

EFFECT OF CANOPY DENSITY IN THE TRELLIS ON THE YIELD AND QUALITY OF GRAPES AND WINE OF THE CULTIVAR 'LIZA'

IVAN KULJANČIĆ, ĐORĐE PAPRIĆ, NADA KORAĆ, SLAVICA TODIĆ,
MIRA MEDIĆ, PREDRAG BOŽOVIĆ, DRAGOSLAV IVANIŠEVIĆ¹

SUMMARY: The objective of this study was to assess the effect of bud load and the green foliage they produce on the yield and quality of grapes and wine of the cultivar 'Liza'. Three levels of bud loading, i.e., canopy density, were applied. The first variant of bud loading was 2 bud spurs and a cane with 12 buds, or 11.7 shoots per meter of canopy length. The second variant of bud loading was two canes each with 12 buds, or 20 shoots per meter of canopy length. The third variant of bud loading was two canes each with 17 buds, or 28 shoots per meter of canopy length. Influence of meteorological parameters on these cultivar features was also monitored. Ripening dynamics and grape and wine quality were observed through the test years. Based on long-term investigations and the results of this study, it was concluded that the increased bud load and canopy density, with the applied small plant distances in the row, decreased the (potential) bud fertility, grape yield, and grape and wine quality.

Key words: grapevine, cultivar, green foliage, bud load, fertility

INTRODUCTION

For centuries, the grapevine had been grown using the gobelet or head training system and pergolas. With the invention of metal wire and its application in vine growing, some old training systems have been modified and new ones have been designed. In mid-19th century, the training systems diversified to include, in addition to stakes, posts and wires. At the beginning of the 20th century, theoretical backgrounds had been established for many well-known training systems, whose large-scale application started after the World War II. Ever since the introduction of the various training systems after the World

Original scientific paper / *Originalni naučni rad*

¹ Dr. Ivan D. Kuljančić, full professor, Dr. Đorđe Paprić, full professor, Dr. Nada Korać, full professor, Mira Medić, M.Sc., assistant, Dragoslav Ivanišević, M.Sc., training researcher, Predrag Božović, B.Sc., training researcher, Faculty of Agriculture, Novi Sad Dr. Slavica Todić, associate professor, Faculty of Agriculture, Zemun

Corresponding author: Ivan D. Kuljančić, Faculty of Agriculture, Trg D. Obradovića 8 21000 Novi Sad, Serbia, Email: kivan@polj.uns.ac.rs Tel: 021-4853 266

War II, they became an object of study by a large number of researchers. The problem of photosynthetic activity of leaves in canopies of different densities was studied most intensively (Schaulis, 1982; Smart, 1985; Reynolds et al., 1985; Kliewer, 1982).

This topic has never been truly exhausted. It still attracts scientific interest because new grapevine cultivars are continually being developed, new training systems are being examined and new vineyards are being established in regions without tradition in grape growing (Cavallo et al., 1999; Pedroso et al., 1999; Scaglione and Pasquarella, 1999; Tarricone et al., 1999; Schwab et al., 2001; Ponchia et al., 2001; Murisier et al., 2001; Castro et al., 2005; Castro et al., 2007; Calo et al., 2007). As a result of long-term work on grape breeding at Faculty of Agriculture in Novi Sad, an array of promising cultivars has been developed. Complete agro-technical and crop protection recommendations must be supplied for cultivars judged to have a chance of being introduced in commercial production. These requirements defined one of the objectives of this study, i.e., to find which bud load and canopy density secure optimum performance of the cultivar 'Liza'.

MATERIAL AND METHOD

Facility

Experiments were organized at the experimental vineyard of Faculty of Agriculture, Novi Sad, Serbia. The farm is located in the northern part of the Fruška Gora Mountain grape-growing region. The study was conducted in the period 1996 - 2004. The experimental vineyard, in which the cultivar 'Liza' was grafted on the rootstock V. berlandieri x V. riparia Kober 5BB, was established in 1987. The training system was the Karlovački type, with the planting arrangement of 2.8 x 1.2 m. For the needs of the experiment, the plants were retrained to the single Guyot system. The applied bud loads were: 2 + 12 = 14 buds per plant - the pruning by the single Guyot system, amounting to 11.7 shoots per meter of canopy length; 12 + 12 = 24 buds per plant - the pruning by the Karlovački system, amounting to 20.0 shoots per meter of canopy length; and 17 + 17 = 34 buds per plant - the pruning by the Karlovački system, amounting to 28.3 shoots per meter of canopy length. The experiment was established in a random block design with three replications. The standard bud loading was two canes, each with 12 buds.

'Liza' is a new cultivar developed at Institute for Fruit Growing and Viticulture, Faculty of Agriculture, Novi Sad (Cindrić et al., 2000). It is a cross between the cultivars 'Kunleany' and 'Pinot Gris'. It is medium vigorous, has a fairly high sugar content in grapes and it is resistant to grey rot and low temperatures.

Method of work

Potential fertility was determined in May, when inflorescences were quite visible. Inflorescences were counted from the first to the twelfth or seventeenth node in the cane, depending on experiment variant. Their number was counted on 15 plants, and this served to determine the bud fertility coefficient. Particular attention was paid to green pruning, the practice of removing superfluous shoots and training preferred shoots in the desired position, to avoid excessive self-shading. Data on average cluster weight and sugar and acid contents in grape must were calculated from data obtained for one crate containing 100 to 130 clusters. Actual fertility, i.e., grape yield, was determined after harvest of the

entire experiment.

After pressing must from the samples, experimental wine was made in a micro wine-making plant. After a period of aging, the wine was scored by a group of professors of the Department using a 20-point scale.

Environment

The environmental conditions at the time of the experiment were highly variable and they significantly affected the fertility of winter buds not only of this but also of the other tested cultivars (Kuljančić et al., 2007). Experimental results showed that weather conditions in the period May-June have a major impact on fertility buildup for the subsequent year. If that period is rainy and cool, yield reduction in the subsequent year might range up to 50%. If the period is fairly warm and humid, the yield would be above-average.

RESULTS AND DISCUSSION

Potential fertility coefficient

It should be mentioned here that the fertility coefficient values were invariably high, in consequence to special technological measures, which were applied at Sremski Karlovci experimental vineyard throughout the experimental period as they are applied today. The 1997 data are missing because of a computer failure.

As can be seen in Table 1, the tested treatments had statistically significant effects on bud fertility per length of productive element in the cultivar 'Liza'. It is evident that the dense canopy in variant 3, where 28.3 shoots developed per meter of canopy, was unfavorable for fertility buildup for the next year, as indicated by the value of the fertility coefficient which was 1.85. The observed changes in winter bud fertility were in agreement with Cindrić et al. (1984) who claimed that a successive reduction in the fertility of winter buds occurs in the case of dense canopies. Such effect of canopy density results from a change in micro-climatic conditions in the canopy. The increase in the number of shoots

Table 1. Potential fertility coefficient of the cultivar 'Liza'

Tabela 1. Potencijalni koeficijenti rodnosti sorte liza (prosek / average 1996-2004)

Godine - Years	Varijante - Variant		
	I	II	III
1996	2,36	2,42	2,70
1997	-	-	-
1998	1,65	1,67	1,81
1999	2,30	1,89	1,65
2000	1,82	1,68	1,61
2001	2,58	2,27	1,82
2002	1,66	1,56	1,24
2003	2,58	2,23	1,99
2004	2,41	2,19	1,95
Prosek/ Average	2,17	1,99	1,85

NZR/LSD	0,05	0,22
	0,01	0,30

per meter of canopy causes significant increases in leaf area per grape plant (Reynolds et al., 1994), simultaneously with an increased shading (Castro et al., 2007). At the same time, the inside of the canopy receives less than 10% of the light falling on the outer surface of the canopy (Reynolds and Wardle, 1989). In cool years, temperature is higher inside a dense canopy than outside of it, which is favorable for grape plants and grapes. In warm years, however, the inside of a dense canopy is cooler and more humid than the outside, which is not good for plants.

Average cluster weight

The primordium of a future cluster form in a previous year, as mentioned in the paragraphs dealing with the environment, but its weight is determined by a combined action of the soil and microclimatic conditions in the current season.

Table 2. Average cluster weight (g) of the cultivar ‘Liza’

Tabela 2. Prosečna masa grozda (g) sorte liza (prosek / average 1996-2004)

Godine - Years	Varijante - Variant		
	I	II	III
1996	133	125	146
1997	110	111	104
1998	137	135	126
1999	152	160	128
2000	122	112	101
2001	149	149	135
2002	102	93	106
2003	120	125	125
2004	117	136	108
Prosek/ Average	127	127	118

NZR/LSD	0,05	9,26
	0,01	12,75

As can be seen in Table 2, the dense canopy, with 28.3 shoots per meter of canopy, produced the lowest average cluster weight of 118 grams. The largest average weight (127 g) was achieved with 20.0 shoots per meter of canopy. These results are in good agreement with those of Reynolds et al. (1994) and Castro et al. (2007) who, working with similar canopy densities, obtained statistically significant reduction in cluster weight as the number of shoots per meter of canopy increased. It is obvious that a large number of leaves in variant 3 were in full shade or half-shade, which lowered their photosynthetic activity that resulted in reduced average weight of the cluster.

Average grape yield

The experiment setup itself included large differences in the number of buds per grape plant, so that it was aware in advance that the increased bud load will increase the yield of grapes. As shown in Table 3, statistically significant differences existed between variants 1 (1.13 kg/m²) and 2 (1.61 kg/m²), and variants 1 and 3 (1.78 kg/m²). Similar results were obtained by Reynolds et al. (1994) who studied the effect of shoot density on production characteristics of the cultivar ‘Rhine Riesling’. It is important to note here

that the three times higher bud load in variant 3 rendered an increase in grape yield of only 50%, which is in agreement with the results of Shaulis (1982), Smart (1985) and Castro et al. (2007). These results indicate that a dense canopy significantly reduces the photosynthetic activity of grape leaves. According to Kriedemann (1968), a leaf that stayed in full or partial shade for two to three weeks in early spring, loses the capacity to increase its intensity of photosynthesis when exposed to light and it keeps behaving as if it had remained in the shade.

Table 3. Average grape yield (kg/m²) of the cultivar 'Liza'

Tabela 3. Prosečan prinos grožđa (kg/m²) sorte liza (prosek / average 1996-2004)

Godine - Years	Varijante - Variant		
	I	II	III
1996	1,36	1,85	2,68
1997	0,99	1,71	1,70
1998	0,99	1,67	2,09
1999	1,39	1,65	1,74
2000	1,12	1,39	1,66
2001	1,34	1,71	1,73
2002	0,73	1,04	1,05
2003	1,05	1,53	1,52
2004	1,20	1,95	1,87
Prosek/ Average	1,13	1,61	1,78

NZR/LSD	0,05	0,20
	0,01	0,28

Average contents of sugar and acids

Very early studies of grapevine physiology had indicated that yield of grapes and sugar content in must are negatively correlated. It means that, in most cases, low yields will be combined with increased sugar content in must, and that sugar content will go down as the yield increases.

Table 4. Average contents of sugar (%) and acids (g/l) in must of the cultivar 'Liza'

Tabela 4. Prosečan sadržaj šećera (%) i kiselina (g/l) kod sorte liza (prosek / average 1996-2004)

Godine - Years	Varijante - Variant					
	I		II		III	
	Šeć. Sugar	Kis. Acid	Šeć. Sugar	Kis. Acid	Šeć. Sugar	Kis. Acid
1996	22,4	10,8	21,5	10,4	20,4	10,1
1997	23,9	10,5	23,8	10,3	23,5	9,7
1998	22,2	10,0	21,6	9,7	21,9	9,1
1999	21,6	8,6	21,5	8,5	22,0	8,6
2000	20,7	7,8	21,2	7,4	19,7	7,3
2001	20,2	10,2	19,2	10,4	19,3	9,8
2002	23,3	8,9	22,3	9,0	22,2	8,9
2003	22,7	8,1	21,5	8,1	20,6	8,4
2004	19,7	10,7	19,7	10,2	19,1	9,8
Prosek/ Average	21,7	9,6	21,3	9,4	20,9	9,2

NZR/LSD	0,05	0,49
	0,01	0,67
NZR/LSD	0,05	0,25
	0,01	0,34

This was confirmed in this study, but the explanation was associated not only with yield but also with the microclimate in a dense canopy. This is especially true for the temperature in the canopy, the change of which tends to change the material used in respiration. At low temperatures, plant metabolism relies on sugars while at high temperatures it relies more on acids. It is certain that the average daily temperature was lower in the dense canopy made by 28.3 shoot per meter of canopy length than in the canopy made by 11.7 shoots per meter length. Accordingly, the denser canopy metabolized mostly sugars by day and mostly acids by night.

The data in Table 4 speak in favor of this assumption – sugar and acid contents in must were significantly higher in variant 1 than in variant 3.

Wine evaluation

A paper dealing with the effect of weather conditions and the fertility of winter buds in grapevine (Kuljančić et al. 2007) stated that climatic factors have significant effects on grape yield and quality, thus on wine quality as well. Table 5 shows that the effect of the treatments, i.e., canopy density, on wine quality was close to being significant. The wines obtained from the grapes cultivated at the densities of 11.7 and 20.0 shoots per meter of canopy length had highest average scores regardless of the fact that their acid content was higher than that obtained in variant 3. This is in agreement with the results of Reynolds et al. (1994) who claimed that wine quality is in agreement with must quality. The factors at work were more favorable photosynthetic conditions and a more harmonious accumulation of all substances in grapes.

Table 5. Wine evaluation of the cultivar ‘Liza’

Tabela 5. Degustaciona ocena vina sorte liza (prosek / average 1996-2004)

Godine - Years	Varijante - Variant		
	I	II	III
1996	17,7	17,9	17,5
1997	18,8	18,6	18,2
1998	17,6	17,3	17,1
1999	18,2	18,9	18,5
2000	18,2	18,6	17,7
2001	16,5	16,3	16,0
2002	18,0	17,2	18,4
2003	17,7	18,1	17,5
2004	18,0	18,2	17,9
Prosek/ Average	17,9	17,9	17,6

NZR/LSD	0,05	0,34
	0,01	0,46

CONCLUSION

Based on our own findings and results of other researchers, this study confirmed the theoretical hypothesis that excessively dense canopies are not favorable for grape growing and that they should be avoided. This study indicates that with plant distances in the row below 1 m, densities of 11 to 12 shoots per meter of canopy length are recommended. With plant distances in the row over 1.0 m, the density up to 20 shoots per meter of canopy length can be used.

REFERENCES

- CALO, A., LAVEZZI, A., ANTONIAZZI, M., PASCARELLA, G., GIORGESSI, F.: Etude pour une classification des systemes de conduite de la vigne. Proc. GESCO15(2)182-1196, Poreč, 2007.
- CASTRO, R., CRUZ, A., FIGUEIRA, L., MOREIRA, M., RIBEIRO, F., RODRIGUES, C., GOMES, C.: Shoot density and leaf removal effects on microclimate, yield, fruit composition and wine quality of the Portuguese vine variety "Touriga nacional". Proceedings of GESCO 14(2)705-711, Geisenheim, 2005.
- CASTRO, R., CRUZ, A., RODRIGUES, C.A., BOTELHO, M., RODRIGUES, C., RODRIGUES, A., GOMES, C.: Shoot density, leaf removal and cluster thinning effects on microclimate, yield and fruit composition of the Portuguese vine variety "Touriga nacional". Proceedings of GESCO 15., 2, 798-811, Poreč, 2007.
- CAVALLO, P., PONI, S., ROTUNDO, A.: Ecophysiology and vine performance of cv. "Aglanico" under various training systems. Comptes rendus GESCO 11., 1, 300-308, Marsala, 1999.
- CINDRIĆ, P., ŠARČEVIĆ, I., STUPAR, S.: Uticaj fitotehničkih mera na povećanje fotosintetičke aktivnosti listova vinove loze. Jugoslovensko vinogradarstvo i vinarstvo, 3:26-31, 1984.
- CINDRIĆ, P., NADA KORAĆ, KOVAČ, V.: Sorte vinove loze, Novi Sad, 2000.
- KLIEWER, W. M.: Vineyard canopy management – a review, Grape and Wine Centennial Symposium Proceedings, Davis, 1982.
- KRIEDEMANN, P. E.: Photosynthesis in vine leaves as a function of light intensity, temperature, and leaf age. Vitis 7, 213-220, 1968.
- KULJANČIĆ, I., PAPRIĆ, Đ., NADA KORAĆ, SLAVICA TODIĆ, MIRA MEDIĆ, BOŽOVIĆ, P., IVANIŠEVIĆ, D.: Influence of weather conditions on fertility of grape vine winter buds. Proceedings of GESCO 15., 1, 722-732, Poreč, 2007.
- MURISIER, F., FERRETI, M., ZUFFEREY, V.: New training systems for steep slopes vineyards in narrow terraces experiments on Merlot in Ticino. Sauvignon. Compte rendu GESCO 12., 2, 421-430, Montpellier, 2001.
- PEDROSO, V., MARTINS, S., BRITES, I., CASTRO, R., LOPES, C.: Influence du mode de conduite et charge en bourgeons sur l'évolution de la surface foliaire et les relations frutification/vegetation du cepage "Turiga National" Regio Dao. Comptes rendus GESCO 11., 2, 656-662, Marsala, 1999.
- PONCHIA, G., BERTAMINI, M., ZULIANI, C.: Influence of training system and canopy management on growth and must composition of Cabernet Sauvignon. Compte rendu GESCO 12., 1, 299-304, Montpellier, 2001.
- REYNOLDS, A. G., POOL, R. M., MATTICK, I. R.: Effect of training system on growth, yield, fruit composition and wine quality of Seyval Blanc. American J. Enol. and Viticult., 36(2) 1985.
- REYNOLDS, A.G., WARDLE, D.A.: Influence of fruit microclimate on monoterpene levels of Gevurztraminer. Am. J. Enol. Vitic., 40(3)149-154, 1989.

- REYNOLDS, A.G., EDWARDS, C.G., WARDLE, D.A., WEBSTER, D, DEVER, M.: Shoot density affects "Riesling" grapevines I. Vine performance. *J. Amer. Soc. Hort. Sci.*, 119(5)874-880, 1994.
- REYNOLDS, A.G., EDWARDS, C.G., WARDLE, D.A., WEBSTER, D, DEVER, M.: Shoot density affects "Riesling" grapevines II. Wine composition and sensory response. *J. Amer. Soc. Hort. Sci.*, 119(5)881-892, 1994.
- SCAGLIONE, G., PASQUARELLA, C.: Effect of pruning intensity and training system on yield and quality of Coda di Volpe grapevine. *Comptes rendus GESCO 11.*, 1 2, 677-681, Marsala, 1999.
- SCHWAB, A. L., KNOTT, R., SCHOTTDORF, W.: Environmental and economic benefit of new fungus-tolerant grape varieties and their usability for different training systems. *Compte rendu GESCO 12*, 1, 201-206, Montpellier, 2001.
- SCHAULIS, N.: Responses of grapevines and grapes to spacing of and within canopies. *Grape and Wine Centennial Symposium Proceedings*, Davis, 1982.
- SMART, R. E.: Principles of Grapevine Canopy Microclimate Manipulation with Implications for Yield and Quality – a Review. *American Journal of Enology and Viticulture*, 36(3)230-239, 1985.
- TARRICONE, L., NOVELLO, V., DE PALMA, L.: Influence of bud load and pruning system on vegetative and reproductive characteristics of table grape cv. "Victoria" first results. *Comptes rendus GESCO 11(2)*718-723, Marsala, 1999.

UTICAJ GUSTINE ZELENE MASE U ŠPALIRU, NA RODNOST I KVALITET GROŽĐA I VINA SORTE LIZA

IVAN KULJANČIĆ, ĐORĐE PAPRIĆ, NADA KORAĆ, MIRA MEDIĆ,
PREDRAG BOŽOVIĆ, DRAGOSLAV IVANIŠEVIĆ, SLAVICA TODIĆ

Izvod

Cilj ovog istraživanja je bio da se utvrdi uticaj opterećenja okcima i stvorene zelene mase iz njih, na rodnost i kvalitet grožđa i vina kod sorte Liza. Istraživanja su se odvijala od 1996. do 2004. godine, na Oglednom dobru Departmana za voćarstvo, vinogradarstvo, hortikulturu i pejzažnu arhitekturu, Poljoprivrednog fakulteta u Novom Sadu, u Sremskim Karlovcima. Ispitivana je novostvorena sorta liza, nastala u ovom departmanu ukrštanjem sorti kunleanji i burgundac sivi, a priznata 1991. godine. Primjenjiva su tri nivoa opterećenja okcima tj. tri gustine zelene mase u špaliru. Prvo opterećenje kondir od 2 okca i luk od 12 okaca tj. 11,7 lastara po dužnom metru špalira, drugo dva luka od po 12 okaca tj. 20,0 lastara po dužnom metru špalira i treće opterećenje dva luka po 17 okaca tj. 28,3 lastara po dužnom metru špalira. Pored uticaja gustine zelene mase i opterećenja rodnim okcima na moguću (potencijalnu) i stvarnu rodnost, praćen je i uticaj klimatskih činilaca na ova svojstva sorte. Tokom godina ispitivanja je praćena i brzina (dinamika) sazrevanja i kvalitet grožđa i vina. Na osnovu dugogodišnjeg posmatranja i dobijenih rezultata se može zaključiti, da sa povećanjem opterećenja i gustine zelene mase u špaliru, pri uobičajenim razmacima između čokota u redu, opada moguća (potencijana) i stvarna rodnost, kakvoća (kvalitet) grožđa i vina.

Ključne reči: vinova loza, sorte, zelena masa, opterećenje, rodnost.

Received / *Primljen*: 28.11.2008.

Accepted / *Prihvaćen*: 17.09.2009.