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Effects of different crop load and pruning applications on vine growing, grape yield and quality parameters of Early Sweet (*Vitis vinifera* L.) grape variety

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Abstract. It is important to examine the yield and quality elements of table grape varieties. There are great differences in winter and summer pruning of the "Early Sweet" grape variety. For this reason, in the study, the effects of different crop loads and pruning processes on yield, quality characteristics and vine development of the Early Sweet (*Vitis vinifera* L.) grape variety were investigated. The study were designed to determine the yield-quality and vine development of the "Early Sweet" grape variety. Although there was no statistical difference between the applications in the 2023 production year, the best yield, especially in the applications carried out in the 2022 production year, was determined by the average cluster weight, cluster length and width, cluster stem width and length, number and weight of fallen berries, fresh and dry weight of the cluster skeleton, 100-berry weight, berry detachment force, water soluble dry matter% and titratable acidity parameters were determined in non-cluster treatments of 15- and 25- cluster loads on short pruning. The most appropriate pruning should be recommended as short and medium one with 25 cluster/vine.

1. Introduction

History BC. 5000s, the vine and its fruit, the grape, is one of the oldest fruits cultivated in the world. While Asia Minor and the Caucasus regions including Anatolia are recognised as the homeland of the grapevine. Türkiye is home to more than 1400 grape varieties, offering a rich diversity of genetic material [1]. The viticulture activities carried out in about 80% of Türkiye's vast geographical area are the most important evidence of the high adaptability of grapevine to various climatic conditions. Turkey has the advantage that the harvest difference between the early varieties grown in the warmer regions and the late varieties grown in the colder regions includes a period of 4-5 months. For the marketing of grapes, there are economic advantages of being early or late. [2, 3 4].

According to Turkish Statistical Institute [5] data, the amount of vineyard production area is 384.537 hectares in Türkiye and the Aegean Region stands out in terms of vineyard areas, covering 51.3% of the total production, with a production of 2 135 849 tonnes.

In table grape varieties, berry size, homogeneity of the berries in the cluster and variety-specific colour are important for the marketing of the product, and cultural practices in the vineyard should be managed well in order to increase the yield and quality of the grape. In order to increase the yield and quality of grapes, the share of cultural practices such as fertilization, winter pruning, irrigation, disease and pest control, as well as green pruning to be applied in the spring and summer periods is very important [6, 7].

Early Sweet is a promising grape variety in terms of its earliness. On the other hand, there are a few research work on Early Sweet table grape variety.

In recent years, the cultivation of Early Sweet (*Vitis vinifera* L.) grape variety has been increasing rapidly in the Aegean Region, Türkiye. Despite that the producers of Early Sweet have applied different pruning methods and crop loads, the variety has not achieved the desired performance in terms of quality and yield, yet.

This research study was conducted to determine the effects of different winter pruning, cluster load, and berry removal treatments on the yield and quality of "Early Sweet" grape.

2. Material and methods

This research was carried out in the 2022-2023 vegetation period in the "Early Sweet" vineyard grafted on a 9-year-old 41 B American vine rootstock located at

38°40'15.4 "N 27°25'14.1 "E coordinates in Güzelköy neighborhood of Şehzadeler District of Manisa Province.

Picture 1. Map view of the study area.

The distance between and above the rows was 2 x 3 meters. The experimental vineyard was established on the "Y" training system. The soil structure of the vineyard is clay-loamy texture, having a medium water holding capacity. Irrigation in the vineyard is done with drip irrigation method (Picture 2).

Picture 2. Experimental vineyard.

"Early Sweet" is an early seedless grape variety that can be stored in cold storage for a long time and is known for its resistance to transportation. Suitable for mixed pruning, yellowish green, elliptical round shaped, very large grains (5-6 g), seedless and has a unique aroma (Picture 3). Clusters are conical, 500-900 g in weight and plump and sparse. Mature berries have 16-19% sugar content [8].

Picture 3. "Early Sweet" grape variety.

41B American grapevine rootstock (Chasselas x V. berlandieri 41B Millardet Et de Grasset) is a short vegetation (early ripening) rootstock, this characteristic also affects the variety to which it is grafted and ensures that the grapes ripen early. Resistant to 40% active lime, roots go half-deep, very resistant to Phylloxera [9]

In this study, three different pruning levels (short, medium, control), two different crop loads (15 cluster/vine and 25 cluster/vine) and two different cluster treatments were realized. Other cultural practices (tillage, weed control, disease and pest control, fertilization) were carried out in a standardized manner.

Harvest dates of fresh grape are 17.07.2002 and 18.07.2023 in the experimental vineyard.

Winter pruning practices:

48 buds/vine were left before bud break to equalize winter pruning.

- **Short** (S): 12 canes were left per vine, each with 4 buds (Picture 4a).
- **Medium** (M): 6 canes with 8 buds each were left per vine (Picture 4b).
- **Control** (C): 4 canes with 12 buds each were left per vine, provided that a total of 48 buds are fixed in each vine (Picture 4c).

Picture 4. Winter pruning practices in vineyard, a: Short (S), b: Medium (M), c: Control (C).

Cluster treatment:

- **Non-Cluster treatment** (nCT): bunch tips were not removed (Picture 5a).
- **Cluster treatment** (CT): bunch tips (1/3 of cluster length) were removed (Picture 5b).

Picture 5. Cluster treatment in vineyard, a: non-Cluster treatment (nCT), b: Cluster treatment (CT).

The research was planned according to the split- split plot experimental design in randomized blocks with three replicates. The experiment consisted of three different pruning, two different cluster number and two different cluster treatments together with the control, a total of 36 plots, with 3 vines in each plot, and a total of 108 vines in total. In the study, yield and quality parameters related to grapes were analysed.

The data obtained from the experiment were subjected to analysis of variance using the TARIST statistical package program, and when a difference was determined between the treatments, the LSD test was applied to determine the significance level of this difference.

3. Results and discussion

Phenological observations were made in the vineyard and the dates are given in Table 1.

Table 1. Dates of phenological periods in vineyard.

Phenological observations	Vegetation year	
	2022	2023
Budburst_1	02.02.2022	26.01.2023
Budburst_2	10.02.2022	30.01.2023
Budburst_3	24.02.2022	18.02.2023
Early shoot growth	01.04.2022	17.03.2023
An inflorescence before flower	20.04.2022	05.04.2023
An inflorescence in flower	27.04.2022	16.04.2023
Flowering	17.05.2022	16.05.2023
Fruit set	24.05.2022	22.05.2023
Véraison	30.05.2022	30.05.2023
Harvest	17.07.2022	18.07.2023

In 2022, the average temperature was 16.11 C^0, the maximum temperature was 40.98 C^0 and the total annual precipitation was 390.8 mm^3. In 2023, the average temperature was 17.88 C^0 and the maximum temperature was 45.34 C^0, while the total annual precipitation was 438.6 mm^3.

Yield values for 2022 and 2023 are presented in Table 2.

Table 2. Yield (kg/vine) values of the treatments in 2022-2023.

Applications	Yield (kg/vine)	
	2022	2023
S15CT	4.62 c	5.23
S15nCT	7.53 ab	6.05
S25CT	7.83 c	9.43
S25nCT	13.28 a	7.27
M15CT	4.89 c	4.01
M15nCT	6.17 abc	4.95
M25CT	10.29 bc	7.31
M25nCT	13.12 a	7.82
C15CT	4.98 c	4.07
C15nCT	7.80 c	5.14
C25CT	7.82 c	8.88
C25nCT	10.50 abc	7.78
LSD	2.65*	ns

ns: non-significant, *:P>0.01, **:P>0.05

The highest yield values were obtained from S25nCT (13.28 a) and M25nCT (13.12 a) treatments in 2022. In 2023, the effect of treatments on yield values was found statistically insignificant (Table 1). The highest yield values were obtained from S25nCT (13.28 a) and M25nCT (13.12 a) treatments in 2022. In 2023, the effect of treatments on yield values was statistically insignificant (Table 2).

In terms of marketable cluster number values for 2022 and 2023, the best treatments were M25nCT and M25CT with values of 20.33 a and 19.83 a (Table 3).

Table 3. 2022-2023 marketable cluster number (piece/vine) values of treatments.

Applications	Marketable cluster number (cluster/vine)		
	2022	2023	Average year
S15CT	14.66 c	16.66 abc	15.67b c
S15nCT	14.00 c	12.00 c	13.00 c
S25CT	22.00 ab	15.00 abed	18.50 ab
S25nCT	21.00 ab	17.00 ab	19.00 ab
M15CT	15.00 c	12.00 c	13.50 c
M15nCT	14. 33 c	12.33 bc	13.33 c
M25CT	22.66 a	17.00 ab	19.83 a
M25nCT	21.33 ab	19.33 a	20.33 a
C15CT	14.33 c	13.66 bcd	14.00 c
C15nCT	14.66 c	14.33 bcd	14.50 c
C25CT	18. 66 b	19. 33 a	19.00 ab
C25nCT	20.33 ab	16,66 abc	18.50 ab
LSD	*3.57**	*4.59***	*3.42**

ns: non-significant, *:P>0.01, **:P>0.05

Unripe and small berries present in the harvested clusters must be removed by hand to correct their appearance before marketing. This process is done very carefully in accordance with the standards.

As seen in Table 4, the number of small berry in the cluster, which is one of the most important criteria for marketable cluster, was obtained from M15CT (2.05 c), M25CT (2.05 c) and C25CT treatment with 2.27 c.

Table 4. Number of small berry (piece/cluster) values of treatments in 2022-2023.

Applications	Number of small berry values (piece/ cluster)	
	2022	**2023**
S15CT	2.94 bc	69.00
S15nCT	7.16 a	61.66
S25CT	3.16 bc	42.33
S25nCT	3.72 bc	46.66
M15CT	2.05 c	26.66
M15nCT	3.27 bc	68.00
M25CT	2.05 c	56.66
M25nCT	3.33 bc	46.00
C15CT	5.22 ab	31.00
C15nCT	4.44 abc	43.33
C25CT	2.27 c	22.00
C25nCT	4.44 abc	36.33
LSD	***2.75****	***ns***

ns: non-significant, *:P>0.01, **:P>0.05

Table grapes are harvested when they are ripe, unlike many fruits, grapes do not ripen after picking, so they should be harvested when they reach the desired level in terms of appearance, colour, flavour and structure. In deciding the ripeness of grapes, factors such as the colour of the grape, the colour of the cluster stem and skeleton, the colour of the seed, the separation of the seed from the flesh of the berry and the flavour are effective. From table vineyards, clusters are harvested that are not only attractive in appearance, but also have characteristics suitable for eating, transportation and post-harvest.

Table 5. Berry detachment force (g) values of treatments in 2022-2023.

Applications	Berry detachment force values (g)	
	2022	**2023**
S15CT	333.55 df	190.33
S15nCT	339.55 cdef	170.77
S25CT	322.27 f	163.83
S25nCT	353.33 bcdef	157.01
M15CT	390.89 abc	150.70
M15nCT	394.00 ab	173.77
M25CT	411.77 a	150.64
M25nCT	387.55 abcd	147.10
C15CT	372.88 abcdef	164.12
C15nCT	381.77 abcde	183.72
C25CT	337.55 def	180.67
C25nCT	372.11 abcdef	183.70
LSD	***51.43****	***ns***

ns: non-significant, *:P>0.01, **:P>0.05

In mature berries, lignification occurs at the bottom of the panicle stem. M25CT (411.77 a) treatment gave the best result in terms of berry detachment force in the treatment year 2022. S25CT (322.27 f) treatment of the same year had the lowest value (Table 5).

In table grapes harvested at the right time, the characteristics that affect quality such as taste, colour and texture are at their best. Chemically determining the sugar (brix = water-soluble dry matter) and acid content of the must is the most reliable way to decide the harvest time.

Table 6. Brix (water-soluble dry matter) % value in 2022-2023.

Applications	Brix (%)		
	2022	**2023**	**Average year**
S15CT	16.24 a	16.36	16.30 a
S15nCT	16.07 a	16.40	16.23 a
S25CT	14.82 c	16.60	15.71 ab
S25nCT	13.33 d	15.06	14.20 c
M15CT	16.56 a	14.93	15.74 ab
M15nCT	14.46 c	14.70	14.58 bc
M25CT	14.64 c	14.93	14.78 bc
M25nCT	13.52 d	14.70	14.11 c
C15CT	16.58 a	14.70	15.64 ab
C15nCT	14.62 c	14.60	14.61 bc
C25CT	15.96 ab	14.50	15.23 abc
C25nCT	15.20 bc	14.03	14.61 bc
LSD	***0.822****	***ns***	***1.28****

ns: non-significant, *:P>0.01, **:P>0.05

Sugar content in table grapes is an important criterion for determining harvest maturity. Table grape varieties are harvested when the brix is 16 and above. S15CT, S15nCT, M15CT, and C15CT treatments are in the best group statistically in terms of brix in 2022 with (16.24 a), (16.07 a) (16.56 a), and (16.58 a) values, respectively (Table 6). S15CT (16.30 a) and S15nCT (16.23 a) treatments were in the best statistical group for brix value according to both year averages.

Titratable acidity was statistically best obtained with M25nCT (4.42 a) treatment at 1% significance level in 2022 vegetation year. Although no statistical significance was obtained, M25nCT treatment gave the best result with a value of 3.50 g/L in 2023 (Table 7).

Table 7. Titratable acid value in 2022-2023.

Applications	Titratable acid value (g/L)	
	2022	2023
S15CT	4.01 ab	4.39
S15nCT	3.81 bc	3.85
S25CT	3.71 bc	3.71
S25nCT	3.43 c	3.99
M15CT	3.68 bc	4.25
M15nCT	3.43 c	4.00
M25CT	3.78 bc	3.50
M25nCT	4.42 a	4.04
C15CT	3.80 bc	4.41
C15nCT	3.59 bc	3.80
C25CT	3.63 bc	4.16
C25nCT	3.68 bc	4.25
LSD	*0.44**	*ns*

ns: non-significant, *:P>0.01, **:P>0.05

The maturity index is a determining parameter for table grape harvesting and marketing. M15CT (45.00 a) application gave the best result whereas M25nCT (30.70 c) treatment caused the poorest result.

Table 8. Maturity index in 2022-2023.

Applications	Maturity index	
	2022	2023
S15CT	40.00 ab	38.70
S15nCT	42.20 ab	43.00
S25CT	39.90 ab	45.00
S25nCT	39.20 b	38.00
M15CT	45.00 a	36.00
M15nCT	42.10 ab	37.10
M25CT	38.70 b	43.00
M25nCT	30.70 c	37.00
C15CT	43.6 ab	34.20
C15nCT	40.7 ab	38.30
C25CT	43.90 ab	35.40
C25nCT	41.30 ab	35.80
LSD	5.7*	ns

ns: non-significant, *:P>0.01, **:P>0.05

4. Conclusions

Pruning balances development, growth, productivity and quality in grapevine. Yield in viticulture is directly affected from number of the buds in the vine. The productivity of the vine is related to the number of clusters, berry length and berry width in the cluster.

In the 2022 production year, the highest yield values were obtained from the S25nCT and M25nCT treatments, and similarly, the results obtained in the average panicle weight were parallel to the yield values. Yield followed a directly proportional result with the highest crop load left and non-cluster treatment.

The highest number of small berries, which is the weakest characteristic of the variety, was observed in the S15nCT treatment (7.16 a piece/cluster). No correlation was found between berry detachment force and the number of berries in the cluster and the number of small berries in the cluster. The lowest cluster load left in the study was found to accelerate ripening and increase berry drop.

According to the average results of two experimental years, P>0.01 was found in the treatments and the highest brix values were determined as 16.30 a in the S15CT treatment and 16.23 a in the S15nCT treatment. This result showed that the lowest cluster load and short pruning had an increasing effect on the value of the Brix.

In this study, different pruning and crop load practices were evaluated on the yield and quality of Early Sweet grape variety. The best results in terms of yield and quality were obtained with short and medium pruning. Therefore, it was concluded that it might be beneficial to prefer short and medium pruning with 25-clusters/vine crop load and without removing cluster tips in future production years of the variety. Although the cluster treatment practices had positive effects on yield and quality in short pruning, it was

concluded that the labour cost is higher than profit earned by the quality.

Consequently, it was considered that berry size inhomogeneity and formation of small berries could be resourced from genetic susceptibility or pollination in Early Sweet. Further studies should be focused on solving the problems.

5. References

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