. In cases when as a consequence of rapid flowering there was no possibility of collecting pollen, to simplify the work we pinched off from the isolator the flowers with open anthers and pollinated directly. This method proved to be successful also from the point of view of the organization of work. The transfer of pollen — except for the immediate transfer with the flower — was carried out with toothpick-sticks stained with black Indian ink which could be readily turned round in the phials. This work could not be carried out with a brush because the small amount of pollen found in the berries had to be employed with the utmost economy. On the other hand we did not succeed in producing the stigma surface lesions with brush bristles which are considered being of good effect by CHALIFMANN (1952) and STEPHEZ (1958) according to BULLMANN (1961). Judging from the results, the method employed did not cause any disadvantage. Pollinations were carried out, in dependence on the weather, in 3—5 days from the castration. SZILÁGYI (1960) observed differences in the fertilization per cent according to the various periods of the day and to flowers of different degree of development. The highest percentage of fruit setting was found in flowers pollinated on the second and third day after castration. With strawberry and raspberry we have also found that additional pollination is necessary within 2—4 days from the first pollination because the flowers are of different grades of ripeness. NEUMANN (1955) also considers additional pollination as necessary and according to him the flowers should even be daily pollinated with a brush in terminal order from the beginning of flowering.

According to our experience the most suitable time of pollination of raspberry and strawberry is when a glittering secretion (nectar) collects at the basis of the styles and they rigidly separate and thicken while in the flowers with one stigma the head of the latter swells and its surface becomes sticky.

Count

The results of pollinations were measured during the period of the growth of the fruit according to the following:

1. evaluation of fruit setting
2. counting of green fruit
3. recording of the matured fruits.

Out of the three counts there is a substantial difference between the number of pollinated flowers and fruits set. Further on, no essential difference occurs with strawberry and raspberry while with gooseberry, black and red currant there may arise a fall of fruits to a higher percentage even between two counts.

After fertilization, simultaneously with the first count, the isolating parchment bags were exchanged with tulle bags.

After having reviewed the methodics of fertilization studies let us come to the subject of examinations.

Examination	Sign
Open pollination	A
Selfing	B
Selfing	B_1
Selfing	C
Crossing between the varieties ...	D
Parthenocarpic examinations	PK

Examination "A"

For *open fertilization* according to variety and fruit species the following number of flowers were marked:

Strawberry	50 flowers each
Raspberry	50—100 flowers each
Gooseberry	50—100 flowers each
Black currant	100 flowers each
Red currant	100 flowers each

Examination "B"

For *self fertilization* the above number of flowers were isolated in parchment bags and left alone without any interference. According to NEUMANN (1955) and LOGINYCHEVA (1958) better results were obtained when the flowers opened after isolation were pollinated also artificially with their proper pollen. NEUMANN (1955) adds that the flowers of black currant do not get fertilized without interference. Our own examinations have however disproved the statement of NEUMANN and in some varieties we even obtained out-standing results.

Examination "B_1"

A study set up from 1963 for self-fertilization — a method assuring good results according to literature — in which after isolation the opened flowers were pollinated also with their own pollen.

Examination "C"

As a control of the examinations "B" 25 flowers for each variety in strawberry and 50 each in other species were castrated for selfing, isolated and pollinated with their own pollen.

Examination "D"

For *crossing among varieties* we used the same number of flowers as in the examinations "C". The flowers were castrated, isolated and pollinated in the way already described according to combinations.

Examination "Pk"

For the purpose of parthenocarpic examinations generally 25, with black currant 50 flowers for each variety were castrated, isolated and left without fertilization.

In this examination it is necessary to point out the fact that respecting the various berry fruits, different communications have been found. The data agree in that in gooseberry, red and black currant inclination for parthenocarpy often occurs. This inclination, however, is highly varying according to varieties. Beside the parthenocarpic inclination lately attention has been paid also to apomictic trend. With our examinations we aimed at verifying such trend in the varieties but we had to abstain from the use of the lately introduced inducing matters (synthetic auxin, gibberellic acid and Beta indole acetic acid) so that our method only extended to isolation and castration of the flowers.

The examination method was uniformly developed for each fruit species (BRÓZIK, 1962).

Results and Discussion

Factors influencing fertilization

During fertilization experiments in the years 1958–1959–1960–1961, certain fluctuation was found concerning the results. Searching for the causes of this phenomenon we had to establish that in the various years and cases the experiments were partly influenced by disturbing natural and other factors. From these, first of all, the dangerous late spring frosts and cool, rainy, windy weather must be mentioned which often occur during the flowering of the berries. From this point of view bad weather prevailed late in April and early in May 1958 when surface temperature decreased to −1°C, late in April 1959 when −4°C surface frost, strong wind and cloudy, rainy weather was observed and in the last days of April 1960 when the temperature above the soil cooled down to zero, with a steadily cloudy, rainy weather.

The damage appeared first of all with strawberry in the freezing of the stigmata and in gooseberry in the abscission of the little fruits set. KRONENBERG (1959) also states that some varieties are highly susceptible to night frosts, e.g. Mad. Lefebre and Mad. Moutot, while Climax was found to be less susceptible. He agreed with us in finding cool, rainy, windy weather having an unfavourable effect on fertilization. Owing to the rainy and windy weather also the collection of pollen becomes difficult and the stigmata of the castrated flowers may be injured by the bags.

A further influencing factor is the number of the skilled workers available as related to the work to be performed especially in the years of simultaneous flowering. This particularly applies to berries where the flowers are tiny and therefore castration requires extraordinary attention and care, otherwise the stigmata might be injured which, as a hidden fault, may often substantially influence the results.

The complicated problem of the influencing factors is mentioned by a number of authors. NAGY (1960) states that in pears the rate of selfing of varieties changes depending on the condition of the trees, the weather and the ecological conditions year by year. NEUMANN (1953, 1955) established that pruning decreases the yield while irrigation and manuring did not affect the yields. KRONENBERG (1959) states that varieties with dense foliage and fertilizer application causing strong development of leaves as well as superfertile soils affect the percentage of fruit setting since the flowers cannot get properly fertilized. He adds that, in conformity with the statement of DARROW, soil types may strongly influence the fertility of strawberries. Thus DARROW (1927) establishes that individuals of Fr. Chiloensis are often well bearing in heavy soils but may be sterile in loose sandy soils. Nutrient supply in spring, on the other hand, may have an important role in sandy soils and the autumn weather greatly contributes to sterility. BULLMANN (1961) presents the data of FEUCHT (1959) pointing to the fact that with trees pollination by wind should not be overestimated since only 1—2% pollen can get even on stigmata at a distance of 20—30 m. Referring to CHALIFMANN (1952) he considers the importance of the pollination by insects to be a further influencing factor, since insects cause by pollinating an injury to the head of the stigma. The role of bees is particularly stressed by BULLMANN (1961) who, relying on the data of SKREBCOVA (1957), demonstrates improvement of the strawberry fruit obtaining after pollination by bees fruits of higher weight.

Thus after 16—20 visits the weight of the fruit was 5.36 g while it increased to 8.13 g after 21—25 visits.

BULLMANN (1961) also established that pollination at full development of the organs of propagation gave a 13.3—58.3% higher result as compared with the pollination of undeveloped or already deflorescent flowers. These authors have experienced the same increase of weight in raspberry and bramble. As to the role of bees BULLMANN further states that even substantial increase of weight can be obtained. He refers (in gooseberry) to the data of GLUSKOV (1956) and SASYKIN (1950—51) according to which the mean yield per bush increased from 1.8 to 7.1 kg.

With black currant RUDLOFF—SCHANDERL (1950) found that four year old bushes with the use of bees yielded 10.9 to 17.3 times more. He also states that in the case of strongly self fertilizing varieties as Silvergieter substantially higher yields were obtained. This is also pointed out by SCHANDERL (1956—57), SKREBCOVA (1959) and BULLMANN (1961).

Conclusions

Prior to the parts dealing with the fertilization conditions of the various berry varieties we have in the General Part discussed the justification of the work, the method and conditions of the experiments and subsequently we have critically described the single phases of the work (isolation, castration, pollination, counting, parthenocarpy). As a conclusion of the General Part the factors influencing fertilization — weather, soil, role of the bees, etc. — have been treated.

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EXAMINATION OF THE BIOTYPE (LIFE HABIT) OF WHEAT VARIETIES

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The life habit (winter or summer type) of several thousand wheat varieties was studied with autumn and spring seeding, on the grounds of winter killing and/or shooting-earing. A distinct differentiation for the characters examined was found, particularly in spring sowing. With the analysis of the relationship of the data we definitely succeeded in demonstrating the quantitative and qualitative distribution of life habit. This differentiation made it possible to group the life habit of the wheat varieties according to types and strength of types.

Introduction

Wheat occurring all over the world is rich in forms both in biological and morphological respects. This great variety of types is obvious since wheat grown wild occurs under very different ecological conditions and growing also comes to pass under the most varied conditions. The number of varieties grown and separated from each other is several thousand, among them much indigenous material which is found at its original habitat while others are adapted also to different conditions and can be utilized or grown respectively on a wide scale.

Environmental conditions have a great influence on the formation and predominance of hereditary properties of plants. Varietal characters may largely modify under the influence of different climatic conditions for which a great number of data are found in literature. The observations of Dudorf (1958) on wheats grown in different localities are verified by our own data (Mesch 1959, 1965). Jakubciner (1962) in his large-scale examinations of a world varietal collection observed changes in connection with winter hardiness.

These manyfold factors are important from the point of view of the manysided utilization of the varieties. Changes on a wide range arising from the geographical distribution of wheat may be of the utmost importance for the breeder.

The general utilization of wheat varieties is first of all determined by their life habit or winter-summer type which is fixed by the sowing date connected with the character complex of cold tolerance and winter hardiness. Related comprehensive or detail studies are always important.

The literature of the etiology of this question is large and had occupied workers for a long time past (GASSNER 1918, MAXIMOV—POYARKOVA 1924, GREBENNIKOV 1928, LYSSENKO 1935, KOPETZ 1937 and others). Recently more and more deep reaching research work has been conducted to elucidate certain problems of detail (HÄNSEL 1949, FEEKES—DANTUMA—WITTENROOD 1954, RAJHÁTHY 1955, BOROJEVIĆ 1958, SCHMALZ 1958, PAVLIČIĆ 1960, ANTONINI 1962 and many others).

Data on the winter-summer type of wheat varieties, are, however, generally rather inadequate, even on world-wide scale. Consequently, this applies also to the material of our wheat collection originating from almost all regions of the world and it has a particular relation to the behaviour of new foreign varieties to be found in Hungary. Also for the Hungarian varietal material these data are rather deficient. Our present investigations are restricted to the examination of such kind of the varietal collection of Tápiószele.

Material and Method

The common wheat (*Triticum aestivum* ssp. *vulgare* (Vill. Horst.), MacKay) material of our varietal collection has substantially increased in these last years and at present consists of several thousand (4721) varieties. As to the number of items this number, on account of the many duplicata, is considerably (by 1/3) higher. These were as well examined for the sake of varietal identification. As to the origin the overwhelming part (2/3) of the varieties is of European provenience (from 22 countries). Rather large is the American material (1/6), beside Argentine and other South American ones, mainly varieties of the United States and of Canada. Also the material from Australia and New Zeeland is rather significant. The Asian wheats are mainly of Japanese, Chinese and Indian origin. Further, to a lesser degree are represented in our collection the varieties of all Asian and African countries, of the Mediterrean, and other African wheats.

A part of wheat varieties annually maintained and examined was studied with respect to their type of life habit (1961—62: 2254, 1962—63: 2716 and 1963—64: 2070 items). The material examined in each year was, on account of the divided maintenance, only partly identical.

The basis of examinations was the one series standard experimental seeding of the same items (varieties) in autumn and spring time. Thus every variety consisted of two plots of the size of 1 sq. m each. Seeding was carried out per grains with 15 $\times$ 5 cm spacing. Seeding dates were as follows:

1961—62: autumn: 5. X.—11. X, spring: 2. IV—11. IV.

1962—63: autumn: 12. X.—18. X, spring: 1. IV.— 9. IV. and

1963—64: autumn: 14. X.—15. X, spring: 6. IV.—13. IV.

The weather in the experimental years was rather varied (Table 1). For other meteorological data see KOVÁCS (1964, 1965).

The life habit grouping and/or separation on these grounds of the material examined has been carried out on the basis of behaviour in autumn and spring sowing. Overwintering has been established in per cent of the winter killing with surveys early and late in winter and spring development determined subjectively in per cent of shooting and earing, respectively.

Table 1

Temperature values during the vegetation period and distribution of precipitation in Tápiószele in the years 1961—62, 1962—63 and 1963—64

Meteorological elements	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.
Mean temperature °C									
Many years' average									
(1901—1950)*	10.8	4.1	0.1	−1.8	−0.3	5.0	10.2	15.9	19.3
1961—62	12.6	6.0	−0.9	−0.4	0.1	1.6	13.0	15.4	18.4
1962—63	10.8	5.6	−2.9	−7.2	−5.4	2.2	12.6	17.6	20.6
1963—64	10.3	8.4	−5.2	−9.1	−0.3	1.6	11.7	15.6	23.0
Number of "frosty" days									
Rad. min. $\leq 0°C$									
1961—62	4	10	23	27	24	24	7	5	—
1962—63	14	13	29	29	28	22	6	—	—
1963—64	7	8	31	30	29	20	1	—	—
Number of "severe" days									
Rad. min. $\leq -10°C$									
1961—62	—	—	8	—	4	4	1	—	—
1962—63	—	—	8	16	13	4	—	—	—
1963—64	—	—	10	22	7	—	—	—	—
Precipitation (mm)									
Many years' average									
(1901—1950)*	51	46	41	28	31	34	45	58	64
(1910—1960)	49.5	54.4	38.1	28.6	32.9	33.7	43.9	59.2	71.5
1961—62	7.9	79.4	35.1	22.3	21.8	45.8	17.8	44.5	8.3
1962—63	2.7	107.7	25.0	66.7	68.1	32.0	26.4	47.9	77.6
1963—64	25.7	2.8	68.1	4.8	23.9	30.9	15.8	33.7	76.3

Explanation: * The interpolated values of Cegléd, Jászberény and Szolnok.

Results and Discussion

On the grounds of a comparison of literary data with our data referring to the collection and to delayed sowing it proved to be necessary to continue examination of life habit on the whole material of our collection. Examination of the variety maintenance plots in autumn and spring seeding for the possibility of sowing in autumn or spring and for utilization supplies information also concerning other features.

A) *Preliminary examinations*

Already in the course of work done in the varietal collection in previous years it has been established that knowledge concerning the winter-summer character is important from the aspect of the maintenance of the collection and mainly of its utilization. While we became acquainted with the varietal material examined, and have studied the same in literature (BARBACKI et al. 1937, JAKUBCINER et al. 1947, JONARD 1951, BAYLES—CLARK 1954, etc.) it has been verified that many foreign varieties as to the type of their life habit behave otherwise than in their locality of origin. This resulted mainly from one-sided and inadequate knowledge of this character.

Often very little is known about the new wheat material obtained in the course of the development of the collection. Rather often the seed samples are received provided only with a varietal name. Moreover, the different varieties respond, in accordance to their adaptability, to different geographical and climatic conditions, depending on whether they are adapted on a narrow or wide range and to changing conditions (BAYLES—CLARK 1954). Naturally, also in consequence of this, the possibility of utilizing the varieties is not always complete.

In the course of earlier investigations connected with life habit (MESCH 1959, 1965) we have more closely established the winter-summer type of many well known wheat varieties which is indispensable for selection and utilization of wheat varieties best adapted to our conditions and for the establishment of seeding dates.

B) *Life habit examinations of the varietal collection*

The life habit of the wheat varieties was determined on the strength of the behaviour of the same material in an autumn and spring seeding period (Fig. 1). In earlier experimental work with delayed sowing technique (time variations) it has been demonstrated that it depends on the environmental factors how far this hereditarily founded character substantiates.

Data on winter hardiness and spring development of the wheat varieties examined each year concerning the determination of the life habit are presented in Tables 2, 3 and 4. These supply information on the variational distribution of the characters examined, through which insight is gained into winter killing and earing respectively of the autumn seeding of the material examined in each year.

On the strength of the variational distributions it can be established that in all three years the differentiation in the spring development was the greatest, by which the winter types can be separated from the summer ones. Between these also transitory forms occurred, to a lesser degree. Winter hardiness separation of the material examined by winter killing is also manifest, though more transitory types were encountered here.

As already referred to, the material of examinations was only partly identical in all three years. In spite of that the data of the three years supplied similar distribution and relationships, although the years, particularly the conditions of the spring were different.

Fig. 1. Wheat variety life habit types. From the left: 1. stake: winter type (standard Bánkuti 1201), 2. stake: dual-purpose type and 3. stake: summer type. The plot beside the stakes is autumn sowing, to the right spring sowing

From the aspect of our examinations not principally the variational distribution data of the winter-summer type are important but the observations on the relationships of these, viz. differentiation according to life habit.

On the strength of the relations of the features examined it can be established that under our conditions the varietal material examined separates into the following 5 (3 main and 2 secondary) types:

1. The *winter (hibernum — H)* type overwinters in autumn seeding, subsequently in the spring it is normally shooting, earing and bears fruit; in spring seeding it does not thrive well. Under conditions prevailing in Hungary the economic importance of this type is by far the greatest.

2. The *summer (aestivum — A)* type in autumn seeding gets winter killed while in spring seeding it normally develops i.e. it is shooting, earing and bearing. Its importance in this country is limited, due to the often late spring.

3. The *dual-purpose (hiberno-aestivum — HA)* winter-summer type which in autumn seeding behaves as winter, in spring seeding as summer type. The practical use of this type in Hungary up to now has also been limited, especially in spring seeding.

4. The *pseudo-winter* (according to Gy. Mándy *pseudohibernum — PH)* type is a non-winterhardy winter type which in autumn seeding behaves as

Table 2

Distribution of winter hardiness and shooting-earing of wheat varieties and their connections in autumn and spring seeding 1961—62

Winter loss %*	Shooting-earing per cent**											Total
	0	10	20	30	40	50	60	70	80	90	100	
0	H 1036 277B	49 20B	12 2B***	5	7	9	12	4	14	33	HA 155	1336 299B
10	96	10	2	2	3			4	7	13	73	210
20	23	2				1		2	1	5	57	91
30	12		1		1	1			2	4	31	52
40	11	1		1		1		2			38	54
50	8		1	1		1		3	1	3	46	64
60	3	1			1	1			2	6	40	54
70	4					1		1	3	1	28	38
80	4		1	1			1	1		2	60	70
90	4									2	79	85
100	3 PH			1		1			1	6	188 A	200
Total	1204 279B	63 20B	17 2B	11	12	16	13	17	31	75	795	2254 299B

Explanation: * winter seeding
** spring seeding
*** Bánkuti 1201 (standard)

Table 3

Distribution of winter hardiness and shooting-earing of wheat varieties and their connections in autumn and spring seeding 1962—63

Winter loss %*	Shooting-earing per cent**											Total
	0	10	20	30	40	50	60	70	80	90	100	
0	H 859 243B	120 86B	12 4B	5 1B***	1		1	1	9	35	HA 123	1166 334B
10	132 4B	31 4B	2		1	1	1		2	19	90	279 8B
20	43	13	2	3		1		3	1	5	79	150
30	25	11		1	1			1	3	11	61	114
40	13	3	1		2	1			1	7	77	105
50	8	5		2				1	1	7	50	74
60	12	2		1		1			1	6	62	85
70	6	5	1							8	73	93
80	3	3	2	1					2	10	130	151
90	19	10		1	1			1	2	15	262	311
100	2 PH	1				1			2	2	180 A	188
Total	1122 247B	204 90B	20 4B	14 4B	6	5	2	7	24	125	1187	2716 342B

Explanation:
* winter seeding
** spring seeding
*** Bánkuti 1201 (standard)

Table 4

Distribution of winter hardiness and shooting-earing of wheat varieties and their connections in autumn and spring seeding 1963–64

Winter loss %*	Shooting-earing per cent**											Total
	0	10	20	30	40	50	60	70	80	90	100	
0	H 22B 754 59F	97B 441 60F	1B*** 10 1F****		2				7	44	HA 322	120B 1580 120F
10	18	3								5	76	102
20	11								2	5	69	87
30	6									1	33	40
40	1	1								1	25	28
50	7										15	22
60	1									1	8	10
70	1	1									10	12
80	3								1		26	30
90	8	1								3	31	43
100	8 PH								1	5	102 A	116
Total	818 22B 59F	447 97B 60F	10 1B 1F		2				11	65	717	2070 120B 120F

Explanation: * winter seeding
** spring seeding
*** Bánkuti 1201 (standard)
**** Fertődi 293 (standard)

summer and in spring seeding as winter type. Consequently it has no economic significance in this country owing to the severe winter prevailing here. It is the winter wheat type of mediterranean regions with mild winter.

5. The *transitory (mesoform — M)* type is of indistinct character. It partly tends to one of the types but cannot be ranged with safety to either. It is insignificant.

According to data the type distribution may suffer a modification depending on the relative number of winter killing vs. shooting-earing that determines the belonging to the individual types. This at the same time indicates the strength or measure of the type.

For characterization of varieties we united the relative numbers of identical value in a differentiation degree. A further simplification can be obtained by the designation or indication of the relative numbers with one figure. This can be achieved on the strength of the Tables in two ways, by a summarizing figure or a type-index figure.

The *summarizing figure* is a number from 0 to 200 (divisible by 10) obtained from the sum of the numerical values expressing the relationship. On this ground, however, only the winter and summer types can be immediately separated, also according to type strength, since 0—40 (i.e. 0, 10, 20, 30 and 40) means winter while 160—200 summer habit. In the former range the lowest, in the latter the highest possible numbers indicate the more explicit differentiation pertaining to the type (habit).

Values from 50 to 150 include all other types, the separation of which takes place on the strength of the difference — in both directions — of the two values of the original relative number. If the difference is between 60 and 100 in the case of the one direction when the first number is lower the type is dual purpose, in the other direction when the first number is higher, it is pseudo-winter. The type showing the greater difference is the more explicit

Table 5

Grading of the strength of winter habit according to the measure of differentiation

Type index number	Relative numbers* or table-fields of identical value	Differentiation per cent
H_1	0/0	100
H_2	0/10 and 10/0	90
H_3	0/20, 10/10 and 20/0	80
H_4	0/30, 10/20, 20/10 and 30/0	70
H_5	0/40, 10/30, 20/20, 30/10 and 40/0	60

Explanation: * winter killing %/shooting-earing %

one. If, however, the difference of the relative number in this sense is 0—50, the type is transitory, i.e. indefinite.

In the separation according to *type index number* all types are delimited again in 5 grades. These show a diminishing strength from the four corners of the Tables (0/0, 0/100, 100/0 and 100/100 towards the centre). E.g. according to the grading of the strength of winter type see Table 5. For the belonging to one of the types thus a differentiation of at least 60 per cent is taken as a basis. Similarly the role of the dual-purpose summer and pseudo-winter types can be established. The transitory type on the other hand has a lower value of separation per cent. The starting point here is the 50/50 relative number of field, respectively, wherefrom outwards, towards the corners and

Table 6

Distribution of wheat varieties according to life habit type and differentiation in 1961—62, 1962—63 and 1963—64

Life habit	Type strength					Total	%	M
	1 (100%)	2 (90%)	3 (80%)	4 (70%)	5 (60%)			
	1961—62							
H	1036	145	45	21	20	1267	56.2	
HA	155	106	84	47	59	451	20.0	
A	188	85	63	30	41	407	18.1	
PH	3	4	4	5	4	20	0.9	
Total	1382	340	196	103	124	2145		109
%	61.3	15.1	8.7	4.6	5.5		95.2	4.8
	1962—63							
H	859	252	86	45	27	1269	46.7	
HA	123	125	107	69	90	514	18.9	
A	180	264	147	85	73	749	27.6	
PH	2	20	13	9	20	64	2.4	
Total	1164	661	353	208	210	2596		120
%	42.9	24.3	13.0	7.7	7.7		95.6	4.4
	1963—64							
H	754	459	24	6	3	1246	60.2	
HA	322	120	81	38	28	589	28.5	
A	102	36	30	10	9	187	9.0	
PH	8	8	4	1	2	23	1.1	
Total	1186	623	139	55	42	2045		25
%	57.3	30.1	6.7	2.6	2.1		98.9	1.2
	Three year average							
%	53.8	23.2	9.5	4.9	5.1		96.5	3.5

Explanation: H: winter, HA: dual-purpose, A: summer, PH: pseudo-winter and M: transitory edges, the validity to belonging to the type is diminishing, and herewith the orientation towards an other type is strengthening.

Unification and simplification of relative numbers by type index number is practically simple and more expressive. With the use of this number we apply, in reality, the usual life habit designation with the type grade or strength which can promote — with this special end in view — to selecting the ground material.

The quantitative and qualitative separation of the life habit types were remarkably definite on the grounds of the data of three years (Table 6). As to the type, the wheat mateiial examined is for the most part (54.3 per cent) winter type. The number of the dual-purpose and summer types is almost equal (22.5 and 18.2 per cent). The number of the so-called pseudo-winter types is very slight, amounting to 1.5 per cent of the varieties. About 3/4 of the varieties is definitely differentiated from the aspect of type strength (51.7 per cent is at 100 per cent strength level and 25.2 at 90 per cent). About 1/5 (19.6 per cent) of the whole material is rather well differentiated to winter, dual-purpose and summer or pseudo-winter type (under Hungarian conditions).

Taken as a whole, almost the whole material of the collection examined (96.5 per cent is differentiating — definitely or strongly enough — as one of the types and according to the strength of the year. The so-called transitory (or indefinite) type (3.5 per cent of the varieties) showed no distributional trend or regularity whatsoever.

Conclusions

Considering the maintenance and manipulation and first of all the examination and utilization of our varietal collection of wheats the knowledge connected with the life habit of the varieties is extremely important. Examination of the autumn and spring sowing of the varieties has proved to be well suited for the practical study of life habit.

On the strength of combined examination of the data on winter losses and shooting-earing, the overwhelming part of the varieties definitely separated into three main and two secondary life habit types. From the varieties examined 54.3 per cent has proved to be winter *(hibernum)*, 22.5 per cent dual-purpose *(hiberno-aestivum)*, 18.2 per cent summer *(aestivum)* and only 1.5 per cent of the so-called pseudo-winter *(pseudo-hibernum)* type. Besides, 3.5 per cent of the varieties is of transitory *(mesoform)* or indefinite character.

The distribution of types can mostly suffer a modification according to how far is the belonging to individual types determined. This, however, does not affect the essential part of the problem.

From the viewpoint of varietal selection the measure of the strength or differentiation of the type is important, the value of which is given by the winter killing/earing relative number. Drawing together of the relative numbers taken as of identical value facilitates the expression of the strength or measure of the individual types. A further simplification of this is the designation or indication with one number. This is possible in two ways, viz. with a summarizing number or with a type-index number.

The use of the latter is practically simpler and more expressive.

Separation according to differentiation of life habit type was also definite. 51.7 per cent of the varieties separated on the 100 per cent level, 25.2 per cent at the 90 per cent and 19.6 per cent of the material still rather well (on 60 to 80 per cent level).

Thus almost the whole material of the wheat variety collection examined (96.5 per cent) definitely or rather strongly differentiated as one of the types or according to their strength. This differentiation is almost independent of the year and of the varieties examined.

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THE BIOCHEMISTRY OF VERNALIZATION

IV. THE CHANGES OF RIBONUCLEASE ACTIVITY IN THE COURSE OF VERNALIZATION

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The changes of ribonuclease activity have been studied on seedlings of winter wheat B 1201. We have proved that the biochemical mechanism of vernalization is partly bound to nucleic acid metabolism. A form of RNase taking part in RNA metabolism and being very active even at low temperatures (0 °C), gets synthesized as early as the first few hours of vernalization. That RNase (being marked RNase I), on the basis of the temperature conditions and the inhibitory circumstances of its formation, takes most probably part directly in vernalization metabolism. We have succeeded in isolating the enzyme. Besides the RNase I system, other RNase systems, too, are active in wheat seedlings. These are now being under examination.

Introduction

In our previous paper (DÉVAY 1965) we reported on the finding that during vernalization the synthesis of specific proteins disposing of enzyme activity took place at low temperatures. On the basis of our experiences gained so far, the close metabolic relationship of protein synthesis and RNA postulated that previous to the enzyme syntheses observed by us, other enzyme syntheses must have as well ensued which preceded, in time, the formation of ascorbin oxidizing system observed by us. These enzymes must have taken a part in nucleic metabolism or in protein synthesis itself. On the basis of these considerations, attention has been given to the ribonuclease (RNase) enzyme taking part in RNA metabolism.

Material and Methods

The preparing of the experimental plant material: seeds of winter wheat B 1201 have been swelled and germinated as previously described (DÉVAY 1962). After the plant embryo had pierced the seedcoat, it was vernalized at 0°C in refrigerator, for 0, 7, 14, 21, 28, 35, 42 and 49 days. At the proper time the seedlings were isolated, then in 0.1 M citrate buffer (pH 5.6 and pH 7.6) homogenized (200 seedlings in 20 ml of buffer). The protein content and the RNase activity of the homogenisate (after having destroyed by way of NESSLER reaction) was determined. Determination of RNase activity: the activity of RNase has been established spectrophotometrically, relying upon basis-liberation. As substrate yeast nucleic acid of 0.2% (MERCK) was used that had been purified previously by repeated precipitation. 1 ml homogenisate (with about 1 mg protein content) was measured into the centrifuge tube, and then added 1 ml nucleic acid solution of 2% concentration. The temperature of both the homogenizate and of the nucleic acid solution was identical with the incubation temperure. The undissolved RNA was precipitated with hydrochloric alcohol of — 10°C (100 ml cc HC 1000 ml ethanol, 96%). The precipitation had been kept at a temperature of —10°C for 30 minutes and after this, it was centrifuged. The quantity of liberated bases was measured at 260 millimicron with spectrophotometer.

Parallel with enzyme activity the quantity of soluble proteins was determined and the activity values were indicated in gamma product (mg protein) per 60 minutes. (In the Tables and the diagram: "activity".) Errors of the determinations did not exceed the ±2.5 per cent. Of course, in the average of biological repetitions the absolute values show greater fluctuation, however, during the time of vernalization the changes can always be reproduced with identical character. In our conclusions, not taking into consideration the numerical values of some biological repetitions, only the character of the alterations have been evaluated.

The enzyme activity tests were generally performed at temperatures of 0°C, 5°C, 10°C and 20°C. The time of incubation was 60 minutes. When applying the inhibiting substances and in experiments referring to the formation of the enzyme, the activity was measured at 0°C incubation temperature only.

Application of metabolism inhibitors; in our investigations the following metabolism inhibitors were applied:

Sodium arsenate	0.02%
DPN	0.01%
Tripaflavin	0.10%
Acridine orange	0.09%
Chloramphenicol	0.10%
$Ag\ NO_3$	0.12%

The inhibitors were applied after being solved in water, and the seeds were steeped in solutions containing already the inhibitor; in the course of vernalization they were sprayed twice with the same solution. The concentration of the inhibitors was chosen with the view that the germinating effect should not be greater than 10 per cent so that after vernalization, plants could develop from the treated variants. Vernalized material treated with distilled water and non-vernalized material served as control.

In order to be able to establish the inhibited state of vernalization, beside biochemical analyses, the effect of the inhibitors was also evaluated by the determination of final leaf number.

Determination of cell count of the plant embryos: According to a previously described method (DÉVAY 1962), the cell count of plant embryos having been treated with 5% chromic acid, was performed in BÜRKER chamber. The data are submitted for one plant embryo in the relation of the initial cell, referred to 24 hours.

The method of enzyme isolation will be discussed separately.

Results and Discussion

a) *Evincing RNase I*

Our work had first been started by activity measurements performed in the homogenisate in order to get data on the presence of RNase and its activity changes ensuing during vernalization. The activity measurements had been made with seedlings at the usual temperatures of 0°C, 5°C, 10°C, and 20°C; vernalization having occurred at 0°C on the 0, 7, 14, 21, 28, 35, 42, and 49th days. First the pH curve of the enzyme had been registered. The pre-examinations showed that, in general, two pH optima appeared at pH 5.6 and pH 7.6. Therefore, the subsequent measurements were made at both pH-s. The data are presented in Table 1.

Table 1

The activity of RNase at various vernalization levels

Vernalization in days, at 0°C		0°C	Activity at incubation temperatures of		
			5°C	10°C	20°C
0		—	2.38	4.16	3.57
7		—	3.27	4.58	9.81
14		—	1.24	4.38	8.77
21	pH 7.6	—	0.49	1.94	15.14
28		—	0.91	6.95	21.70
35		—	1.35	1.36	7.24
42		—	6.44	9.37	36.80
49		—	12.72	19.09	37.20
0		—	2.67	2.97	4.16
7		0.65	1.96	3.27	10.47
14		5.27	7.51	5.62	10.64
21		2.45	3.89	6.35	14.50
28	pH 5.6	2.17	5.21	8.69	16.95
35		0.90	1.35	0.90	11.77
42		1.75	0.58	2.93	3.16
49		7.37	10.00	23.70	28.10

In the Table the activity changes were plotted against the incubation temperature and the degree of vernalization. When comparing the activities appearing at different pH-s, it will be noted as striking that in the higher pH-range the activity can be evinced at higher temperatures only. At pH 5.6 considerable activity can be measured even at 0°C, especially after the start of vernalization. The activity measured at 0°C appears in the first week of vernalization and displays its maximum in the second week of vernalization; then, after great temporary decrease, it increases again.

On the basis of our data obtained so far, it was presumable that we had to deal with several enzymes. The activity of one of these (pH 7.6) could be proved only in the higher temperature ranges and thus it cannot take part directly in vernalization metabolism. The other (pH 5.6) appears only at a certain degree of vernalization and its activity is easy to be measured at 0°C. It was presumable that this enzyme would take part in the metabolism of vernalization.

Subsequently, we tried to approach the problem from two directions. 1. By applying metabolism inhibitors, we tried to decide whether actual protein synthesis could be evinced, whether the activity-inhibition of RNase had bearing on the final results of vernalization. 2. We have investigated how the enzyme formation responds to the changes in temperature.

In order to bring an issue concerning the first problem, we applied various inhibitors during vernalization and measured the activity of RNase at an incubation temperature of 0°C.

b) *The effect of inhibitors on the formation of RNase formation*

On the basis of their effect, the inhibitors applied might be divided into three groups. One group (tripaflavin, chloramphenicol) inhibits the appearance of the first activity peak thus proving that, in this case, we really have to reckon with protein synthesis. These inhibitors produce no effect on the formation of the second maximum. Into the second group can be ranged those

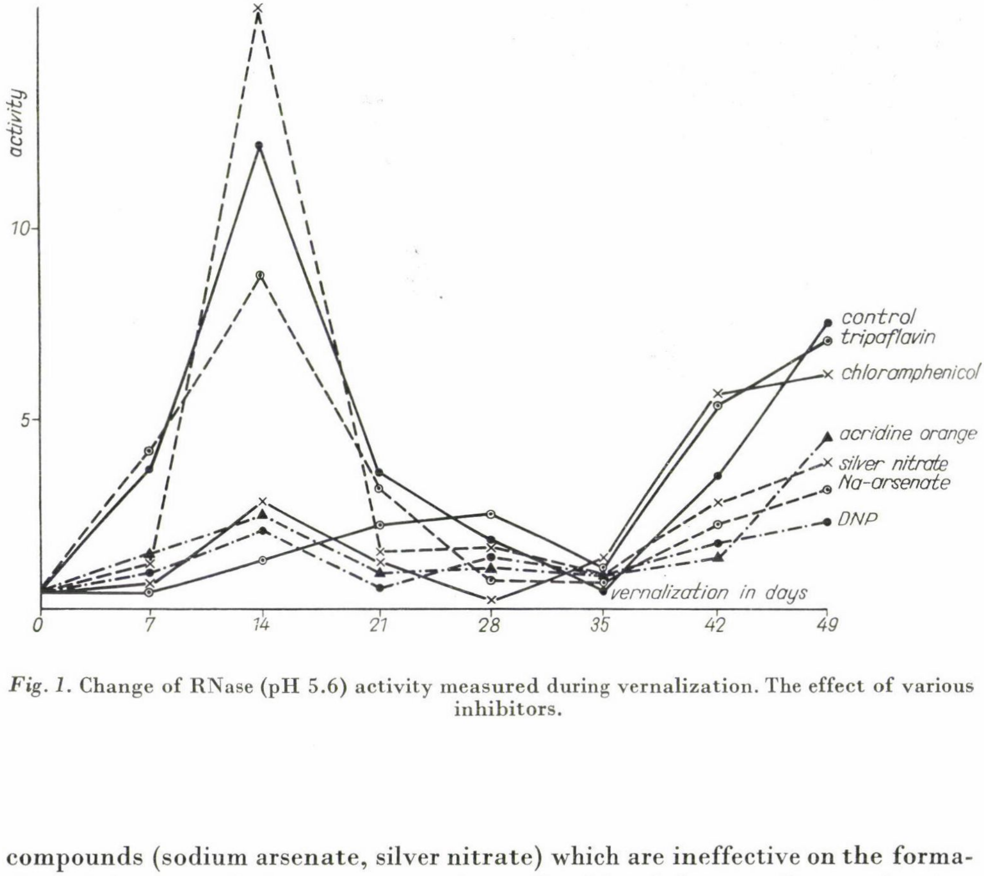

Fig. 1. Change of RNase (pH 5.6) activity measured during vernalization. The effect of various inhibitors.

compounds (sodium arsenate, silver nitrate) which are ineffective on the formation of the prepeak, however, are of considerable inhibitory effect at the time when the second maximum comes into being. The third group (acridine orange, DNP) inhibits both activity maxima. We wish to remark that the acridine orange-inhibition was, in every case, weaker than that caused by DNP.

On the basis of the different antimetabolic effects we might conclude that the formation of the first and second peak consists most probably of two separate processes in the course of vernalization. The increase of activity, in the first quarter of vernalization, is a result of protein synthesis while the formation of the second maximum is resulted, in the last stage of vernalization, by realignment or activation. The appearance of the first maximum might be blocked by the protein synthesis and nucleic acid inhibitors. The inhibition evinced in both states shows the necessity of energy transport while the effect of acridine orange indicates the role of DNA.

The three enzymes with RNase property will be marked hereinafter with figures. The enzyme producing max. activity at the beginning of vernalization is RNase I. RNase II is presumably not taking part in vernalization and working only at higher temperatures, while finally, the enzyme causing at the end of vernalization an activity enhancement is RNase III. The elucidation of the relationship and action mechanism of the enzymes is in progress.

c) *The effect of inhibitors on vernalization*

The effect of the above-mentioned inhibitors being applied on the further development of seedlings during vernalization has been examined. Purvis (1961) explains that the most reliable index of advanced vernalized state is the final leaf number showing exactly the time when plants turn from vegetative into generative. If the final leaf number increases it is to suppose that the vernalization was disturbed or incomplete. According to Napp-Zinn (1963) we might speak of actual vernalization inhibition only in the case if the final leaf number increases at the application of the inhibitor. For this reason, when examining the effect of the inhibitors, only this index has been taken into consideration with the view to eliminate the effect of other factors influencing ear formation. Our data are summarized in Table 2.

Table 2

The effect of various inhibitors on vernalization

Inhibitor	Conc.%	Final leaf number	Difference
Control, vernalized		8.3	
Control, non-vernalized		16.3	8.0
DNP	0.01	14.2	6.1
Tripaflavin	0.10	12.2	3.9
Acridine orange	0.09	15.3	7.0
Chloramphenicol	0.02	14.2	5.9
Sodium arsenate	0.05	8.5	0.2
$AgNO_3$	0.25	10.0	1.7
significant:		$\pm$ 1.2 (2.4)	

Though our data refer only to the results of a single experimental year, they very well represent the effect of inhibitors on the vernalization process. We want to observe that the applied inhibitory concentrations have not resulted healthy plants in every case; we have found numerous deviations especially in the form and construction of the ear. However, the final leaf number could be established in every case.

Data summarized in the referring Table are the mean values of 200 plants/variants. Concerning leaf number, the inhibitors have no effect on the vernalized control. It can be observed that well-defined vernalization inhibition is produced only by tripaflavin, chloramphenicol and acridine orange as well as DNP, viz., by those inhibitors which have inhibited the formation of RNase I. It can be established that the inhibitors of RNase I synthesis and those of vernalization are identical.

d) *Relationship in RNase I synthesis and cell-division*

Our pre-examinations conceining the temperature conditions of RNase I formation have proved that the enzyme gets synthesized in the first 24 hours of veinalization. Therefore, experiments were set up in two directions. Partly we examined how the enzyme activity measured at 0° changed in embryos kept at different temperatures during 24 hours, partly we investigated by taking sample every two hours, and vernalizing the embryos at different temperatures, when the first evincible enzyme activity would appear. Besides, we determined the intensity of cell-division. Our results are shown in Table 3 and Fig. 2. In Table 3 we have summarized cell-growth, in 24 hours, of embryos kept at different temperatures as related to the initial material. (The cell-count of the initial embryo was 13 575.) We have also submitted the RNase activity of embryos vernalized at different temperatures for 24 hours in the relationship of gamma/embryo/60 minutes 0°C, and finally, the interval in which, according to the examinations, active RNase I develops in the embryos vernalized at different temperatures. In Fig. 2 the curve of RNase formation has been plotted against temperature on the basis of activity, as well as the change in cell-division intensity plotted against temperature, on the basis of cell-growth per one enzyme.

It appears from the Table as well as from the graph that the temperature curve of enzyme formation is a maximum curve. The site of maximum is at 2 °C. With the increase of temperature the intensity of formation decreases, and around 10°C no activity at all can be evinced. Concerning the date of the appearance of the first measurable activity, it can be observed that while up to 5°C the formation occurs in the first 4—6 hours of vernalization, at 7°C, as much as 12 hours, and at 10°C, three weeks are required for this process. The temperature curve of cell-division is entirely deviating; thus, enzyme formation is not likely to be the result of embryo-growth; on the contrary, cell-division comes to a standstill at the time of maximal enzyme formation.

The appearance of activity, the formation RNase I occur at the active temperatures of vernalization. Conferring these data with the results obtained

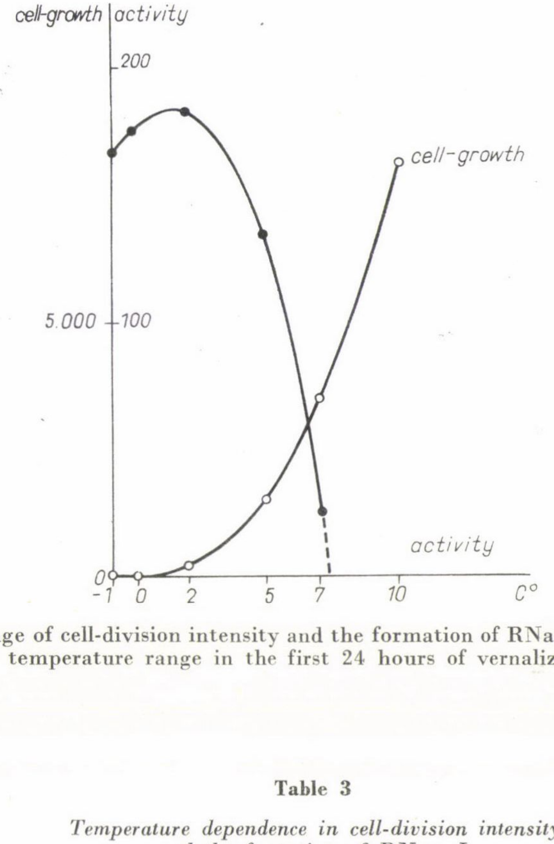

Fig. 2. The change of cell-division intensity and the formation of RNase I in the —1— +10 °C temperature range in the first 24 hours of vernalization

Table 3

Temperature dependence in cell-division intensity and the formation of RNase I

°C	Cell-number growth/embryo in 24 hours	RNase activity/embryo	First activity in hours
—1	—	168	6
0	—	175	6
2	202	183	6
5	1506	135	12
7	3856	27	24
10	8203	—	three weeks
significant:	± 31 (62)		

by inhibitors, it can be established that in this process we have to deal with a biochemical phenomenon closely connected with vernalization.

Since it could be established with much probability that the enzyme takes part in vernalization processes, the isolation of RNase I, in order to carry out further examinations, has become quite necessary.

e) *The isolation of RNase I*

The literature on the subject suggests the isolation of RNases by ammonsulphate fractionation. In view of the fact that the conditions of ammonsulphate precipitability of the enzyme we wanted to isolate were unknown, we first had to carry out the activity tests in precipitations obtained with the 0.1 (10%) saturation level-alterations in order to decide when and with what kind of ammonsulphate fractionation the isolation had to be started. Table 4 presents in the range of 10—80% saturation levels the activity correlations at pH 5.6 and pH 7.6 at temperatures of 0°C and 20°C.

From the data it can be seen that in non-vernalized embryos at 0°C no activity could be evinced at either pH. At 20°C, activity could be measured in the fraction precipitating with 50—70% saturation. After 7 days of vernalization at 40—60% saturation levels we have found, at 0°C, active RNA-breaking proteins. At 20°C, activity can be found at 40—70% saturation levels. This activity is divided by the changing of pH into two definite groups.

Table 4

RNase activity of protein fractions separating at different ammonsulphate saturation levels

	$(NH_4)_2SO_4$ sat. %	Vernalization					
		0 day		7 days		14 days	
		activity gamma/60 min.					
		pH 5.6	pH 7.6	pH 5.6	pH 7.6	pH 5.6	pH 7.6
0°C incubation temperature	10	—	—	—	—	—	—
	20	—	—	—	—	—	—
	30	—	—	—	—	—	—
	40	—	—	26	—	141	—
	50	—	—	60	—	140	—
	60	—	—	22	—	—	—
	70	—	—	—	—	—	—
	80	—	—	—	—	—	—
20°C incubation temperature	10	—	—	—	—	—	—
	20	—	—	—	—	—	—
	30	—	—	—	—	—	—
	40	—	—	50	38	350	133
	50	50	91	107	52	441	245
	60	58	126	28	42	345	470
	70	72	77	24	56	535	885

Table 5

Diagram of RNase isolation from wheat seedlings

Homogenizing in 0.1 M citrate buffer pH: 5.0
10 g/200 ml extraction; 0°C. 20 h. (1)
After centrifuging the residue is to be extracted repeatedly with 100 ml buffer. 0°C. 4—5 hours

precipitate off (2) | (1) supernat. with HCl pH 4.5 0°C 3 hours

precip. off (3) | (4) supernat. with NaOH pH 5.5 + 17.5 g/100 ml ammons. 4—5 hours °0

precip. off | supernat. +13.7 g/100 ml ammonsulph. °0 12 hours

precip. uptake to 100 ml 0.1 M citrate pH 5 °0 2—3 hours | supernat. off (5)

precip. off (6) | supernat. dialysed against 0.01 M citrate buffer pH 5.0 0° 24 hours after dial. 21.2 g/100 ml ammonsulph. 0° 12 hours

(7) precip. uptake in 50 ml citrate buffer. Like previous uptake (6) | supernat. off

precip. off (8) | supernat. with HCl pH 3.8 500 mg NS 0° 1—3 hours

precip. uptake in 20 ml citrate buffer. pH 5.0 0° 1—2 hours | supernat. off

precip. off | supernat. +200 mg NS 0° 1—3 hours

precip. uptake in 20 ml citrate buffer pH 5. 0° 1—2 hours | supernat. off

precip. off | supernat. +5.5 g ammons. 0° 24 hours

precipit. uptake in 5 ml citrate pH 5.5 Dialysis 24 h. 0° against 0.01 M buffer Filled up to 10 ml *Enzyme solution* (9) | supernat. off

At the 40—50% saturation level the activity decreases with the increase of pH, while at the 60—70% saturation levels it increases. These correlations are even more definite on the 14th day of vernalization when the activity measured at 0°C is about seven times as much as that measured on the 7th day. It seemed plausible that the enzyme displaying activity at 0°C and showing activity-decrease response to the increase of pH, was the same RNase I we wanted to isolate, while the other one separating at 60—70% level, is RNase II.

On the basis of the pre-examinations, we have tried to isolate RNase I with permanent activity control. The draft-steps of vernalization are summarized in Table 5. 10 g of wheat seedlings having been precedingly vernalized for 14 days, were homogenized in 200 ml 0.1 M citrate buffer (pH 5) (HOLDEN—PIRIE 1955), then extraction was being performed at 0°C for 20 hours. After centrifuging, the residue was repeatedly extracted with 100 ml buffer in refrigerator for 4—5 hours, then following centrifuging, the two extracts were combined. Thus we succeeded in carrying 90% of the total activity into the solution. The pH of the extracts was then set with HCl to 4.5. After several hours of keeping it in refrigerator, centrifuging was repeated and then the precipitate discharged. By this method we succeeded in precipitating a big quantity of ballast-protein, while the enzyme itself remained in solution. The pH of the pure solution obtained after centrifuging, was re-set to 5.5 with NaOH; then, up to a 30% saturation level ammonsulphate with cooling was added. For getting the precipitate separated the solution was being kept at 0°C for 4 hours. Centrifuging came next again and discharging the precipitate. Now followed the separation of the enzyme containing fraction. The saturation of ammonsulphate was raised to 50 per cent and the solution kept in refrigerator for 12 hours. The separated fine precipitate was centrifuged, the enzyme to be found almost entirely in the precipitate. The precipitate was then taken up in 100 ml pH 5.5 citrate buffer and dialyzed against 0.001 M citrate buffer at 0°C for 24 hours. After having removed the ammonsulphate, the diluted liquid was repeatedly saturated with ammonsulphate to 50% and the precipitate that had been separated in refrigerator and contained the entire activity, was taken up in citrate buffer. After centrifuging, the precipitate did not contain activity which proved that the whole active enzyme-supply had gone into the solution. The further purifying of the enzyme was also tried according to the method of HOLDEN—PIRIE (1955) with the purified yeast-nucleic acid as adsorbent. RNase gets adsorbed on the surface of nucleic acids with high specificity and thus it can be well separated from the accompanying enzymes and other proteins.

The enzyme containing solution was adjusted with HCl to 3.8 pH, then the yeast-nucleic acid that had previously been purified by repeated precipitation, was admixed. After standing for 1—2 hours at 0°C, it was centrifuged and the precipitate was extracted with pH 5.0 citrate buffer. The nucleic acid adsorption was performed twice. After the last extraction made with 0.25 N H_2SO_4 after adjusting the 5.5 pH 50% saturation with ammonium sulphate was achieved and the enzyme got precipitated. The precipitate being taken up

Table 6

The development of activity test in the stages of isolation

Number	Fraction	Total vol. ml	Total protein mg	Total activity	Specific activity
1.	Supernat.	300	598	658.1	1.22
2.	Body elements		690	69.0	0.10
3.	Prec. after acidification		442	0.0	0.00
4.	Supernat. after acidification		176	652.3	3.82
5.	Salting out supernat.	350	109	2.2	0.02
6.	Residue of the uptake		10	1.8	0.02
7.	Precip. of salting out		20.6	573.3	27.70
8.	Residue of uptake		18.4	0.0	0.00
9.	Total end product	10	2.2	569.8	259.00

in citrate buffer, it was dialyzed against 0.01 M citrate buffer. The dialyzed solution being filled up to a final volume of 10 ml, we obtained the enzyme solution which contained very little protein and showed high activity at 0°C.

The development of activity has been checked up throughout the whole experiment at 0°C. The data are presented in Table 6. In the illustration presenting the process of isolation, the activities showing themselves on the spot of figures in brackets, are summarized in Table 6. The specific activity of the total end product was by 216 higher than the specific activity in the supernatant of the original initial homogenisate.

Conclusions

It has been known for long that morphogenesis of plants is influenced by external factors. The investigation of these correlations has recently, in the last decade, made great progress.

Naturally, the question promptly arises as to what the real correlation is between the system reacting with external factors and the mechanism evoking morphogenetic processes. A system being brought about by the environment reacts but in rare cases directly with morphogenesis (Bopp, 1963). In most cases it calls forth only functions as a result of which certain plant-cells or parts of plant give a response. For the time being the biochemical mechanism of such receiving and responding reactions is still a blank space on the chart of biology (Bopp, 1963).

In flower induction the autocatalytic processes play a considerable part (Lang, 1952, Purvis, 1961). This had been the starting point on the basis of which the role of nucleic acids meeting the requirement, was first examined in the flower induction.

The investigations of SALISBURY, BONNER (1960) refer to the role of nucleic acids in flowering induction, however, they could not yet decide if the effect evoked was due to DNA or RNA. HESS (1959, 1961a, 1961b) proved through specific inhibiting experiments that with *Streptocarpus wentlandii* a specific RNA takes part in the flower induction. He advances his view according to which in the case of *Streptocarpus* studied by him and requiring around 10 °C temperature and short days for flower formation, there are two RNA systems working: a vegetative RNA system regulating growth and a reproductive RNA system producing the flower formation. At the time of reproductive RNA synthesis, the vegetative RNA gets inactivated in some way. E.g. with *Streptocarpus* it is the 10 °C temperature that proves to be low enough to inactivate vegetative RNA, however, it is high enough to render possible reproductive RNA synthesis.

Our data referring partly to the inhibition of vernalization partly to the synthesis of new-type proteins and last but not least, to the synthesis of RNase enzyme taking part in vernalization, just under the conditions of vernalization, show that the hypothesis of HESS concerning the two kinds of nucleic acids, stands also regarding vernalization. (The approx. temperature of 10 °C required for normal flowering initiation, is indispensable with *Streptocarpus*, too.) His hypothesis concerning the vegetative inactivation of RNA is the same as, in our case, the synthesis of active RNase at low temperature. In our opinion, low temperature not only inhibits the synthesis of vegetative RNA, but as a consequence of ribonuclease activity, it most probably disturbs it as well; thus, the ratio of various RNAs and the feasibility of synthesis, respectively, are regulated by RNases working under different conditions. The latter theory would be proved by the two curves of Fig. 2. When the formation of RNase is in maximum, cell-division (vegetative RNA) is in the minimum. However, future investigations will have to decide upon these problems.

The changes of ribonuclease activity have been studied on seedlings of the winter wheat B 1201 during vernalization and the following conclusions have been drawn:

A form of RNase taking part in RNase metabolism and being very active at a low temperature, gets synthesized in the first few hours of vernalization. We have succeeded in isolating the enzyme.

The formation of the enzyme is inhibited by chloramphenicol, tripaflavin and acridine orange. Respiratory poisons have no influence on it. The inhibitors of RNase formation are identical with the specific inhibitors of vernalization.

The temperature conditions of RNase formation agree with the temperature-dependence of vernalization. The formation of the enzyme is the maximum in the 0— +2 C° interval. Then the cell-division either stops entirely or is but minimum.

The evinced enzyme transcribed by us as RNase I, is most probably rather an organic part of vernalization than the result of cell-division and growing, respectively.

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CHANGES IN SWARD TYPES AS INFLUENCED BY CHEMICAL FERTILIZER APPLICATIONS

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Several sward types were treated with chemical fertilizers in different ways and the changes examined. The various chemical fertilizers modify the yield and the composition of the swards. Quantitative grass (yield) and qualitative (botanical composition, chemical contents) changes are still more accentuated by the various types of sward.

Introduction

In our days swards are dealt with all over the world, research work on their improvement and possibilities of the increase of their yield is being conducted.

One of the direct modalities of the improvement of sward yields is fertilizer application. Earlier, authors thought this question to have been solved with the use of organic manure while more recently the latter being held useful but not indispensable (KLAPP 1962). From farming point of view the use of chemical fertilizers is emphasized since they are utilized with greater efficiency than organic manure (VINCZEFFY 1964) and are, in most cases, substantially less expensive (ZÜRN 1961).

On account of this, recently chemical fertilizer application on swards has recently been given the preference. As to the varieties and quantities of chemical fertilizers to be used, however, there are still many problems open to discussion.

The results obtained up to now are not unequivocal which must practical farmers remind of caution. It is a general experience that important results may by achieved by one-sided N fertilizer application (TAKÁTS 1962, BALÁZS 1962, SCHUMMEL 1961, LAMMERINK 1962, CIZEK 1963, REIT–INKSON 1964, ZÜRN 1964 etc.). It has been established that N fertilizer favours, in all cases, the grasses while legumes come short of growing (LAMMERINK 1962). Sometimes this latter phenomenon is only comparative (TAKÁTS 1962) as also legumes may be growing well (BALÁZS 1962) while in other conditions they disappear from the sward within a few years (KREIL et al. 1961). The controversial data are mainly due to the different ecological conditions of the experimental localities.

With mixed chemical fertilizer application 300 per cent and even higher results were obtained many times (BUHTZ 1962, CIESLINSKY 1963); which made most authors partisan of mixed chemical fertilizer application (DŐRY 1960, TAKÁTS 1962, SCHECHTNER 1964, ZÜRN 1964 et al.).

The chemical fertilizers have specific effects on the various plants of the swards, stimulating ones while inhibiting others (GROSS 1961, KUENZLEN 1961, BUHTZ 1962, etc.). N fertilizer increases the total protein (GROSS 1961, JONES 1963) although it reduces the proportion of legumes. In many cases also P fertilizer may increase the protein contents, first of all by the rapid spreading of the papilionaceous plants (CARPENTIER 1963).

From the factors influencing the utilization of chemical fertilizers the most important one is the height of the ground water table. Intensive sward farming is possible (without irrigation) but on areas with an adequately high water table. The effect of chemical fertilizers is the greatest on such swards. Similar facts were established by ZAYKOVA (1964) who found that hay yields were increasing towards true meadows while diminishing towards desert and marsh swards.

Also the utilization of the active agent in chemical fertilizers is specific, depending in the first place on the type of the sward. The amount of dry matter obtained per 1 kg active agent changes on a wide range (7—25 kg). The more chemical fertilizer is used the less dry matter is obtained — relatively — per 1 kg active agent (SCHUMMEL 1961). With mixed or increased chemical fertilizer application the carotene content can be enhanced by 20 per cent (CARPENTIER 1963).

As it appears from these few data — and has been found in our own large-scale experiments — the results obtained in the field of the chemical fertilizer application of swards are not concordant. Our small plot experiments have been set up exactly to obtain information on specific effects to be expected in chemical fertilizer application on swards. Therefore, various types of swards have been fertilized differently, with the objective to supply new data concerning the sward types as a contribution to this much discussed question which may perhaps help with better evaluation of this many sided problem.

Experimental Conditions and Methods

a) *Natural conditions*

The place of investigation was Tápiószele, its time 1963—1964. The area is of a low site (110—120 m above the sea level), mostly plane, for some sward types somewhat (0—3 per cent) slopy.

Climate is continental. The annual number of sunlit hours is 1950—2050, in the vegetation period 1430—1460. Mean temperature is 10—11°C, annual fluctuation 23—25°C. The mean temperature of the vegetation period is 13.5°C.

The annual precipitation is — in the average of many years —500—550 mm. During the vegetation period the mean precipitation obtained was 170 mm.

The soil is a meadow clay soil with solonchak, of mildly alkalic reaction (pH = 7.8—8.6).

Since earlier farm experiment data had been processed in the first months of 1963, the experiments were set up only end of March 1963. The chemical fertilizers were spread out in both years at the same time, viz. end of March.

Plot size was 10 sq. m. As the objective was chemical fertilizer application to sward types, parts had been chosen, where the sward appeared to be homogeneous. As from each sward type only small homogeneous areas were found we had to content ourselves with a plot size of 10 sq. m.

The data concerning the types examined are presented in Table 1.

Table 1

Data of sward types examined

Name of sward type (dominating grass) 1		Ground water table 2	Slope % 3
Meadow fescue	Festuca pratensis	0 —1.5	0
Creeping bent	Agrostis alba	0 —1.5	0
Rough-stalked meadow grass	Poa trivialis	0.5—2.0	1
Smooth-stalked meadow-grass	Poa pratensis	1 —3.0	0
Reed canary grass	Festuca pseudovina	2 —4.0	3

The sward types were chosen to be of different hydrological structures and to represent, as far as possible, swards covering larger areas.

b) *Treatments*

Treatments were identical in each sward type and are listed in Table 2. Data are rounded up to a few decimals.

c) *Methods employed in experiments and analyses*

1. Experiments were set up according to 5 × 5 Latin square pattern. Data have been evaluated with analysis of variance.

2. Botanical composition of the sward and its change as an effect of chemical fertilizer application were established by coenological surveys, adapting the HULT—SERNANDER coenological method modified by Balázs.

3. Raw protein contents were determined with the WAGNER—PARNASS mikrokjeldahl method and carotene analyses carried out with CHOLNOKY's column-chromatographic method by the laboratory of this Institute.

Several of the sward types had been pastures before so in the first year the effect of rest was conspicuous. Since our aim was to establish the effect of chemical fertilizers, we laid stress, beside presenting the data of the first year, on those of the second.

Table 2

Treatments

Chemical fertilizer	q/cad. hold*	%	Active agent total a.e. kg/ha
1.	2.	3.	4.
I. treatment			
Pétisó**	1.5	25	65
II. treatment			
Pétisó	3.0	25	130
III. treatment			
Control	—	—	—
IV. treatment			
Pétisó	1.5	25	
Superphosphate	1.0	18	
Potassium salt	0.5	40	130
V. treatment			
Pétisó	3.0	25	
Superphosphate	2.0	18	
Potassiumsalt	1.0	40	260

* 1 cad. hold = 0.57 ha.
** Calcium carbonate = ammonium nitrate fertilizer manufactured in Pét (Hungary)

Results

1. *Quantitative changes*

The action of the various chemical fertilizers on the sward types can be measured, first of all, on the difference in yield. According to Table 3 both percentual and absolute increase of yield were essential.

a) *The effect of N fertilizer on various sward types* (Table 3)

On the action of the first treatment (65 kg N/ha) very different results, depending on the type of the sward, were obtained. ***Festuca pseudovina*** sward showed a yield increase of only 0.7 kg as compared with 4.8 kg in ***Festuca pratensis***. Absolute weights also exhibit important divergences: ***Festuca pratensis*** 13.94 kg, ***Poa pratensis*** 7.68 kg, ***Festuca pseudovina*** 3.68 kg. Surplus yield was 40 to 50 per cent according to sward types; difference between the types 369 per cent.

Upon the action of 1 kg of the first treatment 10.7 to 74.2 kg green yield arose. Highest yields were obtained from hygrophilous swards, lowest from the xeromesophilous ones (for data see Table 4).

Treatment II had a more explicit effect. As an effect of 130 kg N/ha the green yield of *Festuca pratensis* increased by 6.62 kg while that of the *Festuca pseudovina* sward by 2.82 kg. 1 kg active agent produced 13 to 61.2 kg green yield.

N fertilizers increased, to the greatest extent, the yield of the hygromesophilous *Agrostis alba* and *Poa trivialis* swards. The xeromesophilous *Festuca pseudovina* sward could utilize to a lesser degree the one sided N chemical fertilizer application.

b) *The effect of mixed chemical fertilizer application on the various sward types*

Data concerning the changes of grass yield and the surplus yield obtained on the action of 1 kg active agent are found also in Tables 3 and 4.

Treatment III (130 kg mixed active agent per hectare) increased the yield by 62—112 per cent. According to the type of grass on the action of 1 kg active agent a grass yield of 9,6—61,7 kg, was obtained.

Treatment IV (260 kg mixed active agent per hectare) produced the greatest effect, a surplus yield of 125 to 248 per cent. In the first place the yield increase of the hygrophilous swards is conspicuous (211 to 248 per cent surplus yield), while the yield increases of mesophilous (165 per cent) and xeromesophilous swards (125 per cent) are of a lesser degree. As to absolute weights there is a great difference between *Festuca pratensis* and *F. pseudovina* (20.44 kg and 3.84 kg = a deviation of 532 per cent). 1 kg active agent produced 78.4 kg of green grass.

As evidenced by the data, the different chemical fertilizers elicit a characteristically different effect in the amount of yield and this change may manifoldly increase depending on the sward type.

The most essential cause of the different, often contradictory results of chemical fertilizer experiments on swards is the type of the sward utilizing the chemical fertilizer in a particular way.

2. *Qualitative changes*

Chemical fertilizer application increases not only the yield of the sward but also improves both its botanical composition and its analytical value.

a) *Changes in the composition of the sward*

The effect of chemical fertilizers on the botanical composition of the individual sward types is demonstrated in Table 5.

According to the data N fertilizer promotes in all cases the grasses while legumes are handicapped. Both grasses and legumes are fostered by the application of mixed chemical fertilizer. Under drier conditions the development of the grasses is more satisfactory, while under mesophilic conditions

Table 3

The effect of various chemical fertilizers on the

Type of sward	Year	Mean values of treatments			
		I		II	
		kg	%	kg	%
Meadow fescue (Festuca pratensis)	1963 1964	13.10 13.94	147 153	16.36 15.72	183 173
Creeping bent (Agrostis alba)	1963 1964	10.58 11.18	148 156	14.22 15.20	198 212
Rough-stalked meadow grass (Poa trivialis)	1963 1964	7.40 7.66	136 144	11.52 11.72	212 220
Smooth-stalked meadow grass (Poa pratensis)	1963 1964	7.14 7.68	143 138	9.76 10.94	196 197
Reed canary grass (Festuca pseudovina)	1963 1964	2.84 3.78	148 123	3.62 5.90	188 191

grasses and legumes thrive equally well and in hygromesophilic conditions legumes do better upon the action of mixed chemical fertilizer.

Chemical fertilizers in large dosage rates (treatments II and V) reduce the number of plant species. The rate of reduction is different according to sward types and ranges from 23 to 30 per cent. The highest number of species is found in the mesophilous sward types, diminishing towards the hygrophilous and xerophilous conditions. For other reasons (sodic, alkali, acid soil, etc.) the number of species shows a further reduction until, in some extreme cases, no more than 4 to 5 plant species are found in a sward (e.g. *Puccinellia* sward!).

Low dosage rates of nitrogenous fertilizer also diminish, to a lesser degree, while low doses of mixed chemical fertilizer increase the number of plant species in the sward.

In the last analysis the botanical composition of the sward obtained as an effect of mixed chemical fertilizers is better, more varied. Measure and proportions of chemical fertilizer application are essentially determined by the type of the sward.

In the course of investigations we found that some plants responded to chemical fertilizer application with rapid growth while others were handicapped. E. g. *Bromus mollis* and *Cynodon dactylon* showed a good growth in the first year of chemical fertilizer application but later on they fell short. Similarly, some plants of the wet swards were superseded from the sward (e.g. *Carex distans*, *Rhinanthus minor*, etc.).

change of grass yields according to sward types

Mean values of treatments						Analysis of variance			
III		IV		V		M	SD 0.1%	SD 1%	SD 5%
kg	%	kg	%	kg	%				
8.90	100	14.58	164	26.68	299	15.92	4.71	3.33	2.38
9.10	100	15.10	166	29.54	324	16.68	13.78	9.76	6.95
7.16	100	14.10	197	22.98	321	13.81	2.90	2.05	1.46
7.16	100	15.14	212	24.76	348	14.69	2.82	1.99	1.42
5.42	100	9.10	168	15.44	285	9.77	2.74	1.94	1.38
5.32	100	10.48	197	16.56	311	10.35	1.98	1.40	1.00
4.98	100	8.40	168	12.80	257	8.62	0.47	0.34	0.24
5.56	100	9.32	168	14.75	265	9.65	0.67	0.47	0.34
1.92	100	3.18	166	5.60	292	3.43	0.47	0.34	0.24
3.08	100	5.50	178	6.92	225	5.04	0.62	0.44	0.31

According to experimental data the *Agrostis alba* sward was most susceptible to mixed chemical fertilizer application, while the *Poa trivialis* sward utilized the N fertilizer better. Most grasses, however, increased their yield in the first place according to the amount of chemical fertilizer, not to its quality.

Table 4

Green yield surplus upon 1 kg chemical fertilizer and total green yield per sward type

Sward type	Year	I		II		III		IV		V	
		Treatments									
		kg	q/ha	kg	q/ha	kg	q/ha	kg	q/ha	kg	q/ha
Festuca pratensis	1963	64.4	131.0	57.2	163.6	—	89.0	43.5	145.8	68.2	266.8
	1964	74.2	139.4	50.7	157.2	—	91.0	46.0	151.0	78.4	295.4
Agrostis alba	1963	52.5	105.8	55.5	142.2	—	71.5	53.2	141.0	60.7	229.8
	1964	61.7	118.0	61.2	152.0	—	71.6	61.7	152.0	67.5	247.6
Poa trivialis	1963	30.4	74.0	46.8	115.2	—	54.2	28.2	91.0	38.4	154.4
	1964	35.8	76.6	49.2	117.2	—	53.2	39.5	104.8	41.8	162.1
Poa pratensis	1963	33.1	71.4	33.6	97.6	—	49.8	26.2	84.0	30.0	128.0
	1964	32.5	76.8	41.2	109.4	—	55.6	28.8	93.2	35.2	147.6
Festuca pseudovina	1963	14.1	28.4	13.0	36.2	—	19.2	9.6	31.8	14.1	56.0
	1964	10.7	37.8	21.6	59.0	—	30.8	18.5	55.0	14.7	69.2

Table 5

Effect of chemical fertilizer application on the botanical composition according to sward types

Sward type	Treat-ment	Grass		Legume		Weed		Other		Total	
		Number of species	Coverage %	Number of species	Coverage %	Number of species	Coverage %	Number of species	Coverage %	Number of species	Coverage %
	I	5	48.7	6	12.8	8	11.2	15	27.2	34	100
Meadow fescue	II	5	64.7	6	9.7	6	8.1	11	18.1	28	100
(Festuca pratensis)	III	7	26.8	8	12.5	8	26.2	14	29.4	37	95
	IV	6	32.1	8	23.7	8	17.5	15	26.2	37	100
	V	6	49.6	9	30.0	4	5.0	11	15.6	30	100
	I	5	48.4	7	7.8	6	12.8	15	27.5	35	95
Creeping bent	II	5	64.0	5	6.5	4	6.6	11	22.5	25	100
(Agrostis alba)	III	5	31.2	7	8.7	6	18.4	16	29.0	34	99
	IV	5	47.5	9	23.5	6	9.7	14	19.7	34	100
	V	5	50.6	9	36.5	4	3.0	9	10.0	27	100
	I	7	44.4	7	7.8	6	9.7	16	35.3	36	95
Rough-stalked	II	7	66.2	5	6.5	5	5.6	11	22.8	28	100
meadow grass	III	7	35.0	7	8.7	5	10.0	15	33.1	34	85
(Poa trivialis)	IV	7	47.5	9	19.6	6	6.5	18	25.6	40	100
	V	6	52.1	9	28.8	4	5.0	13	14.4	32	100
	I	7	56.2	6	8.1	6	3.7	19	31.2	38	100
Smooth-stalked	II	7	67.8	4	6.8	4	2.5	16	22.2	31	100
meadow-grass	III	7	38.8	6	9.6	6	7.1	23	31.2	42	90
(Poa pratensis)	IV	7	52.1	8	21.2	6	5.6	20	21.0	41	100
	V	6	56.2	7	31.2	5	4.0	14	14.6	32	100
	I	6	60.0	3	3.7	3	2.8	16	23.1	28	90
Reed canary grass	II	5	64.7	3	3.7	2	1.2	12	30.8	22	100
(Festuca pseudovina)	III	6	51.2	3	3.7	3	4.3	16	19.7	28	80
	IV	6	55.6	4	10.0	3	3.7	16	33.1	29	100
	V	6	63.8	5	18.1	2	2.1	11	19.4	24	100

Note: To weeds belong Cyperaceae, Juncaceae and the poisonous and pricking plants. The other plants e.g. buttercup (Ranunculus sp.) dandeleion (Taraxacum), carrot (Daucus) etc. belong to the group of "other plants".

The specific effect of chemical fertilizers can be best established from the quantitative changes of the components of the swards. The changes recorded in this respect may involve also the gradual transformation of the sward treated with chemical fertilizers. According to the results of other experiments the botanical composition of the swards changes after a few years of chemical fertilizer application very conspicuously and according to the new conditions. Similar experiments conducted in Hungary certify that irrigation accelerates the transformation.

The botanical composition of natural swards is determined in reality by the ecological properties of the habitat. These properties involve the composition which can utilize the given conditions to best advantage. If the given ecological conditions are changed, the new milieu brings about a certain change in the vegetation.

The ability of the vegetation as to change, for maximum utilization of the changed conditions, its botanical composition (through the disappearance of some species and the appearance of new ones, further by the high grade of propagation of species with a productivity most adapted to given conditions) is considered as development of the vegetation. This development is the more extensive the greater the change in the given ecological conditions of the habitat.

c) *Changes in the chemical composition of the sward types*

According to the laboratory analyses as an effect of chemical fertilizers not only the absolute amount of grass crops, the quality of the botanical composition but also the analytical values showed a favourable change. Chemical changes are recorded in Table 6. Protein content showed in all sward types the best increase under the action of high dosage rates of mixed fertilizer (treatment V) while the control exhibited the lowest values. From the N fertilizers, treatment II caused medium, while treatment I small increase of protein contents. Gross (1961) and Schummel (1961) found higher amounts of raw protein in their similar investigations.

As to carotene content, no consistent order could be established. According to Carpentier (1963) carotene content showed an increase of even 20 per cent, which was found by us only in the *Agrostis alba* sward.

Conclusions

The results of chemical fertilizer application experiments are often contradictory. Therefore, the effect of the chemical fertilizers must be examined separately for the various sward types. On plain, fresh semi arid and 0—3 per cent sloping dry alkali (Szik) meadow clay soils (pH 7.8 to 8.6) the changes

Table 6

The analytical changes of sward types

Sward type	Labor. anal.	Treatments				
		I	II	III	IV	V
Meadow fescue (Festuca pratensis)	raw protein g/100 g dry matter	8.23	9.01	8.11	9.69	10.48
	carotene mg/kg dry matter	91	115	118	114	109
	d. m. %	89.49	90.20	90.41	90.69	90.28
Creeping bent (Agrostis alba)	raw protein g/100 g dry matter	10.52	10.57	9.07	10.26	10.56
	carotene mg/kg dry matter	119	170	118	132	136
	d. m. %	88.71	87.68	88.43	88.27	88.73
Smooth stalked meadow grass (Poa pratensis)	raw protein g/100 g dry matter	10.01	10.26	9.18	10.45	11.72
	carotene mg/kg dry matter	96	94	103	109	94
	d. m. %	90.96	90.88	90.93	92.17	90.83

of several sward types after chemical fertilizer applications were examined. According to the results the *Festuca pratensis*, *Agrostis alba*, *Poa trivialis*, *Poa pratensis* and *Festuca pseudovina* swards responded in typically different ways to various chemical fertilizers.

On 65 kg/ha N active agent the yield increase was 40 to 50 per cent, the difference among the types 369 per cent. 130 kg/ha N fertilizer brought about 73 to 120 per cent increase of yield; the difference among the types was 342 per cent. 130 kg/ha active agent in the fertilizer resulted in an excess yield of 64 to 112 per cent, while the difference among the types was 402 per cent. Upon a chemical fertilizer of 260 kg/ha mixed active agent the surplus yield was 125 to 248 per cent, the difference among the types 532 per cent.

1 kg active agent produced 10.7 to 78.4 kg green grass yield. Within the sward types the difference on the action of the treatments was 143 to 202 per cent, whereas between the sward types this difference rose to 732 per cent.

Nitrogenous fertilizer favoured the grasses and handicapped the legumes. The mixed chemical fertilizer helped both the grasses and the legumes and thus the economically most useful botanical composition was obtained.

The specific effect of the chemical fertilizers can be best judged from the changes of the components of the sward. Some plants respond with rapid and vigorous growth while others are superseded. In order to maximally utilize the changed ecological conditions the vegetation is capable of changing its botanical composition. This change is considered as a development in the consequence of which the sward may gradually — sometimes rapidly — transform.

According to chemical analyses the amount of raw protein was increased by high doses of mixed chemical fertilizers (treatment V) to best advantage. In carotene contents significant changes were only found with the *Agrostis alba* sward.

Investigations verified that one of the most substantial reasons of the differing, often contradictory results of chemical fertilizer application experiments on swards was the sward type which utilized the chemical fertilizer in a particular way. For a realistic evaluation of results all ecological conditions which may influence amount and quality of yield should be recorded.

Since the interesting data have drawn the attention to new viewpoints, a further detailed investigation of this problem seems to be justified.

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EFFECT OF MOLYBDENUM ON THE SYNTHESIS OF NUCLEIC ACID IN SOYBEAN LEAVES

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Ammonium molybdate in a concentration of 50 ppm, considerably stimulates the nucleic acid synthesis in soy leaves if applied either in the form of leaf spraying or by absorption from the nutrient. The effect of the microelement is more efficient for the incorporation of nucleic acid-P when spraying the leaves than by applying it through the roots. Molybdenum treatment also increases the level of acid labile phosphate besides the uptake of total phosphate. The stimulation as produced by molybdenum treatment, comes to full display through enhancing the intensity of nitrate reduction. Since under the influence of leaf-spraying the biosynthesis and the accumulation of nucleic acid phosphate is greater than in case of absorption from the nutrient through the roots, the hypothesis seems to hold that the process of nitrate reduction is closely linked with the continuous hydrogen transport of photosynthesis. Hydrogen transport starting in the course of the photochemical decomposition of water is connected with nitrate reduction through the transfer of nicotinamide adenine dinucleotide phosphate. On the other hand, the direct condition of enhancing nucleic acid synthesis is nitrate reduction.

Introduction

The problem of phosphate absorption and mobilization has been studied in details (Kiss—Pozsár 1962, Pozsár—Kiss 1962) and a close relationship has been found between the level of nucleic acids and the intensity in the biosynthesis of organic phosphates. As established by Nicol (1962) and Nicholas (1961), too, in plant cells microelements stimulate the intensity of protein synthesis by means of increasing the formation of amino acids. Most certainly, in plant cells the influence of elements with variable valency and catalyzing redox conversion (Mo, Mn), comes also to display via increasing nitrogen fixation and nitrate reduction (Pozsár 1963).

Steward—Margolis (1962) have proved that Mn stimulates the intensity of the biosynthesis of free amino acids in plants, thus increasing the protein content. On basis of the experimental data as well as the submitted results of Steward—Margolis (1962), Bojchenko (1964), and Altman—Dittmer (1964), the manganese content is in papilionaceous fodder plants generally high as compared with the incidence rate of iron.

According to the results obtained by Burkin (1962), Kliewer—Kennedy (1960), Okuda—Yamaguchi—Nioh (1962), Parker—Harris (1962), as well as Walker (1957) — due to the influence directly manifested in nitrogen fixation and in nitrate reduction — molybdenum considerably enhances the total and protein nitrogen content of fodder plants, especially in the case of Papilionaceae. As molybdenum has an important share also in nitrate reduction, we have postulated that, when sprayed on leaves, molybdenum would also stimulate nitrogen metabolism; we have studied this phenomenon indirectly in soy leaves on intact plants by testing nucleic acid phosphate and other phosphate fractions. The supposition has been confirmed by the experimental results of PAVLOV—IVANOV (1960), establishing that under the influence of leaf spraying the accumulation of inorganic anions increases in the leaves considering the stimulation as effected by the absorption through the roots.

Materials and Method

In our experiments we used soy plants being before flowering and the roots of which had been washed. The plants were kept for 18 hours in 100 ml solution containing radioactive phosphate-labelled di-sodium-hydrophosphate of 0.2 milliC activity In the leaves of the "Grey Friar" soy variety the fractionation of radioactive phosphate was performed in three experimental variants: In case of 1. untreated plants not containing microelement, 2. plants being treated with a nutrient of 50 ppm ammonium molybdate $[(NH_4)_6Mo_7O_{27}]$, and 3. plants the foliage of which had been sprayed with a solution containing 50 ppm microelement. In the third case the spraying with ammonium molybdate had been performed directly before placing the plants into the radioactive solution. The infection of the plants by nitrogen binding bacteria might be considered average on basis of the few root nodules. The reason of the application of extremely high (50 ppm) ammonium molybdate concentration lies in the fact that the plants used in the experiments have not been grown under conditions deficient in trace element. After the 18-hour exposition the activity expressed in impulse/min. (c.p.m.) value, was referred to 1 g fresh weight of the leaf. Besides all the activities in question, we have separated 3 important phosphate fractions, viz. phosphate fraction insoluble in 10% trichloracetic acid of +4°C as well as organic and inorganic fractions soluble in trichloracetic acid. The impulse/min. data relate to the mean value of 5 parallel samplings in 3 repetitions gained from the averaging of 20 plants being also completed with the mean error of the mean values expressed by the degree of individual fluctuation. In Table 2 the impulse/min. data of the radioactive phosphate uptake and incorporation are shown also in the per cent of total phosphate as related to the untreated variant. Further fractionation of the organic phosphate content was performed with the aid of the OGUR—ROSEN method determining the quantity of nucleic acid phosphate content. The level of the acid labile phosphate is submitted in the so-called 7-minute phosphate quantity (7'P), being measured with the increase of the quantity of inorganic phosphate after 7 minutes of boiling. The data expressed in mg% were completed by presenting the mean error of the mean value which relates to the dry weight of the leaves. In Table 4 the absolute values are expressed also in the relative % referred to the total phosphate content of the untreated variant with the view to submit an illustrative comparison of the stimulation caused by molybdenum. The application of the isotope method has been described in details in previous publications (POZSÁR 1961a, b).

The effect of the microelement has been studied indirectly through the fractionation of phosphates bringing this in direct connection with the protein synthesis by way of measuring the level of nucleic acid on the supposition that nitrate reduction, i.e. the intensity of nitrogen fixation catalyzed by root nodule bacteria is realized in protein synthesis through the level of nucleic acid. The intensity of protein synthesis and its production related to the time unit, has been studied in soy leaves by the aid of radioactive sulfur-labelled amino acids (cysteine-S-35, methionine-S-35) (POZSÁR 1963, 1964).

Results

Phosphate metabolism is considered important regarding the intensity of both the energy transport and biosyntheses due to the energy transport of macroerg phosphoryl bonds and the biochemical role of the nucleic acid fractions in protein synthesis. Upon the effect of molybdenum, equally considerable stimulation can be shown, concerning the intensity of synthesis, in the phosphate uptake of soy leaves and its incorporation into organic compounds either when applied through the roots or by way of spraying to the leaf. According to the data of Table 1, in the leaves of the intact plant, on the effect of molybdenum taken up by the roots from the nutrient, the accumulation of radioactive phosphate increased by more than 50% through regular xylem transport. At the same time, upon the effect of the microelement when being sprayed on the leaves, phosphate uptake through the roots was increased to more than the double. From Table 1 it is also evident that on the effect

Table 1

Effect of ammonium molybdate in 50ppm concentration on the phosphate uptake of soy leaves and the incorporation into organic fractions either through roots or by spraying on leaves; using a nutrient containing radioactive phosphate (di-sodiumhydrophosphate) in 18-hour exposition — related to 1 g fresh weight leaves from a solution of 200 microC activity, expressed in impulse/min. (c.p.m.) values and submitted in ± data with the mean error of the mean value (me)

Phosphate fraction	Untreated		Molybdenum treatment			
			through the roots		leaf-spraying	
	c.p.m.	me	c.p.m.	me	c.p.m,	me
Total phosphate	12.350	875	18.427	1051	28.103	2132
P insoluble in trichloracetic acid	341	26	562	35	873	41
Org. P soluble in trichloracetic acid	985	75	1.475	123	2.176	171
Inorg. P. soluble in trichlor-acetic acid	11.024	974	16.390	1659	25.054	1876

of the microelement, both phosphate fractions examined increase not only absolutely but also relatively as referred to the total uptake, at the expense of the phosphate level. The fluctuation in the biologic material and in applying the method respectively, is expressed by the mean error of the mean value. Table 2 demonstrates the radioactive phosphate uptake and the incorporation into the organic compounds expressed in the relative per cent being related to the total phosphate content of the untreated controls. By the relative data it is clearly shown that the quantity of fractions containing nucleic acid gets enhanced under the influence of molybdenum treatment. From Table 2 it can

Table 2

Effect of ammonium molybdate on the organic phosphate fractions of soy leaves applied either through roots or being sprayed on leaves, besides total phosphate and inorganic phosphate, expressed in % related to the untreated control, on basis of the imp/min. data of Table 1

Phosphate fraction	Untreated	Molybdenum treatment	
		through the roots	through leaf spraying
Total phosphate	100	153	228
P insoluble in trichloracetic acid	3	5	7
Org. P soluble in trichloracetic acid	8	14	17
Inorg. P soluble in trichloracetic acid	89	134	204

be read definitely that the stimulating effect of molybdenum is much more intensive when spraying is effected on the leaves than by treatment through the nutrient.

The phosphate content of soy leaves and the quantity of its two organic fractions being important from biochemical point of view, are also increased by molybdenum treatment as shown in Table 3, expressed in % and related

Table 3

Total phosphate of the soy leaf, its nucleic acid phosphate and acid labile phosphate level (7'P) in mg% related to dry weight, on the effect of molybdenum treatment applied either through roots or by spraying on leaves, expressed in ± data of the mean error of mean value (me)

Phosphate fraction	Untreated		Molybdenum treatment			
			through roots		leaf-spraying	
	mg%	me	mg%	me	mg%	me
Total phosphate	120	24	170	30	210	28
Nucleic acid-P	46	11	62	14	104	16
Acid labile-P	13	5	20	4	32	6

to the dry weight of the soy leaf. According to Table 3, the phosphate content of the leaves is also more increased through leaf spraying than by a treatment with the nutrient, however, the effect of the microelement enhances — in both treatments — the phosphate content and the nucleic acid level of the leaf. The effect of the microelement is even better demonstrated through the relative values of Table 4. Molybdenum taken up by the leaves increases the nucleic acid level in the leaves much more considerably than the uptake through the roots. From the data of nucleic acid synthesis enhanced by leaf treatment it can be concluded that the nitrate reaching the leaves by way of xylem transport gets reduced — with much greater intensity — under the

Table 4

A comparison of the total phosphate, nucleic acid-P, and acid labile-P level in soy leaf related to the dry material, on the effect of ammonium molybdate applied either through roots or by leaf spraying, expressed in % referred to the quantity of total phosphate

Phosphate fraction	Untreated	Molybdenum treatment	
		through the roots	leaf-spraying
Total phosphate	100	141	175
Nucleic acid-P	38	51	86
Acid labile-P	10	16	26

influence of the microelement, and the resulting amino group will be utilized, through transamination, in processes of amino acid synthesis and nucleic acid-basis synthesis, respectively. In soy leaves the nitrate reduction is much more intensive than nitrogen fixation in the root nodules, — on basis of the intensity of nucleic acid biosynthesis.

Molybdenum treatment increases also the level of acid labile phosphate in the leaves — as Tables 3 and 4 equally present us, however, no increasing shows itself in the acid labile level as related to the total phosphate content, only as compared with plants that had been untreated. Thus, from bioenergetic point of view, the effect of molybdenum cannot be considered positive. On the other hand, the increased intensity of nucleic acid biosynthesis indicates to typical stimulation in protein synthesis — especially in the case of leaf spraying.

Evaluation

In the process of nitrogen fixation, hydrogen transport is usually accompanied by manganese or molybdenum redox transformation. According to VIRTANEN's (1936) original supposition, the atmospheric molar nitrogen is reduced by the dehydrogenase system; meanwhile, in the first step diimide will develop and then, simultaneously with water uptake, hydroxyl amide formation will ensue directly according to the following equation:

$$N_2 + 2\,H^+ \longrightarrow \underset{\text{diimide}}{HN = NH} \xrightarrow{+H_2O} \underset{\text{hydroxylamine}}{2\,NH_2OH}$$

According to BONNER (1950) from dinitrogenoxide, i.e. after oxidation, hyponitrous acid develops from atmospheric nitrogen; then the hydrogen transferred by reduced co-ferments, ensures the formation of hydroxlyamine and ammonia, respectively, in two biochemical steps in the process of nitrogen fixation, with the following transformation:

$$N_2 + 1/2\, O_2 \rightarrow \underset{\diagdown\ O\ \diagup}{N = N} \xrightarrow{+H_2O} HO-N=N-OH \xrightarrow{+2\,H^+} H_2NOH \xrightarrow[-H_2O]{4+H^+} NH_3$$

dinitrogenoxide hyponitrous acid hydroxylamine

Hydroxylamine and ammonia, respectively, might amylate organic acids or bases directly. According to VIRTANEN (1953) by direct addition of oxalate acetic acid and hydroxylamine, l-asparagine acid will develop:

$$\begin{array}{c} COOH \\ | \\ CO \\ | \\ CH_2 \\ | \\ COOH \end{array} \xrightarrow[-O_2]{+NH_2OH} \begin{array}{c} COOH \\ | \\ CHNH_2 \\ | \\ CH_2 \\ | \\ COOH \end{array}$$

oxaloacetic acid hydroxylamine l-asparagine acid

According to the experimental results of COLTER—QUASTEL (1950), an iron containing protein takes part in the formation of hydroxylamine and ammonia. On the basis of data submitted by COLTER—QUASTEL (1950), the reduction is accompanied by haemoglobin $\rightarrow$ methaemoglobin transformation. At the same time, on the basis of the results of KARRER (1958), it has been established that in nitrogen fixation haematin takes part being also of porphyrine skeletal structure; the colour is intensively red and with biochemical activity the haematin content of the root nodules might reach 3.2—3.6% as related to the dry material content.

According to the results of biochemical experiments submitted by DAVIES—GIOVANELLI—AP REES (1964) in the process of nitrate reduction, hydrogen transport starts from the nicotinamide adenine dinucleotide system and the reduced nicotinamide adenine dinucleotide reduces directly the oxidized flavin adenine dinucleotide. In the following phase of hydrogen transport, the transferred hydrogen, with oxygen that has been activated by the terminal oxydase system, changes into water, in the catalysis of nitrogen reductase. At the same time, in the nitrate reductase system the active group is the molybdenum, and the $Mo^{5+} \rightarrow Mo^{6+}$ oxidative electron transport reduces nitrate to nitrite ($NO_3^- \rightarrow NO_2^-$). In the following biochemical step the nitrite gets reduced to hyponitric acid which is reduced by a flavin adenine dinucleotide coferment of iron and copper content depending on the nicotinamide adenine dinucleide system. The nitrite hyponitric acid reduction is specifically activated by the bivalent mangenese. Further reduction of hyponitric acid proceeds according to the BONNER (1950) scheme. The connection between the process of nitrogen fixation with the photosynthetic electron transport process being evoked by light, is reported upon in YOCUM's (1960) comprehensive work. According to YOCUM (1960), the hydrogen transport following the photolysis of water can get linked directly with the mechanism of molar nitrogen reduction, and as such, it might be considered quite analogous with the energy transport of continuous photosynthetic phosphorylation. Electron transport starting from induced chlorophyll leads, due to the photochemical decomposition of water, to the reduction of the nicotinamide adenine dinucleotide system with the catalysis of ferredoxin (ARNON 1963, AVRON 1963 as well as CALVIN—ANDROES 1963). The reduced nicotinamide adenine dinucleotide on the other hand, will get linked either to the process of photosynthetic phosphorylation or to that of photosynthetic nitrogen fixation. Bioenergetically, the two processes might be considered completely analogous. COX—FAY—FOGG (1964) have separated by way of ultracentrifuging, cell-free particles from blue algae; it has fixed nitrogen with oxygen development through a close connection of energy transport in photosynthesis, to the direct reduction of atmospheric nitrogen. Besides nitrogen fixation, the mechanism of nitrate reduction can as well be brought into connection with the electron transport following the photochemical inducing of chlorophyll or with the hydrogen transport accompanying the photolysis of water. From bioenergetic point of view, the nitrate reductase of molybdenum active group is closely linked with the hydrogen transport mechanism accompanying the redox transformation of the nicotinamide adenine dinucleotide system. Thus, the theoretically supported conception can be accepted according to which the activity of nitrate reductase is more intensive in the leaves than in the roots, and the effect of molybdenum is greater in the leaves than through the roots. The process of nitrate reduction is indirectly linked to the nucleic acid biosynthesis, and the increasing level of nucleic acid stimulates the intensity of protein synthesis in a direct way.

According to the data of COX—FAY—FOGG (1964), the reducing activity of the nitrogen fixing and nitrate reducing cell-free particles is closely connected with the photosynthetic pigment content and photosynthetic activity, respectively.

Conclusions

Treatments with molybdenum of 50 ppm concentration have considerably stimulated in soy leaves the accumulation of radioactive phosphate and the uptake into organic fractions as compared with untreated plants.

As a result of molybdenum treatment by way of leaf spraying, the quantity of nucleic acid-P as well as that of phosphate insoluble in trichloracetic acid (nucleic acid phosphate, phosphoprotein, phospholipid) is enhanced more considerably than in case of absorption through the roots.

Due to the molybdenum content of nitrate reductase, the advantageous effect of leaf spraying can be explained by the continuous hydrogen transport of photosynthesis linked with the nicotinamide adenine dinucleotide redox conversion.

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TEN YEARS (1955—1965) OF CHEMICAL WEED CONTROL IN SORGHUM

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While elaborating the farm technology of sorghum varieties in these last ten years (1955—1965) the author has been intensively engaged in chemical weed control in grain sorghums *(Sorghum vulgare* var. *frumentaceum)*, sorghos *(Sorghum vulgare* var. *saccharatum)* and Sudan grasses *(Sorghum vulgare* var. *sudanense)*. On the basis of experience gained in these experiments he has established that 2.4-D is well suited for the chemical weed control in sorghum varieties when applied at a plant height of 10 to 15 cm in amounts of 1.75—2 kg/ha. Pre-emergent and post-emergent spraying may be however harmful.

For weed control in grain sorghum and in sorgho 2.4-D disintegrating in 4—6 weeks proved to be less adapted because it did not afford protection from weeds in the second half of the vegetation period. Propazin, Atrazin as well as Hungazin PK of the same composition as the latter agent were used with good success. 2.5—3 kg/ha was found to be most useful on chernosem soils. Larger dosage rates in given cases might prove injurious, diminishing the number of plants per unit area.

Introduction

Hungarian agriculture, under the prevailing arid conditions, struggles almost constantly with the insufficiency of fodder. These difficulties could be largely eased by growing sorghum varieties which are tolerant to drought and dispose of other favourable characters. Their spreading was, however, to a certain degree hampered hitherto by the slow initial growth and the fields being overgrown with weeds, since in the practice it has more than once occurred that the weeds depress and even kill the culture. The care for sorghum plants with hoeing carried out in the traditional way in due time cannot be realized in our days owing to the deficiency of manpower. Besides, this method of the care of plants is much too expensive. This is why new methods are sought to cope with this task. Such possibilities seem to be afforded by chemical herbicides that became available also in Hungary in the second half of the fifties and from which 2.4-D proved to be well suited for weed control in cereals while the triazine derivatives in maize. Assuming that these herbicides could be successfully used for the chemical weed control in sorghum, experiments were launched at first only with 2.4-D and subsequently extended after 1960 to triazine derivatives. Enlarging the scope of observations year by year new herbicides are being tested with the view of finding those superselective herbicides that do not damage the sorghum varieties. Experience gained up to now is summarized in the present paper.

Literature dealing with chemical weed control in sorghum has a past of about ten years. Most of the experimental results are connected with utilization of 2.4-D but in the last years literary data concerning triazine derivatives have been increasingly accumulating.

Wiese—Rea (1958) in their experiments used 2.4-D for chemical weed control in irrigated grain sorghum. According to their experience higher dosage rates diminished yields, particularly when applied after irrigation. The chemical also inhibited the growth of the roots; this phenomenon was observed, however, only in the third year.

Solovev (1956) refers to the data of the State Plant Breeding Station of Stavropol where 2.4-D was successfully used for the chemical weed control in sorgho and as a consequence the yield has considerably increased.

Storchevoy (1959) found that 2.4-D applied in the 4—5 leaf stage has a yield increasing effect since it destroys the weeds.

Kükedi (1959, 1961, 1962) used for weed control in sweet Sudan grass 2.4-D (dichlorophenoxyacetic acid) postemergently and established that a dosis of 1.7—2 kg/ha is well suited for the chemical weed control in Sudan grass. In the case of pre-emergent use on the other hand 2.4-D diminished plant number. It damaged the roots of sweet sorghum (Sumac) and caused leaf roll in Early Hegari.

Vitrac (1961) in France made the experience that Simazin at a dosage rate of 2—3 kg/ha is well suited for weed control in grain sorghums, stresses, however, that no more than 4 kg/ha should be used because it might cause destruction. He considers also the amino salt of 2.4-D as adapted for the chemical weed control in sorghums.

According to Robinson (1961) the herbicide Randox (GDAA) is successfully used in Minnesota (USA) for the chemical weed control in sorghums. He remarks, however, that Randox in given cases caused also damages, but these are not very serious and the plant easily recovers. According to this author in areas where the prevailing weeds are no species-related to the grasses also 2.4-D can be used with good results. He also-recommends the use of Atrazin and Propazin (postemergently with 2.2 kg/ha) observing, however, that the herbicidal effect of chemicals is largely influenced by temperature and precipitation. In cool, arid weather the effect is poorer.

Hugues (1963) tested 2 4-D in France for weed control in Sudan grass and found one-time application effective. At the same time he calls attention to the fact that Atrazin in given cases may be injurious to sorghums and therefore should be applied carefully in small doses.

Tóth (1964) in his investigations conducted in Hungary found that chemical weed control in grain sorghums can be only partly achieved with the present herbicides under irrigated conditions. The variety Szarvasi barna-cirok (brown sorghum) was not susceptible to Atrazin, Simazin, Hungazin DT and Hungazin PK (dosage 7—8.5 kg/ha). Early Hegari, on the other hand, exhibited a minor susceptibility to Simazin and 2.4-D. According to this author best result can be obtained with Atrazin and with Hungazin PK of the same composition, provided that the prevailing weed species do not belong to Setaria or Echinochloa.

Somogyvári (1964) on the grounds of farm experience states that instead of Atrazin the Hungarian produce Hungazin PK can be used with similar results for weed control in grain sorghums as in maize.

Szigethy (1964) came to similar conclusions stating moreover that grain sorghum can be grown without injury to the plant not only on areas treated in the preceding year with Hungazin PK but also on freshly sprayed fields.

Summing up the data found in literature, the majority of authors consider 2.4-D, Propazin and Atrazin suitable for the chemical weed control in sorghum but at the same time draw our attention to possible damages.

Material and Method

Experiments have been conducted in the Agricultural Research Institute of the Hungarian Academy of Sciences in Martonvásár on a chernosem soil with forest rests from 1955 until these days. The most important data concerning soil analysis are as follows:

pH in the surface soil	6.85 (KCl) 7.72 (H_2O)
pH in the subsoil	7.18 (KCl) 7.96 (H_2O)
Humus content	3.5%
Total nitrogen	2.35%
$CaCO_3$ in the subsoil	14.28%
Sticky point according to Arany 42	
Thickness of humus layer 50 cm.	

It also seems desirable to report from meteorological data on precipitation in 3 months since it depends first of all on precipitation whether the herbicides in question would be detrimental to sorghums or not. Therefore the most important sums of precipitation (for the months April—May—June) are presented in Table 1. The data concerning the precipitation of the later months are irrelevant because from the month of July on in sorghums sown in May no damages occurred depending on herbicides and precipitation.

Evaluating the data of Table 1 it is easy to offer an explanation for the destruction that occurred in sorghums in 1961. In this year grain sorghums, sorghos and sweet Sudan grass were seeded on May 20.

Sprayings were carried out pre-emergently on May 19 with 7 and 14 kg/ha Atrazin and the same amount of Ametrin and Prometrin. The experimental plots had between May 26 and 31 37.1 mm, between June 1 and 10 51.8 mm precipitation and a great part of the sorghums was killed from the 14 kg/ha dosage. The most important damage occurred in sweet Sudan grass, then followed Early Hegari and finally the early brown sweet sorghum (Early Sumac). 7 kg/ha Atrazin in this year did not cause considerable damage.

In the crucial first 4 weeks of the next year 1962, in no case more than 16.6 mm of precipitation fell. Previously a minor drought occurred and consequently the lower dosage rates of application (2—2.5 kg/ha) did not cause any damage at all. Destruction appeared only after the 10 kg/ha treatment.

In the following year 1963 the distribution of precipitation in May was similar to that in the previous year and no destruction appeared.

The situation was similar also in 1964 and therefore no destruction was observed from triazine derivatives in that year either. In 1965 — an extremely wet year — on the other hand,

Table 1

Distribution of precipitation in mm

Years, means, deviations from the mean	April							May
	1–5	6–10	11–15	16–20	21–25	26–30	1–30	1–5
1961	15.6	0.4	—	30.8	1.0	24.4	72.2	9.6
Mean of 40 years (1900–40)	—	—	—	—	—	—	46.0	—
Deviation from the mean value	—	—	—	—	—	—	26.2	—
1962	28.5	5.6	3.6	—	—	1.5	39.2	—
Mean of 40 years (1900–40)	—	—	—	—	—	—	46.0	—
Deviation from the mean value	—	—	—	—	—	—	6.8	—
1963	1.0	7.0	4.5	1.0	15.0	3.5	32.0	2.6
Mean of 40 years (1900–40)	—	—	—	—	—	—	46.0	—
Deviation from the mean value	—	—	—	—	—	—	14.0	—
1964	0.2	0.3	6.8	—	21.4	8.7	37.4	2.7
Mean of 40 years (1900–40)	—	—	—	—	—	—	46.0	—
1965	—	8.5	16.2	15.6	7.6	19.1	67.0	4.6
Mean of 40 years (1900–40)	—	—	—	—	—	—	46.0	—
Deviation from the mean value	—	—	—	—	—	—	21.0	—

the situation was similar to that in 1961. Between May 16 and 31, that is, in the period most crucial for sorghums in Hungary the precipitation amounted to 57 mm which largely increased the damage. Part of the plants was destroyed, in other plots the sorghums lagged behind in growth.

After having discussed data on soil and precipitation let us describe the experiments.

Investigations were conducted with *grain sorghums* (Early Hegari, NK 120, Mv Hybar 101) *sorghos* (Sumac, Early Sumac) and *Sudan grasses* (sweet, common and Mv Hybar 301) partly in experiments with randomized block arrangement and partly in factorial tests. Plot size ranged from 2 to 10 sq. m (sprayings were carried out with manual sprayers between deal frames). The herbicides tested were the following: 2.4-D, its sodium salt, Atrazin, Propazin, Simazin, Ametrin, Prometrin, A 1403, A 1798, A 2099 herbicides, the Hungarian made Hungazin PK of the same composition as Atrazin and Hungazin DT of the same composition as Simazin. Beyond these, also Afalon, Arezin, Karmex and Randox were tried out. The doses ranged from 1.75 kg/ha to 15 kg/ha and the dates of application were also different. The effect of autumnal, April, pre-emergent and post-emergent sprayings were examined. Seeding was carried out for the most part in the month of May; Sudan grasses were sown at a row-width of 24, grain and sweet sorghums of 50 cm, the first with 30 germs, the latter ones with 15 germs per running metre. No manual hoeing was carried out in the experiments. The results obtained are summarized for each group in the following:

Results and Discussion

For weed control in Sudan grasses 2.4-D has been found most suitable. The best results were obtained with spraying in the 4–5 leaf age at a plant height of 10–15 cm with 1.75–2 kg/ha 2.4-D. Spraying applied pre-emergently or immediately after emergence (up to the 2 leaf age) caused damages. On plots

(1961—65)

May						June						
6—10	11—15	16—20	21—25	26—31	1—31	1—5	6—10	11—15	16—20	21—25	26—30	1—30
11.6	5.5	4.0	1.0	37.1	68.8	33.0	18.8	1.2	4.5	—	—	57.5
—	—	—	—	—	66.0	—	—	—	—	—	—	62.0
—	—	—	—	—	2.8	—	—	—	—	—	—	4.5
3.7	16.6	4.4	2.8	10.0	37.5	7.8	3.0	8.4	2.2	—	0.2	21.6
—	—	—	—	—	66.0	—	—	—	—	—	—	62.0
—	—	—	—	—	28.5	—	—	—	—	—	—	40.4
2.6	7.6	8.5	14.7	2.6	38.6	4.0	54.0	3.0	16.9	20.0	—	97.9
—	—	—	—	—	66.0	—	—	—	—	—	—	62.0
—	—	—	—	—	27.4	—	—	—	—	—	—	35.9
5.3	2.3	12.5	9.6	—	32.4	—	46.9	—	21.7	71.6	4.8	145.0
—	—	—	—	—	66.0	—	—	—	—	—	—	62.0
8.9	0.8	1.6	35.3	22.2	73.4	30.1	63.2	5.1	5.8	33.9	41.3	179.4
—	—	—	—	—	66.0	—	—	—	—	—	—	
—	—	—	—	—	7.4	—	—	—	—	—	—	

sprayed after seeding pre-emergently emergence was deficient and the higher dosis of 2.4-D (3.5 kg/ha) destroyed 80% of sweet Sudan grass (1961). Spraying immediately after emergence did not cause destruction but in the sprayed treatments Sudan grass lagged behind in growth.

Investigations conducted with triazine derivatives point to the fact that after maize or silo maize treated in the previous year with Atrazin or Hungazin PK, Sudan grass can be grown with good results on soils of the chernosem type. On such areas, in favourable cases 2.4-D spraying can be often omitted.

Atrazin, Propazin, Hungazin PK did not cause any damage also in the case when they were used at low dosage rates (2 kg/ha) for the spraying of stands. Higher doses on the other hand which it is usual to apply in Hungary to the chemical weed control of maize (7—8 kg/ha) have caused in the present year 20—30 per cent destruction in sweet Sudan grass (spraying before seeding). A further damage was that about 15—20 per cent of the stand lagged behind in growth. The experience gained this year draws the attention to the fact that in chemical weed control of Sudan grasses rules pertaining to maize can not be decisive, since among sorghums Sudan grasses are most susceptible to higher doses of herbicides with triazine base.

Beside the herbicides referred to also Ametrin and Prometrin were given a trial but both chemicals destroyed a great part of the stand. This was probably due to the dosis being too high (7 kg/ha) although in the experiments of Bárdossy a dosis of 3 kg/ha has caused damages this year.

Afalon in 1965 similarly caused heavy damages destroying 32 per cent of hybrid Sudan grass when 2—3 kg/ha were applied post-emergently. Experience gained in the present year clearly demonstrates that Afalon must not be used for weed control in Sudan grass. Similar experience has been obtained with Arezin and Karmex. As to Randox, A 1798 and A 2099 these herbicides at a dosage rate of 2—3 kg/ha have caused the hybrid Sudan grass (Mv Hybar 301) to turn yellow and to lag behind in growth even when spraying of the stands was applied.

Examining the tolerance to chemicals of the first Hungarian hybrid Sudan grass (Mv Hybar 301) it has been established that it behaves similarly to sweet sudan grass and what has been pointed out concerning the latter is also valid for the hybrid. Though 2.4-D sometimes causes leaf roll, the plants soon overcome this and the damage is insignificant.

Let us turn now to the weeds occurring in Sudan grass stands under the conditions of Hungary and to the possibilities of their control. On our chernosem soil with forest rests the weeds occurring most frequently are the following: *Agropyron repens* L, *Amaranthus albus* L, *Amaranthus retroflexus* L, *Chenopodium album* L, *Chenopodium polyspermum* L, *Cirsium arvense* L, *Convolvulus arvensis* L, *Echinochloa crus galli* L, *Fagopyron convolvulus* L, *Lathyrus tuberosus* L, *Raphanus raphanistrum* L, *Rubus caesius* L., *Setaria viridis* L, *Setaria glauca* L, *Sinapis arvensis* L. E. From these weed species those occurring most frequently in Hungary viz. *Sinapis arvensis*, *Convolvulus arvensis*, *Cirsium arvense* can be easily controlled with 2.4-D in the young age. The other weeds listed above, except for *Agropyron repens* and those referred to below, can be also successfully controlled with 2.4-D in the young age or their growth can be retarded to such a degree that they do not further on present a danger for Sudan grasses. A great deal of trouble is caused, however, by *Setaria viridis* proliferating more and more, and by *Echinochloa crus galli*. Unfortunately these weed species cannot be effectively controlled with the low doses of herbicides with triazine base that may be used in Sudan grass.

Grain and sweet sorghums

The chemical weed control of these can be discussed together since the care of these plants is by and large the same. In contrast to Sudan grasses it is not sufficient to protect grain sorghum and sorgho from the invasion by weeds for 4—6 weeks but they must be protected during the whole vegetation period, i.e. 4—5 months. For this purpose 2.4-D alone which mostly affords protection for 4—6 weeks is not sufficient. Notwithstanding in our experiments 2.4-D has been tested (1.75—2 kg/ha) for the chemical weed control in grain and sweet sorghums with the result that it causes deformations on the roots of Sumac and leaf roll — in case of spraying the stands — at Early Hegari. This damage is overcome, however, by the grain sorghum. The leaves of the American hybrid grain sorghum (NK 120) are also rolled from 2.4-D but this disappears in 10—14 days.

From among the triazine derivatives Atrazin, Propazin PK and Hungazin Dt were tested. Under the given conditions of Hungary doses of 2.5—3 kg/ha

Fig. 1. Sweet sorghum (Sumac) crop invaded by weeds. Photo 27. VI. 1963

of the herbicides referred to proved to be adequate. At higher dosage rates (over 5 kg/ha) the grain sorghums and sorghos were damaged depending on the amount of precipitation and other factors. Therefore it is recommendable to sow both sweet and grain sorghums after maize or silo maize treated in the previous year with any of these herbicides and to apply 1.75—2 kg/ha Atrazin, Propazin or 2.4-D when needed for spraying of the stands in the 4—5 leaf age.

Fresh spraying is also permissible for the weed control in grain and sweet sorghum crops but in this case the dosis of Atrazin, Propazin or Hungazin PK should not exceed 2.5—3 kg/ha.

Investigation of the best time of spraying revealed that the least destruction occurred when spraying the stands. The crucial period of possible damages under the conditions prevailing in Hungary is, when seeding was carried out

Fig. 2. Left: control plot invaded by weeds; right: hybrid grain sorghum NK 120 treated with 3.6 kg/ha Atrazin preemergently. Photo 27. VI. 1963

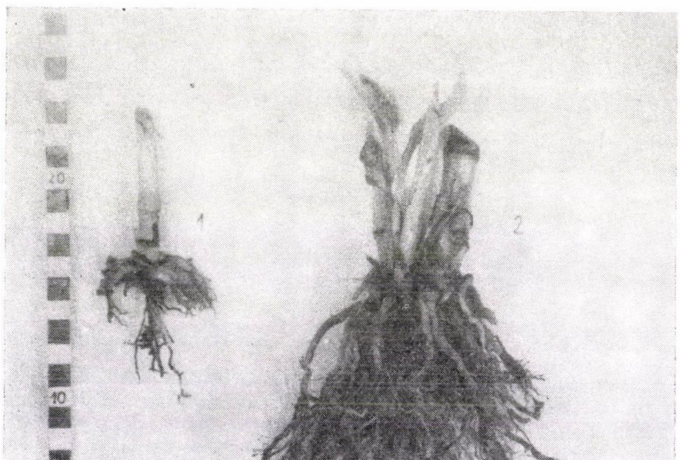

Fig. 3. Deformation on Sumac roots caused by 2.4-D (left: damaged, right: intact root). Photo 26. VI. 1961

at the end of April or early in May, the second half of May and the first 10 days of June and damages occur most frequently when spraying was performed before spring sowing or pre-emergently.

Possible effect of triazine derivatives in diminishing the stands depends, according to our observations, on the following factors in close connection with each other.

Precipitation

It is first of all the amount, distribution and date of occurrence of precipitation which determines whether there is destruction on areas treated with Atrazin, Simazin, Hungazin DT or Hungazin PK. This is proved by the experience gained in 1961 and 1965 and discussed in the meteorological part. In the years 1962, 1963 and 1964 in the months crucial for destruction the precipitation was about average or less and therefore no damage occurred in case of small doses. In the years 1961 and 1965 on the other hand with considerable precipitation in May and June sorghums suffered heavy damages.

Temperature

According to our experience cool weather does not favour the herbicides and in those cases their weed controlling effect is lower.

Soil

Possible damage by herbicides with triazine base largely depends on the composition of the soil. On sandy soils generally half of the doses applied on soils of the chernosem type causes damages and higher doses (3—4 kg/ha) kill, in given cases, the crops, whereas on soils rich in organic matter this dosis can only exceptionally cause damages.

Seeding depth

Damages also depend on the depth of seeding. This could be particularly well observed in the exceedingly rainy months of May and June 1965 when owing to the unevenness of the seed-bed the seed of the grain sorghums and sorghos came into different depths and the great amount of rain washed a considerable part of the 7 kg/ha Hungazin PK presumably to the germinating seeds. Where the seed was not on the same level with the herbicide, the germinated plants remained alive whereas in other places they were destroyed or lagged behind in growth and the crop was of uneven surface. The greatest damage (15—20 per cent) was observed in sweet sorghum (Sumac), it was somewhat less (10—12 per cent) in the grain sorghum Hybar Mv 102 and the least (3—5 per cent) in the NK 120 American hybrid grain sorghum.

Species, variety, hybrid

The importance of the damage also depends on species, variety and hybrid. Sudan grasses are generally susceptible, they are followed in this respect by sweet sorghums while grain sorghums are the least susceptible. Highest resistance was exhibited by the hybrid grain sorghum NK 120. In the

Fig. 4. Leaf deformation on Early Hegari caused by 2.4-D (1.75 kg/ha). Photo 27. VI. 1961

present, exceedingly rainy year in part of our experiments destruction amounted only to 3—5 per cent, whereas on other plots, in the trial launched for the determination of the optimum date of spraying even 10 kg/ha Atrazin caused no damage. Early Hegari on the other hand on farm plots was killed to 25—30 per cent by 7 kg/ha Hungazin PK. The damage was particularly heavy in overlapping parts of sweet sorghums the Sumac in rainy weather also responds susceptibly to higher doses (7 kg/ha) of Hungazin PK.

Dose.

On soils of the chernosem type the triazine derivatives in little doses cause no damage in general, but they do in large doses under given conditions.

Time of spraying

According to experience gained during several years the least dangerous spraying period with herbicides of triazine base is in the 4—5 leaf age, at a plant height of 10—15 cm. There was no damage either when spraying had been performed in the autumn, but this can be attributed first of all to the use of cultivator in the spring by which Atrazin was mixed from the zone of the depth of seeding into deeper layers and the herbicide became distributed on a larger surface. Spraying carried out after the works of soil preparation at the end of April and early in May caused, depending on the dosis, the amount of precipitation and its time in several cases damage in all sorghums.

Of the herbicides tested other than Atrazin, Propazin, Hungazin DT and Hungazin PK the herbicides A 1802, A 1798 and A 2099 Geigy at a dosage rate of 1.75—2 kg/ha did not cause destruction in grain sorghums but temporarily, for about two weeks somewhat turned the plants yellow, a phenomenon that could not be observed either on the control plots or on those treated with Propazin. Similar observations were made with Randox when employed in lower doses (1.75—2 kg/ha). Afalon and Aresin are definitely injurious to grain sorghum crops and consequently cannot be used. Karmex is not suitable for the weed control in sorghums either since it causes destruction.

Finally let us briefly survey the weed flora of grain and sweet sorghum crops. Under the conditions prevailing in Hungary the weed species listed in connection with Sudan grass represent the main danger also here. Much trouble is caused particularly by the ever more propagating *Setaria* species which could not be substantially reduced either with 2.4-D or by the use of herbicides with triazine base. The control of *Rubus ceasius*, *Cirsium arvense* and *Convolvulus arvensis* is also quite a problem. It must be also taken into consideration that herbicides with triazine base have an after-effect for 2—3 years which renders the composition of the crop rotation more difficult. No less trouble is caused by the possible damage done by herbicides. Under such conditions weed control in grain and sweet sorghums cannot be considered as a definitely settled problem. We are expecting the new herbicides that are under no conditions damaging the sorghum crops and have no after-effect either. Also herbicides are apt to control both *Setaria* species and *Echynochloa crus galli*. Temporarily, however, we continue using Propazin, Atrazin and 2.4-D for the weed control in sorghum crops because at the time of initial development they are indispensable for the care of plants.

Conclusions

In the Agricultural Research Institute of the Hungarian Academy of Sciences in Martonvásár chemical weed control in sorghums *(Sorghum vulgare* var. *frumentaceum*, *Sorghum vulgare* var. *saccharatum*, *Sorghum vulgare* var. *sudanense)* has been investigated from 1955 on a chernosem soil with forest rests. Up to now the following herbicides have been tested: Atrazin, Propazin, Simazin, Hungazin PK, Hungazin DT, Ametrin, Prometrin, A 1798, A 2099, Afalon, Aresin, Karmex and Randox. The dosage rates tested ranged from 1.75 to 15 kg/ha. The time of the sprayings was in the autumn (November), after the soil preparation works in April pre-emergently, and post-emergently. The plants examined were sweet Sudan grass, Sudan grass Mv Hybar 301, sweet sorghum Early Sumac, American hybrid grain sorghum NK 120, grain sorghum Hybar Mv 101, Hybar Mv 120 and Early Hegari.

On the strength of the experiments conducted 2.4-D is well suited to the weed control in Sudan grasses at the 4—5 leaf stage for the spraying of stands (1.75—2 kg/ha). Other dates are not suitable for spraying. Sudan grasses can be successfully grown also after maize and silo maize treated in the previous year with Atrazin or Hungazin PK. Fresh spraying with herbicides of triazine content should be avoided because Sudan grasses are susceptible to these herbicides. Afalon, Arezin and Karmex are not, even in small doses, suitable for weed control in Sudan grass.

2.4-D for itself owing to the short duration of its action, is less suited for the weed control of grain and sweet sorghum crops. It is most expedient to sow after maize treated in the previous year with Atrazin or Hungazin PK and spray, if needed, with 1.75—2.0 kg/ha Atrazin, Propazin or eventually 2.4-D. In the case of fresh spraying on soils of chernosem type no more Atrazin or Propazin should be applied than 3 kg/ha. The least dangerous is to spray the stands. Of the herbicides tested Afalon, Arezin and Karmex are qualified as unsuitable for weed control in sorghums. Ametrin and Prometrin destroys in higher doses the sorghum crops whereas herbicides marked A 1798, A 1802 and A 2099 as well as Randox — in given cases — turns them temporarily yellow.

The above statements are valid for soils of chernosem type only.

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CHANGES OF PIGMENTS IN BARLEY LEAVES

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Total pigments of isolated barley leaves decrease in the function of time compared with the pigments of intact leaves kept in light and in dark. Of the pigment components the quantity of chlorophyll-a decreases the most markedly. The level of total pigments in isolated leaves treated with kinetin as well as the quantity of chlorophyll-a are also above the value of intact leaves.

Introduction

The pigments of isolated leaves change within a few days as compared to the intact leaves even if otherwise they are not in want of water (Horváth—Lasztity 1965). After removing the root, as the time of isolation progresses, the leaves get yellow (Farkas et al. 1963, Udvardy—Horváth 1964). Protein decomposition ensuing under the influence of isolation, is accompanied by parallel change of pigments. In the present paper this phenomenon is being examined now from a new angle. On isolation, the absence of the root was combined with effects having bearing on the composition of pigments. First we have applied the contrast of light and dark, while secondly, kinetin treatment has been applied. From previous investigations it is known that kinetin is able to compensate, up to a certain degree, the increasing protein break-up in the isolated leaves. Therefore, it might exert protective effect on the plasts, too, and thus, it can be decided whether the change of pigments in the isolated leaves is in causal relation with the break-up of the chloroplastic structure or, whether we have to take into consideration a biochemical effect which has bearing on the pigment molecule itself. This phenomenon has been tackled by some other research workers in several respects. Thus Bishop—Whittingham (1963) experienced with isolated chloroplasts that it was the colouring matter being bound to the protein that changed; the change of chlorophyll -a and -b are influenced by light conditions. The change of chlorophyll-a, its decrease or increase, is followed by that of carotene and the latter is followed by the change of the xanthophylls. Sironval et al. (1965) have reported on the shifting of the ratio of pigment components with the ageing of chloroplasts. In the etiolated barley plant (Marschner 1964) on the effect of Cs-ion the carotene content increased, and at initial impairing it began to decrease. The decrease as compared with the control, was of 80%. Etiolated maize plant (LEBEDEV—LITVICHENKO 1965) was given light, — after 30 minutes the chlorophyll-a could be evinced. In 60 minutes the biosynthesis of chlorophyll-a increased, and that of the pre-material of chlorophyll, chlorophyll-b was not yet provable.

Material and Methods

For our experiments we have used the MFB barley variety grown under controlled circumstances. The detached leaves are marked by the word *isolated*, while the notation for the control plants with roots, is *intact*.

Each experiment was performed in 3—4 repetitions. Experiment 1. Barley plants were raised up to the 7th day etiolatedly. On the 7th day the experiment was started both with the intact plants and the isolated leaves by exposing them to light. Examinations were started one day after isolation and were continued up to the 7th day. Samples were taken every day from the intact plants, too, this being the control. Experiment 2. 7 day-old intact and isolated plants that had been raised in light, were placed in dark thermostat. The examinations were started on the 4th day of isolation and were ended on the 6th day. In this experiment intact and isolated plants that had been raised and also kept in light in the course of investigation, were used as controls. Experiment 3. The plants were raised in light and at the age of 7 days they were isolated in tap-water and in a solution of 10^{-4} M kinetin and tap-water, both the isolated and the intact plants were allowed to be in light. The examinations were carried out between the 4th and the 7th days of isolation.

The determination of pigments was performed with the method of KOSKI (1951) and FRENCH (1960). The obtained components, chlorophyll-a and -b, the carotene and the xanthophylls were measured with Spectromom-photometer at 430—480, 650—665 mmicron wavelengths.

The calculations were made according to the formula of SMITH—BENITEZ (1963) and the quantity of pigments is given in microgram/mg values.

Results and Discussion

The results of the first experiment are summarized in Table 1. From this table the following can be seen: The quantity of carotene shows significant increase on the first and second day after isolation; after the 3rd day, up to the 7th, it somewhat decreases. In the intact leaves the quantity of carotene increases somewhat from the 4th day of the investigation. In both cases the change of xanthophylls is similar to that of carotene. Light has stimulated a reduction process, the quick transformation of protochlorophyll to chlorophyll-a. This is shown by the value obtained with isolated leaves; after the 4th day of isolation, as presumable consequence of progressing protein decomposition, the quantity of chlorophyll-a decreases. With intact plants gradual increase might be seen in the quantity of chlorophyll-a and then, with development, a relative decrease can be observed.

The values of chlorophyll-b in the isolated and the intact leaves do not show such a change. The decrease of total pigment quantity as occurring under the influence of isolation is the result of the marked change of chlorophyll-a in the ratio of total pigment in isolated and intact leaves.

Table 1

Quantitative change of the pigments in isolated and intact etiolated barley plants placed in light
Calcul. microgram/mg fresh weight

Variants	Isolation days	β carotene	Xanthophylls	Chlorophyll-a	Chlorophyll-b	Carotene + xanthophylls	Chlorophyll a + b	Total pigments	Isolated/intact ratio
Isolated placed in light	1	0.33	0.45	1.39	0.59	0.78	1.98	2.76	1.05
	2	0.35	0.47	1.24	0.58	0.82	1.82	2.64	0.93
	4	0.34	0.44	1.25	0.56	0.78	1.89	2.68	0.81
	5	0.34	0.45	1.09	0.53	0.78	1.62	2.46	0.76
	6	0.32	0.44	0.88	0.51	0.75	1.39	2.15	0.69
	7	0.30	0.38	0.82	0.49	0.68	1.31	1.99	0.65
Intact placed in dark	1	0.31	0.42	1.41	0.49	0.73	1.90	2.63	
	2	0.33	0.42	1.56	0.54	0.75	2.10	2.85	
	4	0.35	0.47	1.87	0.60	0.82	2.47	3.30	
	5	0.36	0.49	1.76	0.61	0.84	2.37	3.23	
	6	0.36	0.48	1.65	0.61	0.84	2.26	3.10	
	7	0.37	0.44	1.64	0.61	0.81	2.25	3.06	

The results of the 2nd experiment are summarized in Table 2.

In dark, the change of pigments can be seen both with the isolated and intact plants. To all probability, the intact plant placed in dark is capable for some time on, to utilize hydrocarbon for syntheses. In isolated leaves in light, with the time progressing, the decrease of chlorophyll-a is easily visible. The relative decrease of chlorophyll-a of the intact leaves being in light is

Table 2

Quantitative change of pigments in isolated and intact barley leaves placed in dark and kept in light

Values calculated in microgram/mg fresh weight

Variants	Isolation days	β-carotene	Xanthophylls	Chlorophyll-a	Chlorophyll-b	Carotene + xanthophylls	Chlorophyll a + b	Total pigment	Isolated/intact ratio
Isolated leaves placed in dark	4	0.35	0.41	1.57	0.45	0.77	2.03	2.79	0.94
	5	0.32	0.41	1.50	0.41	0.72	1.91	2.63	0.98
	6	0.34	0.42	1.32	0.36	0.76	1.68	2.44	1.03
Intact leaves placed in dark	4	0.33	0.44	1.74	0.45	0.77	2.19	2.96	
	5	0.32	0.41	1.55	0.42	0.73	1.96	2.69	
	6	0.34	0.40	1.25	0.40	0.75	1.64	2.36	
Isolated leaves kept in light	4	0.35	0.48	1.62	0.52	0.83	2.14	2.97	0.81
	5	0.33	0.44	1.55	0.48	0.77	2.03	2.80	0.77
	6	0.32	0.41	1.36	0.46	0.74	1.82	2.55	0.72
Intact leaves kept in light	4	0.39	0.49	2.16	0.62	0.88	2.78	3.66	
	5	0.42	0.50	2.11	0.61	0.92	2.71	3.66	
	6	0.39	0.50	2.05	0.61	0.90	2.66	3.56	

Table 3

Quantitative formation of isolated, isolated and kinetin-treated, intact barley leaves grown and kept in light

Calcul. in microgram/mg fresh weight

Variants	Isolation and treatment time, days	β-carotene	Xanthophylls	Chlorophyll-a	Chlorophyll-b	Carotene + xanthophylls	Chlorophyll a + b	Total pigment	Isolated/intact ratio
Isolated leaves	4	0.34	0.45	1.68	0.52	0.79	2.20	2.99	0.83
	5	0.36	0.48	1.58	0.49	0.84	2.07	2.91	0.79
	6	0.35	0.45	1.39	0.45	0.80	1.84	2.64	0.71
	7	0.34	0.45	1.17	0.40	0.79	1.57	2.36	0.70
Isolated kinetin-treated	4	0.36	0.46	2.02	0.56	0.82	2.58	3.40	0.94
	5	0.37	0.47	2.09	0.60	0.84	2.69	3.53	0.95
	6	0.38	0.47	2.17	0.60	0.85	2.77	3.62	1.04
	7	0.38	0.51	2.12	0.59	0.89	2.71	3.60	1.06
Intact leaves	4	0.39	0.48	2.14	0.61	0.87	2.75	3.62	
	5	0.39	0.50	2.21	0.59	0.89	2.80	3.69	
	6	0.36	0.42	2.11	0.57	0.78	2.68	3.46	
	7	0.34	0.41	2.05	0.59	0.75	2.64	3.39	

connected with growth. The ratio isolated : intact expresses the decreasing tendency with those kept in light. With those placed in dark, similarly to the above though to a higher degree, the same will be observed.

The 3rd experiment is summarized in Table 3.

From the table it can be seen that in leaves treated with kinetin, the value of carotene is the same during the whole course of isolation. Those being isolated in tap-water show lower value figures — there is no considerable difference. The quantity of chlorophyll-a in leaves isolated in tap-water markedly decreases as time progresses. In the isolated leaves treated with kinetin, the values are higher than in the intact leaves. In the isolated leaves kinetin is able to keep the chlorophyll colour-substance at the same level; inhibits or hinders protein decomposition ensuing under the influence of isolation, or it is able to start new synthesis from decomposing. Thus the colour material bound to the protein, remains at the level of intact leaves, moreover, since the intact plant has grown, it is above the value of the intact level.

Chlorophyll-b is, in the function of isolation, at the same level separately in the isolated, the isolated and kinetin-treated as well as in the intact leaves. The gradual decrease of the quantity of total pigment can be observed being shown in the ratio isolated : intact pigment; kinetin-treated isolated : intact ratio displays enhancement since the quantity of total pigment in the intact leaves slightly decreases with growth.

Conferring our data with those known in literature, we might establish the following:

Our data show that under the influence of isolation it is the quantity of chlorophyll-a that decreases the most markedly; this considerable decrease directs also the total pigment content. Such observation has been made by KURSANOV (1964) and MARSCHNER (1964), too. If protein decomposition and parallel with it, the destruction of chloroplasts (KURSANOV 1964) are inhibited, the quantity of chlorophyll-a increases more intensively compared to that of chlorophyll-b. In isolated barley leaves treated with kinetin, similar results have been obtained. BISHOP—WHITTINGHAM (1963) experienced the change of colour-material bound to protein. It is the light conditions that influence the development of chlorophyll-a to the greatest extent. This has been experienced when placing the etiolated intact and isolated leaves in light, and the change in intact and isolated leaves being placed from light to dark, is in agreement with the above, i.e., the increase and decrease, respectively, of the quantity of chlorophyll-a was the most marked. As the time of isolation progressed, the change of carotene occurred, too. In etiolated intact leaves the carotene content increased for some time, under the influence of isolation it gradually decreased, then with the growth of the intact plants, decrease was experienced; this is supported by MARSCHNER's (1964) finding. LEBEDEV—LITVICHENKO (1965) evinced with etiolated maize the formation of chlorophyll-a which gradually increased in the function of illumination. In our experiments, too, on the effect of light the chlorophyll-a content showed increasing tendency. UDVARDY—HORVÁTH (1964) proved that under the influence of isolation 35% protein decomposition had occurred as compared with intact plants while kinetin treatment had produced considerable protein synthesis. Our experimental results are related to the above concerning pigment changes. Viz. due to the influence of isolation considerable decrease can be observed in the quantity of pigment. Protein hydrolysis appearing on isolation as well as pigment-decrease which can be observed the most markedly with colour materials bound to the protein (chlorophyll-a), most probably indicate the decomposition of the lamellary structure in plants.

Conclusions

We have investigated the change of pigment content in the isolated and intact leaves of the barley variety MFB. In the course of investigation etiolated plants have been illuminated (8000 lux, F 30). Plants raised in light, were placed to dark. Plants that had been raised in light were kept in light, too, during our investigation. In every variation the total pigment and the components in the isolated and intact leaves were compared. We have performed isolation also in the solution of 10^{-4} M kinetin and tap-water. It can be established that in isolated barley leaves the total pigments decrease in the function of time compared with the pigment content of intact leaves both in light and in dark. The decrease is the most markedly shown in chlorophyll-a. The level of total pigments and also the chlorophyll-a content in isolated leaves treated with kinetin show higher values than those of intact leaves.

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AGGRESSIVITY OF SUGAR BEET ROOT-ROT PATHOGENS

I. METHOD OF BREEDING FOR RESISTANCE

By

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The aggressivity of soil-inhabitant and on the seed balls settled pathogens most dangerous for the sugar beet seedlings has been investigated. Their range according to their aggressivity is as follows: *Pythium* sps., *Aphanomyces* sps., *Phoma betae* and *Fusarium* sps. Breeding for resistance may be carried out successfully under provocative conditions only. The soil infection proved to be a suitable method. Susceptibility of the varieties to the varieties to the pathogenic species appeared to be different.

Introduction

Root-rot causes in the emerging and young sugar beet seedlings considerable losses amounting to 10—35 per cent even nowadays. The present damage is already less than it was 30—50 years ago. This may be attributed to the fact that nowadays beet seeds of Hungarian origin are sown out only. Further there are available already soaking mediums effective not only to the pathogens settled on the clusters but in some measure to the soil-inhabitant ones, too. It is well known that in the first decades of our century sugar beet seeds especially of German origin were used by our sugar-mills for sugar beet root production. As the climate of the sugar beet seed crop area in Germany is generally humid the seed produced there contained more pathogens than home grown sugar beet seeds produced under the more arid Hungarian conditions (Linhart 1900).

The root-rot pathogens are partly settled on the clusters or may be spread by the seeds. To secure the sugar beet root crop it is most desirable to have the least quantity of pathogens on the seed balls. The settlement of pathogens on the seed balls cannot be inhibited in general, only their number can be diminished by changing the sources of disease of the seeds, the soil and the ecological environments.

Root-rot control has become especially recently more important due to the development in agrotechnics of sugar beet culture; i.e. precision sowing of sugar beet seed becomes more possible by abrasing them gently (the Hungarian method of "depellition") and to facilitate the singling labour the beet seeds will be sown in a distance of 3—5 cm from each other. Presently the importance of root-rot may even be increased by the release of new, genetically monogerm *(monocarp)* sugar beet varieties for general sugar beet root production in the next few years in which the pretensions of the precision sowing and the susceptibility to pathogens come into full display. A thin sowing requires that the plant stock should not be decimated or even more diminished due to root-rot, for in this case there will be many missing hills in the fields and a satisfying crop cannot be expected at all.

There are two possibilities to avoid the losses due to root-rot: 1. effective soaking the seeds before sowing (e.g. depellition + soaking) or desinfection of the soil using fungicides and 2. breeding for resistance.

There is a wide international literature concerning the problem of root-rot so I choose to mention here the most important and those dealing with the breeding for resistance only.

In the research work of this problem pioneer work has been done by our celebrated pathologist LINHART (1900), who emphasized the importance of the soil-inhabitant and on the clusters settled parasites, the development of a provocative test method and drew the attention to the "hulling" of seeds — in the sense of our recent "depellition"-procedure — and the importance of breeding resistant varieties. This problem was later dealt with, by HEGYI (1911) and GYÁRFÁS (1911) who proposed to let seeds dry at a temperature of 45—53 °C to a water content of 5—10 per cent. According to our experience both the "depellition" and drying the clusters are advantageous to decrease the quantity of pathogens but unfortunately neither of them can be applied for technical reasons.

Extended soaking experiments were carried out by TERÉNYI (1929) determining the effectiveness of the preparate Germisan.

The importance of the pathogen species was duly evaluated on the basis of data collected in the whole country by Mrs. GYÖRGY (1959). From the spreading of pathogens and the possibilities of their control a report has been recently issued by Mrs. BIRÓ (1964).

Among foreign authors the modern system of resistance breeding methods has been chiefly elaborated in the USA. Here can be mentioned the work of SCHNEIDER (1959) concerning the field provocative method with *Aphanomyces cochlioides* (Drechs.). An infection in vitro method of sugar beet seedlings has been developed by MACWITHEY (1961). WHITEHEAD proposed the soil infection in 1957 already.

Results of controlled breeding methods for resistance to different pathogens are reported by AFANASIEV—SHARP (1961), FINKNER (1954), HENDERSON—BOCKSTAHLER (1946). Several authors dealt with the ecological requirements of the pathogens, we mention here the present studies of NÖLLE (1960) and EBNER (1960). A new-type and pioneer like work was related by SEVCHENKO too (1963).

Material and Method

Our aim was to develop a reliable method of artificial soil and seed infection which can be applied simply and is suitable for a practical breeding method for resistance.

For this purpose we established in the hot-house a pot-trial in boxes using 2 varieties and in the field we tested 11 varieties of different types and origin with full particulars.

In our pot trials the effect of a complete* inoculum giving the infecting material in different depths under the seed-bed could be observed. The effect of the inoculum was tested given it in the seed-bed level, and in soil layers 1—5 cm lower.

Our field trials served for the following 3 purposes: 1. to compare the effect of soil- and of seed infection, 2. to determine the pathogeneity of the fungus-races causing root-rot under different local conditions, 3. to determine the susceptibility of the sugar beet varieties of different ploidy-grade and origin to the infection of the different pathogens.

In our field-tests we investigated in 1963 eight and in 1964 ten treatments. These treatments were as follows: I = untreated control, II = seeds soaked with *Ceredon* Special (400 g/100 kg seeds), III = seed infection with *Phoma betae*, IV = soil infection with *Phoma betae*, V = seed infection with *Fusarium* sps., VI = soil infection with *Fusarium* sps., VII = seed infection with *Aphanomyces laevis*, VIII = soil infection with *Aphanomyces laevis*, IX = seed infection with *Pythium de Baryanum* and X = soil infection with *Pythium de Baryanum*.

Preparation of the inoculum: Pure fungus culture has been made on molasse-agar nutrient medium from the isolates of the pathogens mentioned above. Water suspension (involving the nutrient medium of the fungus) of the cultures developed has been spread on the seed material (50 g seeds + 50 ml suspension of identical fungus concentration) and the so treated seeds dried again in room temperature.

For soil infection we mixed previously the water suspension of the pure cultures mentioned above with a suitable substrate the consistence of which permitted to let it bring easily and uniformly into the soil. For this purpose the grits of dry-sterilized beet clusters proved to be most suitable. From the inoculum prepared in this manner 120 g for 9 m of the row has been scattered in a depth of 1 cm under the seed-bed level.

Sowing of the trials: The hot-house experiments has been sown in 15 cm deep boxes of 30 × 45 cm size in two replications in each box, from two varieties 100 clusters each; in the free land trials 9 m long rows (2 × 4.5 m long rows) were designed from each treatment. A quantity of 50 g seeds was used from the varieties for each treatment scattered uniformly and close rows have been sown.

Evaluation of the trials: In the box experiments the number of the damped off seedlings was determined after emergence in each 4th day till damping off could be observed (about to the seedling-age of 4 weeks). In the free land trials were evaluated the seedlings having 6 leaves already by counting the remained healthy beets in each row. The grades of the statistical security (SD per cent, at P = 5 per cent) both between the varieties and the treatments were calculated from the data of two replications.

Results

1. *Tests carried out in the hot house*

In our box trial the diploid *(multigerm) Beta* 242—53 variety and the diploid *(monogerm) M.* 051 strains have been tested. We could observe that the greatest damage in both varieties might be achieved giving the inoculum in a depth of 1 cm under the seed-bed level (Fig. 1). We became pleasantly surprised observing the monogerm strain in each treatments remaining healthy or containing more healthy plants than those of the multigerm variety. This apparent result may unfortunately be attributed to the fact that from the monogerm strain only seeds with a size over 5—6 mm were used the emer-

* The complete inoculum has been produced from the spore- or myceliumsuspension of the 4 pathogens investigated respectively.

gence energy of which is always higher and so they are more resistant to pathogens than the smaller ones.

2. *Results of the seed and soil infections*

Seed and soil infections have been tested at 11 varieties used 2 and 4 pathogens respectively (treatments III, IV, V and VI in Table 1). It became evident that infecting the seed balls both with *Phoma betae* and *Fusarium* sps.we got contradictory results. Using cereal suspension diluted in the water solution of the molasse-agar nutrient medium the ratio of emerged seeds has been not

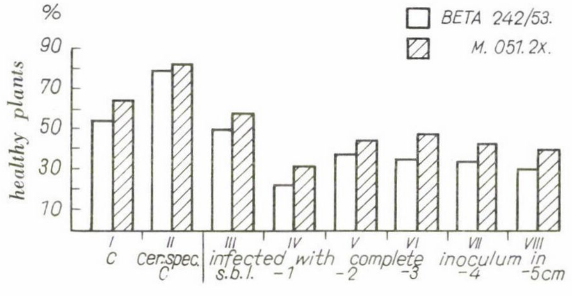

Fig. 1. The formation of root-rot damage given the inoculum into different depths of the soil. On the ordinate: Ratio in per cent of the healthy plants
On the abscissa: I = Untreated control, II = Control soaked in Ceredon Special, III—VIII = Complete inoculum given in the seed bed level (III) and under the seed bed in depths of 1, 2, 3, 4 and 5 cm respectively

decreased but even increased compared to the untreated control (I). Presumably the water-household has been even promoted by the suspension having a cream-density and sprayed on the surface of the clusters by its hydrophil character when the seeds get in the wet soil. We have still to note that a faster emergence could not be observed. We may further presume that at the beginning of emergence when the radicule emerges by 5—15 mm from its original place from the seed-bed, the pericarp becomes a little elevated and gets in a higher, hence drier soil layer. It is well known that in the case of a sowing depth of 15—25 mm a level difference of 10—15 mm indicates an essential change in the microclimate for the seed being the upper soil layer always drier and reacting directly to the lower temperatures of the nights. The development of pathogens will be impeded so and the more sensible radicule and primary roots being no more in connection with the pericarp, involving pathogens, the noxious activity of the pathogens can no more be effective. Undoubtedly, extensive investigations have to be carried out to clear this problem, but for the moment at least the above supposition seems to be acceptable. These suppositions of ours are still supported by the fact that from the altogether 22 cases of treatments IV and V no one correlation breaker occurred and

Table 1

Pathogeneity of the different pathogens used in soil- and seed infection method
Sopronhorpács, 1963. (Inner growing garden)

Varieties or strains (1)	Number of plants tested (2)	Ratio of healthy plants in per cent of the control (3) — Treatments (4): I	II	III	IV	V	VI	VII	VIII	Average per cent (5)	Average of columns IV, VI, VII and VIII (6)	SD% at P = 5 per cent (7)
1. Kleinwanzlebener Poly	8 194	100	138.8	135.4	75.9	132.5	92.2	73.1	92.7	108.1	84.5	±25.4
2. Ramonyi 06.	16 816	100	120.8	118.0	91.2	109.0	90.9	74.5	61.5	95.7	79.7	±12.8
3. Beta tetra 53/27.	7 528	100	173.2	155.8	82.1	147.4	85.3	56.7	72.0	109.1	74.2	±27.1
4. P. 140. 4x.	5 726	100	136.0	134.6	85.2	112.6	73.9	52.4	50.7	93.2	65.6	±29.8
5. E. III. 25/25.	13 075	100	127.6	118.3	85.8	120.7	81.2	56.9	39.1	91.1	65.8	±36.4
6. Beta poly M/101. 3x. } monogerm strains	7 249	100	197.1	104.3	77.6	106.1	85.2	78.3	54.7	100.4	73.9	±31.2
7. Beta poly M/102. 3x. } monogerm strains	3 696	100	216.0	154.5	75.1	179.6	93.7	68.7	68.1	127.1	76.5	±24.3
8. Monogerm 806. 2x. } monogerm strains	6 441	100	189.1	138.9	82.5	125.1	83.0	39.9	28.1	110.8	58.4	±26.7
9. Monogerm 051. 2x. } monogerm strains	5 772	100	194.0	125.6	86.2	131.2	63.7	41.4	54.0	99.5	61.3	±31.4
10. S. 11. 2x. } male sterile strains	8 120	100	116.2	116.1	83.6	112.5	89.1	35.0	29.9	85.3	59.4	±21.9
11. S. 21. 2x. } male sterile strains	5 338	100	133.3	131.8	72.0	128.9	78.6	46.4	35.3	90.8	58.1	±16.5
Total (8)	88 015											
Average per cent (9)		100	158.4	130.3	81.6	127.7	83.4	56.7	53.3			
± Difference related to Col. I. (10)			+58.4	+30.3	−18.4	+27.7	−16.6	−43.3	−46.7			
SD% P = 5 per cent (11)			±27.5	±16.0	±17.0	±32.4	±20.2	±32.7	±21.5			

Signs used:
I = Control untreated,
II = Soaked in Ceredon Special (400 g/q),
III = Seeds infected with Phoma betae,
IV = Soil infected with Phoma betae,
V = Seeds infected with Fusarium sps.,
VI = Soil infected with Fusarium sps.,
VII = Soil infected with Aphanomyces laevis,
VIII = Soil infected with Pythium de Baryanum.

Growing data: Broadcasting in twin rows of 4.5 m each, row-width 20+40 cm; in each treatment 50 g seeds were sown in the two rows.
Soil infection performed in a depth of 1 cm under the seed-bed level using cluster-grit infected artificially with the adequate fungus.
Seed infection carried out in the laboratory two days before the sowing.
Soil of the trial: deep-layered loam rich in humus.
Date of sowing: 26. IV. 1963.
Counting of the remained healthy plants from the 4th to the 11th VI. 1963.

in the average of the 11 varieties compared to the untreated control (I), the difference amounted to +30.3 and 27.7 per cent, respectively, which values surpass the average (25.8 per cent) significant difference of the treatments and varieties (average of treatments I, III and V in Table. 1). Clusters could not be treated — due to technical causes — with *Aphanomyces laevis* and *Pythium de Baryanum* in 1963.

Considerable losses could be observed caused by soil infection in the case of the four pathogens according to their aggressivity characteristical for the species (treatments IV, VI, VII and VIII in Table. 1). This high decay of plants may be partly attributed to the fact that the inoculum was brought in the soil in suitable depth and partly to the condition that the pathogens became more multiplied by the substrate — in this case the cluster-grit — by its physico-chemical characters.

It is well known that the parasites investigated are saprophytes as well and got in the soil with the cluster-grit, this latter absorbed water together with the remnants of the still present agar nutrient medium and in this way the multiplication of the parasite organisms became even stimulated. From the seeds located 1 cm above the inoculum the radiculae reached the infected layer after 7—14 days later only and then they met the pathogens multiplicated in higher quantity already. The loss in beets has evolved in this way to a maximum amounting to 71.9 per cent (variety No. 8 of the treatment VIII in Table 1).

3. *Formation of the pathogeneity of the pathogens*

By reason of the data gained from our experiments it seems reasonable to evaluate here only the results obtained by soil infection. In the whole test 250,000 clusters (i.e. about 350,000 germs) were sown, from which we got in 1963 88,015 and in 1964 23,208 healthy plants. The decay of beets chiefly occurred as early as at the germination of the seeds, and oversensitive or highly diseased germs could not emerge any more (LINHART 1900). Out of the germs sprouted several decayed later. A further dealing with this problem would lead us too far, neither is it the scope of our present study.

Significant differences could be observed between the average of the 11 varieties (Table 1) in comparison to the control (I) in the infection with *Aphanomyces laevis* (VII) and with *Pythium de Baryanum* (VIII), so nearly each variety became damaged significantly by these parasites but in the average of the varieties *Phoma betae* and the *Fusarium* sps. infections did not show significant difference (treatments IV and VI). In the case of these pathogens there were the "S. 21" (male sterile) partner-strain and some other varieties respectively within the limits of significance only.

According to the results of the second year trials it could be stated that most decay (43.3 and 21.4 per cent respectively) is caused by *Aphanomyces* *laevis* and in average (18.4 and 29.2 per cent respectively) by the *Pythium de Baryanum*, but considerable damage is due to the *Fusarium* sps., too (in average 16.6 and 13.1 per cent respectively). Under other ecological and infecting conditions the pathogeneity of the single fungi-species may evolve in an essentially different manner (Fig. 2).

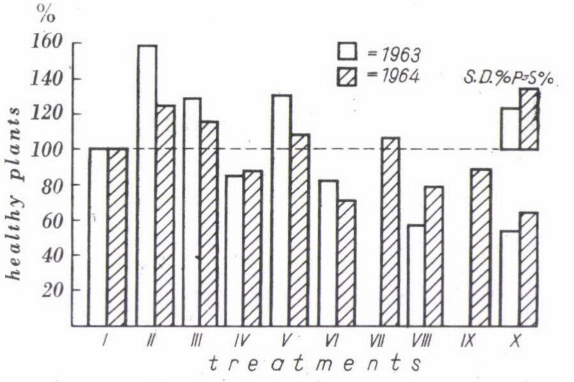

Fig. 2. Formation of root-rot damage used seed and soil infection on the base of two years data

On the ordinate: Ratio in per cent of the healthy plants.

On the abscissa: Treatments: I=Untreated control, II=Control treated with Ceredon Special, III=Seeds infected with *Fusarium* sps., IV=Soil infection with *Fusarium* sps., V=Seeds infected with *Phoma betae*, VI=Soil infection with *Phoma betae*, VII=Seeds infected with *Aphanomyces laevis*, VIII=Soil infection with *Aphanomyces laevis*, IX=Seeds infected with *Pythium de Baryanum*, X=Soil infection with *Pythium de Baryanum*

4. *Varietal resistance to the single pathogens*

According to the results of our tests gained on the basis of the average of the four pathogens it could be seen that the varieties *Kleinwanzlebener Poly* and *Ramonj* 06 were the most resistant ones (84.5 and 79.6 per cent healthy plants, respectively). The Hungarian varieties proved to be intermediarily resistant too. As expected, the behaviour of the varieties against different pathogens showed to be different, too. The variety *Kleinwanzlebener Poly* seemed to be susceptible to *Phoma betae* but resistant to other pathogens.

From the monogerm strains (Fig. 3, varieties No. 6, 7, 8 and 9) the Hungarian anisoploid "*Beta Poly M/102*" is resistant to *Fusarium* sps., enough resistant to *Aphanomyces laevis* and to *Pythium de Baryanum*, too. At the same time the anisoploid "*Beta Poly M/101*" strain showed resistance to *Aphanomyces*, but was only moderately resistant to the other pathogens. The diploid strain Monogerm 051 shows resistance to *Phoma betae* but a high grade susceptibility to other pathogens; in contrary, the diploid Monogerm 806 seemed to be very susceptible to each pathogen. The male sterile crossing partner strain "S. 11" proved to be intermediarily resistant to the *Fusarium* sps. and to *Phoma betae* but very susceptible to *Aphanomyces laevis* and *Pythium* sps. infections.

From the data reported above, it may be concluded that the varieties maintain their genetically stable characters under different ecological con-

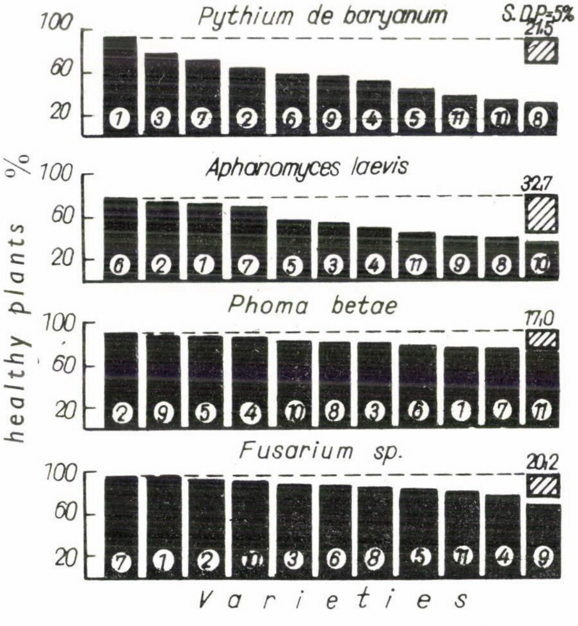

Fig. 3. Resistance of sugar beet varieties or strains to the different pathogens
On the ordinate: Ratio in per cent of the healthy plants
On the abscissa: Varieties or strains: 1=Kleinwanzlebener Poly, 2=Ramonj 06., 3=beta tetra 53—27., 4=P. 140. 4×, 5=E. III, 525/25., 6=beta poly M/101. anisoploid, 7=beta poly M/102. anisoploid, 8=Monogerm 806. diploid, 9=Monogerm 051. diploid, 10=S. 11. diploid male sterile, 10=S. 21. diploid male sterile

ditions, too (varieties 1 and 2 in Fig. 3). We must strongly draw the attention to the urgent necessity of increasing the resistance of our perspective variety-candidates and strains to root-rot infection (varieties No. 8—11 in Fig. 3).

Conclusions

It seems to be a preliminary condition of a successful breeding for resistance in plants the possibility to produce — by using a provocative method — well perceivable infections in plants to be investigated. Under such conditions can only be carried out the selection of resistant varieties of plant species.

The soil infection method elaborated by us proved to be a suitable method for breeding aiming at a resistance to root-rot in beets. Selection of strains resistant to each of the dangerous pathogens can be made even separately but the use of a complete inoculum gives good results too. Unfortunately with the beet — being an allogame plant requiring isolated plots for the change of generations — it is very problematic in the breeding for resistance to root-rot pathogens to select separate strains resistant to the different pathogens because this method would meet technical difficulties in the generative year of its development due to the high number of the isolated plots required. Instead of it we have applied soil infection method using a complete inoculum in a wide range strain material by which the resistance can be increased — more or less successfully — for more pathogens at the same time; i.e. our breeding work is directed for a "group" resistance.

Our soil infection method is simple and can be even mechanized too (e.g. the principle of sowing engines combined with fertilizer scatterer aggregate), thus reliable soil infections can be carried out on greater plots and a wide ranging selection becomes possible.

The resistance of varieties or strains to the different pathogens can also be evaluated by using *in vitro* methods (LINHART 1900, MACWITHEY 1961), but they proved not to be suitable for breeding for resistance on a larger scale as only few individuals can be tested using them.

The results of our tests show the *Fusarium* sps. to play a primary role in the root-rot infection. As we have infected the plants in our tests with a mixture of five *Fusarium* sps. suspension most of them occurring in beet seedlings, it will be still necessary to test the pathogeneity of the single fungus species each separately.

The pathogeneity of pathogens is highly influenced by their origin; it seems very probable that the biotypes of the single fungus species can also be discovered which we have also in mind but it seems desirable to investigate, too, the role of other species of fungi and bacteria in root-rot infection. After all it is a promising fact to have detected some strains of sufficient resistance among our perspective variety-candidates already.

As is well known root-rot occurs in each ecological environment but the decay of beets seems to be the result of an infection caused by one or more pathogens simultaneously, therefore our varieties must be resistant enough to the different pathogens. In the era of an ever increasing mechanization of sugar beet agrotechnics the tendency prevails to sow out sugar beet seeds so thinly that singling labour should not be necessary at all. From such thin sowing a suitable plant crop can only be expected if the beet seedlings are duly protected from root-rot and other damages. Complete control of these pathogens may be achieved by resistant varieties and a reasonable soil and seed desinfection only.

There are still several other problems to be investigated and solved concerning the development of root-rot and effectiveness of the infection methods.

Correlation between the quantity and depth of placing the inoculum are still unknown, similarly the role of the different ecological conditions in the pathogeneity of the different pathogens, the importance of seed size in the formation of susceptibility, etc.

Thorough and eager research work is still to be done to solve these problems successfully.

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ANALYSIS OF THE SITUATION IN CROP HUSBANDRY AND OF THE FACTORS AFFECTING DEVELOPMENT*

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Of the factors affecting the yield of field crops, the cultivated variety, crop rotation, tillage, irrigation and dressing are of particular importance.

Examination of these factors revealed that new improved plant variety in itself might increase the yield only to a low degree in comparison to the performance of currently grown varieties. In the last period the general cropping of hybrid maize has chiefly contributed positively to the augmentation of yields.

Crop rotation depends in the first place on the areal proportion of cultivated crops. It is not possible to modify the country-wide established proportions, this may only be done parallel by increasing average yields. Accordingly, on the present level of growing, crop proportions influencing considerably the productivity of soil can hardly be developed.

Experiments performed in the Agricultural College at Keszthely and in many other research institutes showed that tillage surpassing the customary depth afforded higher yield only on some soil types. In favourable cases row crops respond to deep tillage by higher yields of about 20 per cent, but in subsequent years from succeeding crops only a yield surplus of about 5 per cent can be expected. Thus, deep tillage increases the performance of the entire crop rotation by not more than 8 to 10 per cent.

Irrigation in itself is seldom effective, it must generally be combined with intensive dressing.

Farmyard manure is an important factor in the conservation of soil productivity. But the amount of stable dung cannot notably be raised, because it depends in the first place on cattle population.

As the most important means to increase average yields fertilizers may be looked upon. Fertilization experiments conducted with wheat, maize, sugar beet, potato, silomaize, as well as on meadows and ranges resulted in a very considerable (20 to 100 per cent) augmentation of yields. Higher performances achieved country-wide in the last 3 years may chiefly be attributed to the application of larger fertilizer doses.

However, between fertilization on the one hand and further factors influencing the amount of yield favourably on the other (cultivation of high-yielding varieties, regulation of spacing, adequate tillage and areal proportion of crops, development of manure farming) there is a conceptual difference. Properly speaking, the latter factors raise the yield without additional charges and represent chiefly the utilization of internal farm resources, whereas fertilization increases the expenses of growing considerably and can only be covered from external resources. Therefore, it is highly important to perform investigations into factors influencing the effect of fertilizers and into methods, by which the results obtained on experimental plots can also be adapted to farm patches of not entirely identical soil quality.

Demands on agricultural production are increasing throughout the world. This is due to the quick multiplication of population and to the regrettable fact that about 60 per cent of mankind does even today not obtain the

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minimally needed food containing 2200 calories each day and 800 millions of people are feeding so poorly that comes near to starvation.

Simultaneously, in countries with highly developed agriculture and industry the proportion of biologically valuable food consumption is fast increasing; and consuming more meat, milk and fruit involves just as well the development of the agricultural production.

Hungary belongs to the latter group of countries. Therefore, here beside the multiplication of people also the change of demands, chiefly the increased consumption of animal products rich in protein, must be taken into account. Our export possibilities lay at present and will be found in the coming period, too, in this group of produces.

The fulfilment of growing requirements on agricultural cultivation depends in the first place on the development of crop husbandry. We have to raise by ourselves — by increasing the so-called "areal" productivity (i.e. the productiveness per area unit) — both crops immediately suited for human food and fodders yielding animal products; forage import is allowed only to supplement home fodder yield. Accordingly, the primary task is to augment economically the productivity of field crop husbandry as well as of range and meadow farming.

While in the past farming was largely based upon the firm but slowly erected pillars of centuries' old practical experience, today, to meet the continually increasing demands on cultivation, also the building of science must run up — both in breadth and height — in accelerating rhythm.

The present duty of the science on crop husbandry is to reveal the situation of growing, to establish the principal factors of development, and subsequently to recognize the laws of their economical effectiveness.

As sciences in general, also crop husbandry has grown differentiated, breaking up into several branches, into agronomy, special crop husbandry and plant breeding.

However, the science of rearing plant products must form a unity in the future, too, in order to fulfil its duty outlined above. The correlations of climate, soil and plant may, in fact, be brought to light with scientific pretension only in the unity of analysis and synthesis enabling us to recognize the laws which may successfully promote cultivation.

The factors of development may be examined by the science of crop husbandry on different levels. Its indispensable task is to reveal the laws effective in farming and to study the factors determining the level, trend and rentability of growing within the farm. These investigations can with similar object be extended to a certain region, soil type, and research work may cover a country, continent or even the whole Earth. Crop husbandry research going beyond farm limits requires peculiar methods and encounters factors and laws of more or less different effect. This is due partly to the necessity of reckoning with many kinds of soil, diverse climates and partly to the fact that instead of farm factors influencing crop, economic factors must to a higher degree be taken into consideration. A further essential disparity is that within the farm the conditions of effectiveness of factors influencing crop husbandry differ from those valid within the limits of investigations on larger units.

My present lecture aims at analysing the situation of crop husbandry and the factors of its development in Hungary, since this work — with respect to the continually increasing demand on rapid development of agricultural growing — seems to be absolutely necessary.

The present state of crop husbandry can mostly be characterized by areal productivity. From 1920 to 1960 in the average yield of main field crops as well as of range and meadow areas no essential change occurred. The yield of cereals fluctuated between 7 and 9 quintals (q) per cadastral hold (kh)*, maize yielded 10 to 12, potato 40 to 55, sugar beet 90 to 120, lucerne 19 to 23, red clover *(Trifolium pratense* L.) 16 to 21, meadows 12 to 18 and ranges 4 to 6 q per kh (Table 1).

Table 1

National yield averages of field crops and grasslands in Hungary

Crops	1921/30	1931/40	1946/55	1951/60	1961/64
	q/kh*				
Wheat	7.4	7.9	7.5	8.5	10.2
Rye	6.2	6.5	6.6	6.7	6.1
Barley	7.1	7.9	8.2	9.9	10.5
Oat	6.7	7.1	6.7	7.7	6.6
Maize	8.6	10.8	10.2	12.6	14.0**
Potato	37.2	39.5	40.9	55.5	47.1**
Sugar beet	112.0	119.0	89.0	114.7	131.1**
Lucerne hay	19.2	23.2	21.4	22.0	16.6**
Red clover *(Trifolium pratense)*, hay	16.7	19.0	19.9	21.3	15.1**
Meadow 1949—50	12—18				
Range 1949—50	4—6				

* q/kh = quintal (100 kg) per cadastral hold (Hungarian measure = 0.575 hectare)
** 1961/63

The average yield of some crops has ceased to be deadlocked only in the last three years; this subject will be discussed later.

On examining the actual situation, first of all the problem arises, what is the reason of stagnation in average yields. This question should adequately be answered first, for being able to analyse what is further to be done.

* 1 quintal (q) = 100 kg; 1 cadastral hold (kh) = 0.575 hectare

To formulate an answer, the changes in crop husbandry during the above mentioned 40 years are to be reviewed.

Crop husbandry is kept examining the correlation existing between climate, soil and plant. From these three yield-governing factors climate did obviously not change during the four decades. As to the plant factor, on the other hand, in some crops considerable changes came about. During this period wheat was grown on the largest part of arable land, therefore, it is advisable to analyse in detail above all the changes observed in cultivated varieties of this plant. To elucidate the situation let me go back into the slightly distant past.

Hungarian wheat varieties grown at the beginning of the 20th century represented the type, that had developed from the ancient Hungarian wheat in the course of secular cultivation under the natural conditions of the Carpathian Basin.

In the second half of the 19th century wheat breeding set out from these regional varieties serving as basic material for the work of SZÉKÁCS, BAROSS and other breeders. The ancient Hungarian regional variety played an important role even in the development of recently bred wheats, and it was one the ancestors not only of *Bánkúti* wheats but also of the varieties *F 481*, *Fertődi 293*, etc.

An event of great importance in the history of Hungarian wheat growing had been the reorganization performed between 1931 and 1937, in the course of which we had succeeded — and within a relatively short time — in distributing the most reliable, best producing improved wheat varieties with excellent qualities even for the baking industry. Among them the winter wheat variety *Bánkúti 1201* took the most prominent part at the beginning of its propagation; in 1931 altogether a stock of only 38 wagons had been available. From 1931 to 1937 more than 1 million quintals of wheat grain for sowing had been partitioned among the farms and 94 per cent of this quantity belonged to the varieties *Bánkúti 1201* and *1205*. Beside *Bánkúti* wheats also the varieties *Székács 1055*, *1242* and *17* as well as *Hatvani 1140* and *1201* participated in the seed-grain action. After all, during seven years it was achieved that "more than three-quarters of the Hungarian wheat area had been put under improved wheat, and 90 per cent of them cropped with *Bánkúti 1201*" (TAKÁCH 1938, SURÁNYI 1938).

Reorganization was in the first place motivated by marketing difficulties following economic crisis. To ease marketing it became necessary to distribute the varieties of good quality and to grow uniform crops.

Later, beside *Bánkúti* wheats, important part was given to the winter wheat *F-481*, proving valuable chiefly on poorer soils.

Until last years the winter wheat varieties *Bánkúti 1201* and *F-481* upheld their leading role and went a long way to the lessening of yield fluctuations. Especially the damage by stem rust has diminished substantially, but the yield has scarcely increased as it is demonstrated by the data presented.

From the foregoing the conclusion may be drawn that although in the examined period cultivated wheat varieties were exchanged and ancient regional varieties replaced by valuable improved ones, areal productivity did not considerably increase after all. This was due either to the fact that in the middle of the thirties improved varieties drawn into general cultivation belonged essentially to the same ecotype as ancient regional varieties and accordingly also their productivity corresponded more or less to that of the latter or the reason must be sought elsewhere.

Table 2

National experiments with wheat varieties
1961—1963

Year	Variety		Yield	
			q/kh	%
1961				
	Fertődi	293	20.07	115
	Karcagi	522	17.76	101
	Bánkúti	1201	17.50	100
	Kompolti	169	17.41	99
	F	481	15.31	87
		$SD_{5\%}$*	1—2 q	
1962				
	Fertődi	293	18.50	107
	Karcagi	522	17.32	100
	Bánkúti	1201	17.24	100
	Kompolti	169	17.24	100
	F	481	16.56	96
		$SD_{5\%}$*	1.24 q	
1963				
	Fertődi	293	16.75	122
	Karcagi	344	15.97	116
	Karcagi	388	15.55	113
	Bezostaya	1	15.53	113
	Bánkúti	1201	13.72	100
		$SD_{5\%}$*	**1—1.8**	

* SD = Significant difference (P = 5%)

In order to assess properly the role of varieties in shaping average yields in Hungary it seems expedient to examine the data of the variety trial conducted on country-wide level. Table 2 displays the three-year results of wheat variety experiments as compared with the yield of the wheat *Bánkúti 1201*. Some varieties showed higher productivity and the best of them, *Fertődi 293*, yielded by 7 to 22 per cent more than *Bánkúti* during the three years.

Table 3

National experiments with spring barley varieties
1961

Varieties	Yield q/kh	Yield %
Kleinwanzlebener St. 1405 ..	14.6	106
Frigga	14.5	106
Saale	14.3	104
Dunajski Trch.	14.0	102
Hadmerslebener	14.0	102
Herta	13.9	101
Martonvásári FB	13.8	100
Fertődi C-4-58	13.7	100
$SD_{5\%}$*	**1.5**	**10.9**

* SD = Significant difference (P = 5%)

Table 3 summarizes the data of national variety trials with summer barleys. As to productivity among examined varieties no significant differences were observed.

In Table 4 the results of national experiments with the new hybrid maize varieties may be seen. In comparison to the country-wide distributed *Mv-1* that had proved good, the new best hybrid candidates showed higher productivity of 8 to 10 per cent.

The trend of national average yields in the past four decades and the results of variety trials reported here proved that variety had only a relatively moderate effect on average yields, it did not decisively influence the general level of growing, and no essential progress could from only this factor be expected either.

In 1956, on the Keszthely experiment field and chiefly for teaching purposes small-plot crop rotations of the following types were set up: wheat monoculture, two-course rotation characteristic for rotation husbandry, traditional three-course rotation with stable-dunged fallow, improved three-course rotation (using red clover instead of fallow), ley-farming and Norfolk

Table 4

National experiments performed with Hungarian medium early and medium tardy hybrid maize varieties in 1963

Varieties	Grain yield		
	q/kh	q/ha	%
Mv. 53 sterile	32.66	56.75	111.0
Kollektiv 1	32.11	55.79	109.2
Mv. 53	31.72	55.12	107.8
Keszthelyi 23	30.30	52.65	103.0
Mv. 65	30.24	52.54	102.8
Keszthelyi 16	30.00	52.13	102.0
Mv. 59 sterile	29.98	52.09	101.9
Mv. 1	29.84	51.85	101.5
Keszthelyi 11	29.75	51.69	101.1
Mv. 5	29.62	51.47	100.7
Mv. 48 sterile	29.58	51.40	100.6
Mv. 48	29.14	50.63	99.1
Mv. 39	29.02	50.42	98.7
Mv. 39/a	28.97	50.34	98.5
Mv. 1 sterile	28.81	50.06	97.9
Kollektiv 2	27.46	47.71	93.4
Kompolti 2	25.88	44.97	88.0
Kompolti 1	24.35	41.31	82.8
$SD_{5\%}$*	*2.06*	*3.58*	*7.0*

* SD_5 = Significant difference (P = 5%)

four-shift rotation. In each rotation always the same part of the courses got identical doses of fertilizers, the other part was not fertilized. Cultivated wheat varieties were chosen according to farmyard manuring of crop rotation and — in general — to the intensity of rotation, i.e. as practice is used to choosing varieties suitably. E.g. under most unfavourable conditions the field was put under *F-481* wheat in monoculture, whereas in the Norfolk four-course rotation *Bánkúti 1201*, after stable-dunged fallow the varieties *Autonomia*, *Produttore*, *Etoile de Choisy*, in the three-course rotation after red clover *San Pastore* and *Fertődi 293*, and in the two-course rotation after fallow *Besostaya* wheats were sown.

After rotations had settled, from 1958 to 1964, i.e. in the average of six years, the yields summarized in Table 5 were harvested per cadastral hold and hectare respectively.

Table 5

Crop husbandry experiments in crop rotations 1958—1964

Crops	Average yield of 6 crop rotations in 6 years	
	q/kh	q/ha
Wheat	10.3	17.8
Rye	10.4	18.0
Oat	10.1	17.5
Spring barley	9.0	15.6
Sugar beet	188.0	325.2
Perennial papilionaceae (green mass)	128.0	221.4
Crops	**Average yield of Norfolk crop rotation in 6 years**	
	q/kh	q/ha
Wheat	11.1	19.2
Spring barley	11.1	19.2
Sugar beet	188.0	325.2
Red clover (fresh weight)	103.0	178.2

On reckoning the data of Table 5 it should be considered, that the experimental field has a soil of medium productivity, under a climate better than that of the countrywide average and cultural practices exceed substantially the level which may be reached in farm production.

From crop rotations the Norfolk four-course rotation — appearing very favourable in many respects but not applicable generally on large scale — should separately be examined. It contains 25 per cent of papilionaceae, and sugar beets planted every four years are dressed with 200 q stable-dung per cad. hold, accordingly the whole rotation obtains 50 q farmyard manure per cad. hold annually, which is considerably more than farms are able to produce. After all, average yields achieved in this rotation came near to the upper level that farms may reach by maximum utilization of internal resources under given soil and climatic conditions. Despite all that average yields do not exceed substantially the country's average as it turns out from the following data showing that this rotation yielded

11.1 q wheat
103.0 q red clover (fresh weight of green mass)
11.1 q summer barley and
188.0 q sugar beet per cad. hold.

It is worth comparing these yields with Western-European data elaborated by PRYANISNIKOV (1952). In the examined countries the three-course farming system yielded 7 q cereals per hectare in average. This quantity increased — after red clover cultivation had been promoted and also as a consequence of turning to crop rotation farming system — to a quantity of 16 q.

In Hungary the areal proportion of field crops and the climate are less favourable than in the examined Western-European countries. Accordingly, yields are somewhat lower than those reported by PRYANISNIKOV, but as to the order of magnitude they approach it as up to 1960, wheat yields fluctuated between 13.0 and 14.5 q per hectare, and amounted to 17—18 q in experimental crop rotations.

From what has been stated above, the conclusion may be drawn that in the present position of Hungarian agriculture the distribution of more productive plant varieties in itself does not suffice to raise average yields. Though internal farm resources are not fully utilized and the areal productivity, especially of sugar beet and potato as well as of perennial papilionaceous fodders, may slightly be increased, general and considerable progress can only be achieved by augmenting soil productivity, the third factor affecting yield. In the present investigations the analysis of irrigation is deliberately disregarded, because in connection of plant and soil, identical laws prevail in case of and without irrigation.

Examining the soil, as yield affecting factor, the science of crop husbandry disregards many properties of soil deserving attention from the aspect of pedology and concentrates its interest on the most peculiar, practically important feature: on productivity.

The generally applicable main methods to increase soil productiveness are: tillage, intensive cultivation of plant improving the structure of soil and augmenting its organic substances and nitrogen content, dressing with farmyard manure and fertilizers. Let us examine these methods one by one.

In many farms, tilling does not yet reach the desirable level. In several places the productivity of soil can be increased by deeper tilling; this has been proved by experiments performed by Hungarian research institutes on different soil types. Details pertaining to this object may now be omitted, because it has just been recently discussed in the Hungarian Academy of Sciences. Collected experimental results revealed that on soils responding to deep tillage, seldom a yield surplus exceeding 20 per cent is induced by this procedure in row crops, and in the performance of the whole rotation scarcely an increase higher than 8 to 10 per cent occurs.

Experiments conducted for four years in Keszthely gave similar results, which are presented in Table 6. Tilling experiments were combined with fertilization. Due to deep tillage the performance (in corn unit) of the four-course rotation increased by 4 to 11 per cent. The yield was significantly higher

Table 6a

Soil cultivation experiments in Keszthely
1961–1964
Methods of cultivation

Year	Indicator crop	Yield (q/kh) obtained by treatments				
		1	2	3	4	5
1961	Eared maize	37.6	40.4	42.0	38.4	44.0
	in corn unit	18.8	20.2	21.0	19.2	22.0
1962	Wheat	12.7	13.1	13.6	13.9	13.5
	in corn unit	12.7	13.1	13.6	13.9	13.5
1963	Red clover, green mass	107.6	110.2	108.1	119.4	114.6
	in corn unit	13.5	13.8	13.5	14.9	14.3
1964	Potato	61.9	68.7	66.6	59.4	69.2
	in corn unit	15.5	17.2	16.7	14.9	17.3
Total	in corn unit	60.5	64.3	64.8	62.9	67.1
	in per cent	100	106	107	104	111

1. Ploughing to 24 cm depth
2. Ploughing to 24 cm depth + 15 cm subsoil loosening
3. Progressive deepening of the ploughed layer to 36 cm
4. 10 cm ploughing + loosening to 40 cm depth
5. 40 cm ploughing at the beginning of the rotation, subsequently 24 cm deep ploughing

only in the first year, in the subsequent period the residual effect of deep tillage was very small remaining below the limit of significance.

On the other hand, fertilization in itself and combined with farmyard manuring resulted in yield surpluses of 22 to 35 per cent and amounted to or even exceeded 50 per cent in some crops, e.g. in wheat and red clover. This makes it evident that from better tillage considerable yield surplus cannot generally be expected, even if fatal faults committed in tilling procedures are disregarded. As a consequence of better soil cultivation rather a decrease in expenses of production may occur.

It is not possible to suggest changes for the structure of Hungarian crop husbandry, which might be of significant effect on soil productivity. From crops enriching the soil lucerne occupies an area of about 400,000 and red clover nearly 150,000 cad. holds totalling thus 6–7 per cent of the whole arable land.

In some farms there is a chance to increase the area of lucerne by up to 20 per cent and in this way to affect, directly or indirectly, soil fertility. On national scale the present lucerne area could only be doubled for a longer term and even then it would merely come up to 8 per cent of arable land; this, in

Table 6b

Soil cultivation experiments in Keszthely
1961—1964
Application of fertilizers

Year	Indicator crop	Yield (q/kh) obtained by doses		
		a	*b*	*c*
1961	Eared maize	35.9	40.6	44.9
	in corn unit	17.9	20.3	22.5
1962	Wheat	10.2	14.7	15.2
	in corn unit	10.2	14.7	15.2
1963	Red clover, green mass	85.4	115.0	135.5
	in corn unit	10.7	14.4	16.9
1964	Potato	58.3	66.9	70.3
	in corn unit	14.6	16.7	17.6
Total:				
	in corn unit	53.4	66.1	72.2
	in per cent	100.0	122.0	135.0

a) 0
b) Maize: 130 kg/kh Pétisó* + 150 kg/kh superphosphate
Wheat: 90 kg/kh Pétisó + 150 kg/kh superphosphate
Red clover: 0
Potato: 175 kg/kh Pétisó + 200 kg/kh superphosphate
c) To the row crops: 120 kg/kh farmyard manure + the fertilizers of *b)*

* Calciumcarbonate-ammoniumnitrate salt, produced in Pét, Hungary

comparison to today's situation, would not cause a considerable change in soil productivity nor appreciably increase the performance of the whole arable land.

In maintaining and raising soil fertility, farmyard manure plays an important role; its quantity depends chiefly on the volume of cattle population, which may considerably be augmented only if the areal productivity of arable and range tracts increases. In farms, naturally, the situation is quite different: within their framework cattle population may be as good as doubled from one year to the other and by this also the amount of stable-dung duplicated. As to farmyard manure economy, some reserves are at disposal in Hungary: the treatment of manure may be improved, losses in organic substances and nitrogen diminished. As to quality, beside manure treatment, advance can be expected from increased intensity of feeding. The spreading of produced stable-dung more properly than practised nowadays may also contribute to the augmentation of yields. Losses caused by inadequate treatment and utilization of manure is hard to assess even approximately. However, we are not far from reality if in the value of stable-dung an expectable increase of 20 per cent — due to the improvement of procedures mentioned — is estimated. This implies that instead of the present manure quantity of 15 to 16 q per cad. hold 18 to 20 q would be available. A stable-dung surplus of 3 to 4 q contains about 1 q organic substances and in this quantity 2 kg N, 1 kg P_2O_5 and 2 kg K_2O are to be found. It is evident that this small amount may raise the areal productivity to a very low degree only.

To avoid misunderstandings it should be stressed, that the author does by no means intend to underrate the benefit, which can be attributed to tilling, to the increased use of crops affecting favourably soil fertility and to the improvement of stable-dung farming, but in a review of such extent as presented here, factors of more important order must be searched.

A further, generally applicable mean to increase soil productivity is fertilization.

When in Western-European countries with advanced industry and agriculture fertilization had already became general and increasingly larger quantities of fertilizers were applied, in Hungary as to the economical effectiveness of fertilizers, especially as to the utility of large doses misgivings emerged.

For a long time the superiority of using organic manures had been stressed and chiefly the improvement of stable-dung farming considered as the main way of development. Beside pointing to the probable disadvantageous

Table 7

The amount of fertilizers applied and average yields in some countries

Country	Quantity of agents in fertilizers kg/ha		Average yield: q/ha							
			Wheat		Maize		Potato		Sugar beet	
	1938	1956—1957	1934—1938	1955—1957	1934—1938	1955—1957	1934—1938	1955—1957	1934—1938	1955—1957
Austria	18	95	17	23	26	29	137	176	260	300
Czechoslovakia	54	67	17	21	21	23	135	140	290	250
United Kingdom	60	140	23	92	—	—	169	188	220	280
Holland	326	429	30	38	15	23	—	236	380	420
France	39	77	16	34	15	26	113	157	280	300
German Fed. Rep.	—	225	22	30	30	29	166	225	360	330
Switzerland	50	162	23	29	29	40	158	224	370	410
USA	10	32	9	14	14	28	78	189	260	380
Bulgaria	—	—	13	14	12	16	61	89	160	160
Turkey	—	—	11	10	13	12	—	—	120	170
Hungary	2	12	14	15	20	22	73	104	210	200

influence of fertilizers it was urged that under Hungary's climate inclining to drought the insufficient effectiveness of nutrients had to be taken into account, and this opinion was confirmed by the lag of fertilizer impact in some experiments and years, respectively.

Statistical data, however, revealed that in our century just the development of fertilization was the main promoting force of agricultural growing.

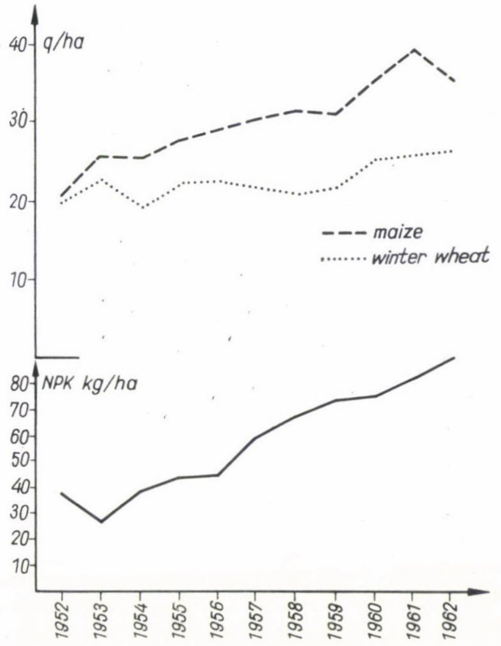

Fig. 1. The connection between fertilizer consumption and yields in Austria

— — — — maize

.... winter wheat

This is proved by Table 7, showing the utilization of fertilizers and average yields in some countries. The close connection manifests itself at first sight!

In the first place the average yield of wheat, maize and potato increases conspicuously parallel with larger fertilizer doses.

In the neigbouring Austria this parallelism is still more significant. Diagram in 1 Fig. demonstrates the development achieved as a consequence of fertilizing in the last decade as well as the collateral increase of fertilizer utilization and average yields. From 1952 to 1962, i.e. in 10 years, the quantity of fertilizer agents had been raised from 38.2 kg to 89.4 kg per hectare; consequently the yield of winter wheat increased from 19.9 q/ha to 26.2 q/ha and that of maize from 20.4 q/ha to 35.6 q/ha.

Let us now examine the increase of areal productivity to be expected due to systematic fertilizing in Hungary.

To do this we must come back to the yield statistics presented at the beginning of this lecture. In the average of the years 1961 to 1964 the yield of wheat grew to 10.2 q/kh (= 17.9 q/ha) as compared with the average of previous 10 years, thus an augmentation of 1.7 q/kh (= 2.9 q/ha), i.e. of 20 per cent was obtained. In the yield of maize and sugar beet a significant increase may also be observed. Put these numbers next to the data of fertilizer utilization.

From 1931 to 1940 the consumption of fertilizer agents averaged to 1.6 kg per hectare. This quantity is so small which could not affect national average yield. Fertilizer agents applied per hectare arable land increased to 31.5 kg in 1960, to 41.3 kg in 1961, to 53.4 kg in 1962 and to 58.7 kg in 1963. Taking into account that in previous years considerable part of fertilizer stock was given to wheat (in any case a larger amount than would proportionately have fallen to the share of this crop) and similarly also sugar beet was favoured, the connection between increased fertilizer doses and larger yields becomes evident. Maize obtained notable fertilizer quantities as well, and could also utilize the residual effect of wheat fertilization. Besides, the yield of maize was augmented by extended cultivation of hybrid varieties, the decreased growing of intercrops, more favourable stand density, etc. Rye, oat, lucerne, red clover and moreover meadows and pastures scarcely obtained fertilizers, therefore no wonder that yields in these cultures continue to stagnate even today.

Let us examine this question as reflected by experimental crop rotation described here, to which 160 kg mixed fertilizers per cad. hold were applied containing 8.5 kg N, 13.4 kg P_2O_5 and 16 kg K_2O, altogether 38 kg (63 kg/ha)

Table 8

Crop husbandry experiments in crop rotations
1958—1964

Crops	Average yield of 6 crop rotations in 6 years					
	Undressed		Fertilized		Difference	
	q/kh	q/ha	q/kh	q/ha	q/kh	q/ha
Wheat	10.3	17.8	13.5	23.4	3.2	5.5
Rye	10.4	18.0	13.7	23.7	3.3	5.7
Oat	10.1	17.5	13.8	23.9	3.7	6.4
Spring barley	9.0	15.6	11.9	20.6	2.9	5.0
Sugar beet	188.0	325.2	224.0	387.5	36.0	62.3
Perenn. papilionaceae (green mass)	128.0	221.4	153.0	264.7	27.0	43.3

of agents. The proportion of nutrients cannot be considered as very favourable and their whole quantity surpassed hardly the national average. In our crop rotations systematically fertilized courses gave the following yields in the average of 6 years (Table 8).

Accordingly, the yield of cereals increased by about 3.0 to 3.5 q, that of sugar beet by 36 q and the green yield of perennial papilionaceae by 25 q. Fertilizer effects of that degree correspond to average data published in literature (SCHMITT 1958).

Table 9

Wheat growing experiments
1961—1962

Effect exerted on yield by	Yield q/kh	Yield %
Time of sowing		
October 6	20.0	100.0
October 16	18.4	92.0
November 2	18.4	92.0
November 15	13.5	67.0
December 1	13.6	68.0
*$SD_{5\%}$	**2.9**	**14.5**
Fertilization: kg/kh		
600	19.1	145.8
480	18.2	138.9
290	16.9	129.0
0	13.1	100.0
$SD_{5\%}$	**1.2**	**9.2**
Number of grains		
3.8 to 4.4 million	17.2	100.6
3.2 to 3.8 ,,	17.1	100.0
2.6 to 3.2 ,,	16.2	94.7
$SD_{5\%}$	**1.2**	**2.9**
Varieties		
A Fertődi 293	19.9	100.0
B Bezostaya 1	16.0	80.4
C San Pastore	14.5	72.9
D Etoile de Choisy	17.0	85.4
$SD_{5\%}$	**1.5**	**7.5**

* Significant difference (P = 5)

The extent of yield augmentation due to fertilizing may be assessed best from the data of experiments.

It would be over the framework of my lecture to present the results of experiments conducted in different regions of Hungary; as to their trend they resemble each other. Allow me, therefore, to perform the analysis relying upon our own experiments.

In the course of wheat growing experiments and depending on treatments, the following yields were obtained in 1961/62 (Table 9). Disregarding two wheat varieties unsuited for Hungary as well as the entirely inefficient sowings carried out in mid-November and at the beginning of December, fertilizing has proved to be the factor affecting yield to the highest degree (45 per cent). Similar results were also obtained in 1960/61 and 1962/63.

To examine the effect of fertilizing more in detail further experiments were set up with nitrogen, phosphorus and potassium fertilizers in 1963/64. The examined winter wheat *Fertődi 293* got 29 kg N and 23 kg K_2O per cad. hold as basic dressing and responded with a yield surplus of 69 per cent to the largest quantities of phosphate (Table 10). The highly favourable effective-

Table 10

Fertilization experiments with the wheat variety Fertődi 293
1964

Fertilizers	N	K_2O	P_2O_5
	kg/kh		
1	0	0	0
2	29	23	0
3	29	23	14
4	29	23	18
5	29	23	42
6	29	23	56
Grain yield	q/kh	q/ha	%
1	12.7	22.1	100
2	14.3	24.9	113
3	18.1	31.4	142
4	18.2	31.7	143
5	20.6	35.8	162
6	21.5	37.3	169
*$SD_{5\%}$	**1.6**	**2.8**	**12.8**

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 11

Fertilization experiments with the wheat variety Fertődi 293
1964

Fertilizers	N	P_2O_5	K_2O
	kg/kh		
1	0	0	0
2	29	29	0
3	29	29	23
4	29	29	46
5	29	29	69
6	29	29	92
Grain yield	q/kh	q/ha	%
1	13.7	23.9	100
2	18.9	33.0	138
3	19.9	34.5	145
4	20.1	35.0	147
5	19.3	33.5	141
6	19.1	33.2	139
*$SD_{5\%}$	**1.3**	**2.3**	**9.4**

$SD_{5\%}$ = Significant difference ($P = 5\%$)

ness of phosphate is in accordance with the small phosphorus content of the soil, amounting only to 1.5—2.0 mg per g soil according to investigations.

The effectiveness of the potassium fertilizer was considerably lower, the yield surplus did not exceed the significant difference; whereas nitrogen and phosphate proved to be efficacious also in this experiment (Table 11), because they increased the yield by 38 per cent. The reason for the low potassium influence is that the soil contains moderate or sufficient quantities of K (17 to 18 mg/100 g soil). The effect of nitrogen fertilizers on the yield was most thoroughly studied (Table 12). After basic dressing with phosphorus and potassium the most favourable nitrogen dose increased the yield of wheat by 95 per cent, reaching thus the level (35 to 37 q/ha) characteristic for the yield of countries advanced in fertilizing. Moreover, experiments revealed that it was not profitable either to break up large doses of nitrogen fertilizers into small portions. Naturally, in order to answer the question satisfactorily, it is intended to continue the experiments still for some years.

In connection with the use of larger fertilizer doses and underlining Hungary's climate inclining to drought, forsight is often advised by several

Table 12a

Fertilization experiments with the wheat variety Fertődi 293
1964

Fertilizers	P_2O_5	K_2O	Nitrogen				
			Time of application				Total
			autumn	spring	shooting	flowering	
	kg/kh						
1	0	0		0			
2	29	23		0			
3	29	23	25				25
4	29	23		25			25
5	29	23		25	25		50
6	29	23	25	25			50
7	29	23		75*			75
8	29	23	37.5	37.5			75
9	29	23		37.5	37.5		75
10	29	23		25	25	25	75
11	29	23	25	25	25		75
12	29	23		50	50		100
13	29	23		33	33	33	100
14	29	23		37.5 62.5*			100
15	29	23	33	33	33		100
16	29	23	25	25	25	25	100

* carbamide

authors. It seems, therefore, necessary to publish some main results of experiments conducted in the driest region of the country.

In wheat fertilizing trial set up at Szeged in 1955, due to the effect of 20.5 kg N, Kocsárdi obtained a yield surplus of 30 to 32 per cent (Kocsárdi 1961).

Koltay examined the yield-increasing influence of N fertilizers on wheat after different preceding crops in Martonvásár. Dressing the soil with 200 kg/kh Pétisó (calcium carbonate-ammonium nitrate fertilizer produced in Pét, Hungary) he obtained a surplus of 51 per cent in grain yield after maize preceding crop and of 64 per cent after Sudan grass *(Sorghum vulgare sudanense)*; 150 kg/kh Pétisó increased the yield of wheat sown after flax by 25 per cent and after peavine *(Lathyrus* sp.) by 3 per cent (Koltay 1961).

Bajai performing experiments in 1957 and using 200 kg/kh Pétisó succeeded in augmenting the yield of wheat. The result changed according

Table 12b

Fertilization experiments with the wheat variety Fertődi 293
1964

Grain yield	q/kh	q/ha	%
1	10.6	18.4	100
2	14.2	24.7	135
3	17.2	30.0	163
4	17.2	30.0	163
5	18.0	31.3	170
6	18.8	32.6	178
7	19.2	33.3	181
8	19.0	33.0	180
9	20.6	36.0	195
10	19.3	33.5	182
11	19.3	33.6	183
12	19.1	33.2	181
13	18.4	32.1	175
14	19.0	32.9	180
15	19.3	33.6	183
16	19.5	33.8	184
*$SD_{5\%}$	**1.7**	**2.9**	**15.8**

* $SD_{5\%}$ = Significant difference (P = 5%)

to different preceding crops: maize increased the quantity of grain from 13.6 q to 16.8 q (by 24 per cent), sunflower from 12.0 to 17.6 q (= 47%), sweet Sudan grass from 8.0 to 13.6 q (= 70%) and *Lathyrus* from 16.8 to 18.4 q (= 10%) (Bajai 1961).

These data corroborate the statement of Pryanisnikov (1952) that from nitrogen fertilizing an economical effect can be expected not only under humid but also under arid climate.

For a long time the opinion was and is still held by many authors that maize does not respond to fertilizing with such favourable efficiency like wheat, sugar beet or potato. Let us examine the results of our experiments.

Here the data of our monocultural maize growing trials started in 1961 are as follows. In the first year fertilizing induced a slender yield surplus of 16 to 20 per cent only. The reason of this result is obvious: the performance of the untreated plot was relatively high, producing 26—33 q grain yield shelled in May (Table 13). Yields of such level can be raised merely to a moderate degree. By regulation of stand density a yield surplus similar to or even exceeding slightly the fertilizer effect could be obtained. Data of experiments

Table 13

Fertilization experiments with the hybrid maize variety Mv. 5
1961

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25.0	50
N	0	37.5	75
K_2O	0	24.0	60
Spacings	70×35 cm	70×45 cm	70×60 cm

Eared yield

Fertilization \ Spacing	70×35 cm		70×45 cm		70×60 cm		Average	
	q/kh	%	q/kh	%	q/kh	%	q/kh	%
0	55	100	48	100	44	100	49	100
I	65	118	57	119	48	109	57	116
II	66	120	58	121	51	116	59	120
$^*SD_{5\%}$							**4.8**	

* $SD_{5\%}$ = Significant difference (P = 5%)

simultaneously reveal that higher stand densities influence the efficiency of fertilizers favourably, because identical fertilizer quantities augmented the yield of maize of 0.24 m² spacing by 10 to 11 q/kh but only by 4 to 7 q/kh if spacing was increased to 0.42 m².

In 1962 the experiment was repeated so that the residual effect of fertilizers given in the previous year could also prevail. The control plot remained untreated again. Therefore, the difference between fertilized and undressed plots as to the nutrient supply of soil has increased (Table 14). This resulted naturally in greater efficiency of fertilization: in the average of spacings a yield surplus of 26 to 36 per cent was observed. The connection between fertilizer effect and stand density became still more conspicuous: owing to fertilization stands planted with 0.42 m² spacing yielded a surplus of only 6 to 9 q/kh, but those of a 0.24 m² spacing 14 to 19 q/kh.

In the third year of the experiment (1963) the difference between nutrient supplies of fertilized and untreated plots continued to increase and on account of this fertilization a yield surplus of 90 to 155 per cent was gained. Despite the fact that fertilizers had the greatest effect in maize stands of smallest spacing even here, the highest yield was obtained in stands proving to be of most favourable density (23,000 to 24,000 plants per cad. hold) in previous years (Table 15).

Table 14

Fertilization experiments with the hybrid maize variety Mv. 5
1962

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25.0	50
N	0	37.5	75
K_2O	0	24.0	60
Spacings	70×35 cm	70×45 cm	70×60 cm

Eared yield

Fertilization \ Spacing	70×35 cm		70×45 cm		70×60 cm		Average	
	q/kh	%	q/kh	%	q/kh	%	q/kh	%
0	43	100	40	100	39	100	41	100
I	57	142	52	130	45	116	51	126
II	62	144	56	140	48	124	55	136
$SD_{5\%}$*							**8.4**	

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 15

Fertilization experiments with the hybrid maize variety Mv. 5
1963

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25.0	50
N	0	37.5	75
K_2O	0	24.0	60
Spacings	70×25 cm	70×30 cm	70×35 cm

Eared yield

Fertilization \ Spacing	70×25 cm		70×30 cm		70×35 cm		Average	
	q/kh	%	q/kh	%	q/kh	%	q/kh	%
0	17	100	19	100	25	100	20	100
I	35	207	39	204	41	167	38	190
II	50	295	50	260	54	220	51	255
*$SD_{5\%}$							**5.72**	

* $SD_{5\%}$ = Significant difference (P = 5%)

The year 1964 brought the highest yield (Table 16). Though also the untreated control plot produced much more than in the preceding year, by fertilization a yield surplus of 103 to 141 per cent was gained and the quantity of dry grains exceeded 46 q per cad. hold, i.e. 80 q per hectare.

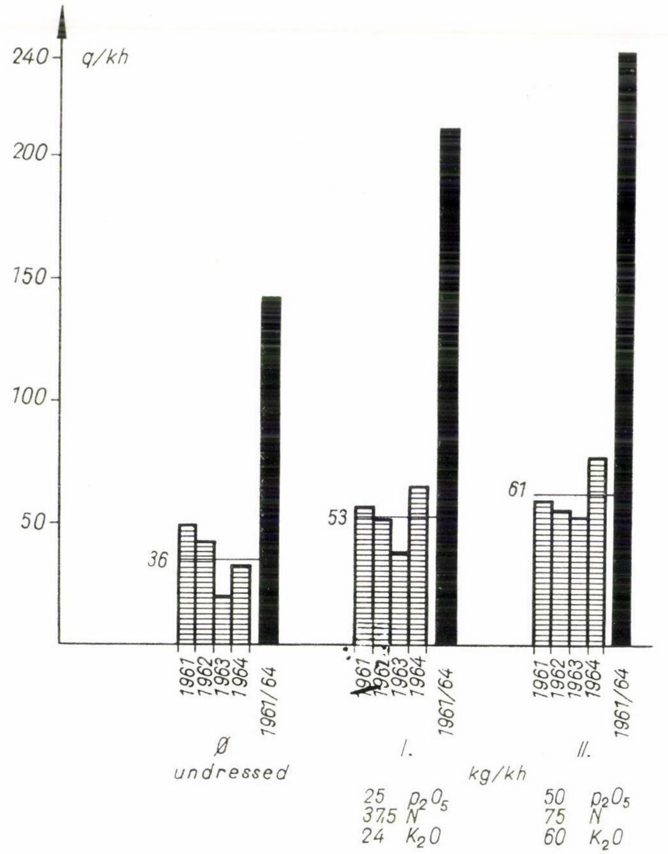

Fig. 2. Fertilizing experiments with maize (Eared yield q/kh)

In the average of four years and as compared with the performance of undressed plots (36 q/kh eared maize), after fertilization 53 and, respectively, 61 q/kh maize in ear were gathered in (Fig. 2). This equals nearly the same quantity of grain yield per hectare. The diagram also displays that unfavourable weather conditions in 1963 affected the fertilized plots less harmfully than undressed ones, i.e. beside augmenting the yield of maize, systematic fertilization has diminished yield fluctuations: increased yield security and lessens the damages done by drought.

The level of sugar beet yields is high as compared to that of cereals. This is obviously due to the fact, that farms reserve their best grounds for

Table 16

Fertilization experiments with the hybrid maize variety Mv. 5
1964

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25	50
N	0	37.5	75
K_2O	0	24	60
Spacings	70×25 cm	70×30 cm	70×35 cm

Eared yield

Fertilization \ Spacing	70×25 cm		70×30 cm		70×35 cm		Average	
	q/kh	%	q/kh	%	q/kh	%	q/kh	%
0	30	100	30	100	37	100	32	100
I	65	217	65	217	65	179	65	203
II	77	256	77	256	77	209	77	241
*$SD_{5\%}$							**6.4**	

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 17

Fertilization experiments with sugar beet
1958

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25	50
N	0	20	40
K_2O	0	24	48
Spacings		50×20 cm	38×20 cm

Root yield

Fertilization \ Spacing	50×20 cm		38×20 cm		Average	
	q/kh	%	q/kh	%	q/kh	%
0	302	100	324	100	313	100
I	326	108	335	103	330	105
II	383	127	339	104	361	115
*$SD_{5\%}$					**48**	

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 18

Fertilization experiments with sugar beet
1959

Fertilizers	0	I	II
		kg/kh	
P_2O_5	0	17	50
N	0	20	40
K_2O	0	24	48
Spacings		52×20 cm	38×20 cm

Yields

Fertilization \ Spacing	52×20 cm		38×20 cm		Average	
	q/kh	%	q/kh	%	q/kh	%
Roots						
0	274	100	253	100	263	100
I	277	101	275	109	276	105
II	302	110	300	118	301	114
$^*SD_{5\%}$					**11.6**	
Beetroot-tops						
0	140	100	109	100	125	100
I	167	119	147	135	157	126
II	200	143	165	151	182	146
Total						
0	414	100	345	100	379	100
I	444	107	402	116	423	112
II	500	120	445	129	472	125

* $SD_{5\%}$ = Significant difference (P = 5%)

sugar beet grown in relatively small areas and provide this crop first of all with farmyard manure. The technique of sugar beet production has been improved considerably by the participation of family members in cultivation, which manifests itself also in national average yields. In this crop further results may be achieved by fertilization. The effect of fertilizers on the yield of sugar beet as a function of spacing was examined for three years, from 1958 to 1960. Plants were set out in every plot at 20 cm distance in rows 38 and 50 to 53 cm apart from one another. These experiments should also answer the question how greater row distance affects the yield of sugar beet. This is important to know, because larger row space facilitates mechanized

Table 19

Fertilization experiments with sugar beet
1960

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	17	50
N	0	20	40
K_2O	0	24	48
Spacings		52×20 cm	38×20 cm

Yields

Spacing / Fertilization	52×20 cm		38×20 cm		Average	
	q/kh	%	q/kh	%	q/kh	%
Roots						
0	216	100	231	100	223	100
I	286	133	292	126	289	130
II	301	139	307	133	304	136
*$SD_{5\%}$					**31**	
Beetroot-tops						
0	64	100	61	100	62	100
I	77	120	81	134	79	127
II	103	162	107	176	105	169
Total						
0	279	100	291	100	285	100
I	363	130	373	128	368	129
II	404	145	414	142	409	143
*$SD_{5\%}$					**37.5**	

* $SD_{5\%}$ = Significant difference (P = 5%)

care of plants on farm-scale and decreases the expenses of singling, hoeing as well as the demand on live labor.

Table 17 shows the results of the experiment conducted in 1958. As it may be seen, fertilization had in the average of spacings, only a very modest effect, which was due to the exceedingly high yield of the control plot. However, it deserves attention that while on untreated plots greater stand density gave — though not significantly — higher yield, as a result of fertilization, stands of minor density surpassed in performance those of smaller spacing.

Table 20

Fertilization experiments with the potato varieties "Margit" and "Somogyi sárga"
1958

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	17	50
N	0	20	40
K_2O	0	24	60

Yield

Fertilization	"Margit"		"Somogyi sárga"	
	q/kh	%	q/kh	%
0	93	100	111	100
I	106	114	125	112
II	126	135	150	135
$^*SD_{5\%}$	**5.1**			

* $SD_{5\%}$ = Significant difference (P = 5%)

In 1959 (Table 18) the level of yields was lower in every treatment and just an opposite trend could be observed. But the results of both years correspond to one another as to the effect of fertilization having increased the yield by nearly identical proportion, 5 to 14 per cent.

The result of the third year (Table 19) was similar to that of the first one, but dressing had a much more favourable effect manifesting itself in a yield surplus of 30 to 36 per cent, though the level of control plots was also relatively high.

The prosecution and extending of trials would be desirable in order to find out, how much the spacing of most important Hungarian sugar beet varieties may be increased under different conditions of climate, site and fertilizing without losses in yield and aiming at reducing the expenses of growing and to raise the standard of mechanization.

From the trials the conclusion may be drawn that as to the relation of soil and plants intensive fertilization creates — similarly to maize — also in sugar beet a new situation, the examination of which is a significant field of research into crop production.

Now some of our experiments on potato growing are to be outlined. In 1958 a yield increase of 35 per cent could be reached in comparison to the level of control plots yielding 93 to 111 q/kh (Table 20). In 1959, dependent

Table 21

Fertilization experiments with the potato variety "Somogyi sárga" 1959

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	17	50
N	0	20	40
K_2O	0	24	60
Spacings		0.18 m²	0.28 m²

Yield

Spacing / Fertilization	0.18 m²		0.28 m²	
	q/kh	%	q/kh	%
0	185	100	164	100
I	208	112	186	113
II	237	128	205	124
$*SD_{5\%}$	**18.1**			

* $SD_{5\%}$ = Significant difference (P = 5%)

on spacing, control plots yielded very high quantities, 164 to 185 q/kh; in spite of that, fertilization still increased the yield by 24 to 28 per cent (Table 21) in both examined stands of different density. In 1960, on the untreated plot, an exceedingly high yield totalling 207—209 q per cad. hold (Table 22) was obtained. Despite this fact fertilizer doses identical with those applied in previous years augmented the yield by 30 to 37 per cent even at this high level. In 1963, the effect of variety, spacing and fertilization was investigated in a factorial experiment. As it is evidenced by Table 23, variety and fertilizer have resulted in a yield difference, but in the examined stands of dissimilar spacing yields have not differed significantly. It is well known that in potato the variety, the quality of tubers has an especially important part in the formation of yield volume, yet fertilization is still the decisive factor.

Let us examine now, how silo maize, one of our most important field mass fodder crops, responds to fertilization. Trials in 1959 were performed on a soil in good condition, consequently, fertilizing augmented the green yield only by 7 to 13 per cent, equalling 32 q/kh in absolute number (Table 24). The increase in dry matter yield was greater, amounting to 16—19 per cent. In 1960 experiments were performed on a poorer soil and as a consequence

Table 22

Fertilization experiments with the potato variety "Somogyi sárga"
1960

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25	50
N	0	25	50
K_2O	0	24	48
Spacings		0.18 m²	0.28 m²

Yield

Spacing / Fertilization	0.18 m²		0.28 m²	
	q/kh	%	q/kh	%
0	209	100	207	100
I	247	118	223	108
II	288	137	269	130

the untreated plot yielded by 100 q/kh less in comparison to the performance of the previous year (Table 25).

This difference was compensated by fertilization raising the yield by 41 to 63 per cent. Increases of dry matter (38 to 66 per cent), starch value (50 to 76 per cent) and especially of digestible protein (89 to 162 per cent) were still more considerable.

Pastures and meadows are, on their present condition, fallows of minimum yield. The development of ley-farming depends also on the augmentation of areal productivity. On and off grazing or even effective weeding cannot essentially modify fodder yield, and continuous irrigation alone, for years over, is damaging rather than favourable. From its present dead lock ley-farming can be removed also only by intensifying soil productivity, i.e. by dressing. First of all, fertilizers must also here be brought in. Experiments conducted by Dőry (Department of Crop Husbandry, College of Agricultural Sciences in Keszthely) have proved the exceedingly favourable efficiency of fertilization; some of his results are presented in Tables 26 and 27.

Table 26 shows the data of a range fertilization trial. By applying a fertilizer combination made up suitably, the yield could be raised to 48 q/kh, i.e. to more than 2.5 times the quantity, obtained on a relatively favourable, or at least medium level (16.7 q/kh). The effectiveness of nutrients given in the fertilizer is also very advantageous (58 to 83 per cent).

Table 23

Fertilization experiments with potato varieties
1963

Varieties	Chemicals / Doses	Fertilization P_2O_5	K_2O	N
		kg/kh		
1. Amsel	I	0	0	0
2. Pierwiosnek	II	44	75	25
3. Epocha	III	44	75	63
4. Somogyi sárga	IV	44	75	94
5. Somogyi korai				
6. Gülbaba				
7. Mindenes	Spacings	62.5×30 cm	62.5×40 cm	62.5×50 cm

Tuber yield

In the average of	q/kh	q/kh	%
Fertilization and spacings			
1. Amsel	136	237	100
2. Pierwiosnek	119	207	88
3. Epocha	138	240	101
4. Somogyi sárga	70	121	51
5. Somogyi korai	150	260	110
6. Gülbaba	130	226	96
7. Mindenes	148	258	109
$^*SD_{5\%}$		**19**	
Varieties and spacings			
I	106	183	100
II	130	226	123
III	137	239	130
IV	138	241	131
$^*SD_{5\%}$		**18**	
Varieties and fertilization			
62.5×30 cm	128	223	100
62.5×40 cm	130	225	101
62.5×50 cm	126	218	98
$^*SD_{5\%}$		**22**	

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 24

Fertilization experiments with the hybrid silo maize variety Mv. 5
1959

Fertilizers	0	I	II
	kg/kh		
P_2O_5	0	25.0	50
N	0	27.0	75
K_2O	0	24.0	60

Yield

Treatment	Green mass		Dry matter	
	q/kh	%	q/kh	%
0	258	100	56	100
I	276	107	65	116
II	290	113	67	119
*$SD_{5\%}$	**11.7**			

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 25

Fertilization experiments with the silo maize variety "Aranyözön"
1960

Fertilizers	0	I	II
	kg/ha		
P_2O_5	0	25.0	50
N	0	37.5	75
K_2O	0	24.0	60

Yield

Treatment	Green mass		Dry matter		Starch equivalent		Digestible protein	
	q/kh	%	q/kh	%	q/kh	%	q/kh	%
0	152	100	3930	100	1621	100	89	100
I	214	141	5411	138	2426	150	169	189
II	250	165	6519	166	2853	176	233	262
*$SD_{5\%}$	**18.5**	**12**						

* $SD_{5\%}$ = Significant difference (P = 5%)

Table 26

Range fertilization experiments in Keszthely
1960

Treatment \ Fertilizers	N	P_2O_5	K_2O
	kg/kh		
1.	0	0	0
2.	16.0	6.5	20
3.	32.0	13.0	40
4.	48.0	19.5	60
5.	62.5	27.0	32
6.	64.0	26.0	80
7.	80.0	32.5	100

Yield

Treat-ment	Hay yield		Efficiency of nutrients	Hay yield per 1 kg of fertilizer agents
	q/kh	%	%	%
1.	16.7	100	0	0
2.	24.9	149	82	19.2
3.	29.1	174	62	14.6
4.	34.1	204	58	13.6
5.	37.5	224	—	16.4
6.	42.9	256	66	15.4
7.	48.0	287	63	14.7

Table 27 informs us of another trial conducted on a range, which was in a highly bad state, yielded without treatment only 2.4 q/kh hay consisting to 35 per cent of sedge and weeds. On this pasture of minimum performance the yield could by a single year's fertilization be augmented to 25 q/kh and, in addition, the proportion of sward components yielding worthless fodder has decreased to 8 per cent. The degree of yield increase was very high, more than 1000 per cent.

Finally in Table 28 an experiment performed for four years on a meadow of higher than medium quality producing 18 to 31 q/kh hay without dressing is shown. In trial "A" farmyard manure supplemented with fertilizers, in trial "B" only fertilizers were applied. The averages of four years reveal that nutrients given in stable-dung and fertilizers showed practically identical efficiency. Yields increased proportionally to manure doses in both trials and amounted to 50 to 60 q/kh hay.

Table 27

Range fertilization experiments in Keszthely
1963

Treatment \ Fertilizers	N	P_2O_5	K_2O
	kg/kh		
1.	0	0	0
2.	16.0	6.0	20
3.	32.0	12.0	40
4.	48.0	18.0	60
5.	64.0	24.0	80
6.	62.5	25.5	32
7.	80.0	30.0	100

Yield

Treatment	Hay (1st moving)		Gramineae and papilionaceae	Sedge and weeds
	q/kh	%	%	%
1.	2.4	100	65	35
2.	7.7	320	74	26
3.	8.8	366	75	25
4.	14.7	612	91	9
5.	17.8	741	90	19
6.	19.4	808	22	8
7.	25.0	1041	92	8
$^*SD_{5\%}$	5.5			

* $SD_{5\%}$ = Significant difference ($P = 5\%$)

Examining the effect of fertilizers either on the yield of cereals, root and tuber crops or on that of mass fodders, meadows and ranges, the conclusion must be drawn that a yield increase of similar degree cannot be achieved by any of the analysed factors. The effectiveness of irrigation not examined in detail here depends also on the development of nutrient supply.

Between fertilization on the one hand and other factors influencing the amount of yield favourably on the other (cultivation of intensive varieties producing rich crop, regulation of spacing, adequate tillage, rational modification of the areal proportion of crops, development of barnyard manure farming) there is such a conceptual difference that may not be neglected. Properly speaking, the latter factors raise the yield without higher additional charges and represent chiefly the utilization of internal farm resources, whereas fertilization

Table 28

Meadow dressing experiments in Berkeháza
1961—1964

Treatment \ Nutrients	N	P_2O_5	K_2O
	kg/kh		
1.	0	0	0
2.	24	9.7	30
3.	48	19.5	60
4.	72	28.2	90
5.	96	39.0	120

Trial "A": N was given to 50% in farmyard manure and to 50% in fertilizers. The P_2O_5 and K_2O contents of stable dung were supplemented by fertilizers to the above quantities.
Trial "B": All plant nutrients were given in fertilizers.

Hay yield

Dressing \ Years	1961	1962	1963	1964	Average	
	q/kh				q/kh	%
Trial "A":						
1.	21.9	31.0	18.3	27.9	25.0	100
2.	27.1	35.9	28.4	37.5	32.3	129
3.	35.9	49.0	36.4	47.6	42.2	169
4.	47.3	58.0	41.7	51.7	49.7	198
5.	57.4	64.0	47.2	53.0	54.7	219
Trial "B":						
1.	27.1	29.9	19.2	30.0	26.5	100
2.	29.3	34.3	28.4	34.8	31.7	119
3.	37.6	45.6	37.2	44.8	41.3	156
4.	50.1	50.1	38.2	50.0	47.2	178
5.	53.4	58.1	48.0	52.8	53.1	200

increases the expenses of growing considerably and can only be covered from external resources. Consequently, in choosing fertilizers and in deciding their quantities the demands of rentability must not be disregarded. It is an important task to determine the factors and laws, which affect the efficiency of fertilizers. This is all the more necessary, because — as it was shown — some experiments evidenced that — sometimes — yield surplus after fertilization failed to come about or was only small.

To find out the reason of this phenomenon is a significant scientific task as well. Though the above-mentioned exceptions affect unfavourably the rentability of fertilization, they cannot — of course — modify the direction of the trend.

Elaboration of the principles for rational fertilization providing lucrativeness is an important objective of scientific research work. More than a half century has elapsed since CSERHÁTI started systematical fertilization experiments. Plant physiology, pedology, agricultural chemistry and crop husbandry have accumulated a large bulk of scientific results and also ample experience in growing is available. We have enough comprehensive and thorough knowledge to warrant the rentability of using large fertilizer doses. In spite of this, there are still many open questions awaiting to be answered by science in years to come. Most important of these is — in my opinion — the following problem. A suitable method — both in principle and for practice — should be found by the aid of which the results of exact scientific experiments can with similar efficiency be adapted to practical farming. As a matter of fact, systematic experimental work cannot be performed in every farm and on every patch, however, preconditions for the efficiency of fertilizers in sample plots are often different from those in the patches of neighbouring farms.

The difference between experimental plot and farm patch regarding phosphorus and potassium is usually spanned over by soil examinations in Western Europe. This work is aided by a lot of data collected from systematic fertilization trials in the course of decades. Accurate results of such amount are not available in Hungary. The most important soil varieties have not been yet investigated country-wide and experimental data gathered in different regions are also inadequate. However, some investigations, e.g. wheat fertilization experiments reported here evidence that between the uptakable phosphate and potassium content of the soil and the expectable effectiveness of fertilizers a connection may also be supposed in Hungary.

Another formulation of this problem is: we are in bad want of an adequate method of consulting fertilization experts.

This lack was of little importance until only small quantities of fertilizers were used. But the higher the expenses of fertilization are, the greater is the weight of this problem both from farm and national aspects.

On the way to solution, the building up of a suitable experimental network is therefore indispensable and urgently needed, because the collection of a sufficient number of data requires many years and, in addition, the consumption of fertilizers will increase at an accelerated pace in the next years.

Beside what was aforesaid the possibilities of increasing efficiency in fertilization must also be investigated to a large extent. But it should equally be examined how to shape the areal proportion of field crops and in what direction to develop stable-dung farming in connection with using large fertilizer doses. Furthermore, plant varieties are wanted by which increased soil productivity can favourably be utilized. In planning experiments on cultural practices and irrigation the desirable development of fertilizer supply must also be considered. Accordingly, all three branches of crop husbandry are confronted with important tasks. But they cannot be solved without the harmonized assistance of pedology, agricultural chemistry, botany, plant protection and many other branches of science.

The knowledge thus piling up will be evaluated by the science of farm management from the aspect of production and lucrativeness. Only scientific activity planned and built up on the broad basis of the same principles is able to cope successfully with the demands made by practice on research work.

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ENVIRONMENTAL INFLUENCE AND SELECTION*

By

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Connected with our genetic conversion experiments being carried out for ten years so as to convert spring wheat into winter wheat, on several occasions the question has been raised what of the genetic conversion might be attributed to environmental influence and what the role of selection might be. According to a rather extreme idea, the genetic conversion is nothing else but selection. Such view was expressed two years ago here in Lund, too, during the discussion of my paper presented at the Second International Wheat Genetics Symposium. Further by several newer evidences I would like to elucidate the role of environmental influence and that of selection in the genetic conversion.

The third cycle of conversion genetics experiments started in 1962. In general the applied methods have been corresponding with those of previous two cycles of experiments (Rajki 1960, 1962, 1963, 1965) with the difference that in the third cycle of experiment only seeds of spikes which bloomed under bag have been used for planting, besides, that each year more autumn sowing dates have been applied than before.

The realization of sowing times method shown in Fig. 1 actually results in launching a new cycle of experiment each year. As to the notations, S means normal spring sowing, W_1, W_2, W_3 and W_4 are sowings of September, October, November and December, while O_1, O_2, O_3 and O_4 are sowings of first, second, third and fourth weeks of October.

The data of the last experiment to be presented here were obtained on the old Russian spring wheat variety, Lutescens 62 obtained by individual selection from a local variety and they related to its single pure line. The role of environmental influence and that of selection in conversion I wanted to demonstrate by data of overwintering, heading dynamics and type of young shoots, whilst, for the sake of brevity, the results of other genetical, moreover physiological and biochemical tests should be now omitted.

In Table 1 the overwintering data of the first three seasons of this cycle of experiment are shown with the variants of 1962/63 and with their progenies autumn-sown in the two subsequent years. With the latters the overwintering mean values of the different autumn croppings were applied. That could

* Paper presented in the IVth Eucarpia Congress (Lund, Sweden) on July 16, 1965.

be done all the more, since with the 1963/64 and 1964/65 progenies of all three variants of 1962/63 the same sowing dates were used. The overwintering values of the first season relate to 30—30, those of the second season to hundreds, and those of the third season to thousands, but in each variant always to near the same number of plants. According to the methods used in the experiment conducted on single plant basis, for the sowing of the 1962/63 variants

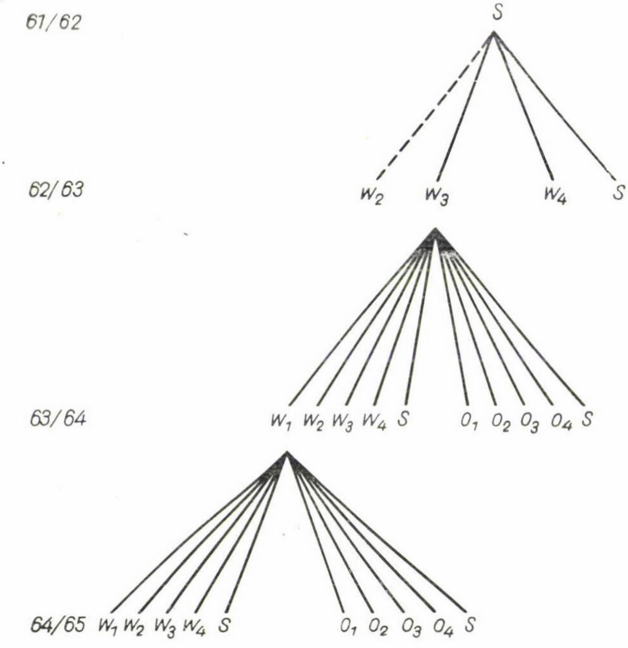

Fig. 1

having been reviewed here, 120 seeds of a single plant that had been blooming under bag in 1961/62, were used in such a way that they were shared into four lots in conformity with the four sowing dates.

In Table 1 the October sowing variant (W_2) cannot be included since the October cropping was killed during the severe 1962/63 winter. Of the early

Table 1

Variants 1962/63	Overwintering, %		
	1962/63	1963/64	1964/65
W_3	6.6	77.2	74.8
W_4	10.0	65.3	58.4
S	—	61.1	62.9

November cropping (W_3) 6.6% of plants, of the early December cropping (W_4), however, 10.0% of plants overwintered, both variants in a very weakened state. Taking again into consideration that all the evidences of this experiment relate to the progenies of a single plant and all plants have bloomed under bag, moreover, conferring, in the second and third seasons, the overwintering values of progenies of plants having overwintered in the first season

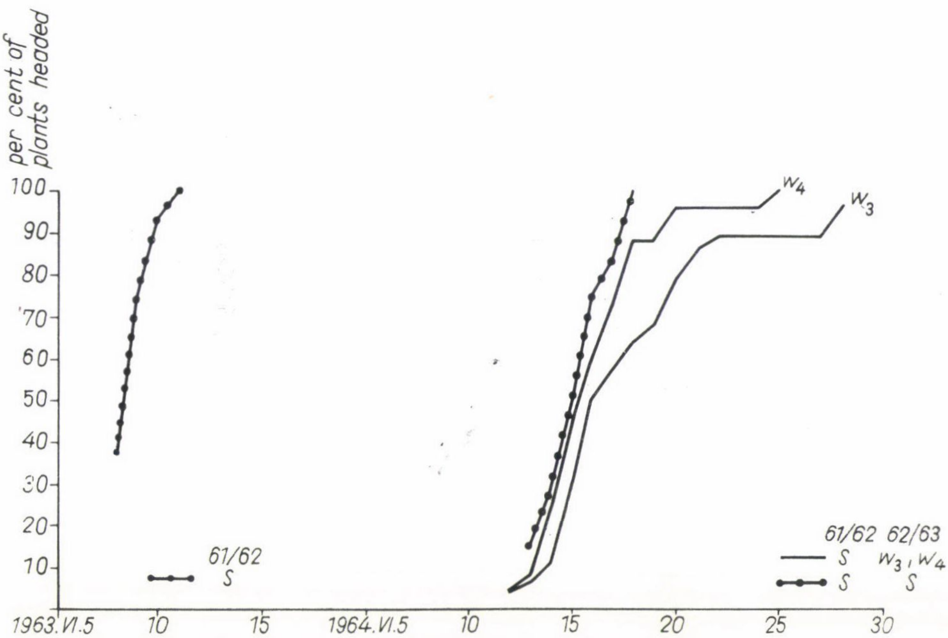

Fig. 2

with those of plant progenies having originated from the first season's spring cropping (S), it can be stated that the severe winter of the first season did not select winterhardy plants within the pure line.

In each case the heading dynamics were established with the variants sown for progeny test in spring (S). The curves of 1963 and 1964 each was made on the basis of heading data of about 30 plants, however, each of the curves of 1965 related to the heading data of, in general, 60 plants.

The left-hand curve of Fig. 2 shows the heading data of the original plants in spring sowing of 1963. The right-hand curves, however, show in spring cropping of 1964 the heading dynamics of previous season variants, thereof two were autumn-sown and one spring-sown. As it is apparent, the heading of variants sown in early November and early December of the previous season, was late by about 10 days as compared with the permanently spring-sown variant (SS). With the progenies of a single plant, all the plants having bloomed under bag, such variation observed in heading cannot be ascribed to selection influence, all the less, since the heading variation amplitude established in the subsequent spring season progeny of autumn croppings exceeds significantly the variation amplitude of the variants (S and SS) sown permanently in spring and having the same origin as the preceding ones. Consequently the former could not be selected from the latter. As the single reason for the late heading, the autumn sowings of the preceding season might be only supposed.

This supposition gets confirmed by the curves of Fig. 3, mainly by the left-hand ones. Influenced by the repeated autumn croppings the heading variation amplitude has grown even wider. The plants of one variant (SW_3W_1) did not head at all in spring cropping, they showed a winter habit. On the basis of the analogy of test cross results in the former cycles of experiments (RAJKI 1962) and of progeny test results, the plants of this variant influenced by two proper autumn croppings, are to be considered as genetically converted into winter ones.

It has to be mentioned that instead of erect type of young shoots being characteristic to the spring habit plants, the type of young shoots of the converted plants (SW_3W_1) has become prostrate being characteristic to the winter habit plants. At the same time in several of the variants headed partly (SW_3W_{2-4} and SW_3O_{1-4}) the type of young shoots was semi-erect, even prostrate as compared with the erect type plants of the variants being sown continuously in spring (SSS).

In spring cropping of 1965 the heading curves of the variants spring cropped in 1964 after an early November sowing of 1962/63, show that the effect of a single proper autumn cropping can be demonstrated — without significant modification — in the second spring cropping, too. (Cf. the variants of SW_3S in Fig. 3 and of SW_3 in Fig. 2!)

The middle curves of Fig. 3 show that though in the previous season the heading variation amplitude as the effect of early December sowing completed two years before, has remained, but influenced by the additional autumn cropping (W_{1-4} and O_{1-4}) it has not progressed any more. The reason, presumably, is to be found in the early December cropping of 1962/63, that, according to the supposition expressed already connected with the preceding cycles of experiments, did not provide proper basis for additional widening the heading variation.

The tendency of the right-hand curves in Fig. 3 is essentially corresponding to that of the right-hand curves in Fig. 2. This is not surprising since they are substantially the same variants (SW_{3-4} and SSW_{1-4} and SSO_{1-4} respectively) but in the spring croppings of two subsequent seasons. It is of interest to mention here that the overwintering values of the preceding variants (SW_{3-4}) were 6.6% and 10.0%, respectively, whilst those of the latter variants (SSW_{1-4}

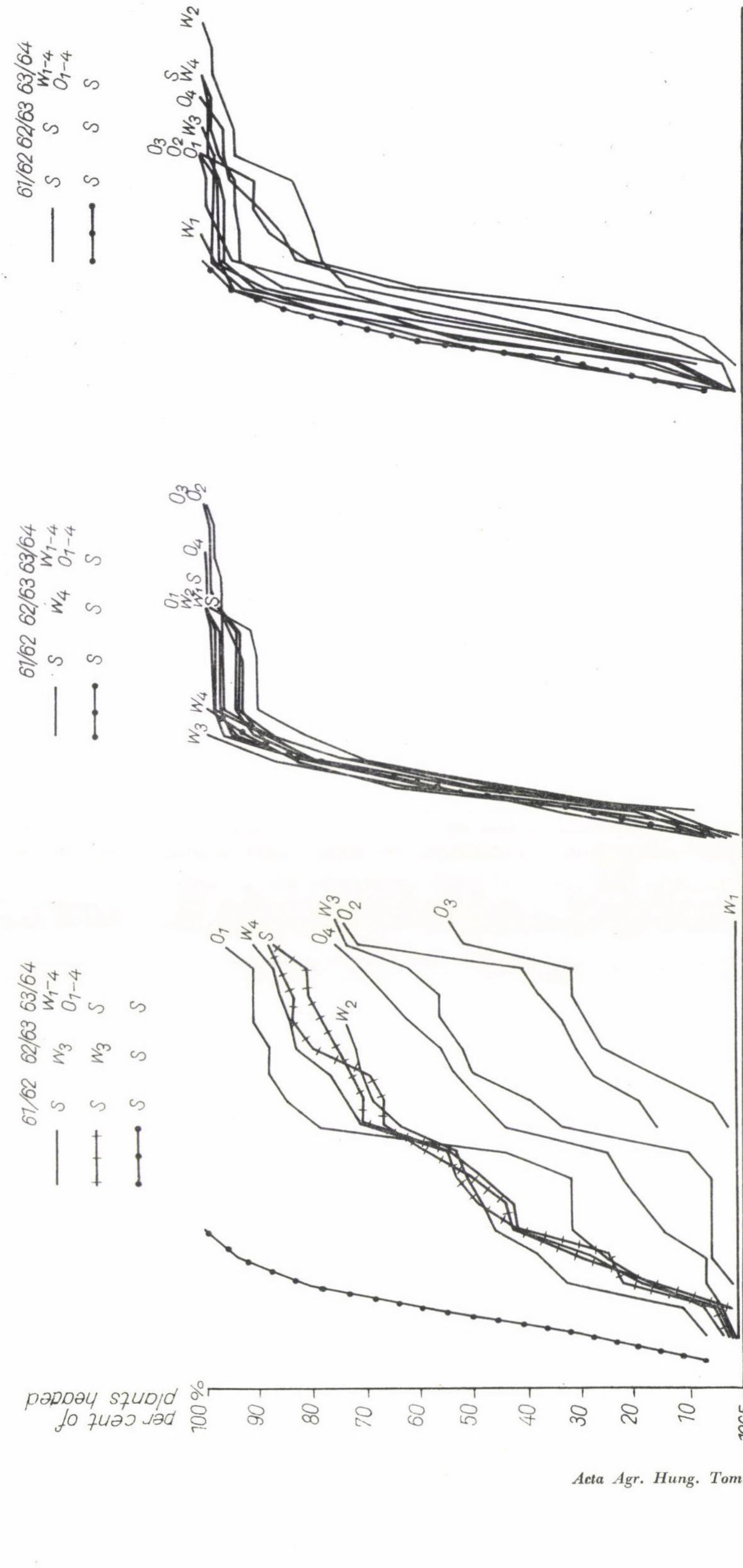
per cent of plants headed
100 %
90
80
70
60
50
40
30
20
10
1965
VI.13
15
20
25
30
61/62 62/63 63/64
S W3 W1-4
S W3 O1-4
S S S
61/62 62/63 63/64
S W4 W1-4
S S O1-4
61/62 62/63 63/64
S S W1-4
S S O1-4

Fig. 3

and SSO_{1-4}) 61.1% (mean value). This confirms again the above-mentioned statement on the neglectable effect of selection in genetic conversion.

Consequently, the widening of the heading variation — from spring type on to winter type — as stated repeatedly in the conversion genetics experiments is to be basically attributed to environmental influence and not to selection.

Otherwise, the investigation of biochemical genetics mechanisms of conversion has been going on (RAJKI 1965), the results thereof are to be said next.

The author would like to express his gratitude to all his colleagues for their assistance in the field and laboratory work, of them to Mrs. I. JEHODA and Mrs. M. KOVÁCS by name, too.

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VARIA

State certified plant varieties

Tomato "Kecskeméti Konzerv" (Canning)

Origin: K 363 ♀ × K 42 ♂
K Konzerv

Beginning of breeding: 1953
Breeders: Dr. Gyula Mészöly and Béla Báldy
Year of qualification: 1964
General plant characteristics: 70—80 cm high, half determined type, developing abundant dark green foliage, productive, mid-season, vital variety.

Root system: the deep reaching rich root system utilizes well the humidity of the soil.

Foliage: The dark green leaves are deeply lobed, the leaflets sitting on short leaf stalks. The leaf blade is sparsely haired. The foliage shades well the berries.

Stem: Vigorous, sparsely haired. Joints short. Tillering.

Inflorescence: Flowers large, of vivid yellow colour, with 5—7 petals. Stigma strong, of medium length, completely covered by the synandrium.

Fruit: Berries somewhat oblong, of intensive red colour when ripe. Mean berry weight 100—120 g. Berry index 0.85. The pulp thick, red coloured, skin yellow. The hard berries are resistant to transportation. Number of septa 3—5. Seed yield low.

Data on production: According to national variety trials it has exceeded the varietal mean by 19 to 23 per cent in total yield.

Since 1960 included in national production with an ever growing area. In 1965 the variety has been grown on nearly 70 per cent of the area contracted for canning purposes.

Soil requirements: can be successfully grown both on soils of sandy and heavier type. Under drier climatic conditions supplies a high yield even with 550—600 mm mean annual precipitation including 400—420 mm during the vegetation period. When grown without irrigation, in the case of deep ploughing in the autumn, 250 q organic manure per hectare and 13 q mixed chemical fertilizer used, a total yield of 330—400 q/ha can be reckoned with depending on the year. More calcareous soils should be given the preference in growing.

Nutrient restitution can be recommended for soils of 7.5 pH (KCl) and per cent Ca values according to the following proportions as related to pure active agent: N: 120 kg, P: 120 kg, X: 70 kg.

Maturation: Ripening begins in 112—120 days after seeding. Ripening period 6 to 10 weeks. The number of berries per kg is 8 to 10.

Average analytical data:

Refr.%	Sugar	Acid	Vitamin C mg/100 g
6.5	4.0	0.38	26.4

Colour of concentrates excellent.

Mean data of pure analyses:

Total score (max. 110)	Colour (max. 40)	Flavour (max. 40)	Aroma (max. 10)	Substance (max. 20)
94.3	34.7	34.4	7.7	17.5

Consistency	Sugar	Acid
7.67 mm	16.3%	1.54%

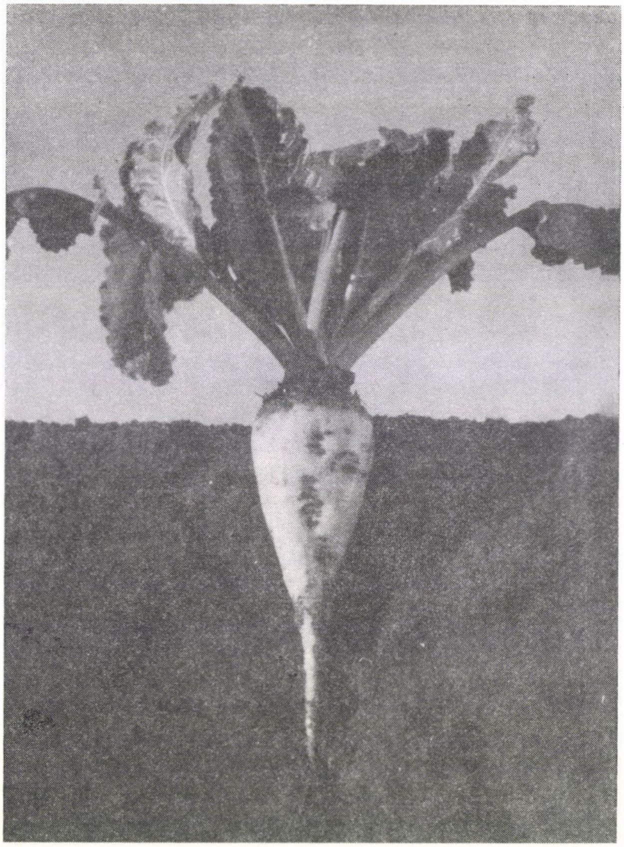
Total carotenoid stain = 580 /g.

Lycopin = 560 /g.

Resistance to diseases: Resistant to Fusarium and Verticillium, moderately damaged by fungus diseases of the leaf. Exhibits a certain tolerance to TMV.

Growing area: Europe, North and South Africa, North America.

Sugarbeet BETA poly 4



Origin: An anisoploid sugarbeet variety originating from the cross between the parent components BETA TETRA K. 720 and the diploid BETA E. III. Its seed originates from harvesting together the seed grown on the two components at a 3 : 1 ratio.

Beginning of breeding: 1952.

Breeders: Antal Csitkovics and András Varga.

Year of qualification: 1965.

General characterization of the plant: Characteristically of the hybrids in general, its stand is somewhat not uniform. Foliage is of a darker green colour, very abundant, of a somewhat silvery shine. Root and mother beet forms agree with the diploid varieties.

Morphological description:

Root: The body of the beet is shallowly furrowed, its becoming slender rather gradually, owing to which property it is easy to lift although the body is sitting in the ground. Ivory-coloured, on the body of the beet colouring is not frequent. Fertility: "E", sugar content: "N". Noxius ash content low.

Foliage: Very abundant, healthy, somewhat silvery green coloured. The leaf blade is weakly curled, shorter, broader and thicker than in the diploids. Petiole also shorter and thicker.

In the axil of the seed bearing leaf and on the stem of the beet sometimes a weak rosa colouration can be considered as characteristic.

Stalk: The seed stalks are rather even. The main shoot can in most cases be hardly distinguishable from the subsidiary shoots.

Moderately red colouration may extend in stripes to the stalk.

Inflorescence: BETA vulgaris type with polycarpic character.

Fruit: Polycarpic.

Data on production: Very large yield of roots and healthy tops with leaves. Excellent root growing capacity. Useful sugar yield per unit area very high.

Noxious ash and nitrogen content low. A great advantage is its extraordinary resistance to Cercospora. Drought tolerance outstanding.

Development: Initial development exceedingly rapid as compared with the varieties grown up to now.

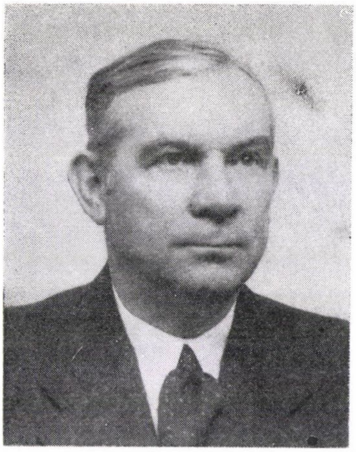
Soil requirement: Not very demanding but responds favourably to a good cultural state and richness in nutrients.

Maturation: Under conditions prevailing in Hungary supplies highest sugar yields per unit area when picked in mid-October.

Resistance to diseases: Exceedingly resistant to Cercospora.

Growing area: Can be successfully grown in all sugarbeet growing soils and regions of the country. Can be grown also in the regions of dryer climate in Europe, Asia Minor, North Africa and South America.

CHRONICA



ÖDÖN VILLAX *

1899—1964

Recently has the sad news reached us that the one-time distinguished personality of Hungary's plant breeding, ÖDÖN VILLAX deceased of a sudden heart attack in Madrid aged 64 on 4 April 1964. In him we deeply regret the loss of a highly estimated Hungarian expert. He had passed — however — from among us much earlier as some 16 years ago an unknowable decision of his had made him abandon his native country and thus excluding himself from the reconstruction of this country he had regrettably chosen the bitter lot of expatriation. We had felt, already then, of sorrow at his departure so much the more do we now when departed this life.

ÖDÖN VILLAX had no compelling reason to abandon his country and his beloved occupation. At that time he had been a valued and distinguished leading personality. Many of us reckoned on his work performed with so much skill and so did the leaders of the country and the Hungarian people itself. ÖDÖN VILLAX did not choose — however — this way and although with his work abroad he only enhanced the appreciation of Hungarian specialists; this of course could not fill the gap left behind with his departure.

ÖDÖN VILLAX was born in Karancsberény (Nógrád county) on 23rd September 1899. His father, Dezső Villax was a certificated agronomist, his mother's name was Anna Schandl. Having done his grammar school studies at Veszprém then at Bonyhád he passed there his final examination from school his way led straight into the war. It was not until he had demobilized as a lieutenant that he went on with his studies at the College of Agriculture

* Commemoration held at the session of the Commission for Plant Breeding of the Hungarian Academy of Sciences.

in Magyaróvár where he obtained his diploma in 1921. Soon after he entered into the service of the National Institute of Plant Breeding, where he worked until 1926 and then changed for the Experiment Station of Plant Production. Here he worked — with shorter interruptions — for a decade as a co-worker of János SURÁNYI. His first work was published then: "A szántóföldi kísérletezés gyakorlata" (The practice of field experimentation, 1927). He also wrote several special articles and finished his complementary studies at the University. After having absolved at the agricultural section of the faculty of National Economy the differential studies for certificated agronomists he graduated from the University in 1929. At that time his second significant work appeared under the title: "A lápgazdálkodás alapelvei" (Principles of Farming on Marshland, 1929). In 1930 he collaborated with SURÁNYI on his new work "A rétek és legelők termőképességének fokozása" (Increased Fertility of Meadows and Pastures). Subsequently, he made his doctoral dissertation and became — in 1931 — Doctor of the Agricultural Sciences with the grade "summa cum laude". In the meantime he had been working for a short period (Sept. 1930—Febr. 1931) at the Experiment Station of Tobacco Growing in Debrecen and wrote another short book, "Útmutató a dohány trágyázására" (A Guide for Fertilizer Application to Tobacco, 1931). In the same year another book of his "A lucerna termesztése" (Lucerne Growing, 1931) appeared.

On coming back from Debrecen to Magyaróvár he started to write in collaboration with SURÁNYI, a new modern work on maize "A kukoricafajták és termesztésük" (1932) which was published also in German (Maissorten in Ungarn) and English (Varieties of Corn in Hungary). This is the first thorough discussion of Hungarian maize varieties and at the same time a high level summary of Hungarian maize growing.

In 1932 he was entrusted by the Ministry of Agriculture with the reorganization of the exhibition of plant production and plant breeding in the Museum of Agriculture and in the same year he obtained an assignment to lecture on plant breeding and genetics at the College of Agriculture in Magyaróvár. As a professor he had conducted his work relentlessly for one decade and a half.

His highly successful work "Szántóföldi herefélék" (Field Clovers) appeared in 1933, this book of his dealing with lucerne was in the second edition extended to other clover species. Too in the foreword, he emphasized that he had been stimulated to write this book by the fact that in Hungary "extensive and up to date clover production is of special importance". The book covered also his experimental results obtained in Magyaróvár, and being published soon also the second volume: "Hüvelyesek" (Legumes, 1935) the series of Field Papilionaceae became complete.

In 1936 he returned to the National Institute of Plant Breeding of which he became director in a few months time and herewith inspector of plant breeding and seed growing of the whole country. As early as the first period of his activities he joined in the preparation of a decree brought out in 1936 which declared, that only varieties having been confirmed as satisfactory ones in the preliminary trials conducted by the National Institute for Plant Breeding can obtain state certification be satisfactory.

In quick succession he participated in producing two works: "A talaj termőerejének fenntartása" (Maintenance of Soil Fertility) was written with co-workers and appeared in 1936, while his popular work: "Növénytermesztés"

(Crop Production) was published in 1937 and ran into four editions within ten year's time.

The publications discussing the work of the National Institute of Plant Breeding were issued continuously: "Nemesített növényfajták jegyzéke" (Register of Improved Plant Varieties, 1938, 1939, 1941, 1942, 1944) and "Magyar nemesített növényfajtákkal végzett kísérletek eredményei" (Results of Experiments with Improved Hungarian Plant Varieties, 1939, 1941, 1943). In these publications he performed a zealous work. It is his great merit that he assumed an outstanding role in the preparation of the decree appeared in 1941 on the state regulation of the certification of varieties. VILLAX (1944) had every right to stress that this regulation "marks a turning point in the history of Hungarian plant breeding". Within the meaning of that decree "the sale of the seed of plant species with indication of the variety falls to the full extent within the regulation which divides the varieties in two great groups: those not under legal protection and those under legal protection which obtained state qualification".

"Általános növénynemesítés" (General Plant Breeding) as the first volume of his book entitled: "Növénynemesítés" (Plant Breeding) came out in 1944, while the second volume "Különleges növénynemesítés" (Special Plant Breeding) only in 1947 with the co-operation of several Hungarian breeders of distinction (FLEISCHMANN, HORN, UDVAROS, SEDLMAYR, BERZSENYI-JANOSITS) and a geneticist (GYŐRFFY).

In the period between 1941 and 1945 he had been leading as director general the National Experiment Station of Plant Production temporarily amalgamated with his Institute and then separated again, and finally he also obtained the title of deputy undersecretary of state.

In the interest of the development of plant breeding he established several training courses in the framework of which he cared partly for the instruction of the rising generation of plant breeders and partly for the training of good professional attendants. Also by means of national conferences and inquiries he promoted the cause of Hungarian plant breeding. On several occasions he adequately represented abroad the Hungarian plant breeding as well as in his study tours he was always led by the intention of using the results obtained in foreign countries for the development of Hungarian plant breeding.

His valuable activities came to a sudden end in 1948 when he left the country together with his family. From March 1949 to October 1951 he had been working in Clermont-Ferrand, France, at the Centre de Recherches Agronomiques and from November 1951 until June 1958 as a co-worker of the Estacao de Melhoramento de Plantas in Elvas, Portugal. Here he came upon the invitation of the Portuguese government which invitation in view of the more favourable financial conditions, was readily accepted by him. While in France he was mainly concerned with the breeding of maize and fodder plants and with the amelioration of the meadows and pastures of Massif Central, in Portugal his task was chiefly the breeding of legumes and the production of a cereal species by means of wheat-rye crossings more suited for the soils of low quality of this region. In Elvas VILLAX succeeded in breeding 16 *Triticale* varieties and thus was the first to breed *Triticale* in the Iberian peninsula.

From June 1958 until his death he worked in Rabat, Morocco, as a co-worker of the "Institut National des Recherches Agronomiques" at first as leader of the section of fodder plants and medicinal herbs and later as leader of the station. He relentlessly worked in Morocco giving lectures all over the country and conducting experiments. In Morocco it was he who introduced the practice of ensilage.

During his activities in foreign countries he produced a number of papers on various subjects and took part in many international conferences. In 1961 he started to write the last great work of his life. This work under the title "La culture des plantes fourragères dans la région occidentale du bassin méditerranéen", on 600 pages, with rich illustration appeared to be his last work because in the circle of his family he had referred to it often as to his "swan-song".

Ödön Villax during his rich busy life has created and organized a good deal. More than thousand scientific papers, articles, mainly in Hungarian, but also in German, English, Italian, French and Portuguese testify for his immense working capacity. All these constitute a valuable addition to Hungarian special literature on plant production and breeding. He is one of our often mentioned and cited authors even to-day. When we with deep regret commemorate his decease in a faraway country we still feel that in his works he continues to live among us.

Gy. Mándy

JÓZSEF SCHNEIDER

1888—1963

J. SCHNEIDER was born at Alsószeleste (county Vas) on November 30, 1888. His father had been the gardener of baron MIHÁLY BAICH, and had contributed to setting up the arboretum now being directed by the Council of Nature Conservation. From this thoroughly horticultural milieu he got, after his secondary school studies, to the European-famed garden of archduke JÓZSEF HABSBURG at Alcsút, in the year 1903. Here he acquired the practice necessary for gaining admission to the Horticultural College which he entered in 1905, and where he finished his studies with distinction. After taking his degree, he went, as holder of a scholarship, to Germany, Switzerland, England and Belgium in the years 1908—1911, thus improving his horticultural and botanical knowledges. It was the practice gained in the Zürich and London (Kew) botanic gardens that enabled him to take up a leading post at the botanic garden of Pázmány Péter University in 1911. In the course of his activities he organized and directed the growing of plants required for demonstration and experiments, and also took part in the practising work organized for students of the teachers' training college. For long he had been in charge of the library and the herbarium of the botanic garden. From the year 1911 until his death he had been organizing and compiling the lists of seed exchange (Delectus seminum) and it was he who provided for settling the international seed-exchange.

In the years following World War I he reorganized almost entirely the stand of plants that had been deteriorated in the war making use both of domestic collections and the stand of foreign botanic gardens. At the International Horticultural Congresses in Vienna (1927) and in London (1930), he was a member of the committees for judging plant properties.

His extremely vast educating activities ranged from the popular lectures, through training skilled workers, teaching in technical colleges up to the high-levelled horticultural education. In the years 1916—26, throughout a whole decade, he had been teaching the growing of ornamental plants, dendrology and the growing of medicinal herbs at various institutes. Besides these regular teaching fields there was hardly any such institute, association and organization in which he would not have led courses, delivered lectures. In most cases he was the organizer and leader of study excursions connected with growing ornamental plants. In the capacity of an expert, he had always co-operated in planning garden lay-outs of importance.

As organizer and leader of horticultural exhibitions he had been many a time rewarded for his useful work.

As an active and constant participant in horticultural events, he was — from 1912 — committee member of the National Horticultural Society, member and president, respectively, of the committees qualifying assistant gardeners, member of the committee judging plant properties, referee of the dendrology section, vicepresident and president of society.

His vast literary activities concerned almost every field of horticultural growing. His original articles have been published in books and papers, while his linguistic knowledge made it possible for him to review the important foreign special literature in Hungarian papers. In this country he was member of the Society of Natural Sciences and of the Botanical Section, honorary member of the Society of Hungarian Aquarists, while abroad he was member of the German Dendrology Association and of the Cactus Society. He described and introduced several horticultural plant-properties in our country; even some horticultural varieties bear his name.

In hard times during the siege of Budapest and the destruction that followed, he saved up immense scientific values, — library, herbarium and plantstand. He took a great share in the work of reconstruction. His manifold activity had been appreciated on several occasions: in 1961 he was awarded with the "Golden Diploma" of the School for Horticulture, and the governmental distinction "Outstanding Worker of Agriculture"; or in 1963 the commemorative medal "Entz Ferenc".

Due to his kind personality, his helpfulness, he was highly esteemed and beloved by gardening experts of all degrees. In professional field, he had always been the centre of collective actions. In fact he was, right until his death: one of the most popular and most appreciated personalities of Hungarian gardening. The sincere compassion and sympathy having been manifested on the occasion of his funeral in 1963, was meant not only for the scientist but just as well for the man.

J. DOMOKOS

MIKLÓS HORN

1899—1965

On August 3rd 1965 MIKLÓS HORN one of the most outstanding specialists of Hungarian plant breeding deceased. His interesting, colourful personality, his knowledge and love of nature his humanity and attachment in spite of his foreign origin, to the Hungarian soil and people, his unparalleled assiduity and puritan attitude have composed an exemplary course of life. Our esteem and sincere affection accompany his memory and range him among the greatest Hungarian agricultural research workers.

He was born in Odessa, Russia, October 22nd 1899 where his father — a German citizen born in Riga — had worked as a commercial employee. After concluding his secondary school studies in Moscow his parents moved, in 1919, after world war I, to Berlin, here, he embraced the agricultural career but owing to the difficult financial conditions of the family he was compelled to acquire money necessary for university studies by teaching. From the Agricultural College, he graduated in 1921 and after further studies obtained a diploma of plant breeding in 1923. He had been studying the theory of plant breeding in the Institute of the world-famed Professor E. BAUR and working for a year at one of the best German plant breeding stations of this time (STRUBE, SCHLANDSTEDT).

As for plant breeder-manager he obtained — in 1923 — an invitation to the estate of Count Pál ESZTERHÁZY and at Lovászpatona he founded a plant breeding station having been directed by for 38 years, until his retirement on December 1, 1961.

Here in the Hungarian region of Bakonyalja has MIKLÓS HORN learned to love his new country and became her faithful son until his death.

With a most comprehensive knowledge of natural sciences his activities as a plant breeder were directed towards a number of plant species. He has attained his greatest success with the breeding of rye. The *improved Lovász-*

patonai rye variety obtained, as soon as in the thirties, state certification and still before World War II was awarded the highest degree of qualification: state registration. This variety is still the best Hungarian rye and much in demand also from abroad, especially from England. Its seed is exported in a considerable quantity.

The winter wheat *Lovászpatonai 160* had been in its time the best variety of the mountain region of Bakony, as well as the *summer barley Lovászpatonai* having been current all over the country. The *white oat Lovászpatonai* had been bred under intensive conditions while the *yellow oat variety Lovászpatonai* widespread in Hungary under more extensive ones. There had long been state certified and widely grown varieties the maize *Lovászpatonai korai fehér* (early white) and the *Lovászpatonai sárga lófogú* (yellow dent corn), the millet varieties *Lovászpatonai pirosmagvú* (red seeded) and *Lovászpatonai óriás magvú köles* (giant seeded). Until these last years *Lovászpatonai napraforgó* has been a nation-wide grown sunflower variety.

Also remarkable successes were obtained by the production of potato varieties mainly of high yielding farm ones well adapted to the conditions of the Bakony region (state certified variety *Öröm).*

He had a marked preference for the Trifolium species. Until the present day *Lovászpatonai bíborhere* (crimson clover) and *Lovászpatonai fehérhere* (white clover) have been our best certified varieties. Only his most important plant varieties have been mentioned here. In the course of his life he had produced 18 plant species that obtained state certification.

After the Liberation he pursued with unparalleled zeal his work. Struggling against many difficulties he still succeeded in developing, without hesitation, the Breeding Station Lovászpatona into a well working institution. In spite of his advanced age he completed and defended most successfully his Candidate Thesis in 1958.

Since 1962 he had lived in Győr as a pensioner but never for a moment did he detach himself from the work and his beloved profession, plant breeding. As a result of his active work conducted for 38 years his varieties are grown even now on several hundredthousand hectares and they constitute the best evidence for his scientific merits which were rightly acknowledged by our government with conferring upon him two distinctions (1955, 1958).

The memory of MIKLÓS HORN, the scientist faithful to the people, the simple, warm-hearted friend serves, still after his death, as a prominent example for the younger generation of breeders.

A. JÁNOSSY

RECENSIONES

S. Sárkány—I. Szalai: *Növénytani praktikum I. Növényszervezettani gyakorlatok.* (Practical Lessons in Botanics. I. Organization of Plants.) Second improved and enlarged edition. Tankönyvkiadó. Budapest. 1964.

Nearly ten years ago the appearance of the first edition of this book was a significant event of the special literature on botanics since no such work has been published in Hungarian as yet except for some mimeographed university lecture notes on the methodics of the knowledge of plant organisms and their use on a selected material. Students, however, have long been in want of such work in Hungarian and nothing proves more such a demand to be surviving than the fact that the first edition soon after its appearance went out of print and it has become necessary to publish the second, improved and enlarged edition.

Although prior to the present work a number of books of similar objective had been available abroad in many editions with rich material for those who understand foreign languages, the authors were not contented with transplanting simply any of these materials without criticism but published a book that can be considered as new since it is genuinely elaborated in many details and contains a good deal of new materials. It is a great merit of the authors that they have taken under revision nearly the whole of their subject matter asserting the modern results of research in all parts of the work. Thus the book is not a simple adaptation of prominent foreign works into Hungarian but as a whole an original elaboration of the pertaining material. The second edition has provided a new possibility to publish also the results of the last ten years.

The book deals with the "practical" material of the knowledge of the organization of plants in six chapters, on 708 pages.

Chapter I ("Morphological examination of type plants") presents the morphological characters of the well known representatives of our flora. It starts from the most developed plants known already in detail such as: *Ranunculus acer*, *Sinapis alba*, *Consolida regalis*, *Pisum sativum*, *Althaea officinalis*, *Datura strammonium*, *Ricinus communis*, *Lamium album*, *Stachys annua*, *Foeniculum vulgare*, *Calendula officinalis*, *Crepis rhoeadifolia*, *Colchicum autumnale*, *Pinus silvestris*, these are followed by the representatives of the main groups at the lower plants, the more common species of ferns, mosses, fungi, lichens and algae. The detailed morphological knowledge of these informs the student on the main forms of body formation in the vegetable kingdom. The knowledge of the single species is facilitated by original morphological drawings.

Chapter II ("Cytological examinations") discusses the live substance and products of the plant cell which can be studied by simple methods of examination. Here knowledge is obtained, on a selected material, of the building up, construction, microscopically observable properties of the cell and the most important cell components are demonstrated, too.

Chapter III ("Cytological examinations") presents simple tissues and tissue systems building up the body of the plants and the student gets acquainted with the tricks of the simple histological technique. Information is given on the relationship of elements constituting the tissues among themselves and in space and thus necessary directive is obtained for the study of the interior structure of organs.

Chapter IV ("Histological structure of plant organs") discusses the microscopical examination of the vegetative and reproductive organs of higher plants. A thorough knowledge of the histological construction of the plant body can already develop the necessary proficiency and ability for comparative anatomical studies.

Chapter V ("The organizatory conditions of the plant body") mostly presents the body organization and ontogeny of the Spermatophytes from seed to fruit formation, but some examples refer to lower plants. In this chapter the reader will get acquainted with the methods of complex morphological analysis and the regularities of body organization.

Chapter VI ("The principles of microtechnics and ultra microtechnics in plants") is a summary of the principles of microscopic and ultra microscopic technique. Here a knowledge of construction and manipulation of light microscopes and electron microscope as well as of the modern technique of light- and electron-microscopic preparations can be obtained. At the end of the chapter some important microchemical proceedings used in plant microtechniques, the outlines of the history of plant microtechniques and the techniques of the preparations for electron microscopic examinations are discussed.

The extremely instructive book is completed by a detailed review of literature, an explanation of the origin of foreign *termini technici*, register, index and table of contents.

When reading the book we get more and more convinced that the authors prefacing it have not without sufficient reason outlined their aim as "To enable the students, as a means of education to independent work, to acquire a certain proficiency in the main questions of plant organization." We are convinced that the authors have fully succeeded in doing so.

GY. MÁNDY

P. KOZMA: *Szőlőtermesztés I.* (Viticulture I.). Mezőgazdasági Kiadó. Budapest, 1964.

Hungarian special literature has been enriched by a very valuable work with the publication of "Szőlőtermesztés" (Viticulture) written by the professor of the Department of Viticulture at the College for Horticulture and Viticulture in Budapest (the book has been planned for 2 volumes of which the first one is published now). This volume is not only a very valuable product of our special literature on the subject, as it discusses an important branch of the Hungarian people's economy but it is also a work of great significance. By summarizing in the first volume (containing 312 pages) — as the author himself states in his preface — the biological principles of viticulture, thus supplying the botanical knowledge of the vine plant, the book indicates the unique possible pathway for to-day and for the future and a conception that can solely lead to good results. As a principle of modern growing, the old practice based on purely empiristic grounds is more and more definitely replaced by the endeavour to begin the *science* of growing first of all with the knowledge and further development of the theoretical foundations and by research work conducted in this field. Without further development of ground sciences the knowledge of growing cannot adequately develop and on the other hand both the practice of growing and the scientific research of the issues in production supplies many ideas and problems for the ground research to which the solution can only be found by the methods of the latter. Thus the work of KOZMA while offering the theoretical foundations of viticulture and being constructed for the practice, in its first volume may be qualified at the same time as a botanical compendium in which a summary of all knowledges is found that has been for the cultivated vine plant expounded so far by the botanical science. In the first volume of the work the author proves the inseparable unity of ground research and science of growing, i. e. to attain the objective both trends are indispensable.

The author's peculiarity is that he has entirely transferred the principles laid down in this volume into his own research work and not being satisfied at all with the knowledge of practical issues of growing he did penetrate into the depths of the ground science to such an extent that not only feels quite at home in that field but he has enriched the ground science with new results of basic significance in several directions. Only hereby has he attained the fame that makes him mention among the best known specialists of viticulture, even in international aspect, as a scientist working on the most up-to-date basis. The thorough and wide work achieved is sufficiently evidenced by the review of the literature at the end of the volume, listing more than 800 references.

Chapter I of the work deals with palaeobotanical knowledges concerning the vine, evolution of the garden vine which is illustrated with a map of spreading, too. This is followed in Chapter II by the botanical description of the family *Vitaceae*, by subdivision of the family and of the subgenus *Vitoideae*. The reconciliation of the different systematical conceptions may be of great interest here.

The next Chapter includes the morphological description, ontogeny and growth of the vine plant propagated from seeds and vegetatively, always extending to the knowledge of factors influencing development. In connection with the stem the types of pruning, with the leaf the differences in form and hairs so important from ampelographic point of view, with the buds, beside their morphological differences, their differentiation, morphological and histological organization are discussed.

Next follows the description of inflorescence in detail, finally the much detailed discussion of the flower, based for the most part on the author's own issues. A number of types are distinguished here part of which is based on sexual distribution and proves to be teratoma from botanical aspect, without a thorough knowledge of which there can hardly be question of increase in the yield of vine on a scientific basis. This part is followed by the discussion of the morphological properties of clusters, berries and seeds.

Chapter IV deals with the anatomical construction of the vine plant written by Á. HEGEDÜS. This chapter elaborates in full detail the anatomical conditions of the vine plant which have an importance for the practice first of all in the determination of degree of maturation at the vine-shoot then, in their thickening and histological knowledge of the graft welding grafts.

The discussion of the anatomical properties of types and type-varieties of flowers exhibits again the results of the very thorough and detailed work of KOZMA. This part includes the cytological conditions of the vine.

Chapter V on the metabolism of vine is the work of J. EIFERT. This is the physiological chapter of the work dealing with inorganic nutrition, assimilation, metabolism of carbohydrate, protein and other substances, colouring matters and tanning agents on a phytophysiological basis.

The subject of Chapter VI is the ecological factors of viticulture, its climatic, soil conditions and drought possibilities.

The concluding Chapter VII deals with the life stages, biological cycles, vegetation phases of vine, among others bleeding, budding, growth of the shoot, flowering, pollinating and fertilization, abscission of the flowers and its causes, growth and ripening of the berries, maturation of the shoots and the period of rest of the vine (dormancy) are here discussed. The work is closed by the very detailed classified list of references and by a table of contents.

176 Figures and 44 Tables greatly enhance the easy use of the work which is excellently and logically arranged and easy to survey. The book has been carefully edited by the Publishing House for Agricultural Books and Periodicals in Budapest.

One more remark to finish. Hungarian viticulture is world-famed. The comprehension and experience of Hungarian specialists could be needed far beyond the frontiers of the country. This, however, is limited by the isolation of our language. It would therefore be desirable that the works of KOZMA may appear also in foreign languages.

Z. E. KÁRPÁTI

V. WESTSIK: *Vetésforgókisérletek homoktalajon* (Crop Rotation Experiments on Sand). The 30-year results of crop rotations at the Farm for Experiments on Sand in Nyíregyháza. Publishing House of the Hungarian Academy of Sciences, 1965. 208 pages, 18 Figures, 58 Tables.

In research work on farm technology the long-term experiments of several decades represent a special value. Dr. VILMOS WESTSIK as director of the Farm for Experiments on Sand in Nyíregyháza had been studying for thirty years the problems of farming on sand with long-term experiments of the crop rotation type. In his book results attained with experimental crop rotations during three decades are dicussed and thus data of unparalleled value supplied for the farming on sand. The material of the book is happily completed by the studies of expert co-workers on soil science, soil analysis and climatology. The book consists of 10 chapters and deals with the following.

Chapter One discusses the significance of crop rotations and rational fertilizer application stressing that no profitable farming can be conducted on the poor and very loose sandy soils of the Nyírség district without introducing rational crop rotations.

Chapter Two characterizes the Nyírség district as an agricultural regional unit and describes the history, situation and soil conditions of the farm for experiments on sand.

Chapter Three written by Dr. PÁL STEFANOVICS deals in full detail with the soil conditions of the experimental area and with the characteristic morphological description of soil profiles.

In Chapter Four humus and nutrient conditions on soils of crop rotations, analytical data of average samples taken from the 0 to 20 cm layer of experimental crop rotations and data pertaining to the humus quality of experimental plots, are exposed. According to the analytical data of J. SARKADI, under the influence of various methods of farm technology the humus conditions of sand have changed within a comparatively short period — 20 to 25 years — and these changes can also be demonstrated by the humus fractioning method based on continuous leaching. The demonstration of changes has been somewhat disturbed by the fact that the soil of the crop rotations was not completely identical even at the beginning. Therefore a factor of uncertainty is introduced particularly into the study of the effect of strawmanures. However it can be pointed out that under the influence of organic manuring (application of farmyard and green manure) and/or of greater amounts of stubble and root remains, the amount of "loosely bound" humus substances of "brown humic acid" type has mostly accumulated.

Chapter Five — by Dr. JÁNOS JUSTYÁK — shows the development of temperature elements in the period from 1930 to 1960. Evaluation in the text is completed by a number of tables and graphs. Weather conditions in the experimental years and the connection of the crop yields of the sandy crop rotations with precipitation and temperature, are briefly illustrated.

Chapter Six analyses the causes of the more important fluctuations in yield with special regard to the losses in yield brought about by elemental calamities and difficulties in farming.

Chapter Seven contains the distribution of the 12 crop rotations for the amelioration of sands established in autumn 1929 and the three more crop rotations started in autumn 1933 as well as the guiding principles for the rentability calculations of these crop rotations.

Chapter Eight discusses in detail the thirty-year crop yields of the following 15 crop rotations for the amelioration of sands, with the technique of production and balance of rentability of these crop rotations:

1. crop rotation with fallow
2. crop rotation with lupine-green manuring as a main crop
3. crop rotation with root manure of lupine as a main crop
4. crop rotation with ploughing-in raw straw
5. crop rotation with straw manure fermented by Pétisó* and chemical fertilizer application
6. crop rotation with straw manure fermented by water and chemical fertilizer application
7. crop rotation with straw manure fermented by water
8. crop rotation with root and stubble green manuring
9. crop rotation with fodder growing
10. crop rotation with double fodder growing
11. crop rotation with farmyard manure and chemical fertilizer application
12. crop rotation with fodder growing and green manuring
13. crop rotation with spring ploughing-in of stubble green manure remains
14. crop rotation with autumn ploughing-in of stubble green manure.
15. crop rotation with spring ploughing-in of stubble green manure (remain).

Of the results in crop rotations for the amelioration of sands it appears that on the sterile sand of the Nyirség region green manuring and even stubble green manuring has an extraordinary significance. According to the results farmyard manure is not superior to green manuring.

Chapter Nine supplies a summary of rentability data of the 15 crop rotations. All calculations unequivocally verify that the most inexpensive organic manure on sand is the green manure crop if its yield is, in the average of several years medium at least. During the period from 1931 to 1960 the net income supplied by the crop rotations with green manure was the highest. Every year during three decades the highest rye crops were obtained after green manure as a main crop while the green manures grown in stubble exercised the best influence on potato crops.

Chapter Ten deals with the practical problems of sand amelioration based on mixed organic manure application. Lupine species grown in the Nyírség region, their requirements, significance and value in growing are discussed.

Finally, the results of green manuring experiments conducted with sunflower are summarized and the conclusion drawn that in the foreseeable future the Nyírség region cannot do without lupine as green manure.

The book of Dr. VILMOS WESTSIK affords first of all invaluable help to those farming on sand. In the second place the discussion of the oldest long-term experiments with crop rotation system in this country may rightly reckon on general interest.

The book has been published on excellent paper and brought out attractively under the auspices of the Publishing House of the Hungarian Academy of Sciences.

Á. KOLTAY

G. LÁNG: *Növénytermesztés* (Crop Production). Fifth revised edition. Mezőgazdasági Kiadó, 1965. Budapest.

The work of G. Láng, member of the Hungarian Academy of Sciences, can look back on a very rare career since it has been published within a comparatively short time, in the fifth revised edition this year; the first edition was in 1952. This is partly explained by the author himself stating in the preface to the book: "I have made an effort to write a book that includes all important agricultural plants and the

* Calcium carbonate-ammonium nitrate fertilizer produced in Hungary

latest experience gained and methods used in large-scale agriculture, so as not only specialists of practical agriculture can use it with good success but also college students for a guidance in their education." Thus the book is intended by the author for a double use: as a manual of practical specialists who want to brush up and complete their knowledge and at the same time as a guide towards getting acquainted with this wide branch of knowledge. The book is a fortunate and masterly compilation indeed because students can find in it the principles of our science and the practical expert who wants to improve his knowledge encounters new proceedings and methods wherever new chapters of this many-thousand-year old practical science may open.

The book comprehending 420 pages, deals with crop production "in detail only" and extends to soil cultivation only so far as it is made necessary by the special requirements of plants in question. It is rather characteristic of the compact and easy flowing style taking always in consideration the utility in practical farming that this very widely branching material is given in such a limited shape and still embracing the whole essence of the scope of themes.

As an introduction the book discusses on pages 7—14 the main periods in the history of plant production and the tasks for the future.

Subsequently, the author deals with the various factors that determine the notion of good seed and with the various methods of seed preparation (Chapter 2, pages 15—31).

In Chapter 3 which closes the part on basic concepts of plant production, the general notion of seeding, the diverse modes of seeding and the up-to-date methods of seed calculation are exposed, completing the concise summary of the many-sided scientific results with some methods that have proved good in practice (pages 32—42).

Chapter 4 — pages 43—138 — is devoted to the growing of cereals with special regard to latest results obtained in Hungary and abroad concerning wheat and maize. Thus, ample space is reserved to the reasonable application of weed control, to a modern view on the application of chemical fertilizers, the large-scale production of hybrid maize seed, production of maize with irrigation; and generally to those modern methods and proceedings which in these last years have been used in up-to-date large-scale agricultural crop production.

In Chapters 5, 6, 7 and 8 on nearly 100 pages (139—245) the following groups of plants are dealt with: legumes, roots and bulbs, oil crops, fibre crops. Subsequently, Chapter 9 (246—317 pp) discusses the growing and utilization of species. In these chapters the production of legumes as main protein basis in fodder production of Hungary should have been worthy of a more detailed treatment since in the post-war direction of crop production just, when large-scale farming was being developed, this group of plants was somewhat over-shadowed and nobody could be more qualified than the author as to help this group of plants to get back again its due place in the agricultural production.

A very valuable part of the book is Chapter 10 on "Raw fodder" (pp. 318—394) where under the subtitle "Perennial papilionaceous plants" the growing of lucerne, various clovers, sainfoin and bird's foot trefoil is dealt with. A separate subchapter is devoted to the production of ley and especially to herbage grasses, to the composition of suitable seed mixtures and finally to the seed production of perennial herbage grasses, the methods of which require so much special knowledge. In the same chapter the subdivision on "Growing of two year and annual papilionaceous raw crops" includes the basic knowledge of the growing of melilots, kidney-vetch, crimson clover, Berseem and seradella. It is to be regretted that the subchapter on "Growing of fodder mixtures" (pp. 374—377) similarly to the Legumes has not obtained as much space as it deserves in our new production system, if only to attract increased attention; at the same time it can be stated that the material essentially does include the basic knowledge of their growing and points out their importance with stress. Finally, to complete the chapter on "Raw fodder" under the title of "Annual non-papilionaceous raw forages" the various silo and green maizes, green sunflower, various fodder sorghums, Hungarian millet, chumiz, white mustard, millet, etc. are discussed as to methods of production and results of new studies.

In Chapter 11 (pp. 395—396) the methods of the use of second crops are briefly described.

On pages 397—398 a scheme of green conveyor belt is explained.

Finally, in the concluding part of the book (Chapter 12, pp. 402—413) a very important part of raw fodder production the various methods of "Haymaking" and the rational storage of hay is discussed.

Discussion of methods of cultivation of various plant varieties is happily completed by the description and characterization of varieties that have proved to be useful in home production, with indication of the regions of growing. Similarly useful is the discussion of diseases occurring, to a greater or lesser degree in the production of several groups of plants or varieties in Hungary and of the modern methods and means of their control.

A very valuable part of the book is the general characterization preceding the chapters or discussions on plant groups because these parts not only supply a comprehensive characterization of the plant groups dealt with but also a biological evaluation and basis to the solution by techniques of production.

This is a completely new and successful characteristic of the book as compared with Hungarian works of similar kind because in up-to-date crop production, in the age of modern mechanization and chemization the knowledge of soil and plant biology, of their connection and the biological view extending to the mechanism of the whole production are still more a basic requirement of this science than they ever have been before. Therefore this new endeavour deserves special esteem.

The book has been published with much care in tasteful get-up by the Publishing House of Agricultural Books and Periodicals, Budapest.

J. Bajai

Symposium in the Bulgarian People's Republic on Maize Breeding and Maize Growing

The Maize Breeding and Growing Symposium organized by the Bulgarian Agr. Sci. Academy and by the Ministry was held in Russe, on the 1—4 days of September, 1965; from 15 countries (Austria, Bulgaria, France, Czechoslovakia, Israel, Yugoslavia, Poland, Hungary, Roumania, Italy, the German Democratic Republic, the German Federal Republic, Turkey, the Soviet Union, the USA) nearly 100 experts took part. The symposium was followed by a three-day study excursion in the frame of which the partakers had the opportunity to visit research institutes, state farms and co-operatives. The program of the symposium included also a valuable display of books on maize and on agriculture in general.

Nearly 60 lectures were held, being delivered in brief exposés. Part of the lectures submitted general outlines on maize research while others analysed the methods and results of positive breeding and growing experiments. The lectures of the symposium held in one section might be grouped according to the following subjects:

1. General problems of maize breeding and growing.
   a) The situation and the tasks of maize breeding and growing in Austria, Bulgaria, Czechoslovakia, France and the Soviet Union.
   b) The importance of collecting, grading, evaluating and maintaining regional varieties in hybrid-corn breeding.
   c) Certain problems concerning the soil cultivation, fertilizing, irrigation and chemical weed-control of maize.

2. The breeding and seed-production of maize.
   a) The cold-resistance and the drought-resistance of maize.
   b) Studies concerning the effect of gamma irradiation of various doses, on inbred lines for producing mutations.
   c) The variability of certain properties with inbred lines and the study of new methods regarding combining ability.
   d) Utilization of single crosses in the production for the market.
   e) Comparison of the productivity of hybrids produced from F_1, F_2, F_3 single crossed partners.
   f) The importance of producing synthetic varieties in maize breeding.
3. Examination of certain maize diseases.
   a) Recent results in the research work connected with the Helminthosporium and the corn-borer.
   b) Some bacterial and viral diseases of maize.
   c) The description of the reddening of maize and the damage caused by it.

The lectures were completed by surveys in nursery gardens as well as by informal meetings which provided good opportunities for scientific discussions, exchange of opinions and for the better understanding of problems in certain breeding methods. Due to their new trend, the following problems have called the attention of the experts:

a) The feasibility of producing mutations with old inbred lines by applying gamma irradiation of smaller doses.
b) Studying certain properties in the populations of inbred lines having been inbred for long time, especially those referring to the variability of combining ability and to relationships in heredity.
c) Method to produce synthetic varieties from I_1 inbred lines
d) Recent data also prove that the most valuable double crosses can be produced from the F_1 of single crosses (*not* from F_2 or F_3).
e) The reddening of maize the damage of which has been observed not only in Yugoslavia but also in Roumania and Bulgaria.
f) Recent results obtained in the soil-cultivation, fertilization, irrigation and chemical weed-control of maize.

The symposia: in Bernburg (1961), in Martonvásár (1963) and in Russe (1965) are each a new stage of maize-breeding, seed-producing and agrotechnical researches. In general, it can be established that on the occasion of the Russe symposium, too, the researchers reported very valuable results and experiences which will render further assistance in producing hybrids with even higher yielding ability than hitherto, and in elaborating new growing methods.

I. Kovács

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