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Impact of shoot trimming height on productive characteristics and fruit composition of Istrian Malvasia vines

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Abstract

The height of shoot trimming has a considerable importance in viticulture production, as longer shoots have higher leaf area, and consequently higher assimilate production. The impact of three different shoot trimming heights on the productive characteristics of Istrian Malvasia vines was evaluated in this study. Measured from the basal wire, shoots were trimmed to the height of 70, 100 or 130 cm. Vines with longer shoots had higher leaf area/yield ratio, produced higher yield and its grapes had higher Brix. Obtained results indicate that the height of shoot trimming can effectively be used in order to manage the productive characteristics and fruit composition of Istrian Malvasia vines.

Key words: grapevine, Istrian Malvasia, shoot trimming height

Utjecaj visine vršikanja mladica na proizvodne karakteristike i sastav grožđa Malvazije istarske

Sažetak

Visina vršikanja mladica ima veliku važnost u vinogradarskoj proizvodnji budući da dulje mladice imaju veću lisnu površinu i stoga veću proizvodnju asimilata. U ovom je istraživanju istražen utjecaj tri različite visine vršikanja mladica na proizvodne karakteristike i sastav grožđa Malvazije istarske. Mjereno od osnovne žice, mladice su bile vršikane na visinu od 70, 100 ili 130 cm. Trsovi s duljim mladicama imali su viši omjer lisne površine i mase grožđa, veći prinos i povišeni udio šećera u grožđu. Dobiveni rezultati ukazuju da se visina vršikanja mladica može uspješno koristiti sa svrhom reguliranja proizvodnih karakteristika i sastava grožđa Malvazije istarske.

Ključne riječi: vinova loza, Malvazija istarska, visina vršikanja

Introduction

Istrian Malvasia (*Vitis vinifera* L.) is considered as an Istrian autochthonous white grapevine variety and in the region of Croatian Istria it is planted on almost 60% of vineyard area. The effects of different canopy management practices are widely studied on this variety in recent years in order to get satisfactory production results needed to compete not only on the national but also on the global market. One of the canopy management practices studied is shoot trimming, with the accent on the height of shoots. Longer shoots have higher leaf area with higher potential of assimilate production (Poni and Giachino, 2000). On the other hand they have also higher transpiration demand due to higher leaf area, leading to possible drought problems in critical seasons if irrigation is not applied. Yield is usually not considerably modified with this practice as the number of clusters per shoot and per vine remains untouched. Consequently, with this technique it is increased the leaf area/yield ratio, as one of the important factors in the achievement of high quality grapes (Kliewer and Dokoozlian, 2005).

The aim of this research was to determine the impact of shoot trimming height on productive characteristics and fruit composition of cv. Istrian Malvasia vines.

Materials and methods

The experiment was performed in 2011 and 2012 on *Vitis vinifera* L. cv. Istrian Malvasia vines, clone VCR4, grafted on SO4 rootstock (*Vitis berlandieri x Vitis riparia*), in the experimental vineyard of the Institute of Agriculture and Tourism in Poreč (West Istrian winegrowing region, Croatia). The vineyard was planted in 2006 on the typical red Mediterranean soil (*Terra rossa*). Row and vine spacing were 2,5 × 0,8 m. Vines were trained to spur cordon training system. Shoots were vertically positioned and sustained with two pairs of catching wires, positioned 40 cm and 80 cm above the basal wire. Shoots were manually thinned before bloom, at grapevine growth stage 18 according to the modified E-L system (Coombe, 1995), with the aim to obtain approximatively 15 shoots per meter of canopy. Only normally developed shoots were retained at shoot thinning, while all underdeveloped shoots and most unfruitful shoots were removed. Leaves and laterals were partially removed in the cluster zone when berries were pepper-corn size, at grapevine growth stage 29 according to the modified E-L system (Coombe, 1995). Leaf and lateral removal was performed in order to obtain moderately open canopy in the cluster zone. Other viticultural practices were standard for the cultivar and region.

Three different heights of shoot trimming were investigated in this research. Measured from the basal wire, shoots were trimmed to the height of 70 cm, 100 cm or 130 cm. Shoot trimming was performed at berry set, at grapevine growth stage 27 according to the modified E-L system (on June the 6^{th} in 2011 and June the 8^{th} in 2012), and it was repeated on the same height three weeks after first shoot trimming (on June the 28^{th} in 2011 and June the 29^{th} in 2012). Each treatment was applied in three replications with six adjacent vines, set in complete randomized block design.

Grapes were harvested on 12^{th} September 2011, and 10^{th} September 2012, when Brix values was between 22 and 23 Brix and titratable acidity was approximately 6 g/L. Yield and number of clusters per vine were recorded at harvest. 200 berries were randomly chosen from each treatment replicate to determine mean berry mass. Mean cluster mass were calculated from yield and clusters per vine data, while berries per cluster were estimated from cluster mass and mean berry mass. Leaf area was determined as described by Smart and Robinson (1991). Soluble solids (°Brix) were assessed by HR200 digital refractometer (APT Instruments, Litchfield, IL, USA). Titratable acidity and pH value were analyzed by O.I.V. methods (2001).

The sum of growing-degree days in the period from April the 1st to September the 30th in season 2011 was 1917, while in season 2012 it was 1949. The sum of rainfall in season 2011 was 269 mm, while in season 2012 it was 328 mm.

Data were analyzed using the Mixed Model Procedure of the SAS statistical package (SAS Institute, Cary, North Carolina, USA). Analysis of variance was computed with treatment and growing season considered fixed. Mean differences were calculated using the LSD values if the F-test was significant at $P = 0.05$.

Results and discussion

Although not expect as the cluster number per vine was not modified by this practice, shoot trimming influenced yield per vine. 100 cm and 130 cm treatments had significantly higher yield than 70 cm treatment, while 130 cm had higher, although not significantly higher yield than 100 cm treatment (Table 1). Higher yield per vine resulted from higher cluster mass obtained by vines with longer shoots, while both the number of clusters per vine and the number of clusters per shoot was not significantly different among treatments.

Table 1. Yield components of Istrian Malvasia trimmed at 70, 100 and 130 cm. Data represent mean values of years 2011 and 2012.

Treatment	Yield / vine (kg)	Clusters / vine	Cluster mass (g)	Clusters / shoot
70 cm	2,46 b	18,8	131 b	1,63
100 cm	2,74 a	19,0	144 a	1,60
130 cm	2,90 a	19,3	151 a	1,59

Means within column designated by different letters are significantly different by the LSD test at P = 0.05.

Higher cluster mass in treatments with longer shoots resulted from a cumulative effect of both higher berry mass and higher number of berries per cluster in these treatments (Table 2). Berry mass was significantly higher in 100 cm and 130 cm treatments than in 70 cm treatment, while number of berries per cluster was significantly higher in 130 cm treatment in comparison to 70 cm treatment. Accordingly, yield per shoot was higher in treatments with higher shoot length. Lower number of berries per cluster in 70 cm treatment is most probably the result of lower fruit set. Due to trimming to shorter shoots, higher proportion of photosynthetically active leaf area was removed in 70 cm treatment at fruit set phenological stage. As it is documented in previous studies, the removal of a considerable amount of leaf area on the basal part of the shoots at post bloom phenological stage can lead to lower fruit set (Poni et al., 2006; Intrieri at al., 2008). In our study leaves were removed with shoot trimming on the upper part of the shoots, but this removed leaf area was at that time also functional and produced assimilates needed for the fruit set, leading to analog results as the removal of the basal leaves on the shoot, although in lower extent.

Shoot trimming at flowering or at fruit set phenological stage promotes the fruit set (Vasconcelos and Castagnoli, 2000), as young shoot apices which consume assimilates are removed with this practice. In our case, the differences in fruit set among treatments should not be a result from this effect as the shoot apices were removed on all the treatments.

Berry mass was lower in 70 cm treatment due to limited assimilate supply due to restricted leaf area in the weeks following fruit set in this treatment, a period when the berry is actively growing and the berry cell number and cell volume is increased. Lower berry mass with shorter shoots was also confirmed in the research conducted on Cabernet Sauvignon by Poni and Giachino (2000).

The number of shoots per vine and the number of shoots per meter of canopy did not differ significantly among treatments. This result was expected as shoots were not removed with trimming, but only their height was modified.

Table 2. Number of shoots per vine, shoots per meter of canopy, yield per shoot, mean berry mass and number of berries per cluster of Istrian Malvasia trimmed at 70, 100 and 130 cm. Data represent mean values of years 2011 and 2012.

Treatment	Shoots / vine	Shoots / m of canopy	Yield / shoot (g)	Berry mass (g)	Berries / cluster
70 cm	11,6	14,4	212 b	2,06 b	65 b
100 cm	11,9	14,8	231 a	2,21 a	68 ab
130 cm	12,1	15,2	239 a	2,16 a	72 a

Means within column designated by different letters are significantly different by the LSD test at P = 0.05.

As expected in this research, leaf area per shoot varied considerably among treatments. This was a direct result of different shoot height obtained by trimming. 130 cm treatment had significantly higher primary shoot leaf area and total shoot leaf area than both other treatments, while 100 cm treatment had significantly higher primary shoot leaf area and total shoot leaf area than 70 cm treatment (Table 3). Leaf area of laterals followed the same trend, although the difference between 70 cm and 100 cm treatments was not statistically significant.

Table 3. Leaf area per shoot of Istrian Malvasia trimmed at 70, 100 and 130 cm. Data represent mean values of years 2011 and 2012.

Treatment	Leaf area per shoot (m^2)		
	Primary shoot	Laterals	Total
70 cm	0,092 c	0,152 b	0,243 c
100 cm	0,129 b	0,172 b	0,301 b
130 cm	0,165 a	0,213 a	0,378 a

Means within column designated by different letters are significantly different by the LSD test at P = 0.05.

As the shoot number per vine was almost the same on all treatments, leaf area per vine was in accordance with the leaf area per shoot. Treatment 130 cm had significantly higher main, lateral and total leaf area per vine than 100 cm treatment, while the latest had significantly higher leaf area per vine than 70 cm treatment (Table 4). Since the differences among treatments were higher in leaf area per vine than the differences in yield per vine, leaf area/yield ratio was significantly highest in 130 cm treatment, followed by 100 cm treatment, while 70 cm treatment had significantly lowest leaf area/yield ratio. Leaf area/yield ratio is considered as important factor in the achievement of high quality grapes (Kliewer and Dokoozlian, 2005). This indicates that vines with longer shoots produce more assimilates per unit of yield, thus having a potential for the production of higher quality grapes.

Table 4. Leaf area per vine and leaf area/yield ratio of Istrian Malvasia trimmed at 70, 100 and 130 cm. Data represent mean values of years 2011 and 2012.

Treatment	Leaf area per vine (m^2)			Leaf area / yield (m^2 kg^{-1})
	Main	Lateral	Total	
70 cm	1,06 c	1,73 c	2,79 c	1,16 c
100 cm	1,53 b	2,04 b	3,57 b	1,33 b
130 cm	2,00 a	2,58 a	4,59 a	1,59 a

Means within column designated by different letters are significantly different by the LSD test at P = 0.05.

Grape quality as described by basic must composition varied significantly among treatments (Table 5). Both 100 cm and 130 cm treatments had significantly higher soluble solids content than 70 cm treatment. Titratable acidity was significantly higher in 70 cm treatment than in 130 cm treatment, while pH was significantly higher in 130 cm treatment than in other two treatments. Higher grape quality of vines with longer shoots was a consequence of higher leaf area/yield ratio obtained with these treatments, as leaf area/yield ratio determine the capacity of vines to ripen their crop (Kliewer and Dokoozlian, 2005). In a research conducted by Poni and Giachino (2000) on Cabernet Sauvignon, Brix was also reduced in a treatment with shorter shoots.

Although the differences in Brix between 100 cm and 130 cm treatments were not significant in our study, 130 cm treatment had both mildly higher Brix and mildly higher yield per vine than 100 cm treatment, indicating its better whole-canopy photosynthetic production and a potential to produce higher yield together with high grape quality. Generally speaking, this statement is only valid if other agronomical and environmental factors are not limiting for this type of production, in the first line the water and nutrients supply and the meteorological conditions, as they are needed for the adequate ripening of such crop. Obviously, in the conditions of this study these factors were not limiting.

Table 5. Fruit composition of Istrian Malvasia trimmed at 70, 100 and 130 cm. Data represent mean values of years 2011 and 2012.

Treatment	Soluble solids (Brix)	Titratable acidity (g L^{-1})	pH
70 cm	21,8 b	6,1 a	3,42 b
100 cm	22,8 a	5,7 ab	3,44 b
130 cm	23,0 a	5,5 b	3,48 a

Means within column designated by different letters are significantly different by the LSD test at P = 0.05.

Conclusions

The results of this study showed that the choice of shoot trimming height is an effective tool used for the regulation of cv. Istrian Malvasia vine productive characteristics and fruit quality. If applied correctly and with other agronomical and environmental factors not being limiting, vines having higher shoot length obtained with higher shoot trimming have a potential to produce higher yield per vine with better grape quality. This fact is of great importance for the economic results of the Istrian vitiviniculture sector, which in the recent times is gradually forced to compete on increasingly competitive national and global market.

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