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INTEGRATED MANAGEMENT OF VINEYARD PLANTATION - COMPARATIVE STUDY OF OLIVIA VARIETY AND FETEASCA NEAGRA 4VI CLONE

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Abstract

Knowledge of the biological, ecological, technological and managerial peculiarities applied in vineyard, as well as their integration in the context of sustainable development and the economic and resource crisis, is a permanent concern of the specialists working in this field of activity. This paper presents some of the results obtained from the research carried out within the ICDVV Valea Calugareasca during three agricultural years (2017-2019) regarding the management of the vineyard. The behaviour and adaptation to climate change of the Olivia variety and the Feteasca neagra 4VI clone were observed. These were chosen due to the fact that both were obtained at ICDVV Valea Calugareasca, they are intended for winemaking, they have the same ripening period (IV-V, depending on the characteristics of the agricultural year), and their production potential is similar (9.3 t/ha in the variety and 10.0 t/ha in the clone). The results indicate that, under identical eco-pedological and technological conditions, the Feteasca neagra 4VI clone adapted better to the climatic conditions of the research years, managing to obtain 9-16% higher yields compared to the Olivia variety.

***Key words**: vineyard management, wine grapes, variety, clone, yields.*

INTRODUCTION

In recent years, more and more winegrowers and researchers in the field have come to the conclusion that the selection of clones is a gain for viticulture, both from the point of view of high productions and their quality (Alecu et al., 2018; Burin et al., 2011; Costescu et al., 2010), as well as of the favorable response to the tested agro-technologies (Bigot et al., 2022).

Recently, the management of the vineyard, as well as the improvement activity through the selection of valuable clones, also consider adaptability to climatic conditions (Bucur, 2021; Ranca et al., 2022; van Leeuwen & Destrac-Irvine, 2017), which variability is constantly increasing, influencing the good development of the plants and, likewise, the annual yields.

Grape genotypes for wine are more and more exposed as they have to meet the specific requirements of the respective variety (Tudorache et al., 2014), with particular reference to the amount of accumulated sugar and acidity (Dimovska et al., 2013) - both directly influenced by abiotic factors. As the vineyards are located in arid areas, where rainfall decreases from one year to the next, varieties and clones are needed to use the available water as efficiently as possible (Mairata et al., 2022).

The value of clones has been confirmed by practice over more than a century, observing that they remain constant as long as no further mutation occurs, and then a new selection is required (Hajdu et al., 2011), which correspond to the new demands of the environment.

It should also be mentioned that, depending on the variety and clone, both in the case of table grapes and those for wine, the agrobiological and technological characteristics differ (Przic & Markovic, 2019), therefore it’s necessary to constantly carry out research and to monitor very carefully any changes that appear (Salimov et al., 2022). Research institutes for viticulture and winemaking all over the world started the selection of clones from native varieties (Filip et al., 2018; Sivcev et al., 2011), which they tested by replacing old cuttings, following their evolution, establishing their characteristics and homologating the most valuable ones.

Considering all the above, we aimed to test to what extent a variety and a clone with similar characteristics adapts to the new climatic conditions of the area where the test field is located. The climatic conditions (temperature and precipitation) for the years 2017-2019 were followed, and depending on them the entry into the main phenophases and the obtained yields.

MATERIALS AND METHODS

In a period of three years (2017-2019), at the Research Institute for Viticulture and Winemaking in Valea Calugareasca (ICDVV), were carried out research that aimed to monitor the main climate elements for the period of maximum interest for the vineyard, namely the months of April-October, which were later correlated with the quantitative and qualitative results of each year's yields.

Most of the vineyards of the ICDVV are found at altitudes between 110 and 260 m. Reddish-brown soils with a heavy texture, loam-clay and clay-loam predominate, with a humus content in the range of 1-3.3%. The apparent density of the soil shows, in the bare horizon (0-60 cm) of most soils, average values (1.20-1.35 g/cm^3), but also high values (1.35- 1.48 g/cm^3), depending on the texture and the state of loosening or settling of the soil.

The physical-chemical composition of the soils, both in terms of pH, the degree of saturation in bases and the presence in moderate proportions of $CaCO_3$ ensure a good quality of yield, especially of the varieties intended for high-quality red wines.

The local climate of the area where the Valea Calugareasca viticultural center is located is temperate continental, with early springs, hot summers, mild and prolonged autumns and less harsh winters, without excluding the frosty periods that may occur in certain years. The data recorded at the Valea Calugareasca weather station (latitude 44°59', longitude 26°13', altitude 210 m) were used to prepare the study on the climate of the wine-growing location.

As plant material, the Olivia grape variety and the Fetească neagră 4VI clone were used, both of which are ICDVV's own creation, intended for winemaking and having the comparative characteristics presented in Table 1.

Table 1. Properties of the Olivia variety and Fetească neagră 4VI clone - a comparative look

Crt.	Genotype / Index	Olivia variety	Fetească neagră 4VI clone
1.	Homologation year	2003	2010
2.	Parents	(Babeasca neagra x Pinot noir) x Pinot noir	Feteasca neagra population
3.	Ripening date	IV-V (10-30.09)	IV-V (10-30.09)
4.	Average grape weight (g)	111	199
5.	Average grain weight (g)	1.2	1.8
6.	Sugar in must (g/l)	202	194
7.	Must acidity (g/l H_2SO_4)	4.5	3.8
8.	Yield potential (t/ha)	9.3	10.0

The plantation where the research was carried out was established in 2011, in order to follow the evolution of the Olivia variety and the Cabernet Sauvignon 30VI and Feteasca neagra 4VI clones in parallel. The Cabernet Sauvignon 30VI clone wasn't included in the study, mainly due to differences in ripening age and productive capacity.

So, benefiting from identical pedo-climatic and management conditions, the behaviour of the variety and the clone was followed in terms of the elements of fertility and productivity, respectively:

- RFC - relative fertility coefficient;
- AFC - absolute fertility coefficient;
- RPI - relative productivity index;
- API - absolute productivity index.

The results obtained after the analysis of the six plots monitored annually, three from the Olivia variety, and three from the Fetească neagră 4VI clone, were managed in tables, and later processed statistically with the help of Anova and Table Curve 3D programs. The aim of the research was to compare how the variety and the clone reacted to the climatic conditions of the three years of study, so that it could be concluded whether or not the clone brings an increase in viticulture, in the case of applying an integrated management, similar to the one used until now for wine grape varieties.

RESULTS AND DISCUSSIONS

Compared to the values taken as a reference, namely the average of the years 1985-2016, the main indicators related to temperatures, precipitation and hygroscopicity were tracked (Table 2), all of which contribute essentially to the quantity and quality of grapes obtained at the end of a production cycle. The average monthly temperatures from April-October 2017-2019 were, on average, very close, even identical to the multi-year ones, and analyzing them monthly, some differences of 1-2°C are observed, but they are adjusted by lowering the average in one of the between previous or following months. With a few exceptions (the month of September 2019, with only 3.8 mm of precipitation), it can be seen that no extremes were recorded during the analyzed period. In addition, in the months of maximum importance for the formation of production elements, the amount of precipitation exceeded that of the control in each of the three years, so that the crop didn't suffer from lack of water.

Table 2. The thermal regime in the months of April-October of the years 2017, 2018 and 2019, in the studied area

Month	Monthly average temperature (°C)				Precipitations (mm)				Hygroscopicity (%)			
	Normal	2017	2018	2019	Normal	2017	2018	2019	Normal	2017	2018	2019
IV	11.7	10.9	14.7	11.2	44.8	107.0	65.0	74.8	67.7	68.3	67.0	74.8
V	17.5	18.4	15.6	17.0	67.3	56.4	82.2	190.6	68.4	65.9	75.0	77.6
VI	21.5	21.2	22.1	23.6	81.5	84.7	81.8	85.6	70.1	69.5	72.3	70.9
VII	23.6	22.9	23.7	22.7	75.8	86.6	70.2	68.4	67.5	71.0	63.3	44.6
VIII	23.3	24.1	22.7	24.2	62.7	36.4	78.2	37.0	66.5	61.1	65.4	60.9
IX	18.1	19.4	19.0	19.1	54.4	40.2	66.0	3.8	70.7	65.3	65.1	57.9
X	12.2	10.5	12.1	12.5	46.2	86.8	120.0	15.6	77.0	76.4	82.0	69.6
Mean/Sum	18.27	18.20	18.56	18.61	432.7	498.1	563.4	475.8	69.7	68.2	70.0	65.2

Source: own data, measured at the Valea Calugareasca meteorological station

Air hygroscopicity (relative humidity), an indicator of maximum importance for vines, had average values, close to those of the control period. There was also an exception here, namely the month of July 2019, when it dropped to 44.6%, without representing a critical situation and which didn't perpetuate itself in the following months. At the same time, it is observed that during the period of grain growth, when the requirement is 70-80% hygroscopicity, these values weren't reached, so the maximum yield potential of the variety and/or clone couldn't be reached either, through the lens of this parameter.

Depending on the clues presented, the times at which the variety and clone phenophases were reached in each of the three years can be explained (Table 3).

Table 3. The dates of reaching the phenophases by the Olivia variety and the Feteasca neagra 4VI clone, in 2017-2019

Phenophases	Bud burst			Flowering			Verasion			Harvest		
Genotype \ Year	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Olivia	11.04	16.04	23.04	17.06	9.06	18.06	13.08	7.08	16.08	12.09	18.09	7.09
Feteasca neagra 4Vl	15.04	18.04	12.04	13.06	19.06	10.06	15.08	18.08	12.08	10.09	25.09	13.09

Source: own observations, from the study location from Valea Calugareasca

In 2019, in the Olivia variety, ripening occurs early, three days before the start of the period. Outside of this particular situation, ripening occurs within the optimal range. It should also be noted that, within the same year, several of the phenophases have different periods for the variety and the clone, that is why in 2017, for example, the Olivia variety blooms first, but the Feteasca neagra 4VI clone blooms first, enters the fall earlier the Olivia variety, but the clone reaches maturity faster. Such successions also occur between years, there being no constant in terms of phenophases.

To calculate the elements of fertility and productivity, the classic calculation formulas were used, and in order to obtain the RFC, AFC, RPI and API values, 10 grape vines, respectively 10 bunches from each research batch were analyzed, in order to establish:

- the total number of shoots per vine;
- the number of fertile shoots per vine;
- the number of inflorescences;
- average weight/grape (g).

Yield (t/ha) was calculated by finding the average yield/vine, which value was then multiplied by the number of vines/ha. The average of the results for each of the three research years is centralized in Table 4, and the values of the fertility and productivity elements were processed with Anova, resulting in the graphs in Figure 1.

Table 4 shows that the percentage of fertile shoots (FS) is, without exception, higher in the Olivia variety, with values between 76 and 81%. On the other hand, the Feteasca neagra 4VI clone, which anyway we observe that normally has a lower total number of shoots per vine, also has a lower yield of fertile shoots, with FS between 62 and 71%.

The proportions are reversed when we analyze another parameter, the average weight of the grapes (g), which is favorable to the Feteasca neagra 4VI clone - compared to the Olivia variety there is an increase of 20-25%, compensating for the lower number of shoots/vines, as well as that of inflorescences and fertile shoots.

Table 4. Yields parameters for the Olivia variety and Feteasca neagra 4VI clone, measurements from the research period, 2017-2019

Year	Genotype	Total no. of shoots per vine	No. of fertile shoots (FS) per vine	No. of inflores-cences	RFC	AFC	FS (%)	Average weight/grape (g)	RPI	API	Yields (t/ha)
2017	Olivia	46.2	36.8	45.3	0.98	1.24	79.94	112.14	109.89	139.05	7.81
	Feteasca neagra 4 VI	33.9^{OOO}	24.4^{OOO}	33.1^{OOO}	0.98	1.37	71.80	133.79	131.11	183.29	9.05
2018	Olivia	32	26	36	1.13	1.38	81.30	111.78	126.31	154.25	8.10
	Feteasca neagra 4 VI	32	20^{OO}	27^{OOO}	0.84	1.35	62.50	130.97	110.01	176.81	8.98
2019	Olivia	49.4	37.7	51.7	1.06	1.38	76.40	105.72	112.06	145.89	8.33
	Feteasca neagra 4 VI	32.6^{OOO}	23.1^{OOO}	35.4^{OOO}	1.07	1.50	70.90	130.77	139.92	196.16	9.50

Source: own data, observations and calculations.

Coming back to the fertility and productivity elements, they were calculated using the following formulas:

$$RFC = \frac{No.\ inflorescences/vine}{Total\ no.\ of\ shoots/vine} \quad (1)$$

$$AFC = \frac{No.\ inflorescences/vine}{No.\ fertile\ shoots/vine} \quad (2)$$

$$RPI = RFC \times Average\ weight/grape\ (g) \quad (3)$$

$$API = AFC \times Average\ weight/grape\ (g) \quad (4)$$

Being an analysis with two genotypes, over a period of 3 years, with four elements of fertility and productivity, the trifactorial analysis performed with the statistical program Anova resulted in obtaining four different graphs, one for each coefficient (RFC and AFC) and indicator (RPI and API). The 4 graphs, presented in Figure 1, have been numbered with letters (a-d) and they highlight the fact that the Olivia variety is equal or superior to the Feteasca neagra 4VI clone only in terms of the relative fertility coefficient (RFC), and here the differences are smaller or higher, depending on the particularities of the year.

Close values are found for the absolute fertility (AFC), which is always above unity, falling into the middle fertility category.

The yield, expressed in t/ha, was analyzed by entering the data into the Table Curve 3D statistical analysis program, with the help of which we obtained a graph (Figure 2) from which we can see the differences between the Olivia variety and the Feteasca neagra 4VI clone. It should also be mentioned here that the yield was continuously increasing, this is due to both biotic and abiotic factors, as well as the maturity of the crops, established in 2011, now starting to approach the era of maximum productivity and of reaching the potential of the genotype.

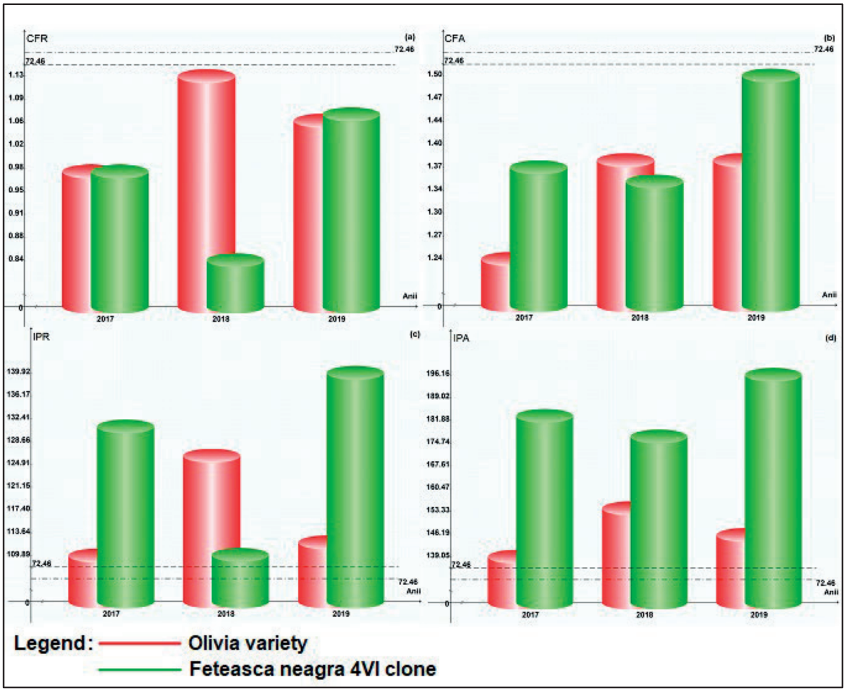

Figure 1. Graphs highlighting the differences between the Olivia variety and the Feteasca neagra 4VI clone, in terms of RFC (a), AFC (b), RPI (c) and API (d), in the years 2017-2019
(Source: own determinations and analysis)

The differences between the variety and the clone are maintained throughout the monitoring years (2017-2019), being between 9 and 16%, each time in favor of the clone. Taking into account all the other parameters that led to finding out the production, we can say that the Olivia variety is limited, in the formation of production elements, by the weight of the grapes (g), which otherwise limits its yield.

On the other hand, Feteasca neagra 4VI clone could have a much better yield if it would have managed to have a higher number of fertile shoots per vine, a category in which it loses a lot. It can therefore be stated that each of the analyzed genotypes has pluses and minuses, but also that both are productive and don't require a particular management, managing to obtain competitive results with classic technologies, already consecrated, to which they respond very well.

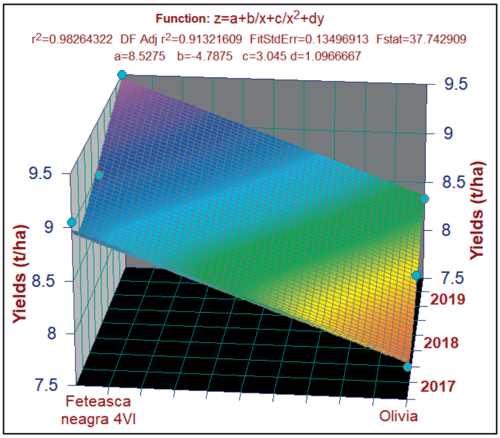

Figure 2. Three-dimensional graph of the productions made by the Olivia variety and the Feteasca neagra 4VI clone in the years 2017-2019
(Source: own determinations and analysis)

CONCLUSIONS

Considering the climatic conditions of the three years (2017-2019) in which the Olivia variety and the Feteasca neagra 4VI clone were monitored, we could conclude that the one that adapted better to the biotic and abiotic factors, in continuous dynamics, was the clone.

The higher productive potential of the Feteasca neagra 4VI clone significantly influenced the yield results obtained, but it cannot be ignored that there is an additional difference of 9-16% in favor of the clone, compared to the Olivia variety.

If these results are going to be confirmed by other research, in the future there is a possibility that clones will be preferred over cultivars, provided that integrated management doesn't involve additional specific operations, as was the case in this study, where all lots have benefited from the same technological conditions.

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