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STUDY ON THE INFLUENCE OF RUPESTRIS DU LOT ROOTSTOCK ON SOME TECHNOLOGICAL TRAITS OF MUSCAT RUSENSKI AND SUPER RAN BOLGAR TABLE GRAPE CULTIVARS

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Abstract. The choice of rootstock is important not only for the power that it induces on the grafted variety of grapes, but also with respect to its effects on mineral nutrition, content of sugars, total acids and other technological traits. Two table vine varieties–Misket Rusenski and Super ran Bolgar were the objective of the study, grafted on two different SO_4 rootstocks (which is widely used in practice and thus accepted control) and Rupestris du Lot (with common name Montikola). A total of 12 technological traits were reported for both varieties during the vegetation. Data obtained were statistically analyzed using Fisher (F) and Student (t) evaluation criteria. The results showed different levels of significance of the individual traits in both varieties using Rupestris du Lot rootstock compared to the control. Via Fisher's criterion it was found that 58 % of the traits showed significant differences in Montikola rootstock compared to the control, as the comparison was made based on variability of the traits, while when using the Student criterion for statistical evaluation, the percentage was only 33. The highest significance was reported in the influence of the rootstock on the traits: number of seeds in 100 berries and resistance of berry to pick up from the fruit stalk for cv. Misket Rusenski, determined via both criteria. Comparing the samples tested regarding variability, significant differences were reported of Rupestris du Lot rootstock for the traits: % of berries in grapes and % of mesocarp in berry mass for the same variety. Rupestris du Lot rootstock has significant influence on content of sugars, total acids and mass of 100 seeds in cv. Super ran Bolgar (by the criterion of Fisher) and traits: % of mesocarp of berry mass and % of skin of berry mass (found by the criterion of Student). These traits influence significantly on tasting qualities of grapes and technological qualities of wine. As a result of the analysis of both vines (Misket Rusenski and Super ran Bolgar) a high degree of variability of the values of some technological traits was determined, and it is recommended both criteria to be used for better statistical evaluation.

Keyword: Rupestris du Lot rootstock, statistical evaluation, table vine varieties Misket Rusenski and Super ran Bolgar (*Vitis vinifera L.*), technological traits

Introduction

In experiments with permanent crops conducted under field conditions, the value of the data is determined by the degree of accuracy.

For this reason, one of the requirements is to obtain data with the highest possible accuracy, respectively the differences as small as possible between the variants tested to be determined and statistically significant because only of such results correct conclusions could be made also and recommendations for practice.

Real values of the variants tested in field study are always burdened with some uncertainty and this is taken into account when discussing and interpreting the results.

The impact of accidental causes of variation of data of the experiment, i.e. the error is defined as the data is subjected to statistical processing [SHANIN, 1977].

The choice of statistical evaluation criterion is an important stage of research in agricultural studies.

This study investigated the influence of two vine rootstocks (SO_4 and Rupestris du Lot) on some technological traits of

two table varieties–Misket Rusenski and Super ran Bolgar.

The influence of the rootstocks on the technological traits of grapes was indirect [NICOLIC *et al.*, 2000; GARCIA *et al.*, 2001a; GARCIA *et al.*, 2001b].

A number of authors reported the influence of the rootstock on the nutrition regime of vine plants, and therefore on the biosynthesis of anthocyanins [HARDIE and CONSIDINE, 1976, BUTNARIU, *et al.*, 2012].

That affected both–the growth and the structure, also and color of grape berries [WINKLER, 1958; GAWEL *et al.*, 2000; WALKER *et al.*, 2000, BUTNARIU *et al.*, 2005; RODINO, *et al.*, 2014].

The quality of grapes and wine are closely related. Factors influencing the quality of grapes that ultimately affect the quality of wine are: sugars, organic acids, pH, phenols and anthocyanins, non–simultaneous development of berries, *etc*. [JACKSON and LOMBARD, 1993].

The chemical composition of grapes is crucial for its quality.

Numerous studies on the chemical composition showed that it is very complex and it includes different groups of compounds–sugars, organic acids, nitrogen and pectin substances, anthocyanins, tannins, polyphenols, aromatic substances, ferments, vitamins, *etc*. [KATEROV *et al.*, 1990. BUTNARIU, *et al.*, 2014 RASHED and BUTNARIU, 2014a. IANCULOV, *et al.*, 2005].

The influence of the rootstocks: Kober 5BB, Chasselas 41B and Rupestris du Lot on grape quality of Muscat Hamburgski, Rkatsiteli, Cabernet Sauvignon, Aligote, Italian Riesling and Misket cherven vine cultivars was subject of the study of Georgiev [GEORGIEV, 1980].

In terms of sugar content of grapes–the highest one was registered in grafted on Kober 5BB, and the lowest–in those on Chasselas 41B.

The study of Hristov and collab. [HRISTOV *et al.*, 1998] and Popov and Hristov [POPOV and HRISTOV, 2008] about the influence of Ferkal and Chasselas X Berlandieri 41B on Bolgar, Muscat Ottonel, Super ran Bolgar, Pleven, Druzhba and Naslada rootstocks, showed insignificant differences in the examined elements of the chemical composition and tasting evaluation of grapes and wine (in table and wine varieties–Naslada and Druzhba).

All the minerals in grapes are found as compounds of organic acids. Grapes are rich in tartaric, malic, citric and other acids, but the first two prevailed.

Walker and collab. [WALKER *et al.*, 1998] noted that wines of grafted Cabernet sauvignon and Chardonnay contain significantly less tartaric acid and more malic one, unlike to the non–grafted.

Bocelli and collab. [BOCELLI *ET AL.*, 1992] and Bocelli and Volpe [BOCELLI and VOLPE, 1993] examined the impact of Teleki 5C, 1103 P, Kober 5BB, Chasselas 41B, SO_4, *etc*. rootstocks on the pH and the concentration of K and organic acids in the juice of grapes of Chardonnay variety, 130 SMA clone.

SO_4 and Kober 5BB rootstocks induced the highest values of K and pH, while in the variants with 1103 P and Teleki 5C were the lowest.

The authors found a positive correlation between the pH and the content of K in the grape juice. Kaserer and collab. tested the effects of rootstocks: Kober 5BB, Teleki 5C, SO_4, 41B, Ferkal, EM333 and Ruggeri 140 on Gruener Veltliner and found that the accumulation and concentration of sugars, the decrease of titric acidity, the levels of malic and tartaric acids, the concentration of K^+ in grape juice and wine quality were influenced by the type of rootstock, as SO_4 influenced most favorably on the traits tested [KASERER *et al.*, 1997, SAMFIRA, *et al.*, 2014, PETRACHE, *et al.*, 2014, BUTNARIU, 2014, BUTNARIU, *et al.*, 2014. RASHED and BUTNARIU, 2014b. BARBAT, *et al.*, 2013].

Besides the mechanical composition and chemical composition of the table varieties, the appearance of cluster and berry resistance to pressure and resistance to pick up from the stalk are of great importance.

The last properties are directly related to grape cracking and rot of grapes and indirectly to its transportability, storeability and organoleptic qualities.

The objective of the study is two statistical criteria to be applied for mathematical processing of data, reported by 12 technological traits of two dessert

vine varieties–Misket Rusenski and Super ran Bolgar, grafted on two different rootstocks in order a higher level accuracy of results to be reached.

Material and methods

Two early ripening seed table vine varieties–Misket Rusenski and Super ran Bolgar were the object of the study.

Brief characteristics of the table vine varieties studied:

Super ran Bolgar was created at the Institute of viticulture and wine production in Pleven in 1961 via crossing of Italia and Yantur varieties [TODOROV, 2005; PANDELIEV *et al.*, 2006]. The cluster is semi–large to large (18.8 x 13.2 cm), conical, sometimes with one brunch, half–compact to loose.

The berry is very large (24.9 x 17.2 mm), oblong, slightly acute on both sides (at the base and at the top). The skin is yellow–green to amber, thin and elastic.

The consistence is fleshy crispy, gentle, and the taste–harmonious.

The vines are mid–growing. Grape yield in half standard Guyot training system is about 1 400 kg/da. The mass of the cluster is 250–300 g, and the mass of the berry–4.8–5.0 g. Grapes ripen in early August and contain 15–20% sugars and 5.5–5.9 g/L titric acids.

Misket rusenski variety was created at IASS „Obraztsov chiflik" via crossing of Misket hamburgski and Kardinal [TODOROV, 2005; PANDELIEV *et al.*, 2006].

The berry is large (19.4 x 17.3 mm), ovate. The skin is medium thick, dark violet, with a thick waxy covering. The consistence is crispy and the taste–muskat. The vines are fast–growing.

Grape yield in half standard Guyot training system is about 1 300 kg/da.

The mass of the cluster is 300 g, and the mass of the berry–4.8 g. Grapes ripen in late July–early August and contain 16 % sugars and 4.24 g/L titric acids.

Every variety is grafted on two rootstocks—Rupestris du Lot and SO_4.

Brief characteristics of the rootstocks, involved in the study:

Monticola/ Rupestris du Lot/ rootstock is mid–growing, but gives fast growth to the grafts. Therefore the grafted onto it, fast–growing and susceptible to blossom drops and virgin berries varieties, enhance the expression of these disadvantages.

The rootstock is suitable for warmer areas with deep friable soil with a content of calcium carbonate not more than 25% total and 14% active. It gives the grafts high productivity, excellent quality of grapes and longevity.

Berlandieri x Riparia SO_4 rootstock is mid to fast–growing. It is resistant to drought and to active carbonates in soil up to 17 %. It has a good affinity with most of the table and wine vine varieties.

The plants grafted onto it distinguished with longevity, abundant fruitfulness and qualitative grapes. It is believed that it improves the maturation of the wood of grafts and makes them more resistant to winter frosts.

The study was conducted at the Experimental vineyard of IASS «Obraztsov chiflik»–Rousse in four replications, 11 plants in every replication, in which uniform in vegetative development first class vines were used, produced from rootstock cuttings and grafts taken from elite mother plantation of vine nursery.

The plants were pre–marked and the study was registered in seven consecutive years. The vine planting was conducted at the distance of 2.0 m/1.4 m on hilly areas, facing South, about 1 km from Danube river. Soil type was carbonate chernozem on deep loess.

The formation was half standard Guyot, stem height being 0,60 m and vine loads 19 winter buds, by average, realized in 5 spurs of 2 buds each and 1 fruiting cane of 9 buds. Loads were equal in both varieties, because they were high yielding.

The technological traits tested were the following:

1) Weight of grape cluster, g
2) Weight of 100 berries, g
3) % berries in cluster
4) % of mesocarp of berry weight, %
5) % of seeds of berry weight, %
6) % of skin of berry weight, %
7) Number of seeds in 100 berries
8) Mass of 100 seeds, g

9) Content of sugars, %
10) Content of total acids, g/L
11) Endurance of berry to pressure, g
12) Resistance of berry to pick up from the stem, g

They were combined in three groups, as their measurement was accomplished as follows:

Mechanical composition of grapes

It characterized the varieties mainly in terms of the ratio of the individual structural units (rachises, skins, seeds and mesocarp) in the construction and structure of the cluster. The parameters were determined according to the conventional methods of Prostoserdov after Ivanov [IVANOV, 1981], who proposed the mechanical composition of grapes to be characterized with the parameters of the construction and structure of the cluster and the berry.

The group of those parameters included: weight of grape cluster and of 100 berries (g); % of berries in the cluster (by weight); % of mesocarp, seeds and skin in the berry (by weight); number and weight of seeds in 100 berries.

The weight of the cluster was calculated as the yield of the four replications was divided to the number of clusters, and the mass of 100 berries–via the mass measured of 3 samples of 100 berries of each replication.

Chemical composition of grapes and degustation evaluation

The content of sugars and acids defined the technological maturity of grapes.

The beginning of that phase was found through periodical preliminary measurements of sugars with handheld refractometer in three days.

The content of sugars was determined by the areometer of Dujardin, in %, and the total acids—via titration with 0,1 n NaOH, in promiles (g/L).

Transportability of grapes

Theoretically–experimentally it was determined via measurement of the resistance of the ripe berry to pressure (g) (up to cracking of skin) and to picking up from the stalk (g). The endurance of the berry to the both resistances mentioned above, was measured by specialized equipment's of three samples of 100 berries each replication.

Two parametrical criteria–Student (t–test) and Fisher (F) were used in the statistical processing, as for the purpose SPSS 19 was used for analysis of the data obtained. Standart formulas were used for calculating the criteria [ZAPRYANOV and DIMOVA, 1985; MENCHER and ZEMSHMAN, 1986].

Results and discussion

Data obtained of the mean values and the mean squared deviations for the both table varieties by the technological traits studied are presented in tables 1 and 2.

In five of the traits studied—weight of grape cluster, weight of 100 berries, number of seeds in 100 berries, endurance of berry to pressure and resistance of berry to pick up from the stem, very high values of «mean squared deviation» were reported.

Values for Misket rusenski cultivar ranged from 38.05 to 364.9, while for Super ran Bolgar cultivar those values ranged from 36.02 to 370.27.

That gave us grounds to summarize that concerning those five traits, both varieties were influenced in the utmost by the factors of the environment, therefore those traits were with the highest variability, compared to the others. After analyzing the results of those traits, significant differences in the levels of significance were found in both varieties.

For Misket rusenski variety the influence of the rootstock was a significant difference for the trait „number of seeds in 100 berries and resistance of berry to pick up from the stem, compared to the control.

A higher degree of significance was observed using F–criterion. Respectively, for Super ran Bolgar variety, in the comparison conducted with both criteria, significant differences compared to the control were not reported.

For the same variety, significant influence of Rupestris du lot rootstock was reported for another five traits: % mesocarp of berry weight and % skin of berry weight, analyzed by the criterion of

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Student, and for the traits–weight 100 seeds, content of sugars and total acids, reported via Fisher (tables 1 and 2).

Table 1.

Comparative evaluation of cv **Misket Rusenski** by technological traits via criteria Student (t) and Fisher (F)

Traits	Misket Rusenski							
	Rootstock SO_4 control		Rootstock Rupestris du Lot		t exp	Confid	F exp	Confid
	$\bar{x}$	S	$\bar{x}$	S				
1. Weight of grape cluster, g	338.3	75.62	295.21	94.36	1.88	ns	1.55	ns
2. Weight of 100 berries, g	548.1	48.48	530.92	38.68	1.47	ns	1.57	ns
3. % berries in cluster	0.38	0.62	0.13	0.37	1.67	ns	**2.9**	**++**
4. % mesocarp of berry weight	92.97	1.35	5.64	2.38	0.88	ns	**3.08**	**++**
5. % seeds of berry weight	2.22	0.4	2.11	0.32	1.07	ns	1.6	ns
6. % skin of berry weight	4.80	1.6	4.07	1.33	1.80	ns	1.45	ns
7. Number of seeds in 100 berries	270.3	84.36	229.53	38.05	**2.33**	**+**	**4.91**	**+++**
8. Weight of 100 seeds, g	5.09	0.77	4.95	0.87	0.62	ns	1.25	ns
9. Content of sugars, %	15.74	1.69	16.20	2.28	0.86	ns	1.81	ns
10.Content of total acids, g/L	5.99	1.73	6.57	1.89	1.20	ns	1.18	ns
11. Endurance of berry to pressure, g	1442.8	302.68	1340	364.9	1.15	ns	1.45	ns
12. Resistance of berry to pick up from the stem, g	372.92	88.35	456.14	144.52	**2.60**	**+**	**2.67**	**++**
In critical values of the criterion:					$t P_{5\%} = 2.005$		$F p_{5\%} = 1.9$	
					$t P_{1\%} = 2.670$		$F p_{1\%} = 2.5$	
					$t P_{0.1\%} = 3.480$		$F p_{0.1\%} = 3.4$	
							Confid= Confidence	

Using both statistical criteria for all possible comparisons (48) in the planned study, 77 % of them were reported with insignificant differences compared to the control, which was two thirds of all comparisons. 12.5 % of the comparisons were reported with significant differences in probability of 5%, in probability of 1 %–8.33 % were reported, and in probability of 0.1 %–only 2.08 % of all analyzed comparisons.

Table 2.

Comparative evaluation of cv. **Super ran Bolgar** by technological traits via criteria of Student (t) and Fisher (F)

Traits	Super early Bolgar							
	Rootstock SO4 control		Rootstock Rupestris du Lot		t exp	Confid.	F exp	Confid.
	$\bar{x}$	S	$\bar{x}$	S				
1. Weight of grape cluster, g	372.44	75.12	350.82	55.38	1.22	ns	1.83	ns
2. Weight of 100 berries, g	536.33	69.46	534.70	79.33	0.08	ns	1.3	ns
3. % berries in cluster	98.02	0.78	97.92	0.68	0.48	ns	1.29	ns
4. % mesocarp of berry weight	93.39	1.09	92.69	1.08	**2.34**	**+**	1.02	ns
5. % seeds of berry weight	1.74	0.38	1.96	0.51	1.81	ns	1.8	ns
6 % skin of berry weight	4.56	1.25	5.33	1.13	**2.36**	**+**	1.23	ns
7. Number of seeds in 100 berries	193.73	36.02	184.29	38.03	0.85	ns	1.11	ns
8. Weight of 100 seeds, g	4.77	0.63	5.19	0.97	1.62	ns	**2.43**	**+**
9. Content of sugars, %	16.46	1.33	17.37	2.07	1.93	ns	**2.43**	**+**
10. Content of total acids, g/L	5.70	0.75	5.9	1.19	0.74	ns	**2.56**	**++**
11. Endurance of berry to pressure, g	1557.03	376.39	1537.25	370.27	0.19	ns	1.03	ns
12. Resistance of berry to pick up from the stem, g	426.69	132.3	462.37	131.3	0.99	ns	1.01	ns
In critical values of the criterion:					$t P_{5\%}=2.005$		$F p_{5\%}=1.9$	
					$t P_{1\%}=2.670$		$F p_{1\%}=2.5$	
					$t P_{0.1\%}=3.480$		$F p_{0.1\%}=3.4$	

The availability of significant differences only in 11 of all comparisons showed that for statistical evaluation of similar field experiments with vine and other permanent crops, the criterion should be carefully selected.

In the case of both table vine varieties, for the three groups of technological traits it is important which one of the two criteria were used to evaluate the influence of the rootstock on those traits.

For example, in Table 1, for Misket rusenski variety, significant differences were reported for traits of the group of the mechanical composition and transportability of grapes.

When using t–test, significance was reported for the trait „number of seeds in 100 berries", and „berry resistance to pick up from the stalk", while using F–criterion, the significance was reported for traits of the group of mechanical composition: % berries in the cluster, % of mesocarp of berry weight and number of seeds in 100 berries, also and berry resistance to pick up from the stalk of transportability traits.

In Table 2 for Super ran Bolgar variety the significance of differences was presented for the traits from the groups of mechanical, chemical compositions and degustation assessment of the cluster.

Via t–test the differences for % mesokarp and skin of berry weight, compared to the control were proved, while using F criterion, the same level of significance was found in the weight of 100 seeds and content of sugars and total acids (with higher level of significance in the last trait).

Similar studies on the application of both statistical criteria for assessment the influence of Rupestris du Lot in two dessert vine varieties have not been done yet.

Most researchers used the criterion of Student for evaluation of the variants tested under field conditions, and in most cases they obtained insignificant differences compared to the control, which created difficulties in their interpretation and data analysis.

Conclusions

On the base of the results of that study we can conclude:

In half of the technological traits associated with the mechanical composition of the cluster and transportability traits, high levels of variability of traits for both varieties Misket rusenski and Super ran Bolgar were reported, which allows us to conclude that those technological traits were influenced to a greater degree by the environmental factors.

And perhaps that was the reason mostly insignificant differences were reported, using Rupestris du Lot rootstock compared to SO_4 rootstock, the control accepted.

For future studies with this kind of traits it is recommended the both criteria to be applied for evaluation of the variants compared in order the degree of probability to be found even in the smallest existing differences with the control.

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