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Original scientific paper

COMPARISON OF TECHNOLOGICAL CHARACTERISTICS BETWEEN CLONES AND TRADITIONAL VARIETY OF CARDINAL TABLE GRAPE

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ABSTRACT

The aim of the research was to determine the technological potential of the clones of the Cardinal variety. The trial included clones VCR 26 and clone 80 of the Cardinal variety which were compared with the standard traditional variants. The experiment was set up in the Tikvesh vineyard - locality Kavadarci on production plantations of the company GD Tikvesh – Kavadarci in Republic of North Macedonia. The experimental plot were established in 2002 on SO4 rootstock by applying a simple double guyot pruning. Regular agro-technical measures applied during the vegetation. The research focused on perceiving the results of: identification of clones, technological characteristics such as sugar, acid content and organoleptic assessment of grape. By applying the ampelographic key and the CODE system of OIV, the connection of the clones with the standard of the variety was ascertained: The clones VCR 26, were characterized by the largest amount of packaged grapes. The quality expressed through organoleptic assessment, which the best quality were seen in clone VCR 26 of variety Cardinal. Based on the obtained results, as the most favourable clone for cultivation in conditions of Kavadarci vineyard, were seen clone VCR 26, compared to clone 80 and traditional Cardinal variety.

Key words: variety, clone, technological characteristics, organoleptic assessment.

INTRODUCTION

Climatic and soil conditions are a favourable, but not sufficiently used aspect for the production of table grapes in North Macedonia and in the region.

Increasing the production of grapes means focusing on several segments and measures such as: expansion and cultivation of new areas, good agricultural practice, application of irrigation, effective protection program and others. In addition to the above measures, the quality and yield of grapes can be increased by applying varieties with high genetic potential and the selection of appropriate clones (Maicas et al., 2020). Lately, in various research institutions, great emphasis has been placed on finding clones with a higher yield or better technological characteristics.

Table grape varieties are highly valued by consumers because they are an important source of health through bioactive compounds with antioxidant properties, anti-inflammatory action and potential regulatory function of the endothelium (Manach et al., 2013; Milella et al., 2014).

Figure 1. The research location

Ampelography has long been practiced in botany and other natural sciences. Writings on ampelographic research date back to antiquity, and as written documents were found in Greece and the Roman Empire, especially with increasing interest during the Roman period.
With the introduction of phylloxera, this science began to develop even more because it is the foundation for the development of viticulture.

The application of clones today is the basis for the development of viticulture, achieving higher yields and higher quality of raw material, without increasing the cost of production.
As a result, today the largest producers of vine seedling are devoting more and more time and money to finding and registering new clones. By selection and cross-breeding of varieties with positive characteristics such as: resistance to diseases and pests, higher yield, high quality of production, but also marketing aspects, such as those of transport resistance, berry and bunch size, taste etc., a large number of clones of different varieties have been obtained, which allows us a greater choice when raising new plantations.

The production of grapes is of great economic importance due to the high values of use of grapes, production of wine, juices, fresh consumption and others. (Ruel and Walker, 2008).

The application of the most suitable clones is the new world trend with a great impact on yield, adaptation to agro-ecological conditions, as well as higher quality of production. Almost half of the total production is used for wine production, 37% is table grapes for fresh consumption, 9% is used as raisins and about 4% for processed liquids - juices (Taurino et al., 2017).

The term "clone" was coined by Weber in 1903. It is etymologically derived from the Greek word "clone", and since 1910, the name has been generally accepted (Stellmach, 1972). Clone selection is a tool for intensive improvement, successfully adapted to several species such as: Riesling, Muscat d'Adda, Pinot sp., Steinschiller, Hárslevelû, Welsch/Italian Riesling, Müller Thurgau, etc. (Németh, 1958; Cindrić, 1981).

In Western Europe, German, French, and Italian breeders have achieved significant results in clone selection (Hajdu, 1993). Clone selection is just one of the many important decisions that need to be made when raising a vineyard (Goliano & Wolpert, 2001).

In Germany, the amount of wine produced using clones has increased from 56.97 hl / ha in the years 1951-1960 to 94.71 hl / ha in the years 1964 to 1973 (Becker, 1990; Bleser et al., 2004). Good results have also been achieved in France.

Clone selection takes a long growing period of 15 to 20 years. Thus, according to Kiss (1990) it should be applied only to promising varieties with high market demand and grown in large areas. It would be pointless to spread varieties that are not in demand and are losing markets.

Smart and Coombe (2006) define the clone as a population of vineyards obtained by vegetative propagation from a single vine. There are clear implications of choosing a clone for proper yields and sugar, sparkling wine acids, although quality impacts are largely ignored. Thus Pinot Noir clones for sparkling wines have higher acidity, higher yields and lower anthocyanin and tannin content than the population (Jones et al., 2014).

In United States, the combination of grape varieties, including American vines (V. Riparia, V. Rupestris and V. Aestivalis) with the European cultivar (Vitis Vinifera), has begun. The purpose of these crosses is to improve the quality of the raw material of the American vine. Good results have been obtained from the Asian species (V. Amurensis) with the European vine (V. Vinfera), from whose hybridization a number of varieties with increased resistance to low temperatures and diseases have been obtained (Çakalli & Susaj, 2004). One of the most successful selections is that of the famous selector, Professor Miller from Turgu, Switzerland, who created the variety "Muller Thurga". which was obtained by crossing the Riesling x Madeleine Royale and today is very successful in Germany, Austria, Switzerland, occupying in a short time over 20% of the total vine area (Cindric, 1981).

Clone selection is considered to be one of the most important methods for improving the genetics of vineyards, based on the selection of clones and cell changes of varieties, accompanied by increased vegetative mass (Salillari & Hoxha, 2001). Through clonal selection, the production and commercial qualities of varieties can be improved. When choosing a clone, the most important parameters are: the shape and size of the grape, the mechanical composition of the grape and the berries, the quality of the grapes and wine, as well as disease resistance (Rühl et al., 2004).

Clone selection in Turkey begins in 1980, and clone selection trials are still conducted on different varieties (Kadir, 2005; Çelik, et al., 2010). It is considered one of the most important methods for genetic improvement, based on clone selection and variety variation, accompanied by vegetative growth (Salillari & Hoxha, 2001). The main goal of choosing a clone is to choose the best properties, to remove the weak properties, to get the best varieties according to yield and quality. The successful development of commercial vineyards is conditioned by the use of seedlings selected by the grower and better grafting through the selection of the clone (Koronica et al., 2005).

The first scheme of true clonal selection is considered to be that used by Froelich (1896), who succeeded in creating the Sylvaner variety. Later, the elements of the scheme and the stages of clone selection were perfected by scientific institutions in France, such as the ENTAY Institute (National Institute for Viticulture Improvement) and the INRA (National Institute de la Recer Agricola) (Foss, 2008). A key contribution to quality improvement is made by the VCR by experimenting with colonial selections conducted each year in their experimental vineyards. They allow continuous checking of the oenological potential of different clones, both domestic and foreign.

Research and innovation efforts are now moving towards the formation of new varieties and new substrates to cope with climate change, to meet the needs of growers around the world in terms of environmental sustainability and the protection of the health of workers, consumers and in general all citizens (VCR, 2010).

The aim of the research

Increasing of production and the quality can be made by different ways in viticulture. Starting from the expansion and increasing the surface of vineyards cultivation, application of irrigation systems, application of various agro-technical measures, appropriate programs for protection and fertilizers throughout the year. But of particular importance in increasing the yield and quality of production is the application of the most suitable and best selected clones and variety.

Therefore, the aim of the research is to determine which of the clone of the examined varieties give the best results for parameters such as: chemical compositions, packaged grape, organoleptic properties of the grape. The obtained results should give an answer which of the examined clone is characterized by the best production in conditions of cultivation of North Macedonia. The results of this research will contribute to finding the most appropriate clones for future development. Meanwhile, the identification of the best clones will contribute to the improvement of the examined grape varieties.

MATERIAL AND METHOD

As work material we used clones and traditional variety of the varieties *Cardinal*. The examined clones were VCR 26 and clone 80. The clones were compared with the standard traditional variant. Internationally recognized methods (O.I.V.) of Vine and Wine were used. The trials included 300 vines for each clone, with 100 vines in a row (or 300 replicates per clone). During ripening, 10 vines with an average yield were taken. We measured all the grape per vine in research work. The chemical composition of the must is determined by measuring the content of sugar and total acids. The content of the sugar was determined using the Exlo's device, and the total amount of acids was determined by volumetric method, using 0.025 mol/l solution of NaOH. The amount of sugar in the must extracted from the grape based on codes (505 code of the OIV). (Measurements in 5 kg of the control variant and 5 kg experimental variants). The amount of acids extracted from must (506 code OIV).

Regarding the organoleptic evaluation, a 10-point scale was applied. The evaluation commission, composed of experts, with the help of the senses of taste, sight and smell, evaluated the submitted samples of each variant, based on the external appearance, consistency, taste and typicality, ie the originality of the variety.

For basic statistical processing of the results of repetitions and variants, descriptive statistics is applied, through an arithmetic mean, difference from the standard, percentages, as well as the absolute (SD) and relative distribution (CV) of the values or standard deviation and the variation coefficient.

The results of the three-year trials (from replicates and variants) were statistically processed through analysis of variance (ANOVA), in all parameters. For a comparative procedure of the obtained values between the variants and determination of significance or significant differences at the probability level of $p > 0.05$ and $p > 0.01$, the LSD test (LSD - Least Significant Difference) was performed.

RESULTS AND DISCUSSIONS

The results obtained from the field examinations during the research, laboratory analyses, as well as organoleptic evaluation of all examined varieties and clones are presented in the following discussions.

The yield of harvested grape

Regarding the variety of *Cardinal* the analysis of variance for the yield of packaged and the total yield of grapes determined a significant difference between the standard variety and the clones, while for the rest of the grapes no statistical significance was determined (tab 1).

Table 1. Yield of harvested grape in clones and standard variant (kg/Ha)

Years	*st.*			*VCR 26*			*cl. 80*		
	packed	leftover	Tot.	packed	leftover	Tot.	packed	leftover	Tot.
2015	12 400	2 984	15 384	14 440	3 235	17 675	14 080	3 590	17 670

2016	14 000	3 654	17 654	16 000	4 219	20 219	16 800	3 528	20 328
2017	13 600	3 536	17 136	15 200	3 116	18 316	15 700	3 423	19 123
x	13 333b	3 391a	16 724b	15 213a	3 528a	18 736a	15 527a	3 514a	19 041a
Index	100	100	100	114	104	112	116	104	114
SD	832.67	357.66	1 189.59	780.09	605.4	1 323.14	964.43	84.42	1 330.93
CV %	6.12	10.11	6.94	5.13	19.43	7.22	6.34	2.47	6.96

According to Winkler (1974), good quality table grapes are a combination of medium-sized grapes, even in size, excellent grains with a characteristic colour, representing the taste and texture of the variety. Today, the vineyards where table grape is grown, and which are under irrigation system, very easily reach yields above 25 t / Ha (Rotim & Gašpar, 2016), ie an increase in yield of 20 to 47% is achieved depending on year (Kryeziu. S, 2017). Several authors (Bozinovic et al., 1998; Prculovski et al., 2017; Prculovski, 2019) state in their research that the yield and quantity of packaged grapes is increased by applying green operations such as pinching and thinning the shoots.

There are a number of studies today that show that clone selection has a major impact on overall yields. (Dimovska et al., 2013; Dimovska et al., 2011; Atak et al., 2014; Marković et al., 2017), in their research have determined the impact of clone selection on the yield of grape varieties.

Organoleptic grape evaluation

The organoleptic assessment of the quality of grapes depends on the external appearance, mechanical properties, content and composition of sugars and organic acids. Despite the lower content of organic acids compared to the sugars in the composition of grapes, organic acids have a significant impact on the quality of table grapes.

Organic acids improve the taste of grapes and help to improve the taste qualities of grapes. The balance between sweetness and sourness is a very important criterion for the quality of consumer acceptance (Topalovic et al., 2010).

In our research, a 10-point scale was applied. The evaluation commission, composed of experts, with the help of the senses of taste, sight and smell, evaluated the submitted samples of each variant, based on the external appearance, consistency, taste and typicality, ie the originality of the variety (Table 1, Table 2).

Table 2. Cardinal and clones characteristics

Cardinal			
2015	**St**	**VCR 26**	**Cl.80**
External look	2.7	3	2.8
Consistency	3	3	3
Flavour	2.9	3	2.9
Typicality and organoleptic	1	1	1
Total	**9.6**	**10**	**9.7**
2016			
External look	2.43	3	2.16
Consistency	2.43	2.16	2.66
Flavour	2.5	3	2.4
Typicality and organoleptic	0.72	0.75	0.83

Total	**8.08**	**8.91**	**8.05**
2017			
External look	2.52	2.9	2.5
Consistency	2.45	2.2	2.7
Flavour	2.53	2.8	2.6
Typicality and organoleptic	0.78	0.79	0.71
Total	8.28	8.69	8.51
$\bar{x}$ (2015, 2016, 2017)	**St**	**VCR 26**	**Cl.80**
External look	2.6	3	2.5
Consistency	2.7	2.6	2.8
Flavour	2.7	3	2.7
Typicality and organoleptic	0.9	0.9	0.9
Total	8.65	9.2	8.75
Classification	**Excellent**	**Extra quality**	**Excellent**

Table 3. Organoleptic evaluation of clones and standard variant

	Cardinal		
Years	st.	VCR 26	Clon 80
2015	9.6	10.0	9.7
2016	8.1	8.9	8.1
2017	8.3	8.7	8.5
X	8.7b	9.2a	8.8b
SD	0.83	0.70	0.85
CV %	9.97	8.07	10.01
Classification	Excellent	Extra quality	Excellent

Based on organoleptic evaluation in the clones of the *Cardinal* variety, results shows that in the standard variant and clone 80 were found excellent quality, while in the clone VCR 26 were found extra quality. The results of the organoleptic evaluation of the *Cardinal* variety are presented in (tab 2). Analysis of variance showed significant differences between clone VCR 26 compared to standard and clone 80, while the variance coefficient was low and ranged from 9.97% to 10.01% (clone 80) (Table 2).

Figure 1. Cardinal and clones

Chemical composition of grape juice

The chemical composition of grapes is quite complex and has not yet been fully studied. It is not permanent, it varies depending on the variety, the degree of maturity, the ecological conditions, the applied agro technics, the health condition, etc. In general, after the analyses, it

was noticed that the clones of the examined varieties have significant differences in the amount of sugar and the acid content in relation to the standard variant, (Table 4).

Table 4. Sugar and acids content in C*ardinal variety*

Years	*Cardinal*					
	Sugar content			Acids content		
	st.	VCR 26	cl. 80	st.	VCR	cl 80
I	151.0	124.0	138.0	6.5	7.0	6.8
II	178.0	163.0	154.0	5.3	5.0	5.4
III	174.0	155.0	150.0	6.1	6.3	5.8
X	167.7a	147.33b	147.3b	6.0a	6.1a	6.0a
SD	14.57	20.60	8.33	0.62	1.00	0.69
CV%	8.37	13.29	5.55	10.16	15.90	11.96

In the C*ardinal* variety, the sugar content in the must range from 147.3 g / l in clones 80 and VCR 26, to 167.7 g / l in the standard variant. Analysis of variance and LSD test for sugar content determined the significance of the standard compared to all clones, while for the total acids no statistical differences were found between the variants. The variation coefficient for both parameters in most variants is with average values and ranges from 5.55% (clone 80) to 13.29% (clone VCR 26).

Our research has shown similarities in the chemical composition of must with several other studies (Dimutru et al., 2016; Korać et al., 2012; Avramov et al., 1987; Çakall & Lush, 2004; Kok et al., 2017; Kryeziu, 2012; Prculovski et al., 2017), as well as the influence of clones on the content of sugars and acids (Dimovska et al. 2014; Dimovska et al., 2011; Marković et al., 2017, etc.).

Table 5. pH values

Years	St	VCR 26	Cl.80
I	3.45	3.5	3.6
II	3.4	3.6	3.6
III	3.4	3.6	3.7
x	3.4	3.6	3.6

There were also differences in the values of pH, which in the respective clones were 3.6, meanwhile to standard variant it was 3.4

CONCLUSION

By applying the ampelographic key for identification of the clones, their connection with the standard variety was ascertained. Using the CIVE system of OIV for identification, differences were found between the clones and the parent variety in the sugar and acid content in *Cardinal* varieties. Clone VCR 26 were characterized by uniform berry, good colour, high percentage of packaged grapes, good transportability compared to standard variant and clone 80. From the organoleptic evaluation Cardinal variety in standard and cl. 80 were characterized with excellent quality of the grape meanwhile in the variant VCR 26, were characterized with "Extra" quality. As regards the amount of sugar in must the higher value were to standard variant 164.0 g/l. Regards of acids the average higher value reached to cl.80, 6.08 g/l. The

values of Ph reached 3.4 to standard variant and cl. VCR – 26 were characterized with significant higher value at 3.6, while the lowest value were to cl. 80 with of 3.6 .

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