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Full Length Research Paper

Influence of shoot topping on yield and quality of *Vitis vinifera* L.

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This study was carried out in a 20 year old spur pruned Karasakız (Kuntra) vineyard during the 2003 and 2004 growth season. Vines were topped at 1, 3 and 5 nodes beyond the last cluster on the main shoot. Yield and quality parameters were analyzed to determine the effects of shoot topping. The results showed that weather conditions had more statistically important effects compared to the topping level. One (1) node topping resulted in more loss of yield due to increased vegetative growth.

Key words: *Vitis vinifera* L., shoot topping, yield, quality, canopy management, shoot topping, fruit set, yield components, fruit composition.

INTRODUCTION

Vineyard responses to management practices such as irrigation, nutrition and pest and disease control have long been a part of good viticulture. Over the last decades, particular contribution of canopy microclimate to vineyard productivity, including fruit composition and disease incidence has been identified by experimentation. “Canopy management” describes a range of practices aimed at avoiding within canopy shade and poor ventilation (Smart, 1992). Canopy management typically has two components. The first includes increasing canopy surface area, using canopy division techniques for existing vineyards and canopy division or close row spacing for new vineyards. The second component related to reducing within-canopy shade by considering such variables as shoot positioning, pruning level, trimming and leaf removal (Smart, 1992).

Canopy management techniques have been exploited on grapevines for decades. Earliest studies go back to late 1950s. Since then, many valuable studies have been published on shoot topping (hedging) or tipping (Coombe, 1959; Koblet, 1987; Wolf et al., 1990; Gay et al., 1996; Iacano and Sparacio, 1999; Keller et al., 1999; Cartechini et al., 2000; Benismail et al., 2007, Pisciotta et al., 2007) or leaf removal from the cluster zone (Kliewer and Bledsoe, 1987; Poni et al., 2006; Iannini et al., 2007).

This research was carried out to determine the effects of shoot topping applied as leaving 1, 3 and 5 buds beyond the last cluster on the yield and quality of *Vitis vinifera* L.

MATERIALS AND METHODS

Karasakız (Kuntra) is a grape (*V. vinifera* L.) cultivar mainly processed into sherry and wine and grown in most viticultural areas in northwest region of Turkey. It is also freshly consumed. The vines subjected to the treatments were 20 years old and on their roots. Spacing was 2 x 2 m. Vines were trained to spur pruned bush vine. Two-node spurs were retained as bearing units (approximately 12 buds/vine). Vineyard was not irrigated and fertilized during the experimenting years (2003 and 2004). Chemical applications against fungal diseases were carried out with sulphur and penconazole. Sprays were applied in 12 day intervals. The initial spray was made 11 days before the first of shoot topping.

Shoot topping was made at two different times, 3 - 5 days after the full bloom at the beginning of June and at the beginning of the pea size of grape berries (beginning of July). During the first green pruning, shoots were topped beyond the 1st, 3rd and 5th buds of the last cluster. While the shoot tops were removed, water shoots and aged basal leaves up to the first cluster were removed. Lateral shoot formed except for the ones at the tip were also removed. During the second green pruning, water shoots formed later on were removed from the vines and outermost lateral shoots were pruned to 1 - 2 leaves left at the bottom.

Time for grape harvest and sampling were determined when berries at 5th bud topping treatment reached optimum ripeness for making sherry (average 9 bome). Harvest was made on September

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Table 1. Meteorological data in 2003 and 2004 of the vineyard in which shoot topping was applied.

Year	Parameter	April	May	June	July	August	Sept.	Mean
2003	Mean Temperature (ºC)	9.8	18.5	24.0	25.6	26.4	20.2	20.75
	Max. Mean Temperature ºC)	14.7	24.7	30.1	30.9	32.3	25.8	26.42
	Min. Mean Temperature (ºC)	5.9	13.3	17.8	19.8	20.8	15.5	15.52
	Relative Humidity (%)	77.8	69.2	58.4	61.2	56.2	63.4	64.37
	Mean Rainfall (mm)	2.77	0.48	-	-	-	0.76	1.34
	Total Rainfall (mm)	83.2	14.9	-	-	-	22.9	40.3
2004	Temperature (ºC)	12.7	17.1	22.6	25.3	24.8	21.5	20.67
	Max. Mean Temperature (ºC)	16.2	21.1	27.3	30.2	30.1	26.4	25.22
	Min. Mean Temperature (ºC)	9.5	13.1	18.1	20.8	19.5	17.5	16.42
	Relative Humidity (%)	80	72.4	69.3	62.5	67.5	68.9	70.10
	Mean Rainfall (mm)	1.71	0.45	0.73	0.04	0.14	0.01	0.51
	Total Rainfall (mm)	51.3	14.0	21.9	1.3	4.4	0.2	15.52

2 in 2003 and September 6 in 2004.

The effects of shoot toppings at different levels on grape yield and quality were determined by means of criteria such as cluster weight and number, cluster tightness, cluster length and width, berry weight, total soluble solids, titratable acidity and maturity index. Cluster number was obtained by counting all the clusters per vine. Cluster weight (g) was cluster number per vine divided by yield per vine. Cluster length (cm) and width (cm) was determined by measuring the length and width of approximately 8 clusters per vine. Cluster tightness was determined according to OIV 204 (IPGRI, UPOV, OIV, 1997) on a scale of 1 - 9. Berry weight (g) was the mean value of 400 berries (100 per replicate) from a treatment. Total soluble solids (TSS, %) and titratable acidity (TA, %) were determined with a refractometer and pH meter, respectively. Maturity index was the ratio of TSS to TA.

Monthly average values during the vegetation period for the climatic data obtained for both years during which the study was conducted were given in Table 1.

To determine the incidence of powdery mildew (*Uncinula necator* L.) on leaves and clusters and the efficiency of the fungicide spraying, the number of powdery mildew lesions on grape clusters and leaves was counted 12 days after the final spray. 0 - 4 scale values [0 = no infection on clusters, 1 = 25% infection, 2 = 50% infection, 3 = 75% infection, 4 = over 75% infection] were used for lesion counts on the clusters, whereas 0 - 3 scale values (0 = no powdery mildew colony on the leaf surface, 1 = 1 - 2 colonies, 2 = 3 - 10 colonies, 3 = more than 10 powdery mildew colonies) were used for the foliage (Yıldırım et al., 2002).

The experiments were established in randomized parcels with four replications and 8 plants were used for each replicate. The data obtained were assessed using SPSS for Windows (ver. 15) statistical software. The means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

From the results of the statistical analysis, it was shown that yield and quality attributes were certainly dependent on weather conditions. Only cluster number was not affected. The first year values were higher in all characteristics. Sensory characteristics were under the interaction effect of year and topping level. Berry weight was influenced separately by the year and topping (Table 2 and 3).

Yield per vine increased as the severity of topping decreased in 2003 but the same trend was not observed for the year 2004. In 2004, yield was highest in the vines topped at 3-bud level. Cluster numbers increased as the topping level decreased. Berry numbers were inversely affected from the topping level. The heaviest clusters and berries were obtained from the 3-bud topped vines. TSS and maturity index increased as more buds were left on the vines, whereas titratable acidity decreased at an important level (Table 2 and 3).

The difference between the treatments was greater in 2004 than in 2003 in TSS, TA and maturity index (Table 3).

Incidences of the powdery mildew on leaves were 16.6 and 70.2% in 2003 and 2004, respectively. The efficiency of the fungicides on the leaves was respectively 80.3 and 29%. The clusters showed the disease 25.5% in 2003 and 40% in 2004. The efficiency of the chemicals on protecting clusters was 72.3% in 2003 and 61.8% in 2004.

The data obtained showed that yield and quality characteristics were under the effect of several factors, mainly of weather. Weather conditions greatly impacted yield. Rain throughout the vegetation especially during flowering (May-June) reduced the yield per vine. It was, therefore, inconclusive to suggest that shoot topping was responsible on reduced yield. There are contradicting reports on the effects of shoot topping on yields of grapevine, depending on cultivar and time and level of topping. Wolf et al. (1990) found that when vines were topped to 10 or 20 leaves per shoot, more fruit was harvested from shoot-topped vines than from control vines in two of three years. Iacono and Sparacio (1999) showed that shoot topping at fruit set did not affect crop load in Cabernet Sauvignon. Nobuo et al. (1999) found that in the vineyard where shoots were topped, fruits were high in quality and quantity. Cartechini et al. (2000) hedged 6 *V. vinifera* L. cultivars one and five weeks after

Table 2. Effects of shoot topping on yield and quality characteristics of Karasakız grape cultivar.

Shoot topping	Yield (kg/vine)			Cluster length (cm)			Cluster width (cm)			Cluster tightness			Cluster number (n)			Cluster weight (g)		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
1 bud	2.535	1.354	1.945	15.20	14.23	14.72	10.32	8.22	9.27	8.04	6.41	7.23	10.1	10.0	10.1	266.9	136.4	201.7
3 bud	2.665	1.686	2.176	15.15	14.23	14.69	10.45	8.20	9.33	8.09	6.91	7.50	10.0	10.7	10.3	270.1	154.4	212.3
5 bud	2.796	1.443	2.120	15.45	14.42	14.94	10.73	7.99	9.36	8.11	6.52	7.32	9.6	11.7	10.7	291.5	122.0	206.8
Mean	2.665 A	1.494 B		15.27 A	14.29 B		10.50 A	8.14 B		8.08 A	6.61 B		9.9	10.8		276.2 A	137.6 B	

Means within columns followed by different capital letters and those within the same row followed by different small letters differ significantly at $p < 0.05$ by Duncan's new multiple range test.

Table 3. Effects of shoot topping on quality characteristics of Karasakız grape cultivar.

Shoot topping	Berry number (n)			Berry weight (g)			TSS (%)			TA (%)			Maturity index		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
1 bud	101.8	69.4	85.6	2.55	1.98	2.26 B	16.35 Ba	12.93 Cb	14.64	1.016 Ab	1.159 Aa	1.088	16.09 Aa	11.19 Cb	13.64
3 bud	93.2	64.6	78.9	2.83	2.38	2.61 A	17.06 ABa	14.98 Bb	16.02	1.025 Ab	1.052 Ba	1.039	16.71 Aa	14.25 Ba	15.48
5 bud	99.2	57.2	78.2	2.86	2.13	2.50 AB	17.87 Aa	17.35 Aa	17.61	1.012 Aa	0.983 Ca	0.998	17.68 Aa	17.66 Aa	17.67
Mean	98.1 A	63.7 B		2.75 A	2.16 B		17.09	15.09		1.018	1.065		16.83	14.37	

Means within columns followed by different capital letters and those within the same row followed by different small letters differ significantly at $p < 0.05$ by Duncan's new multiple range test.

bloom retaining 9 – 10 leaves per shoot. Cabernet S., Verdello, Drupeggio and Sauvignon Blanc showed a good capacity to produce laterals and therefore responded better to early-hedging with increased cluster weight and yield and improved soluble solids. Independent of cultivar, with early-hedging, the titratable acidity and pH of the juice were significantly reduced. They reported that late-hedging, 5 weeks after bloom, reduced yield. In all cultivars except Sauvignon Blanc, the soluble solid content and anthocyanins concentration diminished. Vasconcelos and Castagnoli (2000) found that topping increased yield per shoot but decreased vine yield of mature Pinot noir. Topping the main shoot in Italian Riesling during flowering promoted the fruitfulness of the main shoot and when carried out 6 - 7 days before flowering, it promoted the growth of fruitful auxiliary shoots and raised the overall grape yield (Cindric, 1968).

The effects of shoot topping on grape clusters and berries were varying under the influence of yearly weather conditions. Cluster and berry characteristics were under climate control, making it hard to ascertain the results attributable to shoot topping only. Features relating to cluster and berry were all diminished in the second year, resulting in a loss in quality and quantity. Vasconcelos and Castagnoli (2000) found that shoot tipping at bloom in Pinot noir vines increased percent fruit set, berries per cluster, cluster weight, yield per shoot, and yield to pruning ratio. Tipping, however, decreased total yield per vine, juice pH, leaf area per vine, pruning weight, and cane weight and sugars in the trunk during dormancy. El-Zeftawi and Weste (1970) reported that topping (removal of 15 cm or more from the shoot tip) when compared with pinching (removal of 8 cm or less from the shoot tip) tends to check the increase in berry size and to reduce the sugar content of the juice, which suggest that the reduction in leaf area as a result of topping is more harmful than that of pinching as far as berry size and the sugar accumulation in the berries are concerned. In a vigorous Cabernet Sauvignon vineyard, Kliewer and Bledsoe (1987) found that shoot topping to about 14 nodes at 5 weeks post bloom delayed fruit maturity, reduced berry weight, °Brix and pH of fruit when compared on the same date, but when fruit was compared at the same °Brix, there was little difference in fruit composition. Shoot topping markedly reduced the amount of bunch rot in wet years. Over a three year period, crop yield of topped and untopped vines did not differ

significantly. Intrieri et al. (1983) studied the effect of shoot topping, 1, 7 and 11 weeks after anthesis, on Albana and Sangiovese cvs and showed that berry growth and TSS increased with topping 1 week after anthesis, and topping 7 weeks after anthesis decreased berry growth, TSS and slowed acidity breakdown. Benismail et al. (2007) researched the effect of different bud loads (14, 20, 30 and 40 latent buds per vine) combined with shoot topping (at the level of the 10^{th} leaf) at the beginning or at the end of flowering on growth and development of 6 years old 'Cardinal' grapevine. Shoot topping enhanced canopy development through stimulation of lateral bud growth. This enhancement was higher when bud load was low and topping occurred at the early stage. In vines with a load of 20 buds, topped at the end of flowering, grape production was improved by 31.3% with a 6.6% reduction in soluble sugar content.

Although it was not experimented in this study, powdery mildew and the fungicides used against it might have played a significant role in the yield and quality of the vines. The higher incidence of powdery mildew on leaves and clusters and relatively lower efficiency of the chemicals in the second year might have diminished the amount of grape obtained from the vines.

Conclusions

Topping has its effects on grapevines by changing the environment within the canopy due to increased or decreased leaf number and/or leaf layer, providing food for developing clusters and next year's crop. Topping made 1-bud after the last cluster resulted in a lower grape yield and quality. Nevertheless, it gave rise to higher vegetative growth compared to the other treatments. Topping performed at 5-bud beyond the last cluster provided overall best results in terms of quality and yield. However, seasons in which powdery mildew incidence is intensive, it might be better to summer prune the vines by leaving 3 buds beyond the last cluster. When powdery mildew is not intensive, 5-bud topping might be useful in yield and quality.

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