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THE INFLUENCE OF CLIMATIC FACTORS ON THE LEVEL AND QUALITY OF YIELD OF VRANAC VARIETY IN PODGORICA VINEYARDS

SUMMARY

Due to the favourable climatic and soil conditions, the vineyards of Podgorica have always been known as a very favourable area for successful cultivation of grape vine.

The influence of climatic factors on the grape yield, weight of vine cluster and quality of grape vine of Vranac variety were studied during 2003, 2004 and 2005. The estimation of grape quality is done on the basis of sugar content and total acid content in the must. The highest yield of grape, as well as the mass of the cluster is achieved in 2005 (1.52 kg/m², i.e. 239 g), while the lowest yield (1.13 kg/m²) and cluster mass (173 g) were measured in 2003. The highest sugar content and the level of acid in must were measured during 2003 and the lowest content was found in 2005. In 2003 with the highest average temperature during growing season, deficit of rain falls was measured in comparison with that period and with climatic normal, but also in the relation to the actual needs of the vine grapes for water. Such yield and the quality of grapes in that year were in direct concordance with the weather conditions.

The average grape yield in the three year period was 13.5 t/ha, the sugar content about 24%, the acid level 6.10 g/l, which means Vranac variety from this vineyard had the optimal production conditions.

Although these three years were warmer with greater amount of rainfall in comparison to long term average, a more detailed analysis of differences between monthly values of climatic parameters during that period, especially during growing period, can explain differences in yield and grape quality.

Keywords: Vranac, climatic factors, yield, grape quality.

INTRODUCTION

The grape vine is a perennial plant which during its growth and development has special requirements according to agro and ecological conditions in the cultivation area. The favourable conditions of the soil and climate are the most important factors for successful growth and development which lead to the regular yields of high quality grapes. (Mirošević and Karoglan – Kontić, 2008).

The climate is the main environmental factor and it has a crucial importance for the successful cultivation of vine. The climatic conditions are

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manifested with complex action of their factors which are mutually conditioned and are changing. The normal growth of grape vine is significantly conditioned by these influences. Quite important are also relief, exposure, temperatures, brightness and physical and mineral properties of the soil (Van Leeuwen and Seguin, 1994).

According to Ulićević (1966) Vranac variety is also called Vranac krstač, Crmnička loza, Vranac crmnički. These synonyms are related to origin from Crmnica and the colour of very ripe black berries. Vranac is regarded as the local indigenous variety. According to Cindrić et al. (2000) it is mostly cultivated in Montenegro (dominating in the assortment of red grape varieties), in Macedonia, occasionally in Dalmatia, Hercegovina and Serbia. The wine of this variety has a pleasant, harmonious and specific varietal taste, known for its very intensive dark red colour (Avramov, 1991).

Vranac variety is the dominant grape variety in a lineage assortment of Montenegro and it occupies around 80% of the total area under grape vine. For this reason during the three years we conducted studies and made detailed analysis of climatic factors prevailing in Podgorica vineyards, and examined the impact they have on the amount and quality of the yield of this variety.

MATERIAL AND METHODS

The influence of climatic factors on the yield and grape quality of Vranac variety was analysed during three years (2003-2005). For this particular study pilot it was used vineyard of Bio-technical faculty in Lješkopolje in Podgorica.

This vineyard was founded in 1986 with a space between the rows 2,50m and 1,20m in the row. Cultivation form is double horizontal cordon with tree height of about 80cm. The mixed pruning was used such as two arcs with ten buds and two spurs with two buds. The study is done on 18 vines, i.e. 3 repetitions with 6 vines.

During the three-year study, the grape yield (kg/m^2), cluster mass (g), sugar content (%) and acid (g/l) in must were examined.

Total yield was obtained by measuring the harvested grapes and calculation of grape yield per m^2 , and the cluster mass was determined using ratio between yield from six vines and the number of clusters. The sugar content in the grape juice was determined aerometrically (Oechsle Scale) and the share of the total acids in grape juice by neutralization of acids and their salts n/10 with solution NaOH with an indicator bromothymol blue.

For the analysis of climatic conditions of Lješkopolje area data of meteorological station in Podgorica were used. The results were statistically analyzed by using the analysis of variance and LSD test.

RESULTS AND DISCUSSION

Podgorica vineyards are characterized by a Mediterranean climate modified with the influence from the high mountains that surround it. In contrast

to the narrow coastal area, summers are warmer and drier and winters are more humid.

The amount and quality of the grape yield depends largely on the climate and meteorological conditions that prevail in the regions of production. Therefore, in this paper we analyze the most important climatic elements by comparing their values during studied years with the average values from the period of twenty years.

Table 1. Average monthly, annual and vegetative air temperature (°C)

Year	Months												Average year	Average vegetation	Sum vegetation
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
2003	7.2	4.4	10.3	13.7	23.5	28.6	28.8	30.3	21.1	15.3	12.8	6.9	16.9	23.0	4936.9
2004	4.8	6.9	10.0	15.5	17.4	23.7	27.5	25.7	22.3	18.1	10.1	8.5	15.9	21.5	4594.7
2005	5.2	4.5	9.6	13.9	20.8	24.2	27.4	24.7	22.0	16.1	9.8	6.8	15.4	21.3	4560.3
2003-2005	5.7	5.3	10.0	14.4	20.6	25.5	27.9	26.9	21.8	16.5	10.9	7.4	16.1	21.9	4697.3
1985-2005	5.7	6.9	10.4	14.0	19.8	24.0	27.2	26.9	21.5	16.3	10.7	6.7	15.8	21.4	4583.3

By comparing the studied years we came to the conclusion that the hottest year was 2003, both on annual average and during the growing season.

The average annual temperature in 2003 was 16,9 °C and it was for 1,1 °C higher in comparison to multiannual average. During second and third year of the study, average annual air temperature was 15,9 °C and 15,4 °C and they were slightly different from the multiannual average (15,8°C). The average temperature during growing season in the first year of study was 23,0 °C and it was higher in comparison with other two years measuring 21,5 °C and 21,3 °C.

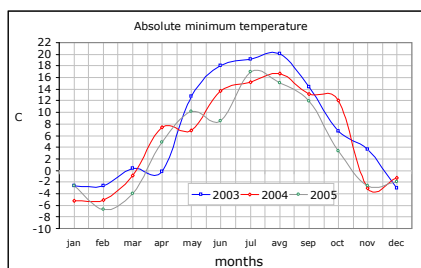


Chart 1. Absolute minimum temperature

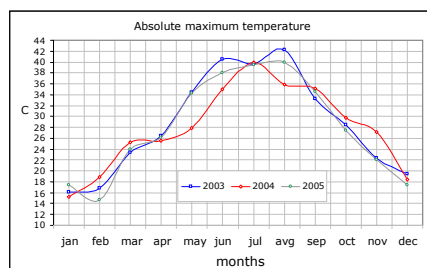


Chart 2. Absolute maximum temperature

In Podgorica vineyards the temperature sum during the vegetation period in a multiannual period from 1985 to 2005 amounted to 4583.3 °C. In the studied

period, the temperature sum during vegetation period was in 2003 counting 4936.9 °C, which comparing to 2004 and 2005 was higher by 342°C and 375°C.

Based on the data given in the Chart 1 it is shown that during the studied years there were no low temperatures that could lead to the freezing of vine grape. The minimal air temperatures in the period May – September were highest in 2003. They showed significant discrepancies such as the minimal air temperature, in June 2003 it amounted to 18 °C and in the same period 2005 it was only 8 °C.

In Podgorica vineyards the warmest summer months are July and August, which is shown in Chart 2. The high temperatures during July and August were not adversely affecting the growth of the vine grape.

The period May - June - July - August in 2003 was warmer than the same period in 2004 and 2005. During the remaining part of the year the temperatures were fairly consistent, only in 2003 their slight increase was recorded. The most distinct difference between the maximum temperatures was determined during the period from April to July by comparing 2003 as the warmest year and 2004 as the one with the lowest maximum temperatures.

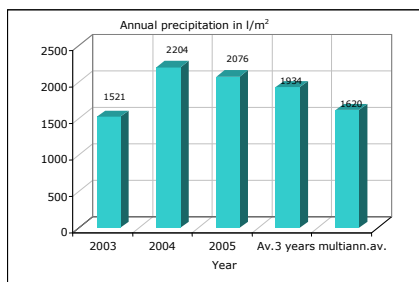


Chart 3 Annual precipitation

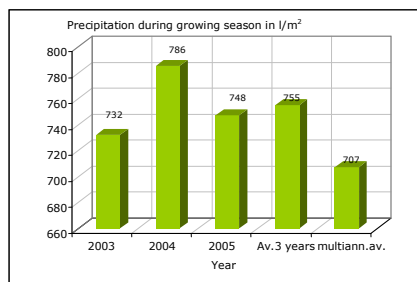


Chart 4 Vegetation precipitation sum

In Podgorica vineyards the average annual precipitation quantity for the period

1985-2005 was 1619.7 mm (Chart 3). In 2003 the annual amount of precipitation was 1521.1 l/m², which is 98.7 l/m² less than the multiannual average. However, during the second and third year annual precipitation amount was higher than the multiannual average and it was 2204, i.e. 2076.1 l/m², which is 584.3 and 456 l/m² more than the multiannual average. The annual precipitation for 2004 was 45% higher than the amount in 2003 and by 6% than the amount in 2005.

By analysing the amount of precipitation during growing season (Chart 4) it can be noticed that in 2003 there was 732 l/m² of rain, which is significantly less compared to the amount in 2004 when during the growing season it was 786 l/m² of rain and 2005 was 748 l/m² precipitation. Although in the studied period when comparing it to the multiannual average (707.3 l/m²) more precipitation was registered and that does not mean that the vine grapes during that period had enough water. Namely, distribution of precipitation was rather unfavourable, and

the deficit during the period May – August had a negative impact on the growth and fruiting of the vine grapes.

Chart 5 shows that distribution of total precipitation during the three years was annually distributed in the following manner: 2004 - 38%, 2005 - 36% and only 26% for 2003.

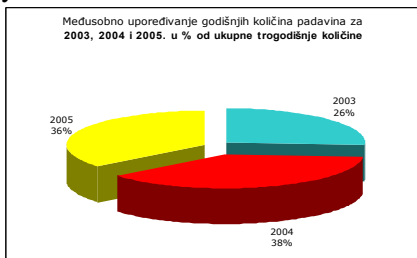


Chart 5 Annual precipitation quantity in % of the total amount during three years

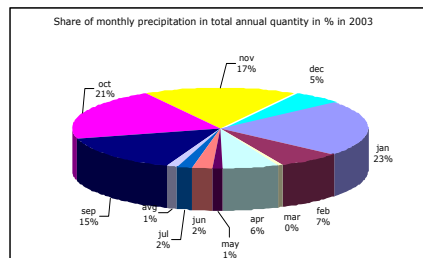


Chart 6 Share of monthly precipitation (%) in 2003

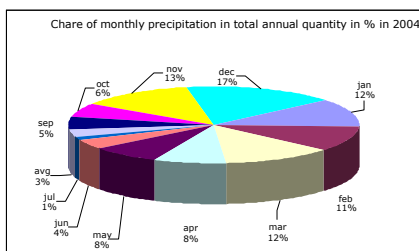


Chart 7 Share of monthly precipitation (%) in 2004

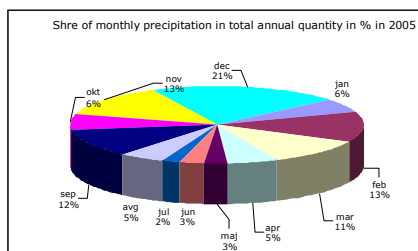


Chart 8 Share of monthly precipitation (%) in 2005

Although the amount of precipitation in the three years of studies during growing period was over 700mm, the distribution of precipitation per month was significantly different during these years (Charts 6, 7 and 8).

The yield of grape by unit area, as an absolute indicator of cropping of particular variety is influenced by a number of factors. The most important factors are the biological characteristic of the variety and environmental conditions in the study years.

The obtained yield of grapes (Table 2) was in accordance with the meteorological conditions during the studied years. The lowest yield (1.13 kg/m²) was measured in the first year, which was also the hottest and with the lowest precipitation – both in annual terms and during the growing season. The significantly higher yield was achieved in the second year - 1.40 kg/m², and the highest in 2005 - 1.52 kg/m². The statistical analysis of the data showed a significantly higher yield of grapes in the third year than in the first and significantly higher in the second year comparing to the first. The difference in the yield of grapes between the second and the third year of the study did not have any statistical importance at any level of probability.

The yield of grape for all the studied years was within the limits for Vranac variety, as cited by numerous other authors: Ulićević (1966), Ulićević et

al. (1991), Pejović (1982), Burić (1995), Cindrić (2000), Popović (2003) and others.

The cluster mass is a biological characteristic of every variety. Table 2 presents the variation of this particular characteristic in relation to the climatic elements. In the analysis the average weight of cluster by years of study, it is evident that in the first year (173 g) was significantly lower than in the second and third year of study. The higher average cluster mass in the second (229 g) and third year (239 g) is primarily the result of more favourable environmental conditions, mostly because of the higher precipitation during the growing season. This is consistent with the results of Koev (1984) who is stating that the cluster mass was higher in years with more favourable environmental conditions.

Table 2. The yield and quality of Vranac grape variety

Year	Yield (kg/m ²)	Cluster mass (g)	Sugar content (%)	Acid content (g/l)
2003.	1.13	173	25.00	7.50
2004.	1.40	229	23.90	5.50
2005.	1.52	239	23.50	5.30
Average	1.35	214	24.1	6.10
<i>LSD 0.05</i>	0.23	51.07	-	1.17
<i>LSD 0.01</i>	0.33	74.31	-	1.67

The results of the three year study showed that the cluster mass had the same values which are stated for Vranac variety by Avramov (1991), Ulićević (1966), Ulićević et al. (1991) and Pejović (1982).

The influences on physiological processes and ecological potential of the production region significantly affect the quality of the grapes which is primarily reflected in the change of the sugar content, acid content, coloured and aromatic compounds, etc. The quantity of sugar in the grapes, depending on variety, degree of ripeness and health significantly depends on the climatic conditions in the ripening stage of grapes (Ranković - Vasić, 2011).

During the three year study different results were obtained for the chemical composition of the must, although the grapes used are from the same experimental plots. That suggests that the results are dependent on the specific meteorological conditions. Based on the results given in the Table 2 it can be noticed that the highest sugar content in grapes was measured in 2003 (25,00%), and that particular year had the highest average temperature during the growing period/ The lowest sugar content was obtained in 2005 (23,50%). All noted differences in sugar content by years had no statistical importance. The obtained results are in accordance with results of Vukosavljević et al. (2011) which are stating that during the years with higher average temperatures in growing period there was a higher content of sugar in the must.

The share of acids in the must is an important indicator of the quality of grapes and it is linked to the taste and harmony of the grape and later wine. The sugar content and acids in grapes are important for the content and share of other important ingredients of grapes (minerals, phenolic compounds, vitamin complex and other components of the extract of wine). The data presented in Table 2 show

that the acid content in the studied period was satisfactory in general and typical for Vranac variety in agro and ecological conditions of Podgorica vineyards. The highest content of acid in the must was in 2003 – 7.50 g/l. Although in the same year, the growing season had the lowest precipitation, the high amount of rainfall in September (231,5 mm) significantly influenced the quality of the grapes, primarily on the total content of acid in the must. These results are in accordance with the results that Pajović et al. (2002) obtained in agroecological conditions in Lješkopolje. In 2004 and 2005, the acid content was by 2 i.e. 2.2 g/l lower than in 2003, which can be assigned to more favourable climatic conditions in the stage of the ripening grapes. Statistical analysis showed that the acid content was significantly higher in the first than in the other two years.

CONCLUSIONS

Based on three years of research following conclusions are made:

- In Podgorica vineyards there are extremely favourable agro and ecological conditions for growing of Vranac variety.
- The results showed a significant influence of climatic factors on the level and quality of the yield of Vranac variety.
- The yield of grape and cluster mass were the lowest in 2003, which was assigned to the lack of precipitation during the growing season.
- However, the highest content of sugar had been measured in 2003 which was the result of the higher air temperatures during the growing season of the vine grape.

In 2003 the highest content of acid was established and it was the result of heavy precipitation during September.

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UTICAJ KLIMATSKIH FAKTORA NA VISINU I KVALITET PRINOSA SORTE VRANAC U PODGORIČKOM VINOGORJU

SAŽETAK

Podgoričko vinogorje je zbog povoljnih klimatskih i zemljišnih uslova odavnina poznato kao veoma povoljna oblast za uspješno gajenje vinove loze.

Uticaj klimatskih faktora na prinos grožđa, masu grozda i kvalitet grožđa kod sorte vranac proučavan je tokom 2003, 2004 i 2005. godine. Kvalitet grožđa procjenjen je na osnovu sadržaja šećera i ukupnih kiselina u širi. Najveći prinos grožđa, kao i masa grozda ostvareni su u 2005. godini (1,52 kg/m², odnosno 239 g), dok su najmanji prinos (1,13 kg/m²) i masa grozda (173 g) izmjereni u 2003. godini. Najveći sadržaj šećera i kiselina u širi ustanovljen je tokom 2003. godine, a najmanji u 2005. godini. U 2003. godini, koja je imala najveću srednju vegetacionu temperaturu, izmjeren je deficit padavina tokom vegetacionog perioda u poređenju sa klimatskom normalom, ali i u odnosu na stvarne potrebe vinove loze za vodom. Dobijeni prinosi i kvalitet grožđa u ovoj godini bili su u direktnoj saglasnosti sa meteorološkim uslovima.

Prosječan prinos grožđa u trogodišnjem periodu iznosio je 13,5 t/ha, sadržaj šećera oko 24 %, kiselina 6,10 g/l, što znači da je sorta vranac u ovom vinogorju imala optimalne prizvodne uslove.

Iako su sve tri godine bile toplije i imale veću količinu padavina u odnosu na višegodišnji prosjek, detaljnija analiza razlika mjesečnih vrijednosti klimatskih parametara tokom proučavanog perioda, posebno u periodu vegetacije, može objasniti razlike u prinosu i kvalitetu grožđa.

Ključne riječi: Vranac, klimatski faktori, prinos, kvalitet grožđa