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Environmental management, land use, biodiversity

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Environmental management, land use, biodiversity

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Graphic designer
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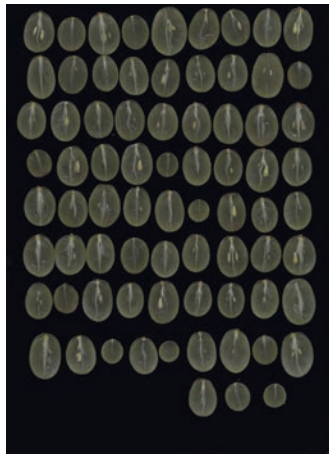


DIGITAL IMAGE ANALYSIS METHODS IN GRAPEVINE UVOMETRIC INVESTIGATIONS

PÉTER **BODOR-PESTI** – ESZTER **SOMOGYI** – ZSUZSANNA **VARGA**

Hungarian Agricultural and Life Sciences University, Institute of Viticulture and Enology, Villányi út 29-43. Budapest 1118

Corresponding author: Péter Bodor-Pesti, e-mail: bodor-pesti.peter@uni-mate.hu

SUMMARY

Morphological evaluation of the grapevine (*Vitis vinifera* L.) bunch and berry have great importance from the beginning of the cultivation. The size of the fruits influences the yield, while the shape has enormous effect on the consumer's perception. During the centuries, characterization of the uvometric properties developed a lot from the qualitative trait analysis to the recently applied geometric morphometric evaluations. In this review, we introduce the most important literatures in uvometry, and show the possibilities and limitations of the methods.

Keywords: berry morphology, ampelometry, digital image analysis

INTRODUCTION

Ampelography is the science dealing with the morphological characteristics, production value traits, phenological and economic characteristics of grape species (*Vitis* spp.) and cultivars. *Ampelometry* is a sub-science of this, described by Louis Ravaz in 1902. The main aim of his method was the characterization of cultivars based on measurable leaf traits. Although the author developed the method specifically to describe the leaf - and the term is still used today mainly for leaf morphology - it now encompasses several sub-sciences. Kozma (1956) divides ampelometry into leaf, flower, cluster and seed morphology as: *foliometry*, *florimetry*, *uvometry* and *carpometry* respectively. In fact, ampelometry - and its sub-specialities - refers to the morphometric methods used in viticultural descriptions.

The characterization of the grape berry is important in the description of both wine and table grape varieties, so the methodology is developed in detail. The fruit of the grape is the berry, which form a complex cluster on the cluster stalk. The berries are developed on the crown of the peduncle, which is connected to the cluster branches through the berry stalk (Kozma 2002). The shape of the berry is typical to the cultivar, as is the size of the berry, but the latter is more dependent on external factors. Besides the variety, berry size is determined by environmental factors, plantation structure and cultivation technology. Among the annual vineyard maintenance practices, bud load, fruit load and number of berries per cluster in particular determine berry size. Varietal differences in flowering biology, such as fertility, also have a significant effect on size.

HISTORICAL BACKGROUND TO THE DESCRIPTION OF BERRY SIZE AND SHAPE

The written record of the size and shape of grape berries dates back a long time, but the practice of characterization is probably as old as the cultivation itself. Already in Szikszai's *Nomenclatura* (1590), we find references to berry size when he mentions *'uva spionia'*, i.e. *'large-berried grapes'*. In the *Paradisi in Sole. Paradisus Terrestris* Parkinson (1629) describes several grape varieties and the color appendix attests that both berry size and berry shape were important part in the descriptions. Rea (1676) in his *Flora Ceres & Pomona* also gives observations on berry morphology (size, color) when describing varieties. In Langley's *Pomona, or the fruit garden illustrated* (1729), the descriptions of the grape varieties also include references to the shape of the berries and the author also illustrates cross-sections of the berries. The above examples attest to the importance of berry shape and size, but no data on size are given. In contrast, Frege's *Versuch einer Classification der Wein-Sorten nach ihre beeren* (1804) not only gives dimensions, but also includes a 'size marker' to measure the length of the berry. The author describes the dimensions in *zoll*, which is equivalent to 2,634 cm. Tersánczki (1865) later divides the berry shapes into 3 main groups, defining globular, oblong, ovate and long cylindrical or goat's-cheek shaped berries, these categories are further subdivided into subgroups according to size. Length and width data are assigned to the shapes, which are given in "lines" (1 line equals 2.195 mm). For example, medium sized long cylindrical

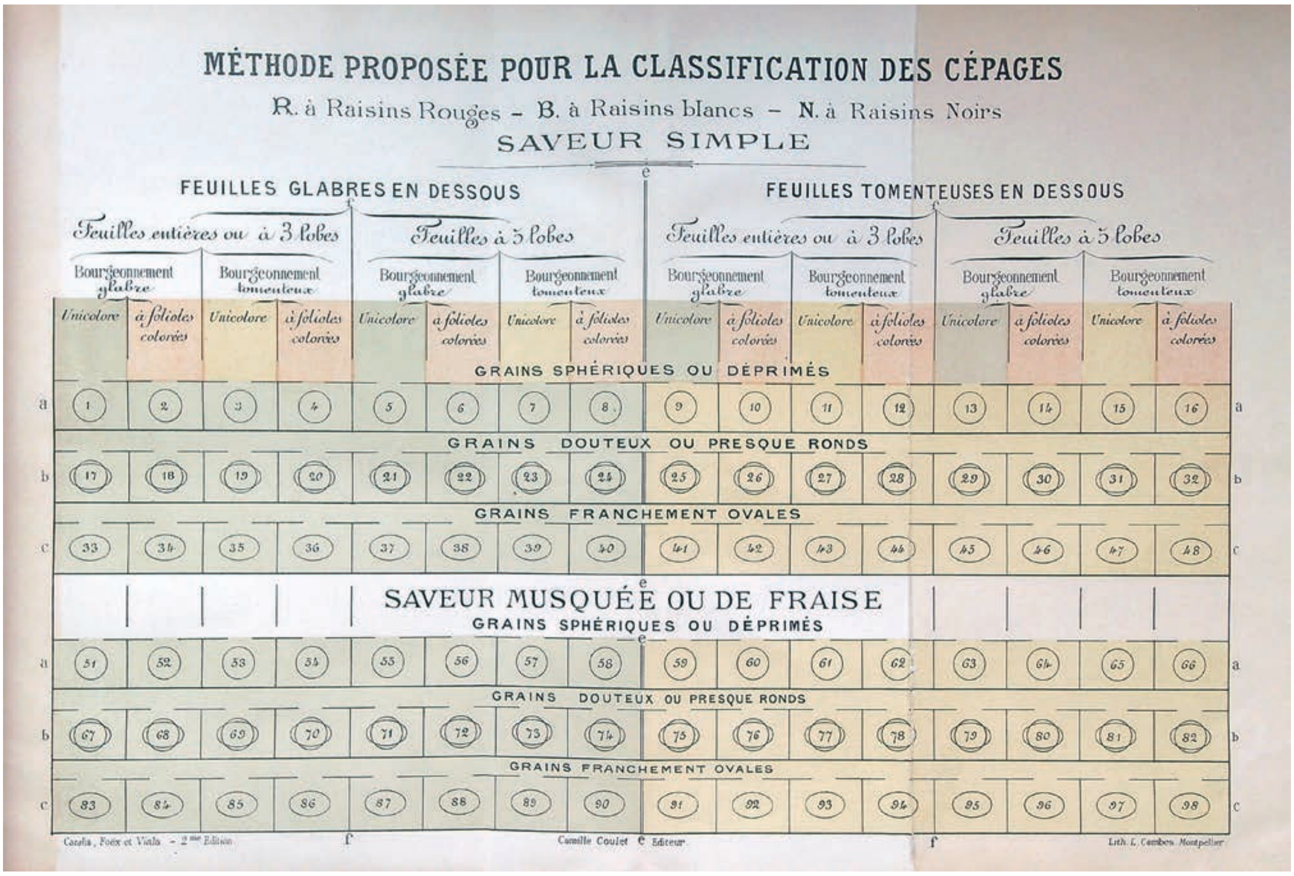


Figure 1: Classification of grapevine cultivars according to leaf and berry morphological traits by Rovasenda (1887)

berries are 8-8.5 lines long and 5-6.5 lines wide, which means they are 17.56-18.66 mm long and 11-14.27 mm wide. Berry morphology had high importance not only in the characterization of the cultivars, but for example in the classification. Rovasenda (1887) grouped the cultivars according to leaf and berry characteristics (Figure 1), where shape of the berry had a high importance. Molnár (1897) also included berry shape in the classification. The ampelographic albums of the 1800s, such as the work of Lauche and Goethe (1895), abound in illustrations of berry shapes in particular. In the 20th century, characterization has become increasingly important, especially in the evaluation of experiments on cultivation techniques and the morphological diversity of grape varieties, while the methodology of description has also evolved.

POSSIBILITIES FOR DESCRIBING BERRY SIZE

Cultivars can be divided into classes according to berry size. The weight or width-length limits of the classes may vary from author to author, as may the number of classes. As mentioned above, the work of Frege (1804) is one of the earliest where classes are quantified for berry size and where the author includes a tool for the analysis. Later, the variety descriptions of Tersánczki (1865) provide information on quantified berry characteristics. Kozma (2002) distinguishes between the following classes: very small (less than 8 mm), small (8-12 mm), medium (12-17 mm), large (17-22 mm) and very large (more than 22 mm), whereas the OIV (2009) gives the following approximation of size: very small (less than 8 mm), small (around 13 mm), medium (around 18 mm), large (around 23 mm) and very large (more than 28 mm).

There is several equipment for the uvometric phenotyping. For example, caliper can be used to determine size (Kircherer et al. 2013), or perforated plates where berries are sorted into classes on holes of different diameters (Melo et al. 2015). Another possibility is the analysis of data obtained through digital imaging (Roscher et al. 2014). In 2010, Rodríguez et al. presented a program called Tomato Analyzer (TA), which allows the morphological characterization of tomato and other crops. The digital image analysis program generates basic morphological data (width, length), as well as shape indices and geometric morphometric data calculated from the landmarks fitted to the outline. The method can also be used to assess the morphological diversity of grape varieties and even to evaluate the variability between growing areas. In their studies Somogyi et al. (2021) found that the berry size traits of the 'Italia' grapevine cultivar significantly influenced by the growing area, moreover the numbers of seeds in the berries also modify the size

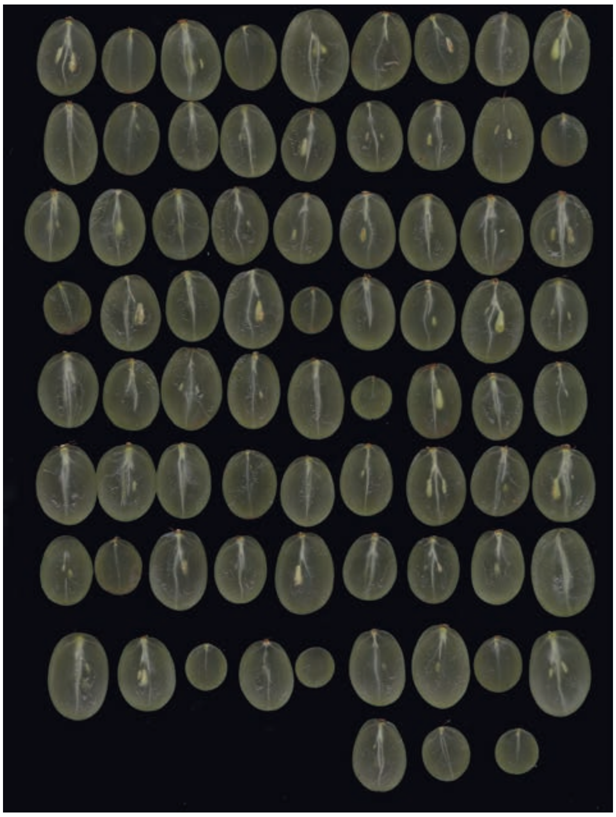


Figure 2: Digitalized berry samples of the Italia grapevine cultivar

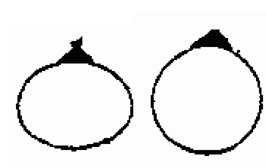
(Figure 2). Later Bodor-Pesti et al. (2022) showed that the TA provides valuable information about the uvometric traits of grapevine cultivars which would help the classification and discrimination of the genotypes according to the berry size traits. They carried out classification on genotype and group-of genotype level and found that size and shape traits are more effective in the level of group-of genotype classification. Concerning the seed number of the berries their results are in line with former investigations and found that seed number has a positive correlation with most of the size traits. According to their results digital image analysis would be a powerful tool to evaluate the uvometric diversity within and among grapevine cultivars.

POSSIBILITIES TO DESCRIBE BERRY SHAPES

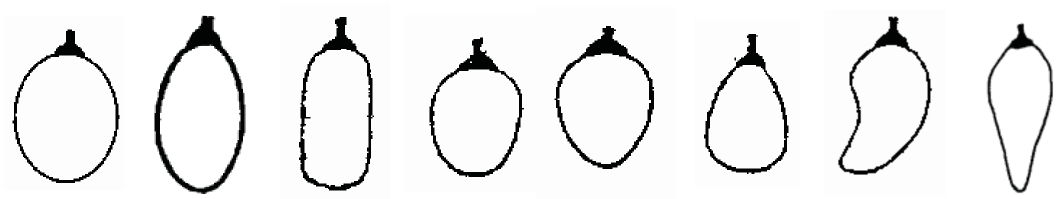
Comparing the different literatures there is more variation in the shape of the berry than in size of those between authors. Németh (1966) describes 14 berry shapes, Kozma (1968) 21, while Tatai (1835) describes only 4 and Molnár (1897) 5 groups. Foreign authors have also made different groupings of berry shape. Lauche and Goethe (1895) describe 9 berry shapes, Pacottet (1905) mentions 5 berry shapes, whereas Bioletti (1938) divides berries into 15 groups. Goussard (2008) mentions 6 forms in his work. The OIV (2009) and the IPGRI, FAO, OIV (1997) variety identification guides, which are widely used today, contain 10 reference shapes. Shape description is most often based on references (e.g. the OIV guide published in 2009), where the shape is determined by comparing the samples with the drawn figures (Table 1). This method is time-consuming and subjective in the absence of expertise, so its reliability and repeatability may raise questions. Another possibility is to use the berry shape index, where the shape is inferred from the ratio of width to length (Kozma 1968). This method has also certain limitations, at the same time very effective and informative.

Digital imaging and image analysis offer further possibilities. Elliptic Fourier analysis (EFD) (Kühl and Giardina 1982) is for example a commonly used method for describing closed contour objects. This method gives the base of the SHAPE software introduced by Iwata and Ukai (2002). This software was widely applied to describe the shape features of various horticultural crops. Recently Bodor et al. (2019a) investigated grapevine berry shape according to this method. Later different grapevine cultivars were compared based on the outline analysis. These results emphasized that berry shape is not uniform, and samples collected from the top, middle and bottom of the bunches have different features. These results underline the importance of the precise sampling and the detailed interpretation of the sample collection methodology (Bodor et al. 2019b). Later Somogyi et al. (2021) showed that diversity of the grapevine berry shape is variable and some of the cultivars have uniform, while others have more divers shape features. Most recent studies reported by Kupe et al. (2021a, 2021b) showed that berry shape features are more complex and not only single cross section but multiple sections provide valuable information about the morphological diversity.

Table 1: Berry size and shape categories according to the OIV (2009)

Characteristics	OIV code	1	
Berry length	OIV220	up to about 8 mm	
Example varieties		Corinthe noir N	
Berry width	OIV221	up to about 8 mm	
Example varieties		Corinthe noir N	
Characteristics	OIV code	1	2
Berry shape	OIV223	obloid	globose
Example varieties		Riesling B	Chasselas B
Reference figures			

Characteristics	3	5	7	9
Berry length	about 13 mm	about 18 mm	about 23 mm	about 28 mm and more
Example varieties	Cabernet-Sauvignon N	Schiava grossa N	Italia B	Cardinal Rg
Berry width	about 13 mm	about 18 mm	about 23 mm	about 28 mm and more
Example varieties	Riesling B	Portugieser Blau N	Muscat of Alexandria B	Alphonse Lavallée N

Characteristics	3	4	5	6	7	8	9	10
Berry shape	broad ellipsoid	narrow ellipsoid	cylindric	obtuse ovoid	obovoid	obovoid	horn shaped	finger shaped
Example varieties	Barbera N	Beyrouth B	Khalili belyi B	Ahmeur bou	Bicane B	Muscat d'Alexandrie B	Santa Paula B	
Reference figures								

CONCLUSION

The characterization of the berry characteristics of grape varieties is an important part of ampelographic descriptions. Examinations can be carried out manually, but methods based on digital imaging, which are nowadays widely used, provide fast, accurate and reproducible observations.

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THE PREVALENCE IN 2015 AND 2020 OF WINE GRAPE VARIETIES BRED IN HUNGARY

ISTVÁN **FAZEKAS** - DIÁNA **NYITRAINÉ DR. SÁRDY** - DÓRA **TARANYI** - GÁBOR SÁNDOR **VÉRTES** - ZSUZSANNA **VARGA**

MATE Institute of Viticulture and Enology, Budapest

Corresponding author: István Fazekas, email: Istvan.Fazekas@uni-mate.hu; tel.: + 36 1 3057488

ABSTRACT

Some of the grape varieties grown were produced by cross-breeding. The beginnings of Hungarian grape breeding date back to the 19th century. The importance of hybrid varieties has gradually increased over the last hundred years, and the process accelerated dramatically, especially in the second half of the 20th century. By the turn of the millennium, the range of hybrid wine grape varieties had further increased, with both intra- and interspecific varieties. In this article, we examine the results of Hungarian wine grape renewal based on the 2015/2020 varietal composition.

Keywords: bred, Hungary, variety sortiment

INTRODUCTION

Many cultivated grape varieties have been produced by cross-breeding. Hybrids can be derived from intra- or interspecific crosses. The former are known as intraspecific varieties and the latter as interspecific varieties. According to most authors, the first "artificial" hybrid was the "Petit Bouschet" (1824), bred in France in the early 19th century. Later in the second half of the same century, a number of hybrids (foxy grapes) were created in the USA. Cross-breeding really took off at the end of the 19th century with the appearance of powdery mildew and phylloxera, followed by downy mildew, in the major wine-growing countries. The beginnings of Hungarian vine breeding can also be traced back to this period.

At the turn of the century and in the first half of the 20th century, until the Second World War, private breeders (Adolf Stark, Pál Kocsis, János Mathiász) produced varieties. They created a large number of hybrids. Today, only four of them remain in the varietal composition of wine grapes.

For the last 70 years, vine breeding has been a state task, with state support, in various state institutes and institutions. Among the intra- and interspecific hybrids produced by the breeding workshops during this period, the National

Bianca

Council of the WineComunities, Hungary (Hungarian abbreviation: HNT) registered 42 white wine grape varieties with varying areas of production in 2015, increasing to 50 by 2020. We have seen a similar increase in the expansion of our red wine grape breeding, with 10 red wine grape varieties registered in 2015, rising to 12 by 2020.

The importance of hybrid varieties in the variety supply has gradually increased over the last hundred years, and the process accelerated spectacularly, especially in the second half of the 20th century.

The Decree 210.800/1941 of the FM contains for the first time a hungarian hybrid wine grape variety, the Kecskemét

Cserszegi fűszeres

virága. Of the wine grape varieties still cultivated today, Csaba gyöngye is already included in this decree, albeit among the table grape varieties. In Decree-Law No 23 of 1959, two hybrids, now registered as wine grapes, were added to the list of table grape varieties that can be planted, namely Irsai Olivér and Kocsis Irma. Decree-Law No 36 of 1970, followed by Decree No 40/1977 (29.11.1977) of the Ministry of Agriculture and Forestry, further increased the number of selectable cross-bred wine grape varieties in the variety range. The latter lists a total of 19 bred varieties among the varieties authorised for planting. For the first time, the list includes interspecific varieties (Kunbarát, Kunleány) and two varieties with a red fleshed, Bíborkadarka and Kármin, which are still in cultivation, have been added to the list after Baracsi rubint. By the turn of the millennium, the range of hybrid wine grape varieties had further increased with both intra- and interspecific varieties (Fazekas 2015, Lőrincz - Bényei 1999, Lőrincz - Bényei 2000, Lőrincz - Bényei - Fazekas 2006).

In 1960, the Hungarian Central Statistical Office (KSH) published the distribution of the main grape varieties. No hybrid varieties are included in this list. However, in a similar statement of 1970, three cross-bred wine grape varieties, Rizlingszilváni (Müller Thurgau) (1,039 ha), Kecskemét virága (31 ha) and Bouvier (5 ha), and three hybrid varieties, Csaba gyöngye (950 ha), Kocsis Irma (520 ha) and Irsai Olivér (346 ha), which are now included in the list of wine grapes and were also registered as table grapes, are already included, making a total of 2,891 ha of vineyards. This is just over one percent of the total area under vines at that time (230,000 ha) (Csepregi - Zilai 1988). Their role in the varietal composition has increased steadily since then.

From the 1970s onwards, an increasing number of hungarian intra- and interspecific wine grape varieties received state recognition, enriching the list of grape varieties. The range of wine grape varieties has also increased in such a way that, after our accession to the EU, several hybrid varieties (Csabagyöngye, Irsai Olivér, Nero, Pölöskei muskotály), which were previously registered as table grapes but had dual uses, were reclassified as wine grapes.

In this article, we set out to examine the hungarian hybrid wine grape varieties based on the 2020 varietal composition.

MATERIAL AND METHODS

In our work we used and analysed the data provided by the National Council of the WineComunities, Hungary (HNT). In our evaluation we also took into account statistical data from previous years (KSH, HNT). Thus, we have not only recorded a static picture, but also changes in the use of the breed since the turn of the millennium.

Göcseji zamatos

Most of the data used in the paper are national aggregates.

The cross-bred white and red wine grape varieties included in the study were those that had a separate area in the data of the wine-growing districts in 2020. These varieties are: Abigél, Aletta, Bianca, Borsmenta, Csaba gyöngye, Cserszegi fűszeres, Csillám, Ezerfürtű, Favorit, Füredgyöngye (Zalán), Generosa, Gesztus, Göcseji zamatos, Gyöngyrizling, Heuréka, Irsai Olivér, Jázmin (8/1), Jubileum 75, Kabar, Karát, Kocsis Irma, Korona, Kunleány, Lakhegyi mézes, Mátrai muskotály, Nektár, Odysseus, Orpheus, Palatina, Pátria, Pelso, Pölöskei muskotály, Refrén, Rozália, Rózsakő, Sylver, Taurus, Táltos, Trilla, Úrréti, Vértes csillaga, Viktória gyöngye, Vulcanus, Zalagyöngye, Zefír, Zenit, Zengő, Zéta, Zeusz, Viktor; Bíborkadarka, Duna gyöngye, Kármin, Kurucvér, Magyar frankos, Medina, Messiás, Nero, Pannon frankos, Pinot regina, Rubintos, Turán. In total, 62 varieties (50 white and 12 red).

However, two varieties, Kunbarát and Nosztori rizling, have been withdrawn from wineproduction compared to 2015.

In reviewing the status of cross-bred wine grape varieties, their role and importance, and in compiling summary tables to aid analysis and evaluation, we have relied on the publications of breeders' workshops and breeders, as well as on summary ampelographic works (Bényei - Lőrincz 2005, Bényei - Lőrincz - Gácsi 2000, Csepregi - Zilai 1988, Csizmazia 1982, Fazekas 2015, Füri - Szegedi 1987 a, b, Hajdu 1997, 2013, Hajdu - Ésik-né 2001, Koleda 1980, 1987, Lőrincz - Bényei 1999, 2000, Lőrincz - Bényei - Fazekas 2006, Lőrincz - Sz. Nagy - Zanathy 2015, Sz. Nagy 2002, Tóth - Pernesz 2001, Zanathy - Lőrincz - Bényei - Fazekas 2005, Zilai 1984).

Table 1: Changes in area size of hungarian hybrid white winegrape varieties in 2015/2020 (Source: HNT 2015, 2020)

Number	Grape variety	Area		Trend
		2015 ha	2020 ha	
1.	Bianca	4622	5642	↑
2.	Cserszegi fűszeres	4117	4088	↓
3.	Irsai Olivér	1291	2278	↑
4.	Aletta	1387	2067	↑
5.	Generosa (K15)	203	750	↑
6.	Kunleány	1046	719	↓
7.	Zenit	576	697	↑
8.	Zalagyöngye	1193	661	↓
9.	Viktória gyöngye	192	183	↓
10.	Zengő	226	177	↓
11.	Ezerfürtű	285	145	↓
12.	Pölöskei muskotály	119	125	↑
13.	Zéta	118	116	↓
14.	Lakhegyi mézes	177	76	↓
15.	Karát	53	41	↓
16.	Csaba gyöngye	64	36	↓
17.	Jubileum 75	95	36	↓
18.	Kabar (Tarcal 10)	29	36	↑
19.	Zeusz	28	29	↑
20.	Odysseus (Odüsz-szeusz)	25	25	→
21.	Nektár	24	22	↓
22.	Csillám	21	21	→
23.	Rózsakő	15	19	↑
24.	Mátrai muskotály	50	14	↓
25.	Gyöngyrizling	16	11	↓
26.	Zefír	32	9	↓
27.	Vértes csillaga	12	8	↓
28.	Vulcanus	5	6	↑
29.	Göcseji zamatos	10	5	↓
30.	Pátria	3	5	↑
31.	Jázmin (8/1)	-	3	↑
32.	Palatina	-	3	↑
33.	Kocsis Irma	3	2	↓
34.	Rozália	2	2	→
35.	Orpheus	0,5	1,1	↑
36.	Trilla	1	1	→
37.	Korona	1	0,9	↓
38.	Viktor	-	0,8	↑
39.	Borsmenta	-	0,7	↑
40.	Pelso	0,6	0,6	→
41.	Füredgyöngye (Zalán)	-	0,4	↑
42.	Sylver	-	0,4	↑
43.	Úrréti	0,1	0,4	↑
44.	Refrén (RF16)	0,3	0,3	→
45.	Taurus	-	0,3	↑
46.	Abigél	-	0,2	↑
47.	Táltos	0,5	0,2	↓
48.	Gesztus (K38)	0,2	0,2	→
49.	Favorit	-	0,1	↑
50.	Heuréka (K35)	0,1	0,1	→
51.	Kunbarát	0,3	-	↓
52.	Nosztori rizling	0,1	-	↓
Total		14039,0	18064,7	↑

RESULTS

The area of the white wine grape varieties (2015, 2020) included in the study from hungarian crosses is shown in Table 1 and that of the red wine grape varieties in Table 2. For 2020, the two tables include a total of 62 hybrids of varieties and species, 50 producing white wine and 12 red wine. Out of the 62 varieties, 36 (29 white, 6 red and 1 table grape) are the result of intraspecific crosses and 26 (21 white, 4 red and 1 table grape) are the result of interspecific crosses. Table 3-4. summarises the information on these varieties.

Table 2: Changes in area size of hungarian hybrid red winegrape varieties in 2015/2020 (Source: HNT 2015, 2020)

Number	Grape variety	Area		Trend
		2015 ha	2020 ha	
1.	Turán	173	176	↑
2.	Nero	76	138	↑
3.	Medina	126	113	↓
4.	Bíbor kadarka	116	81	↓
5.	Duna gyöngye	51	44	↓
6.	Pannon frankos	12	15	↑
7.	Rubintos	16	9	↓
8.	Kármin	25	5	↓
9.	Pinot regina	-	0,6	↑
10.	Messiás	-	0,4	↑
11.	Magyar frankos	0,2	0,2	→
12.	Kurucvér	0,1	-	↓
Total		595,3	582,2	↓

The Hungarian viticulture traditionally works with many varieties, and within this, the number of hungarian hybrid grape varieties is significant (about 40% of all wine grape varieties registered by the HNT). However, rather than the number of varieties, the prevalence is a better indicator to correctly assess the position, role and importance of the varieties created by Hungarian breeders in the variety composition and use.

A closer look at the issue shows that in 2020, the number of white wine-producing varieties from hungarian crosses with an area of more than 10 ha was 26, while the number of red wine-producing varieties was only 6. If we draw the line at 100 ha for both groups of varieties, there are 13 hybrids (7 intra- and 6 interspecific varieties) for white grapes and 3 hybrids (1 intra- and 2 interspecific varieties) for red grapes. In addition, 4 varieties are grown on a significant area of more than 1000 ha, which, according to the 2020 area ranking, are Bianca (5642 ha), Cserszegi fűszeres (4088 ha), Irsai Olivér (2278 ha) and Aletta (2067 ha).

Kármin

The total area under hungarian crosses has increased over the period from 16639 ha (2015) to 18647 ha (2020), an increase of 11%. During the same period, the area under vines in Hungary decreased slightly (0.3%). The increase in the importance of hybrid varieties in the variety composition is largely due to interspecific varieties. Overall, the area under hungarian hybrid varieties accounted for 30% of the total area under wine grapes in 2020.

If we look at the changes in the area of each vine variety individually, we get a more nuanced picture. For 41% (26 varieties) of the hybrid varieties in the list, the area has increased, while 59% (38 varieties) have remained the same or decreased.

White hybrid varieties

- Bianca (Eger 2 × Bouvier), the hybrid of József Csizmazia and László Bereznai, is not only the cross-bred variety, but also the leader in the area ranking of all white wine grape varieties. It has overtaken varieties such as

Table 3: Intraspecific hybrids bred in Hungary

Number	Grape variety	Breeders	Pedigree	Year of crossing	Date of listing	Note
			INTRASPECIFIC HYBRIDS			
1.	Bíbor kadarka	Kozma P.; Tusnádi J.	Kadarka × Muscat Bouschet	1948	1974	rf
2.	Csaba gyöngye	Mathiász J., Stark A.	Madeleine Angevine × Muscat Fleur D'Oranger	1904	1956	wg
3.	Cserszegi fűszeres	Bakonyi K.	Irsai Olivér × Tramini	1960	1982	wg
4.	Ezerfürtű	Kurucz A., Kwaysser I.	Hárslevelű × Tramini	1950	1973	wg
5.	Favorit	Szegedi S., Erős J., Darnay E.	Chasselas blanc × Szőlőskertek királynője muskotály	1950	1968	tg
6.	Generosa	Bíró K., Hajdu E.	Ezerjó × Tramini	1951	2004	wg
7.	Gesztus	Kwaysser I., Hajdu E.	Pozsonyi × Szürkebarát	1965	2004	wg
8.	Gyöngyrizling	Csizmazia J., Bereznai L.	Rajnai rizling Gm. 239 × Csaba gyöngye	1964		wg
9.	Heuréka	Hajdu E. et al, Kwaysser I.	Pozsonyi fehér × Tramini hibridcsaládból kiemelve	1965		wg
10.	Irsai Olivér	Kocsis P.	Pozsonyi × Csaba gyöngye	1930	1959	wg
11.	Jubileum 75	Kurucz A., Kwaysser I.	Ezerjó × Szürkebarát	1951	1974	wg
12.	Kabar	Brezovcsik L., Szakolczay G.né, Marcinkó F., Éles S.-né	Bouvier × Hársleveleű T.1007	1967	2005	wg
13.	Karát	Kurucz A., Kwaysser I.	Kövidinka × Szürkebarát	1950	1982	wg
14.	Kármin	Kurucz A., Kwaysser I.	Petit Bouschet × Kadarka	1951	1974	rf
15.	Kocsis Irma	Kocsis P.	Ezeréves Magyarország emléke × Thallóczy Lajos muskotály	1929		wg
16.	Korona	Bakonyi K. et al.	Juhfark × Irsai Olivér	1968	2001	wg
17.	Kurucvér	Kurucz A., Kwaysser I.	Kadarka × Muscat Bouschet	1952	1974	rf
18.	Magyar frankos	Kozma P., Tusnádi J.	Muscat Bouschet × Kékfrankos	1953	1974	rg
19.	Mátrai muskotály	Kozma P., Tusnádi J.	Izsáki × Ottonel muskotály	1952	1982	wg
20.	Messiás	University of Pannonia Georgikon Faculty	Dunaj × Merlot		2018	rg
21.	Nektár	Bakonyi K. et al.	Judit × Cserszegi fűszeres	1970	1994	wg
22.	Nosztori rizling	Bakonyi K. et al.	Olasz rizling × Szürkebarát	1965		wg
23.	Pátria	Bakonyi K. et al	Olasz rizling × Tramini	1975	2001	wg
24.	Pelso	Bakonyi K. et al.	(Olasz rizling×Ezerjó) × (Olasz rizling×Szürkebarát)	1978	2005	wg
25.	Rozália	Bakonyi K. et al.	Olasz rizling × Tramini	1978	2001	wg
26.	Rózsakő	Kiss E., Király F.	Kéknyelű × Budai	1957	2003	wg
27.	Rubintos	Kozma P., Tusnádi J.	Kadarka × Kékfrankos	1951	1980	rg
28.	Táltos	Kozma P. et al.	Kékfrankos × Medoc noir	1951	1983	wg
29.	Turán	Csizmazia J., Bereznai L.	Bikavér 8 × Gárdonyi Géza	1964	1985	rf
30.	Trilla	Kwaysser I., Hajdu E.	Pozsonyi fehér × Sárgamuskotály hibrid-családból kiemelve	1964	2005	wg
31.	Úrréti	Kocsis P.	Hárslevelű × Tramini	1916		wg
32.	Vulcanus	Kiss E., Király F.	Budai × Szürkebarát	1957	2003	wg
33.	Zefír	Király F. et al.	Hárslevelű × Leányka	1951	1983	wg
34.	Zengő	Király F. et al.	Ezerjó × Bouvier	1951	1982	wg
35.	Zenit	Király F. et al.	Ezerjó × Bouvier	1951	1976	wg
36.	Zéta	Király F. et al.	Bouvier × Furmint	1951	1990	wg
37.	Zeusz	Kiss E., Király F.	Ezerjó × Bouvier	1956	1994	wg

Note: white grape = wg; red grape = rg; table grape = tg; red flashed = rf.

Table 4: Interspecific hybrids bred in Hungary

Number	Grape variety	Breeders	Pedigree	Year of crossing	Date of listing	Note
			INTERSPECIFIC HYBRIDS			
1.	Aletta	Csizmazia J., Bereznai L.	Eger 2 × Ottonel muskotály	1975	2009	wg
2.	Bianca	Csizmazia J., Bereznai L.	Eger 2 × Bouvier	1963	1982	wg
3.	Borsmenta	Kozma P. jr.	VRH3082-1-42 × Petra	2001	2020	wg
4.	Csillám	Kozma P. et al.	Seyve-Villard 12375 × Csaba gyöngye	1966	1997	wg
5.	Duna gyöngye	Kozma P. et al.	Seibel 4986 × Csaba gyöngye	1966	1995	rg
6.	Füredgyöngye (Zalán)	Csizmazia J., Bereznai L.	Menoire × Eger 2 (Villard blanc)	1960		wg
7.	Göcseji zamatos	Csizmazia J., Bereznai L.	Kékmedoc × Eger 1	1959	2005	wg
8.	Jázmin	Kozma P. jr.	Bianca × Petra	1985	2016	wg
9.	Kunbarát	Tamássy I., Koleda I.	28/19. magonc × Itália	1960	1974	wg
10.	Kunleány	Tamássy I., Koleda I.	28/19. magonc × Afuz Ali	1960	1975	wg
11.	Lakhegyi mézes	Csizmazia J., Bereznai L.	Mézes × Eger 2	1957		wg
12.	Medina	Csizmazia J., Bereznai L.	Eger 2 × Medoc noir	1959	1984	rg
13.	Nero	Csizmazia J., Bereznai L.	Eger 2 × Gárdonyi Géza	1965	1993	rg
14.	Odysseus	Koleda I., Korbuly J.	[(V. amurensis × V. vinifera) × Thallóczy Lajos muskotály] × Szürkebarát	1966	2004	wg
15.	Orpheus	Koleda I. et al.	(V. am. × V. vin.) F2 × Irsai Olivér	1965	2003	wg
16.	Palatina	Kozma P., Sz. Nagy L. Urbányi M., Tusnádi J.	Seyve villard 12375 × Szőlőskertek királynője muskotály	1966	1995	tg
17.	Pannon frankos	Koleda I., Korbuly J.	(V. amurensis × V. vinifera) F2 × Irsai Olivér	1965	2004	rg
18.	Pölöskei muskotály	Szegedi S. et al.	(Zalagyöngye × Gloria Hungariae) × Erzsébet királyné emléke	1967	1979	wg
19.	Refrén	Fűri J. et al.	Glória Hungariae × Seibel 5279	1964	2005	wg
20.	Sylver	Kozma P. jr.	Bianca × SK 77-4/5	1985	2018	wg
21.	Taurus	University of Horticulture and Food Industry Department of Plant Genetics and Breeding	(Vitis amurensis × Vitis vinifer) F2 × Afuz Ali	1965		wg
22.	Vértes csillaga	Csizmazia J., Bereznai L.	Eger 1 × Medoc noir	1957		wg
23.	Viktor	Csizmazia J., Kostrikin J. A.	Zalagyöngye × Kazachka	1970	2009	wg
24.	Viktória gyöngye	Kozma P. et al.	Seyve-Villard 12375 × Csaba gyöngye	1966	1995	wg
25.	Zalagyöngye	Csizmazia J., Bereznai L.	Eger 2 × Csaba gyöngye	1957	1970	wg

Note: white grape = wg; red grape = rg; table grape = tg; red flashed = rf.

Olasz rizling, which has been the leader among white wine grapes since the Phylloxera, except for a brief period from the early 1970s when Kövidinka was the most widely grown white wine grape in Hungary.

- An increase in area similar to that of Bianca was observed in the period under study in one other hungarian hybrid, Aletta.
- However, the cultivation of most of the old hybrids (Zalagyöngye, Kunleány, Lakhegyi mézes, Csillám, Vértes csillaga, Göcseji zamatos, Kunbarát etc.) is declining, which may be due to the dynamic spread of Bianca and Aletta and the small area under cultivation. The decline in the area of Zalagyöngye is particularly striking. In 2001, its area was 4265 ha, in 2015 1193 ha and by 2020 it had fallen to 661 ha. A similar decline can be observed for Kunleány, which in 2015 had an area of 1046 ha, which by 2020 had fallen to 719 ha.
- In the period under study, the advance of some hybrids and the decline of others were the result of processes in the wine regions of Great Hungarian Plain and the changes that occurred as a result (climate change, loss of area, species change, change in viticultural and oenological technology).
- The latest hybrid breeding results are already visible in the 2020 variety list: Jázmin, Borsmenta, Sylver, Abigél.
- The Cserszegi fűszeres (Irsai Olivér × Tramini) variety of

Zalagyöngye

Károly Bakonyi was ranked 2nd in the regional ranking of both hungarian hybrid and white wine grape varieties in 2015 and 2020. This is by far the most successful among the more recently crossbred hybrids. Although it has registered plantations in all wine regions, the majority of its total area is located in the three the wine regions of Great Hungarian Plain. Its area decreased slightly from 4177 ha to 4088 ha during the period under review.

- Among the varieties producing muscat wine in 2020, Irsai Olivér moved from 11th place (1291 ha) in 2015 to 5th place (2278 ha) in the regional ranking of white wine grapes, Pölöskei muskotály took 33rd place, Csaba gyöngye 39th, and Mátra muskotály 53rd. Overall, the importance of this group of varieties in the variety composition has increased, even though the area of Csaba gyöngye and Mátrai muskotály has decreased.
- Among the more recently hungarian hybrids, after the Cserszegi fűszeres, the aforementioned Irsai Olivér is followed in the regional ranking by Generosa, Zenit and Zengő. All varieties have increased in area during the period under review, except Zengő. The area under the Generosa variety has increased from 203 ha to 750 ha over the last 5 years.
- Among the Hungarian hybrids from old and new crosses grown on less than 10 ha in 2015, we can find intra- (Favorit, Gesztus, Heuréka, Kocsis Irma, Korona, Nosztori rizling, Pátria, Pelso, Rozália, Táltos, Trilla, Úrréti, Vulcanus, Zefír) and interspecific varieties (Abigél, Borsmenta, Füredgyöngye (Zalán), Göcseji zamatos, Jázmin, Kunbarát, Orpheus, Palatina, Refrén, Sylver, Taurus, Vértes csillaga, Viktor). These varieties together represent one tenth of one percent of the total area under white wine grapes.

Red hybrid varieties

- The most widespread red wine grape variety of hungarian breeding is Turán (176 ha). In terms of its distribution, the variety is essentially linked to one wine region, Eger. Within the red wine grape varieties, it is a representative of a specific group, the so-called „red fleshed" varieties. In addition to this variety, there are three other varieties with a varietal character: Bíborkadarka (81 ha), Kármin (5 ha) and Kurucvér (0 ha). The importance of the varietal character has always been small and its role is not expected to increase.
- In 2020, the investigated red wine grape varieties included five hybrids, Nero, Medina, Dunagyöngye, Pannon frankos and Pinot regina. The largest increase in area was observed for Nero, with 76 ha in 2015 and 148 ha in 2020.
- The list also includes two new hybrid red wine grape varieties, Pinot regina and Messiás.

CONCLUSION

In Hungary, the relevance of hybrid varieties in the variety range has gradually increased over the last hundred years, and as a result their share in the variety composition has also increased. As far as hungarian hybrid wine grape varieties are concerned, the process has accelerated in Hungary, especially since the 1970s, and has brought profound changes in the use of varieties. Since then, but especially in the last 30 years, the wine-growing sector has been subject to new and strong influences (regime change, loss of markets, continuous reduction of area, EU accession, climate change), which have fundamentally changed the whole grape and wine production, without leaving the variety policy untouched.

In this publication, we set out to examine the status, role and importance of wine grape varieties n bred in Hungary today. In the course of our work, we processed, analysed and evaluated mostly the spatial statistical data (2015, 2020) provided by the HNT, partly based on literature sources. Only the white and red wine grape varieties included in the HNT's 2015/2020 register were included in the study.

Hungarian grape breeding has traditionally worked with many varieties, and this also applies to the hungarian hybrids of both intra- and interspecific varieties. In the period under study, 62 hybrids of different varieties and species were in cultivation, 50 of which produce white wines and 12 red wines. Out of the 62 varieties, 36 (29 white, 6 red and 1 table grape) were crosses within varieties and 26 (21 white, 4 red and 1 table grape) were crosses between varieties.

The total area of varieties from hungarian crosses increased by 21.5% in the period under review, while Hungary's vineyard area decreased slightly (0.3%). As a result, the importance of hungarian hybrid varieties in the Hungarian variety composition increased to 30% in 2020. Interspecific varieties played a greater role in this change than intraspecific hybrids.

If we look at the change in area of hybrid varieties individually, we get a more nuanced picture. For 41% (26 varieties) of the varieties in the list, the area increased, while 59% (38 varieties) remained the same or decreased.

Among the 25 most widespread white wine grape varieties, which in 2020 accounted for almost 90% of the total area of white wine varieties, there are 4 intraspecific varieties them bred in Hungary (Cserszegi fűszeres, Irsai Olivér, Generosa, Zenit) and 4 interspecific varieties (Bianca, Aletta, Kunleány, Zalagyöngye). However, among the 10 most widespread red wine grape varieties, which accounted for more than 95% of the total area under red wine in 2020, there are no hungarian varieties. The number of wine grape varieties them bred in Hungary and cultivated on more than 100 ha in 2020: 16.

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EVALUATION OF MANUAL AND MACHINE HARVESTING OF IRSAI OLIVÉR, SAUVIGNON BLANC AND PINOT GRIS

ZSUZSANNA **VARGA**[1] - ANDREA **BERNÁTH**[2] – ISTVÁN **FAZEKAS**[1] – GÁBOR SÁNDOR **VÉRTES**[1]

[1] MATE Institute of Viticulture and Enology, Budapest
[2] Solybor Kft. - Nyilas Pincészet, Gyöngyössolymos

Corresponding author: Zsuzsanna Varga, email: Varga.Zsuzsanna@uni-mate.hu; tel.: 06-1-305-72-83

ABSTRACT

In the course of our work, we compared manual and machine harvesting through different aspects, such as weight per vine, cluster numbers, harvest time. We carried out our research on six fields, which included three grape varieties (Irsai Olivér, Sauvignon Blanc, Pinot gris) and two methods of for each variety (cordon and umbrella training).

Keywords: harvest time, cluster number, machine harvesting, manual harvesting

INTRODUCTION

The grapes must be delivered in a state of maturity that meets the desired technology, so that the winery receives the expected quality in the wine at the end of the process. Several factors must be taken into account when harvesting grapes. An example of this is the biological factor, which includes the state of maturity and the health of the crop.
In order to be able to determine the state of maturity of the grapes, a great deal of expertise is needed. In the case of wine grape varieties, depending on the type of wine (white, red, sparkling wine) we want to produce and the technique we would use to make it, we set very different requirements for its maturity, acidity and sugar content.

Large wineries that work on hundreds of hectares, with up to 10 varieties, require huge logistics, since in the case of several varieties, this harvest period can last up to one and a half months (from the beginning of September to the end of October). In addition to the variety of grape, this is also influenced by the size of the area and of the processing capacity. Therefore, in case of a larger plantation, the harvest must be completed in a relatively short time. In the event that we do not have a sufficient number of workers at our disposal, it is worth starting the harvesting of these larger plantations a little before the ripening time, so that it does not turn into the overripen category. (Bényei et al. 1999)

Before the harvest, we must make a yield estimate, as this is the only way to determine the expected yield, which is very important from the point of view of the receiving cellar, since it is necessary to prepare for the appropriate processing and reception of the grapes. In order for the crop yield to show an approximately accurate result, the number of bunches per vine must be determined, and the average weight of the bunches is given with the help of a scale. The estimated yield of the plantation per hectare is obtained by multiplying the number of bunches, the weight of the bunch, and the number of vinestocks per hectare, with the gaps taken into account. After conducting a trial harvest, even several times, we draw up the harvest plan, which we prepare with some attention, since either weather or labour problems can come into play, not to mention unexpected technical failures. (L rincz et al. 2015) Harvesting and preparing the harvest plan is the task of the grape growing specialists, but it is also necessary to work closely with the specialists in the processing units, as this is the only way to get quality wine in the end. (Kozma 1993)

The harvest

Even when choosing and designing the plantation structure, we have to think about how and with what technique we would like to harvest the crop in our plantation in the future. Therefore, the viticultural and technical conditions must be thought through before planting and establishing the trellis system. Metal posts are clearly the most favorable for all purposes, as they are suitable for both manual and mechanical harvesting. It is also important to mention that there are plantations that cannot be harvested by machine due to the slope of the plantation, or the grape variety does not allow for mechanical harvesting (the berries peel off very easily), or the arrangement of the plantation is not appropriate. (Asbóth 2020)

Table 1: The time and place of the examinations

Variety	Vineyard	Year of plantation	Distance between rows and stocks	Training systock	Time of harvest
Irsai Olivér	Babföld	2014	2,5x1 m	medium height cordon	2021.08.31.
Irsai Olivér	Rózsás	2014	3x0,8 m	umbrella	2021.09.03.
Sauvignon Blanc	Ereszvény	2017	3x0,8 m	medium height cordon	2021.09.23.
Sauvignon Blanc	Ereszvény	2012	3x0,8	umbrella	2021.10.04.
Pinot gris	Toka	2017	2,5x1 m	medium height cordon	2021.09.30.
Pinot gris	Toka	2019	2,5x1 m	umbrella	2021.09.30.

Advantages and disadvantages of mechanical harvesting

Advantages of mechanical harvesting

• the grapes enter the processing unit within a short period of time and in the appropriate state of maturity
• the work peak is reduced, as the harvest progresses faster than it is possible to harvest by hand or with one's own labour
• directing the work process, managing and organizing the machines is much more simple than with manual harvesting
• the specific cost of mechanical harvesting is much lower than manual harvesting
• unlike manual work, mechanical harvesting can be done at any time of the day, in fact, the berries arrive at the processing plant at an even lower temperature in the evening and early morning hours, thus saving cooling energy
• there are self-propelled harvesters that also have a berry picking device
• their operation is comfortable and they adapt well to hilly conditions
• the machine can be used for spraying, pruning, pre-pruning and training system by purchasing the appropriate adapters

Disadvantages of mechanical harvesting

• the first, and one of the most important disadvantages is that the procurement costs are high and their maintenance is also expensive. Failure of the machine or its eventual shutdown can lead to delays and interruptions.
• the machine is not suitable for harvesting on a very steep slope, nor is it suitable for all varieties, as there are varieties for which this solution causes yield loss
• in the case of a small vineyard area or a small farm, it is not worth operating it (possibly in the case that you also do work for hire)
• the harvester is not suitable for picking dried, overripen grapes
• especially in the case of wet soil, the passage of the machine may cause soil compaction
• the driver must have a high level of technical knowledge

MATERIALS AND METHODS

During our experiment, we examined three grape varieties (Irsai Olivér, Sauvignon Blanc, Pinot gris) from the point of view of hand and machine harvesting in the vineyards of Solybor Kft. - Nyilas Pincészet in Gyöngyössolymos (Table 1).
We did our manual harvests for each variety and each plantation in such a way that the harvesting machine was also in the plantation at that time.
We completed our experiment at Solybor Kft. - Nyilas Winery in Gyöngyössolymos. They farm almost 400 ha and have more than 20 grape varieties. This family business was started in 1995, and they have been running the company successfully ever since.

The method of tests

During our research, we harvested 10 vines, we measured the time at each vine with a stopwatch to see how long it would take to harvest it. The time was about 1 minute for almost all varieties, of course, this depended on how much fruit was on the stock, whether the foliage was large, and whether we were talking about a variety with small clusters. We measured the yield per vine and also determined the cluster numbers, so we also got the average cluster weight.
It took about an hour to complete the experiment for each board.
In addition to this, we carefully followed the process of the machine harvest, how many minutes it takes to pick a row, and how much glaze comes off per row. We were in constant contact with the head of the harvester. Settings of the harvesting machine is detailed in Figure 1.
We tabulated the data and performed the evaluation with the SPSS statistical program package.

Figure 1: Settings of the harvesting machine

RESULTS AND DISCUSSION

Comparison of manual and machine harvesting

The aspects that we observed during our investigation (yield per stock, number of bunches, harvest time) can be converted to one hectare, and we would like to present them in the following.

Yield

We got these data from the amount of yield per stock measured during manual harvesting (Figure 2), so that since we knew the amount of stock on 1 hectare at the plantations, we multiplied it and got the values.
The results reflect well what we experienced during our tests. We mentioned the state of the Sauvignon Blanc cordon training system plantation, where we got the lowest average yield (6.125 t).
It was also mentioned that the clusters of the Irsai Olivér variety swelled beautifully thanks to a rainier period, so in case of umbrella training system even it showed a relatively large number of clusters, that we got an average yield of nearly 1.60 t as a result.
It can be seen from this summation that the number of bunches was also relatively high for the umbrella-cultivated Pinot gris, but due to the youth of the plantation and a bent stock, an average yield of 8.56 t was shown, which is a good result for a first harvest.

Cluster number

In the following diagram (Figure 3), we present the evolution of the number of clusters per hectare. We think that our previously presented diagram, on which I show the development of cluster numbers on an average vinestock for all types and all training systems, shows the same result very nicely.
The plantation with the highest number of clusters is the Sauvignon Blanc umbrella-cultivated area, while the lowest number of clusters per hectare is shown by the cordon-cultivated Irsai Olivér.

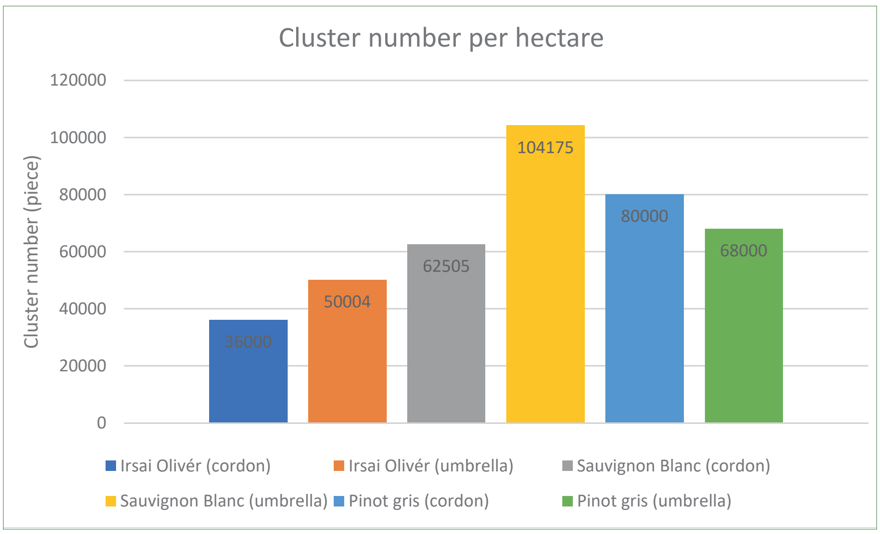

Figure 3: Number of clusters per hectare (expressed in pieces)

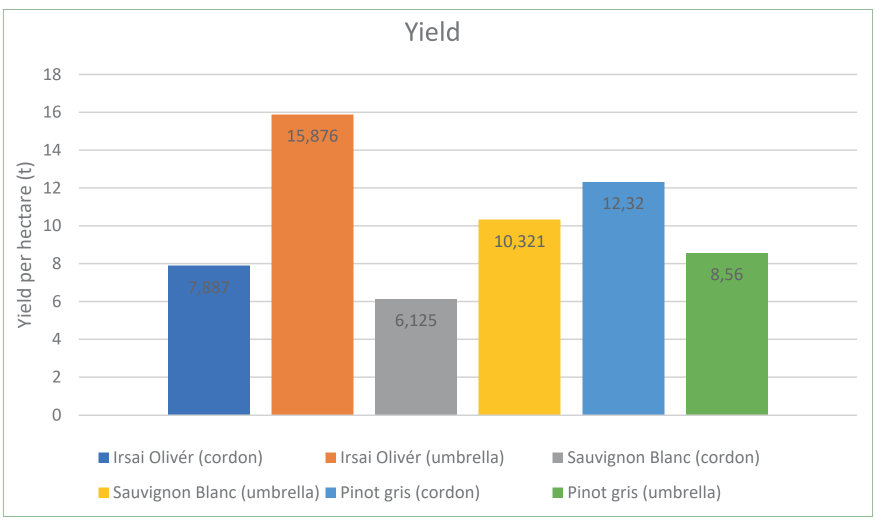

Figure 2: Yield per hectare

Time to harvest the vines

The harvesting time of each sample is summarized in Figure 4. Our most difficult task was perhaps in case of the Sauvignon Blanc plantation with

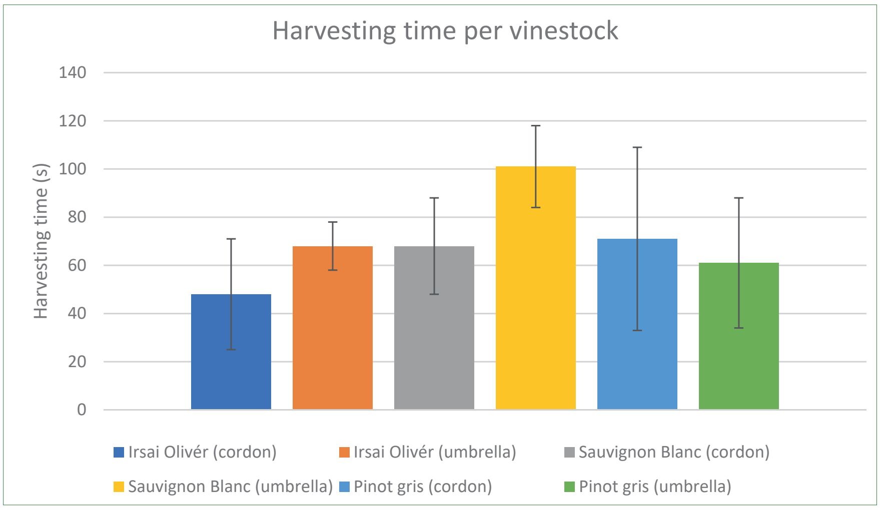

Figure 4:Harvesting time per vinestock (expressed in seconds)

previously mentioned lower number of bunches - in addition to the fact that the planting is younger, so it produces its first crop - that this year it was only possible to arch one cane. Next year, if it will be possible to leave two canes, we can expect a much larger yield. In case of cordon training system, there were large differences between the time results. The least time taken was 43 seconds, while the most time it took to harvest a vinestock was 163 seconds. A big difference can also be discovered in umbrella training system. The time results ranged from 12 to 103 seconds during our test. Their spread is almost the same in both cases (cordon: 38, umbrella: 27).

umbrella training, since this variety is famous for growing dense and relatively large foliage, but at the same time, you can also tell about the variety that its clusters are smaller than the Irsai Oliver's.

Regarding Irsai Olivér, the average time during which we managed to harvest a vinestock was 48 (cordon) and 68 (umbrella) seconds. In case of both plantations, we had to do all this in foliage of approximately the same size, but at the same time, our previous diagram (see: Figure 3) shows that, although not much, we had to collect fewer bunches from the stock in cordon training system, and this is also reflected in the measured time. In the case of the cordon, the harvesting time of the vinestocks ranged from 5 to 80 seconds, which nevertheless shows quite a big difference. This is due to the fact that one of the vinestocks was in rather weak condition during my examination, on which only 1 cluster was found. In case of the umbrella, the same value can be found between 50-79 seconds. Due to this, the standard deviation shows a higher value for cordon training system (23) than for umbrella training system (10).

In case of Sauvignon Blanc, as we mentioned at the beginning of the chapter, we got quite different time results between the two plantations. Our average time for cordon training system was 68 seconds, while this jumped to 101 seconds for the umbrella. Several factors contributed to this result. As we have already mentioned the dense foliage and the smaller bunches, we can also include here that the number of bunches was also higher in the plantation with umbrella training system.

Pinot gris was also rather problemous, because this variety is famous for having relatively small, dense clusters, so it is not necessarily suitable for picking by hand. In case of the cordon plantation, it took an average of 71 seconds to harvest a vinestock, while it was 61 seconds in case of the umbrella. This may be the reason for the shorter harvest time of umbrella training system and the

According to the results of the variance analysis, the Irsai Olivér cordon training system shows a difference compared to the Sauvignon umbrella training system. The training system of the Irsai Olivér variety also differs from that of the Sauvignon variety. From the point of view of the harvesting time, both training systems of the Sauvignon Blanc variety show differences. At the same time, the harvest time of the Sauvignon Blanc and the Pinot gris training system are also different.

Comparison of the costs of manual and machine harvesting

In case of manual harvesting, if we look at the costs per hectare, we will get more than double compared to machine harvesting. In order to harvest one hectare, 24 people will be needed, which, if we multiply it by just 1,000 HUF an hourly wage, we are already at 192,000 HUF. To this we add the rental of the tractor, which is 5,000 HUF/hour, which already means 40,000 HUF. The amount of diesel we will need for the tractor is 13 liters. During our investigations the diesel price was 530 HUF/liter. Thus, all in all, we have to pay nearly 240,000 HUF/hectare during the manual harvest. Of course, this can vary depending on the yield and variety of the crop, but we should expect roughly this much expenses, in the event that we get the right people for the job, because according to our experience, this is very difficult.

During the machine harvest, what we have to take into account is approximately 16 liters of diesel per hectare, the driver's salary, and depreciation, but with everything, the cost of one hectare of machine harvest is roughly 100,000 HUF. Of course, we also know that using a combine harvester is not an option for all farmers, considering the size of their farm and their financial situation. But the price of the combine pays for itself in 2-3 years for a larger farm.

CONCLUSION

In the course of our work, we carried out inspections on the vineyards of Solybor Kft. We compared manual and machine harvesting through different aspects. Such as weight per vine, cluster numbers, harvest time. We carried out our research on six fields, which included three grape varieties (Irsai Olivér, Sauvignon Blanc, Pinot gris) and two methods of cultivation for each variety (cordon, umbrella). During manual harvesting, 10 adjacent vines in each area were sampled, where we individually measured how many kilograms of grapes we managed to pick from each vine, how long it took, how many bunches of grapes were on that particular vine, and how many grams each bunch weighed. I examined the process and time results of mechanical harvesting. For each field, we measured how long it takes the combine to harvest each row, and how much yield we are talking about per row. I also calculated a smaller budget, in which I compared the harvest of one hectare of grapes during mechanical and manual harvesting. this made it clearly understandable that it costs more than twice as much to harvest by hand compared to harvesting by machine. While the cost of manual harvesting per hectare is nearly 240,000 HUF, the cost of machine harvesting per hectare is around 100,000 HUF. My cost calculation proved that manual harvesting is more than twice as expensive as machine harvesting. Deterioration in quality can indeed occur due to an improperly adjusted machine, but this can be eliminated with a professional driver for the harvesting machine.

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