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Training and canopy management influence on grape yield and quality

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Abstract The research was carried out in 2019 in a private vineyard from Recas vineyards area, and the varieties involved in research were early ripening Perla de Csaba and Victoria. The aim of the research was to establish the most suitable agro-biotechnological management for balanced quality and quantity of grape yield. During the growing season, several analysis and observations were made for evaluation of summer pruning influence on the quantity and quality of table grape yield. In the randomized block design, experimental units were three times replicated for: shoot thinning, shoot trimming, cluster zone leaf removal, bunch tinning, and berry thinning. In table grape varieties, summer pruning has positive influence both on the yield and especially on the grape berry size and attractiveness for consumers, which is essential for fresh table grape consumption.

Key words

summer pruning, grapevine training, yield, quality, table grapes

Summer pruning involves intensive hand labour, which is expensive, difficult to accomplish, and must be performed on time, differentiated from one variety to another depending on their biology [16, 25]. Summer pruning extend over the growing season, from May to September, in order to complete the winter pruning and to balance the vines canopy [22]. Climate change and variability is an important challenge for grapevine growers, which have to apply new technologies for canopy management and to plant varieties with moderate vigour adapted to water shortage and higher temperatures [11, 24]. Without summer pruning increases the ratio between unfertile and fertile shoots with wasteful consumption of nutrients [8]. During growing season, canes and shoots must be trained appropriate for each variety and canopy photosynthesis [13, 31]. Suckering is one of the most important processes in grapevine management and is usually done by hand [5]. Suckers pull water, energy and nutrients from grapevine trunk and therefore from fruit developing [6]. Leaf thinning applied to table grape varieties has an influence mainly on the grape berry quality after better sunlight exposure of bunches, which increase sugar content, improves the berry colour and controlling disease [14, 27]. Leaf removal from bunch zone should be performed after berry softening or early, near berry set [9, 26]. In extremely hot seasons basal leaves can protect bunches from sunburn or hot damage and should not be removed [15]. Well-balanced vines with normal canes and grape yield have less injury than unbalanced vines with excessive canopy and wood growth [2, 7]. Canes with large diameter (greater than pencil size) indicate an excessive growth with small crop level and uneven berry size and maturation [21]. Bunch thinning is usually done in first stage of berry development, to avoid the vine energy wasting [12, 29]. Therefore, for both table grape and wine grape varieties winter and summer pruning are important for annual wood maturation and cold hardiness [19, 32].

Material and Method

The research was carried on in 2019 in Recas Vineyards area and was developed in the randomized block design, experimental units were three times replicated for: suckering, pinching back shoot tips, cluster zone leaf removal, bunch tinning, and berry thinning, for two table grapes varieties, with early ripening: Perla de Csaba and Victoria.

The objectives consisted in establishing for each variety the most suitable summer pruning canopy management and training as well as the optimal moment of their execution for high grape yield of best quality. Planting distances was 2 m inter- rows and 1.2 m between vines per row, with a density of 4166 vines/ ha.

Training types were Guyot with two arms and Cordon Cazenave. During the vegetation, several observations and determinations were made to analyse the influence of summer pruning on the quantity and quality of table grape yield.

Data resulted were statistical analysed by GraphPadPrism 7.04 (GraphPad Software Inc. 2017) and statistical significance was expressed as symbols (*, **, ***).

Results and Discussions

Table grape varieties are high vigour varieties, shoots growths are large and abundant, therefore are necessary intensive summer pruning, works that control canopy development, improve the microclimate of the vine and around the bunch and have tremendous influence on grape yield and quality [4]. According to Malaescu et al. (2016) [17] research, shoot thinning and trimming before and after flowering combined with suckers' removal had the highest influence on canopy development in four grape wine varieties.

Table 1

Suckers removing influence on the grape yield and quality in Muscat Perlă de Csaba variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	All suckers removing	1.48	82	134	5.4	24.81
V_2	50% suckers removing	1.59	74	148	4.6	32.17
V_3	20% suckers removing	1.53	76	142	4.2	33.81
V_4	Without suckers removing (Control)	1.42	73	122	5.8	21.03

In tables 1 and 2 is presented the statistical analysis for suckers removing influence on grape yield and quality for Muscat Perlă de Csaba and Victoria variety respectively.
In both varieties, grape yield was higher in experimental variants compared to control however, with some particularities for each variety.

Therefore, in the Victoria variety, the highest yield was registered in the variant with total suckers removing, while in the Muscat Perla de Csaba variety, the best grape yield was recorded when 50% from suckers were removed.

Table 2

Suckers removing influence on the grape yield and quality in Victoria variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	All suckers removing	2.47	96	191	3.6	53.06
V_2	50% suckers removing	2.44	93	188	3.4	55.29
V_3	20% suckers removing	2.15	84	179	4.5	39.78
V_4	Without suckers removing (Control)	2.1	82	176	4.6	38.26

In Muscat Perla de Csaba variety, the most significant quantities of sugars were registered when only on 50% of suckers were removed. In Victoria variety, the sugar content of 190 g / l was noted when all suckers were removed..
The leaf removing must be applied carefully because each variety, in order to produce 1 kg of grapes, requires a certain leaf area, the leaves being considered useful organs of the plant.
However, in both varieties, production increases were registered for all experimental variants compared to the control variant.

Table 3

Leaf removing influence on the grape yield and quality in Muscat Perlă de Csaba variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	Leaf removing in early veraison	2.06	90	187	3.6	51.94
V_2	Leaf removing after veraison starting	2.06	86	183	4	45.75
V_3	Leaf removing before veraison	1.99	82	177	4.4	40.23
V_4	Without leaf removing (Control)	2.04	79	173	4.8	36.04

Table 4

Leaf removing influence on the grape yield and quality in Victoria variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	Leaf removing in early veraison	2.15	90	189	3.5	54.00
V_2	Leaf removing after veraison starting	2.14	87	185	4.2	44.05
V_3	Leaf removing before veraison	2.04	85	181	4.4	41.14
V_4	Without leaf removing (Control)	2.1	81	175	4.7	37.23

In the Victoria variety, the highest yield was recorded when the leaf removal was applied after veraison starting, while in the Muscat Perla de Csaba variety the leaf removal was applied at the veraison stage beginning.

Results concerning the quality, mainly for the total sugars, were near similar with those for grape yield in all experimental variants and both varieties.

One of the green operations that contribute to the improvement of cold hardness is the shoots trimming, especially in the vineyards from plain areas, vulnerable to extreme climate variability over the winter.

Table 5

Shoot trimming influence on the grape yield and quality in Muscat Perlă de Csaba variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	Shoot trimming in early veraison	1.77	75	149	4.61	32.32
V_2	Shoot trimming after veraison starting	1.73	81	151	4.31	35.03
V_3	Shoot trimming before veraison	1.66	77	135	5.01	26.95
V_4	Without shoot trimming (Control)	1.69	76	132	5.21	25.34

Table 6

Shoot trimming influence on the grape yield and quality in Victoria variety

Variant		Yield (kg/vine)	Production (%)	Sugar concentration (g/l)	Acidity (g/l H_2SO_4)	TSS/TA Ratio
V_1	Shoot trimming in early veraison	2.21	88	173	5.01	34.53
V_2	Shoot trimming after veraison starting	2.16	90	184	4.71	39.07
V_3	Shoot trimming before veraison	2.22	90	189	4.21	44.89
V_4	Without shoot trimming (Control)	2.11	81	175	4.61	37.96

In the Muscat Perla de Csaba and Victoria varieties, the evolution of the parameters of interest after shoot trimming in different stage of veraison was the best when the shoot trimming was applied before and after veraison.

However, in both varieties, both the quantitative and qualitative yield represented by the grape production, the sugar concentration of the grapes, the total sugars and titratable acidity ratio, registered values superior to the control (without shoot trimming).

The application of partial leaf removing, berry and bunch thinning in table grape varieties for fresh consumption, have a major influence on both the quantity and quality of grapes. Compared to the biological specificity of each variety, these works have different results. Results of Malaescu et al (2016) [18]

research, showed that shoot trimming before/after flowering and shoot thinning had low influence on sugar content on grape wine varieties; when suckers removal was applied to other summer pruning works, sugar concentration was statistically significant compared with other experimental variants.

The Muscat Perla de Csaba variety behaved differently when applying the summer pruning (leaf removing, berry and bunch thinning), because in this variety, the highest production increases were registered when leaf removing was applied in early veraison.

Table 7

Leaf removing, bunch and berry thinning influence on grape yield and quality in Muscat Perla de Csaba variety

Variant		Yield (kg/vine)	Production (kg/ha)	Production (%)	Difference to control (%)	Significance
V_1	Leaf removing in early veraison	1.53	6374	109	9	**
V_2	Berry thinning after flowering - starting	1.39	5791	99	-1	-
V_3	Bunch thinning after flowering	1.48	6166	105	5	**
V_4	Without leaf removing, berry and bunch thinning (Control)	1.41	5874	100	0	-

$LSD_{5\%}$= 2.81%; $LSD_{1\%}$= 4.92%; $LSD_{0.1\%}$= 11.73%

In Victoria variety (table 8), all the summer pruning variants applied, registered values significant then the control, but the highest yield was registered when berry thinning was applied after flowering. The lowest grape yield was recorded when no summer pruning was applied (control variant). According to Caspari et al. (1998), [3] intensity of leaf removal has to be managed based on canopy density and to enable the light penetration to the grape berries.

Table 8

Leaf removing, bunch and berry thinning influence on grape yield and quality in Victoria variety

Variant		Yield (kg/vine)	Production (kg/ha)	Production (%)	Difference to control (%)	Significance
V_1	Leaf removing in early veraison	2.23	9290	105	5	*
V_2	Berry thinning after flowering - starting	2.53	10540	119	19	***
V_3	Bunch thinning after flowering	2.49	10373	117	17	**
V_4	Without leaf removing, berry and bunch thinning (Control)	2.12	8832	100	0	-

$LSD_{5\%}$= 511%; $LSD_{1\%}$= 9.84%; $LSD_{0.1\%}$= 18.01%

In tables 9 and 10 is presented the statistical analysis for the influence on grape yield of all summer pruning applied in both varieties. In the Muscat Perla de Csaba variety, the influence of the summer pruning application was obvious, the variety registering significant differences to the control in all experimental variants. Usually, cluster thinning adjust the crop load and distribute bunches evenly on canes and vines, and in the same time eliminate weak bunches or misshaped [30].

Table 9

Summer pruning influence on the grape yield and quality in Muscat Perla de Csaba variety

Variant		Yield (kg/vine)	Production (kg/ha)	Production (%)	Difference to control (%)	Significance
V_1	Shoot thinning + Shoot trimming	1.6	6666	113	13	**
V_2	Shoot thinning + Shoot trimming + Leaf removing	1.58	6582	112	12	**
V_3	Shoot thinning + Shoot trimming + Leaf removing + berry thinning	1.5	6249	106	6	*
V_4	Shoot thinning + Leaf removing + berry thinning	1.53	6374	109	9	*
V_5	Without summer pruning (Control)	1.41	5874	100	0	-

$LSD_{5\%}$ = 5.97%; $LSD_{1\%}$ = 9.35%; $LSD_{0,1\%}$ = 15.92%

However, Muscat Perla de Csaba yielded best when shoot thinning and trimming was both applied during growing season.
The smaller yield differences between variants in which were applied: shoot thinning + shoot trimming + leaf removal + berry thinning (V_3) and shoot thinning + leaf removal + berry thinning (V_4) respectively were justified by berry thinning, which in Muscat Perla de Csaba with smaller berry size is not recommended.
In Dokoozlian et al. (2000) [10] opinion, shoot thinning to reduce shoot crowding should be performed at 35-30 cm, when can be choose the shoots with bunches in the best position for light exposure.

Table 10

Summer pruning influence on the grape yield and quality in Victoria variety

Variant		Yield (kg/vine)	Production (kg/ha)	Production (%)	Difference to control (%)	Significance
V_1	Shoot thinning + Shoot trimming	2.25	9374	107	7	*
V_2	Shoot thinning + Shoot trimming + Leaf removing	2.28	9498	108	8	*
V_3	Shoot thinning + Shoot trimming + Leaf removing + berry thinning	2.34	9748	111	11	**
V_4	Shoot thinning + Leaf removing + berry thinning	2.38	9915	113	13	***
V_5	Without summer pruning (Control)	2.11	8790	100	0	-

$LSD_{5\%}$ = 4.35%; $LSD_{1\%}$ = 8.76 %; $LSD_{0.1\%}$ = 12.93

In the Victoria variety, all the variants registered significant higher yields comparing the control, with the mention that this variety behaved very well, when all summer pruning operations are applied: shoot thinning, shoot trimming, leaf removal and berry thinning.
Previous studies concerning leaf removal influence on grape yield in wine grape varieties provided different results. Hunter and Visser (1990) [13], Morrison and Noble (1990) [20], Ollat et al. (1998) [23] found that leaf removal before berry pea size stage, decrease yield and berry size, but without any effect when was applied at veraison stage.
Similar, results reported by Poni et al. (2008) [28] in Sangiovese variety, showed that grape berry composition was improved by leaf removal, mainly sugars, anthocyanins and phenolics. According to Bledsoe et al. (1988) [1], early leaf removal is useful for grape yield control and grape composition improvement, and replace time-consuming for hand labour cluster thinning as well.

Conclusions

Summer pruning must be done carefully according to each variety growing parameters, with the preservation of the leaf area necessary for photosynthesis, and high yield. Over the growing season, from May to September, green pruning accomplish the winter pruning for highly table grapes, canopy balance and better disease controlling.
Regular pruning is need to keep vines productive, and to create a balanced ratio between productive shoots and useless suckers or to long shoots which take nutrients and water from berry development.
The large volume of labour required for green pruning increase the difficulty to find hand skilled labour, therefore this issue is increasingly hard to manage during last years, and best option for vineyard managers is mechanical pruning.
In all experimental variants analysed for different summer pruning works, registered high yields and quality parameters, but specifically for each variety.
The application of green works and operations has a positive influence both on the production and especially on the grape attractiveness for consumers, which is essential for table grapes varieties for fresh consumption.

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