Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Effect of Bud Load Levels and Summer Pruning on Vine Vigor and Productivity of ''Flame Seedless'' (*Vitis vinifera*, L.) Grapevines

Bassiony, S. S.*

Viticulture Research Department, Hort. Res. Inst. ARC. Giza, Egypt.

ABSTRACT

This investigation was carried out through three successive seasons 2016, 2017 and 2018 on 8 years old" Flame seedless" grapevines (*Vitis vinifera*, L.) grown in sandy soil under drip irrigation system in Markz-Bader El-Beheira Governorate, Egypt. The vines spaced at 2 x 3m in a raw and between rows, respectively, trained to bilateral cordon with Gable supporting system. The vines were loaded with four bud load levels according to weight of one-year-old wood (pruning) produced in the preceding season. The suggested levels of bud load were control, B20 (weight of pruning as kg. x 20), B30 (weight of pruning as kg x 30) and B40 (weight of pruning as kg. x 40) alone or combined with two cluster thinning (without thinning and thinning to one cluster/ fruitful shoot) and two shoot topping (without topping and shoot topping leaving 20 leaves/ shoot) treatments as summer pruning. The results cleared that, as bud load level decreased from B40 to B20 as bud purest, fertility, vegetative growth parameters as well as cluster and berry physical characteristics improved. The same trend was noticed with thinning and topping treatments. The combination treatment of B30+ cluster thinning+ shoot topping (T_{15}) appeared to be superior to achieve the balance between vine growth and productivity, since internodes length and diameter as well as pruning weight and total biomass were improved. Moreover, T_{15} recorded the highest yield, enhanced cluster weight, as well as berry physical and chemical quality parameters.

Keywords: Pruning severity, winter pruning, summer pruning, Yield, and Fruit quality

INTRODUCTION

Grape (*Vitis vinifera*, L.) is considered the first deciduous fruit crop in the world and the second one in Egypt after citrus. "Flame seedless" is one of the most popular and favorite table grapes as for consumers, it ripens early with good clusters and berries color. The balance between vine vigor and productivity is a main factor that affects produce sustainable yields and maintaining fruit quality. Some horticultural practices generally used for achieving these probes such as winter and summer pruning. Winter pruning is one of the most important practices in grapes production since; it controls number of buds retained on vine for the optimum yield with best fruits quality. However, the total number of buds per vine is so varying according to cultivar and training system Sahebrao (2013).

Winter and summer pruning as a viticulture practices were discussed by several workers (May *et al.*, 2003; Kurtural and Masabni, 2006 and Khamis *et al.,* 2017). In this respect, Berny *et al.* (2005) reported that, retaining 10, 20, and 40 eyes (sever, moderate and light pruning levels) for the first pound of pruning's and 20 eyes for each additional pound of pruning's in "Chardonnay" grapes resulted in; the severe pruning decreased total carbohydrate reserves (starch) in roots, trunks and canes meanwhile, light pruning showed the greatest reductions, but the starch concentration at bud burst was 1.5% compared with 17% in moderate pruning. Moreover, shoot growth decreased as the total carbohydrates reserves decreased. These findings suggest that; both sever and light pruning may have a negative impact on the productivity of grapevines. Also, reductions of roots and trunks carbohydrate reserves caused by sever and light winter pruning have also been associated with a decrease in number of inflorescence and a decrease in flowers number per inflorescence to 50% less than in balanced-pruning vines Ferree *et al.* (2004). On the other hand, the unbalanced pruning (heavy bud load) even though produced poor clusters and berries quality characters, but gave the highest total yield in "Crimson seedless" grapevines (El-Baz *et al.,* 2002), delayed berry maturation in "Sauvignon Blanc" grapevines (Naor *et al.,* 2002)and less mature fruits with lowest soluble solids content in "Sunbelt" grapevine (Striegler *et al.*, 2002).

Meanwhile, sever pruning (lighter bud load per vine) enhanced cluster and berry physical characters as well as chemical properties as lick SSC%, SSC/acid ratio and berries anthocyanine, but decreased total yield of "Sharad seedless" grapes as showed by Somkuwar and Ramteke (2007), Bates (2008) on "Concord", Abdel-Mohsen (2013) on "Crimson seedless", Fawzi *et al.* (2015) on "Superior seedless"and Uyak *et al.* (2016) on "Ercis" grapevine cvs.

Summer pruning is a viticulture technique that helps maintaining vine vigor and ensures a balance between vegetative growth and yield as well as fruit quality. This usually includes pinching, shoot topping, cluster thinning and defoliation. This technique helps to improve the microclimate of vine canopy, improves ripening and controls the incidence of diseases (DiLorenzo *et al.,* 2001).

Also, determines productivity of vines through adjusting the number of shoots/ vine, number of clusters/ shoot and number of berries/ bunch throughout berry

* **Corresponding author.**
E-mail address: ssbbassiony@gmail.com
DOI: 10.21608/jpp.2020.95611

thinning. Other summer operations include leaf removal, shoot trimming and girdling can be used (Camargo, 2005). In this respect, Pisciotta *et al.* (2007) reported that, shoot topping treatment reduced the variability of shoot diameter and increased the laterals growth of "Cabernet Sauvignon" grapevines. Moreover, Abd El-Wadoud (2015) reported that, pinching and defoliation treatments produced the highest yield, best physical characters of berries and clusters, enhanced vegetative growth and total chlorophyll as well as total carbohydrates of canes in "Melissa" grapevines. The interaction between both winter and summer pruning was discussed by Dami *et al.* (2005)summarized that, berries soluble solids content (SSC%), pH, number of ripened nodes per cane and bud cold hardiness were decreased with increasing bud load from 15 to 25 nodes for each 454g of dormant pruning's in "Chambourcin" grapevines however, number of clusters per vine increased from 10 to 30which increased yield/ vine.

So, this investigation was carried out to evaluate the potential effects of winter pruning, shoot topping and cluster thinning levels on vegetative growth, vine vigor, productivity and fruit quality of "Flame seedless" grapevine.

MATERIALS AND METHODS

The present study was carried out during three successive seasons, 2016, 2017 and 2018 on eight year old "Flame seedless" grapevines (*Vitis vinifera,* L.) grown in a private vineyard at Markz-Bader region of El-Beheira Governorate, Egypt. Data were recorded during 2nd and 3rd seasons only; this manner was adopted for achieving the cumulative effects of treatments. Grapevines were grown in sandy soil under drip irrigation system and spaced at 2*3 meters in rows and between rows, respectively. Vines trained to bilateral cordons with pruned to spur pruning system leaving 90 buds/ vine (3buds/ spur) as usually bud load used in this area (control). Gable supporting system was used. Four bud load levels were investigated depending on one-year-old wood (pruning) which removed during winter pruning. The bud load levels (BL) were adjusted according to the following equation, BL= A + (B * C), where A= basic number of buds per vine regardless its vigor (15buds/ vine), B= pruning's weight (Kg), and C= the suggested levels for the study. The suggested bud load levels were: control (common load used in the vineyard), 20, 30 and 40 buds per each kilogram of pruning's (control, B_{20}, B_{30} and B_{40}, respectively). Bud load levels were combined with two cluster thinning treatments; without thinning and thinned to one cluster per fruitful shoot at one week after fruit set (Th_0 and Th_1,respectively), and two shoot topping levels; without topping and topped leaving 20 leaves per shoot (To_0 and To_1, respectively). So, this experiment planned in completely randomized block design and analysis as factorial experiment with three replicates for each treatment.

Treatments:

Factor (A): bud load levels

- Control
- Bud load level 20
- Bud load level 30
- Bud load level 40

Factor (B): thinning

- Without thinning
- thinning to one cluster/fruitful shoot

Factor (C): shoot topping

- Without topping
- Topping after 20 leaves per shoot

Thus, the combinations among the three factors (4 bud load × 2 cluster thinning × 2 shoot topping) resulting sixteen treatments as follows:

T_1 - Control
T_2 - Thinning
T_3 -Topping
T_4 - Bud load level 20
T_5 -Bud load level 30
T_6-Bud load level 40
T_7-Thinning + topping
T_8-Bud load level 20 + thinning
T_9 -Bud load level 20 + topping
T_{10} -Bud load level 30 + thinning
T_{11} - Bud load level 30 + topping
T_{12} -Bud load level 40 + thinning
T_{13} -Bud load level 40 + topping
T_{14} -Bud load level 20 + thinning + topping
T_{15} -Bud load level 30 + thinning + topping
T_{16} - Bud load level 40 + thinning + topping

The following parameters were conducted.

A-Bud behavior

1.Bud burst (%)

Bud burst per vine was mentoring weekly at the beginning of each growing season and then, bud burst percentages were calculated according to Bessis (1960) by using the following equation:

$$\textbf{Bud burst (\%)} = \frac{\text{Number of bursted buds per vine}}{\text{Total number of buds per vine}} X100$$

2.Bud fertility (%)

After fruit set, the number of clusters per vine was recorded and the percentage of bud fertility was calculated according to Huglin (1958) by using the following equation:

$$\textbf{Bud fertility (\%)} = \frac{\text{Number of clusters per vine}}{\text{Total number of buds per vine}} X100$$

B-Vegetative growth and vine vigor parameters

During the two growing seasons, three non-fruiting shoots per vine were labeled and the apical 5th and 6th leaves were collected to determine the average of leaf area (cm^2) according to Ahmed and Morsy (1999).

Internodes length (cm), diameter (cm), and both laterals number and length (cm) were measured during winter pruning time. Also, pruning's weight (kg) was weighted the wood ripening coefficient was calculated according to Bouard (1996) as well as total carbohydrates per cane were estimated according to Dubois *et al.* (1956).

C- Yield and fruit quality parameters:

At harvest date (last week of May, whine SSC reached 16-17%), number of clusters/ vine recorded, and then five clusters/ replicate were taken randomly to determine average cluster weight (g), length (cm) and width (cm). Also, volume of 100 berries (ml) was measured using water displacement method and weight of 100 berries (g) was determined. The total yield was calculated as ton/ feddan by using the following equation:

Yield per feddan (ton) = Yield per vine (k) x No. of vines/ feddan /1000

The total biomass per vine was calculated as yield per vines+ pruning weight (kg). Berry removal force and firmness were determined in ten berries/ cluster as gramforce (gf) with a help of bush-pole dynamometer (model FDP1000) with 1mm thump to determine berry firmness and hook tool of the same apparatus for determining berry removal force. The data of these parameters were converted into Newton units by using a standard factor (1gram-force = 0.00980665 Newton). Moreover, chemical quality attributes of berries as juice SSC% was determined by using hand refractometer, acidity% (mg tartaric acid/ 100ml juice) was determined according to A.O.A.C. (1995)and then SSC/ acid ratio calculated. Berries anthocyanin content (mg/100 gm FW.) was estimated as described by Husia *et al.* (1965).

D- Statistical analysis:

The collected data were subjected to analysis of variance according to Snedecor and Cochran (1980).The differences among treatment means were tested by using Duncan's multiple range tests at 5% level according to Duncan (1955). Pearson correlation coefficient (r) among some chosen parameters was calculated by using SPSS (version 19) statistics computer software.

RESULTS AND DISCUSSION

1. Vegetative growth

Data presented in Table 1 clear that, vegetative growth parameters (number of laterals/ shoot, total length of laterals, coefficient of wood ripening and leaf area) of "Flame seedless" grapevines were significantly increased as a result of all combination treatments as compared to control. In this respect, grapevines which treated by T_{14} (Bud load level 20+ thinning+ topping) gave the highest values of all the above-mentioned parameters followed by T_{15} (Bud load level 30+ thinning+ topping) treatment in most cases compared to control (T_1).

Concerning main effects of tested treatments, data of the same Table (1) clear that, all the above-mentioned parameters were significantly increased with cluster thinning and shoot topping treatments as well as low level bud load per vine as compared with control in both seasons. The lightest bud load level (B_{20}) recorded the highest values of laterals number/ shoot, laterals length and leaf area followed by B_{30} and B_{40}, respectively. Moreover, the vines that pruned to B_{20} and B_{30} bud load levels showed the highest values of coefficient of wood ripening as compared with that treated with both B_{40} and control in both seasons. Also, cluster thinning (Th_1) and shoot topping (To_1) treatments recorded the highest values of laterals number/ shoot, laterals length and leaf area as compared with (Th_0) and (To_0) treatments in both seasons, respectively. The effect of light bud load/ vine, shoot topping and cluster thinning treatments may be due to reduce the competition among canopy parts, encourage bursting of laterals buds, growth and leaf expansion. These results were ensured by Pearson correlation coefficient (r) as the average of both seasons which showed a highly positive correlation between total carbohydrates of canes and laterals number (0.91), laterals length (0.95) and leaf area (0.89). These results are in line with those of Uyak *et al.* (2016) on "Ercis" grapes and Khamis *et al.* (2008 and 2017) on "Flame seedless", "Crimson" and "Superior" grapevine cvs. Aso, Abd El-Wadoud (2015) cleared that, defoliation and pinching with maintaining laterals as summer pruning treatments recorded the best vegetative growth, leaf chlorophyll and total carbohydrates of canes in "Melissa" grapevines. Moreover, Awad (2003) and Calugar *et al.* (2010) concluded that, "Thompson seedless" vines loaded with 72 buds/ vine showed the longest shoots, while the shortest ones were recorded in vines treated with the heaviest load (108 and 96 buds/vine).

2. Vine vigor parameters:

Data in Table 2 revealed that, the combination among bud load, cluster thinning and shoot topping treatments increased internodes length, diameter, pruning weight and cane carbohydrate percentages of "Flame seedless" grapevine as compared to control (T_1) in both seasons. The highest values of these parameters were showed by vines treated with T_{14} (Bud load level 20 + thinning+ topping) and T_{15} (Bud load level 30+thinning+topping) followed by T_9 (Bud load level 20+topping) and T_8 (Bud load level 20+thinning) in both seasons. Meanwhile, the lowest values were recorded with control vines (T_1) in most cases during both seasons.

The same Table (2) show that, internodes length, diameter and weight of pruning as well as percentage of carbohydrates per cane were increased as a result of different pruning levels used in this study comparing with control. The highest values of internodes length and total carbohydrates per cane were showed with the lighter bud load level (B_{20}). However, light and moderate bud load levels (B_{20} and B_{30}) recorded the highest values of internodes diameter and pruning weight without significant deference between them. On the contrary, the lowest values of all these attributes were recorded with control vines in both seasons. Moreover, cluster thinning (Th_1) and shoot topping (To_1) treatments showed an increase in these vine vigor parameters as compared with the untreated vines (Th_0 and To_0, respectively). Correlation coefficient (r) showed a highly positive correlation between carbohydrates content of canes and pruning weight (0.93). The positive effect of shoot topping on vegetative growth might due to the encouragement the translocation of photosynthetic products towards the main shoot by removing the faster growth part of shoot (shoot tip) which consumes the photosynthetic products. Also, laterals that grow on the main shoots become exporter of photosynthetic to the main shoots (Abd El-Ghany *et al.*, 2005).The obtained results were in line with those of Zhuang *et al.* (2014)on "Cabernet Franc" grapevine and Naor *et al.* (2002) they reported that, shoot density at 14 and 44 shoots/ vine companied with two crop levels (one and two clusters per shoot) on "Sauvignon Blanc" grapevine resulted in greater main shoot length, lateral shoot length, shoot diameter, leaf area per shoot, and specific leaf weight with the lower shoot density (14shoots per vine) as compared to the higher one (44 shoots per vine) for three years. Also, Abd El-Wadoud, (2015) concluded that vine vigor parameters as the coefficient of wood ripening and weight of pruning were significantly increased as a result of pinching and defoliation in "Melissa" grapes. Moreover, DiLorenzo *et al*. (2001) reported that, pinching the main shoots and head suckering with maintaining lateral shoots treatments showed the premier growth characters of "Nero d'Avola" grapevine.

Table 1. Effect of bud load, cluster thinning and shoot topping treatments on vegetative growth parameters of "Flame seedless" grapevine during 2017 and 2018 seasons

Treatments	Number of laterals/shoot		Total length of laterals/shoot (cm)		Coefficient of wood ripening		Leaf area (cm^2)	
	2017	2018	2017	2018	2017	2018	2017	2018
T$_1$	9.5^{g}	11.7^{j}	22.4^{p}	37.6^{n}	0.71^{d}	0.67^{c}	106.2^{k}	98.3^{k}
T$_2$	12.4^{ef}	13.1^{i}	50.4^{n}	57.5^{m}	0.73^{d}	0.82^{b}	111.5^{j}	107.7^{j}
T$_3$	15.3^{d}	14.4^{h}	59.9^{m}	62.8^{l}	0.78^{cd}	0.86^{ab}	114.1^{j}	120.7^{g}
T$_4$	17.2^{cd}	18.3^{e}	142.3^{e}	160.3^{e}	0.92^{ab}	0.93^{ab}	140.1^{bc}	143.3^{c}
T$_5$	13.0 ^{ef}	14.7^{h}	99.4^{h}	142.8^{g}	0.81^{cd}	0.94^{ab}	131.8^{f}	135.6^{e}
T$_6$	10.2^{g}	10.5^{k}	31.8^{o}	61.5^{l}	0.73^{d}	0.68^{c}	120.2^{i}	110.7^{i}
T$_7$	15.7^{d}	17.6^{ef}	67.9^{k}	75.8^{j}	0.85^{bc}	0.87^{ab}	112.9^{j}	114.7^{h}
T$_8$	18.3^{c}	19.3^{d}	148.8^{d}	171.5^{c}	0.95^{ab}	0.94^{ab}	142.4^{ab}	145.5^{bc}
T$_9$	20.4^{b}	21.3^{c}	157.6^{c}	162.9^{d}	0.94^{ab}	0.96^{ab}	142.2^{ab}	146.6^{ab}
T$_{10}$	16.0^{d}	17.3^{f}	122.5^{g}	142.4^{g}	0.91^{ab}	0.91^{ab}	133.2^{ef}	137.2^{de}
T$_{11}$	18.1^{c}	21.6^{c}	136.3^{f}	157.7^{f}	0.95^{ab}	0.94^{ab}	135.1^{de}	139.4^{d}
T$_{12}$	11.3^{fg}	13.3^{i}	64.5^{l}	73.8^{k}	0.76^{cd}	0.85^{ab}	122.6^{hi}	122.5^{g}
T$_{13}$	12.2^{ef}	15.6^{g}	72.6^{j}	86.0^{i}	0.81^{cd}	0.83^{ab}	125.6^{g}	127.6^{f}
T$_{14}$	22.5^{a}	24.2^{a}	176.8^{a}	194.5^{a}	0.97^{a}	0.98^{a}	144.3^{a}	148.8^{a}
T$_{15}$	21.5^{ab}	22.3^{b}	168.7^{b}	181.8^{b}	0.91^{ab}	0.96^{ab}	137.5^{cd}	140.2^{d}
T$_{16}$	13.4^{e}	12.3^{j}	81.7^{i}	93.3^{h}	0.71^{d}	0.82^{b}	124.5^{gh}	130.3^{f}
Main effects								
Control	13.2^{c}	14.2^{c}	50.2^{d}	58.4^{d}	0.77^{b}	0.81^{b}	111.2^{d}	110.4^{d}
Bud load level 20 (B$_{20}$)	19.6^{a}	21.3^{a}	156.4^{a}	172.3^{a}	0.95^{a}	0.95^{a}	142.5^{a}	146.1^{a}
Bud load level 30 (B$_{30}$)	17.2^{b}	18.9^{b}	131.7^{b}	156.2^{b}	0.92^{a}	0.93^{a}	134.4^{b}	138.1^{b}
Bud load level 40 (B$_{40}$)	11.8^{d}	12.9^{d}	62.7^{c}	78.7^{c}	0.75^{b}	0.80^{b}	123.2^{c}	122.8^{c}
Without thinning (Th$_0$)	14.5^{b}	16.3^{b}	90.3^{b}	109.0^{b}	0.84^{a}	0.86^{a}	127.0^{b}	127.8^{b}
Thinning (Th$_1$)	16.4^{a}	17.4^{a}	110.2^{a}	123.8^{a}	0.85^{a}	0.89^{a}	128.6^{a}	130.9^{a}
Without topping (To$_0$)	13.5^{b}	14.8^{b}	85.3^{b}	105.9^{b}	0.82^{a}	0.84^{a}	126.0^{b}	125.1^{b}
Topping (To$_1$)	17.4^{a}	18.9^{a}	115.2^{a}	126.9^{a}	0.87^{a}	0.91^{a}	129.7^{a}	133.5^{a}

In a column under each category, means followed by the same letter are not significantly different at the 5% level by DMRT.

T$_1$=Control, T$_2$=Thinning, T$_3$=Topping, T$_4$=Bud load level 20, T$_5$=Bud load level 30, T$_6$=Bud load level 40, T$_7$=Thinning+ topping, T$_8$=Bud load level 20+ thinning, T$_9$=Bud load level 20+ topping, T$_{10}$=Bud load level 30+ thinning, T$_{11}$=Bud load level 30+ topping, T$_{12}$=Bud load level 40+ thinning, T$_{13}$=Bud load level 40+ topping, T$_{14}$=Bud load level 20+ thinning+ topping, T$_{15}$=Bud load level 30+ thinning+ topping and T$_{16}$=Bud load level 40+ thinning+ topping.

Table 2. Effect of bud load levels, cluster thinning and shoot topping treatments on vine vigor parameters of "Flame seedless" grapevine during 2017 and 2018 seasons

Treatments	Internodes Length (cm)		Internodes Diameter (cm)		pruning weight (kg)		Cane carbohydrate (%)	
	2017	2018	2017	2018	2017	2018	2017	2018
T$_1$	5.7^{f}	5.2^{h}	1.6^{bc}	1.8^{c}	1.05^{e}	1.02^{f}	12.3^{g}	11.6^{j}
T$_2$	6.3^{e}	6.6^{f}	1.7^{bc}	2.1^{bc}	1.52^{d}	1.60^{cd}	14.5^{de}	15.3^{fg}
T$_3$	6.3^{e}	6.8^{f}	1.9^{bc}	2.1^{bc}	1.13^{e}	1.23^{ef}	15.3^{d}	15.7^{f}
T$_4$	8.3^{b}	8.2^{c}	2.3^{b}	2.6^{b}	2.23^{ab}	2.35^{ab}	16.6^{bc}	17.3^{de}
T$_5$	6.7^{cd}	7.6^{d}	2.0^{b}	2.3^{bc}	1.85^{cd}	1.83^{c}	15.6^{cd}	16.1^{f}
T$_6$	6.2^{e}	6.3^{g}	1.4^{c}	1.7^{c}	1.64^{d}	1.36^{de}	13.8^{ef}	12.9^{i}
T$_7$	6.2^{e}	6.6^{f}	1.7^{bc}	2.1^{bc}	1.84^{cd}	1.02^{f}	13.2^{fg}	14.6^{gh}
T$_8$	8.2^{b}	8.3^{c}	2.5^{ab}	3.1^{ab}	2.13^{bc}	2.43^{ab}	16.8^{ab}	18.2^{bc}
T$_9$	8.7^{a}	8.6^{b}	2.5^{ab}	3.3^{a}	2.25^{ab}	2.40^{ab}	17.1^{ab}	18.6^{ab}
T$_{10}$	6.8^{cd}	7.3^{e}	2.2^{b}	3.0^{ab}	2.01^{bc}	2.16^{b}	16.6^{bc}	17.0^{e}
T$_{11}$	6.9^{c}	7.7^{d}	2.4^{ab}	3.3^{a}	2.10^{bc}	2.24^{b}	16.8^{ab}	16.9^{e}
T$_{12}$	6.3^{e}	6.3^{g}	1.7^{bc}	1.8^{c}	1.54^{d}	1.57^{cd}	14.6^{de}	14.3^{h}
T$_{13}$	6.6^{d}	7.1^{e}	1.9^{bc}	1.9^{c}	1.63^{d}	1.74^{c}	15.1^{d}	14.6^{gh}
T$_{14}$	8.8^{a}	9.2^{a}	2.7^{a}	3.5^{a}	2.52^{a}	2.57^{a}	17.9^{a}	19.3^{a}
T$_{15}$	8.7^{a}	8.6^{b}	2.6^{a}	3.3^{a}	2.49^{a}	2.53^{a}	17.3^{ab}	17.8^{cd}
T$_{16}$	6.6^{d}	6.8^{f}	2.1^{b}	2.3^{bc}	1.63^{d}	1.45^{de}	15.4^{d}	16.1^{f}
Main effects								
Control	6.1^{d}	6.3^{d}	1.7^{c}	2.0^{c}	1.39^{c}	1.22^{c}	13.8^{d}	14.3^{c}
Bud load level 20 (B$_{20}$)	8.7^{a}	8.6^{a}	2.5^{a}	3.1^{a}	2.28^{a}	2.40^{a}	17.1^{a}	18.4^{a}
Bud load level 30 (B$_{30}$)	7.3^{b}	7.8^{b}	2.3^{a}	2.9^{a}	2.11^{a}	2.19^{a}	16.6^{b}	16.9^{b}
Bud load level 40 (B$_{40}$)	6.4^{c}	6.6^{c}	1.8^{c}	1.9^{c}	1.61^{b}	1.53^{b}	14.7^{c}	14.5^{c}
Without thinning (Th$_0$)	6.9^{b}	7.2^{a}	2.0^{a}	2.4^{a}	1.74^{a}	1.82^{a}	15.3^{a}	15.5^{b}
Thinning (Th$_1$)	7.3^{a}	7.5^{a}	2.2^{a}	2.7^{a}	1.96^{a}	1.92^{a}	15.8^{a}	16.6^{a}
Without topping (To$_0$)	6.9^{b}	6.9^{b}	1.9^{b}	2.3^{a}	1.75^{a}	1.84^{a}	15.1^{b}	15.3^{b}
Topping (To$_1$)	7.4^{a}	7.7^{a}	2.2^{a}	2.7^{a}	1.95^{a}	1.90^{a}	16.0^{a}	16.7^{a}

In a column under each category, means followed by the same letter are not significantly different at the 5% level by DMRT.

T$_1$=Control, T$_2$=Thinning , T$_3$=Topping, T$_4$=Bud load level 20, T$_5$=Bud load level 30 , T$_6$=Bud load level 40, T$_7$=Thinning + topping, T$_8$=Bud load level 20 + thinning, T$_9$=Bud load level 20 + topping, T$_{10}$=Bud load level 30 + thinning, T$_{11}$=Bud load level 30 + topping, T$_{12}$=Bud load level 40 + thinning, T$_{13}$=Bud load level 40 + topping, T$_{14}$=Bud load level 20+ thinning + topping, T$_{15}$=Bud load level 30 + thinning + topping and T$_{16}$=Bud load level 40 + thinning + topping.

3- Bud burst and fertility (%)

The highest percentages of bud burst and fertility were recorded with vines that treated by T$_{14}$ (Bud load level 20+ thinning+ topping) in both seasons while, the lowest values were belonged to control vines (Fig.1). This could be reflected to increase of carbohydrates contents that accumulated during the previous growing season where, the correlation coefficient (r) results cleared a highly positive relationship between total carbohydrate of canes and each of bud burst (0.97) and bud fertility (0.95). These findings were in line with those of Abdel-Mohsen (2013), Porika *et al.*(2015) and Abd El-Wadoud (2015) they reported that, the percentages of develop buds were in negative correlation with number of buds that left after winter pruning. Moreover, the maximum bursting buds and fruitful buds percentages were recorded in spurs of 4 buds/ spur as compared to 6 and 8 buds/ spur pruning level in "Perlette" grapevines (Ahmad *et al.*, 2004).

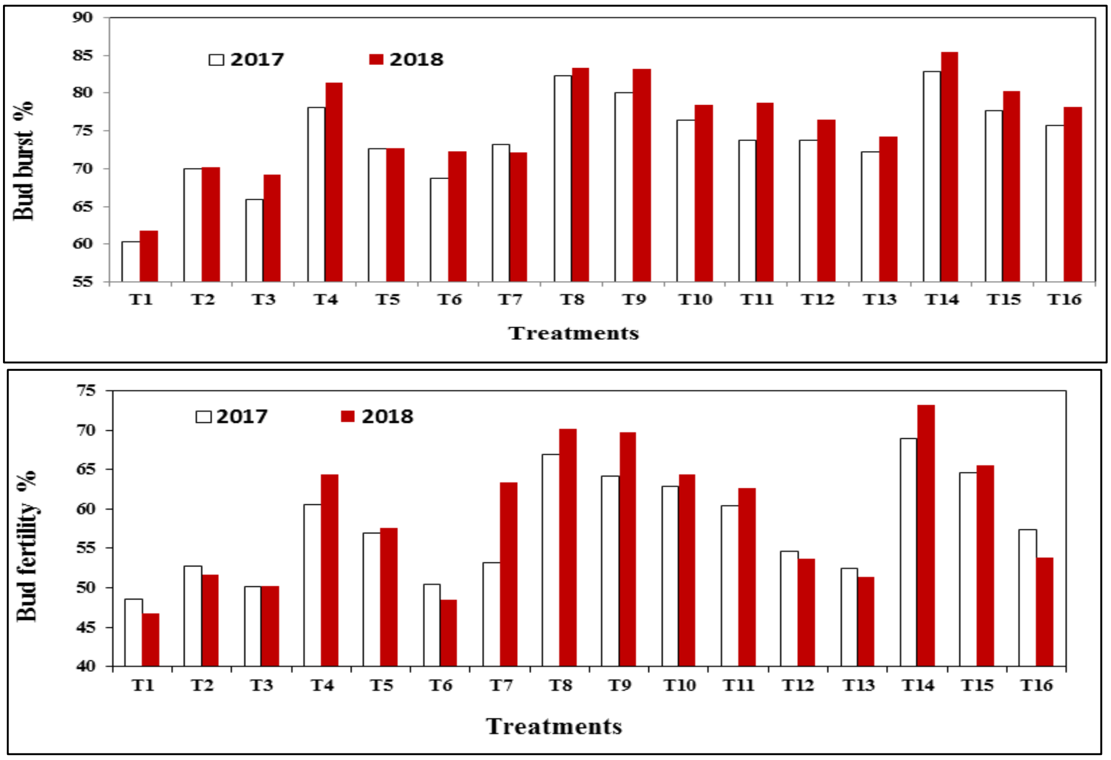

Figure 1. Effect of bud load levels, cluster thinning and shoot topping on bud burst and fertility of "Flame seedless" grapevine during 2017 and 2018 seasons

T_1=Control, T_2=Thinning, T_3=Topping, T_4=Bud load level 20, T_5=Bud load level 30, T_6=Bud load level 40, T_7=Thinning+ topping, T_8=Bud load level 20+ thinning, T_9=Bud load level 20+ topping, T_{10}=Bud load level 30+ thinning, T_{11}=Bud load level 30+ topping, T_{12}=Bud load level 40+ thinning, T_{13}=Bud load level 40+ topping, T_{14}=Bud load level 20+ thinning+ topping, T_{15}=Bud load level 30+ thinning+ topping and T_{16}=Bud load level 40+ thinning+ topping

4- Total yield, cluster characters and vine biomass

Data in Table 3 show that, "Flame seedless" grapevines treated with T_1, T_3,T_6 and T_{13} gave the highest clusters number per vine however, the application of T_{14} (Bud load level 20+thinning+ topping) and T_{15} (Bud load level 30+ thinning+ topping) produced the highest weight of cluster as compared to the others. Meanwhile, the highest total yield per feddan and total biomass per vine were recorded in vines that received T_{15} (Bud load level 30+thinning+shoot topping) as compared to control and other treatments. This trend was true during both seasons of the study.

Cluster number per vine was increased gradually as bud load level/ vine increased. The highest number of clusters was obtained on vines loaded with the highest bud load level (B_{40}) and control followed by that of moderate level (B_{30}) and the lowest number was obtained on vines of sever pruning level (B_{20}). On the contrary, cluster weight was in negative trend with bud load level since, the highest values were recorded in vines loaded by B_{20}andB_{30}. Meanwhile, the highest total yield per feddan and total biomass per vine were produced by vines of moderate bud load (B_{30}) followed by B_{20} however, the differences between B_{40} and control were not significant. This trend was true during both seasons.

While that, the cluster thinning (Th_1) treatment reduced cluster number/vine, it increased cluster weight and total yield as compared to untreated vines (Th_0) in both seasons. Also, shoot topping (To_1) treatment showed an increase in cluster weight, total yield/ feddan and total biomass per vine as compared with control (To_0) during both seasons. Correlation coefficient (r) cleared a positive relation between total yield and cluster number (0.77) as well as cluster weight (0.85).These results could be explain according the results of Bowed and Kliewer (1990) they reported that, the total yield increased as bud load increased but only to certain point when the vines became over loaded and then, the total yield eventually decreased. On the other hand, sever pruning (low bud load level) leads to increase of cluster weight but the yield was decreased through fewer number of clusters/ vine. In addition, shoot topping treatment will lead to the reorientation of carbohydrates from the direction of rapid growth point of shoots (shoot tip) to clusters and storage organs. Also, cluster thinning reduces the competition among them enhancing cluster quality. These results were in agree with those of Fawzi *et al.* (2010) on"Crimson seedless", Roberto *et al.* (2017) on "Thompson seedless" Also, Khamis *et al.* (2017) they concluded that, cluster number/ vine and total yield were greatly enhanced with increasing the bud load/ vine in both "Crimson seedless" and "Superior" grapevine cvs. Moreover, Uyak *et al.* (2016) reported that, cluster thinning and shoot topping as well as winter pruning enhanced weight of cluster of "Erciş" grapevine.

Table 3. Effect of bud load levels, cluster thinning and shoot topping on clusters number, cluster weight, yield/ feddan and total biomass of "Flame seedless" grapevine during 2017 and 2018 seasons

Treatments	Number of clusters/ vine		Cluster weight (g)		Yield/ fed (ton)		Total biomass / vine (kg)	
	2017	2018	2017	2018	2017	2018	2017	2018
T_1	37.8^a	36.4^a	305.5^j	299.4^j	8.08^{bc}	7.63^{ef}	12.59^g	11.92^f
T_2	30.8^b	29.3^b	331.3^{ef}	326.5^{gh}	7.14^{cd}	6.70^h	11.72^h	11.17^f
T_3	37.8^a	38.4^a	310.4^{ij}	303.3^j	8.21^b	8.15^d	12.86^{fg}	12.87^e
T_4	23.4^d	25.4^c	421.3^d	427.4^{cd}	6.90^d	7.60^{ef}	12.09^h	13.61^d
T_5	28.4^{bc}	30.2^b	420.6^d	407.4^e	8.36^b	8.61^c	13.79^e	14.13^c
T_6	36.4^a	37.4^a	315.3^{hi}	310.6^{ij}	8.03^{bc}	8.13^d	13.11^f	12.97^e
T_7	29.3^{bc}	30.4^b	337.3^e	340.7^f	6.92^d	7.25^{fg}	11.73^h	11.38^f
T_8	26.4^{cd}	28.8^b	460.2^b	448.4^b	8.50^b	9.04^b	14.27^{cd}	15.34^b
T_9	29.3^{bc}	30.5^b	434.5^c	420.6^d	8.91^{ab}	8.98^{bc}	14.98^b	15.23^b
T_{10}	27.9^{bc}	28.2^b	442.5^c	451.5^b	8.64^b	8.91^{bc}	14.34^{cd}	14.89^c
T_{11}	29.5^{bc}	30.4^b	419.7^d	431.7^c	8.67^b	9.19^b	14.49^c	15.37^b
T_{12}	29.5^{bc}	30.4^b	320.5^{gh}	318.5^{hi}	6.62^d	6.78^h	11.00^i	11.26^f
T_{13}	38.9^a	36.8^a	317.0^i	310.7^{ij}	8.63^b	8.00^{de}	13.96^{de}	13.17^d
T_{14}	26.3^{cd}	28.7^b	471.6^a	463.1^a	8.68^b	9.30^b	14.92^b	15.86^b
T_{15}	29.1^{bc}	30.6^b	478.3^a	465.6^a	9.74^a	9.97^a	16.40^a	16.77^a
T_{16}	31.2^b	29.6^b	327.3^{fg}	331.6^{fg}	7.15^{cd}	6.87^gh	11.84^h	11.26^f
Main effects								
Control	33.93^a	33.63^a	321.1^b	317.5^b	7.59^c	7.43^c	13.04^c	12.80^b
Bud load level 20 (B_{20})	26.35^c	28.35^c	446.9^a	439.9^a	8.25^b	8.73^b	14.07^b	15.01^a
Bud load level 30 (B_{30})	28.73^b	29.85^b	440.3^a	439.1^a	8.85^a	9.17^a	14.76^a	15.29^a
Bud load level 40 (B_{40})	34.00^a	33.55^a	320.0^b	317.9^b	7.61^c	7.45^c	12.48^c	12.17^b
Without thinning (Th_0)	32.69^a	33.19^a	368.0^b	363.9^b	8.22^a	8.29^a	13.48^a	13.66^a
Thinning (Th_1)	28.81^b	29.50^b	396.1^a	393.4^a	7.92^b	8.10^a	13.28^a	13.49^a
Without topping (To_0)	30.08^b	30.76^b	377.2^b	373.7^b	7.78^b	7.93^b	12.86^b	13.16^b
Topping (To_1)	31.43^a	31.93^a	387.0^a	383.4^a	8.36^a	8.46^a	13.90^a	13.99^a

In a column under each category, means followed by the same letter are not significantly different at the 5% level by DMRT.

T_1=Control, T_2=Thinning , T_3=Topping, T_4=Bud load level 20, T_5=Bud load level 30 , T_6=Bud load level 40, T_7=Thinning + topping, T_8=Bud load level 20+ thinning, T_9=Bud load level 20+ topping, T_{10}=Bud load level 30+ thinning, T_{11}=Bud load level 30+ topping, T_{12}=Bud load level 40+ thinning, T_{13}=Bud load level 40+ topping, T_{14}=Bud load level 20+ thinning + topping, T_{15}=Bud load level 30+ thinning+ topping and T_{16}=Bud load level 40+ thinning + topping.

5-Cluster length and width

Regarding Figure 2 it could be noticed that, as bud load level reduced as cluster length and width increased, especially when companied with thinning and shoot toping treatments. Also, interaction among low bud load level plus cluster thinning and shoot topping treatment (T_{14}) showed the highest increase in cluster length and width followed by T_8 (Bud load level 20 + thinning) treatment during both seasons. In the contrast, the lowest values of these parameters were showed by control (T_1) vines. This trend was true in both seasons.

These results were in agreement with those of Bondada *et al.* (2016)and Radwan and Masood (2017) concluded that, agriculture practices such as thinning, topping and controlling of bud load level per vine improved yield and cluster quality of "Ruby seedless" grapevine cultivar. Also, Fawzi *et al.* (2015) indicated that, increasing of bud load per vine reduced cluster weight, volume and length. Moreover, Abd El-Wadoud (2015) reported that, all summer pruning treatments as lick pinching and defoliation resulted in significantly increase in bunch length and width of "Melissa" grapevines.

6-Berries physical characters:

Data presented in Table 4 mentioned that, weight and volume of 100 berries as well as berry removal force and firmness were significantly increased with all interaction treatments as compared with control (T_1) in both seasons. The highest values of weight and volume of 100 berries were produced by vines that treated with T_{14} (Bud load level 20+ thinning+ topping) followed by that received T_{15} (Bud load level 30+ thinning+ topping). However, the highest values of berry removal force and firmness were recorded with T_{14} followed by T_8 (Bud load level 20+ thinning) and T_9 (Bud load level 20+ topping) in descending order, but control treatment (T_1) showed the lowest values in both seasons.

Regarding the specific effects of studied factors, the results showed that sever and moderate pruning levels (B_{20} andB_{30}) recorded the highest significant values of weight of 100 berries. Meanwhile, light bud load level (B_{20}) showed the highest values of volume of 100 berries, removal force and firmness as compared with other pruning levels. However, the lowest values of these characters were recorded with control vines in most cases in both seasons. The cluster thinning (Th_1) treatment showed a significant increase in both weight and volume of 100 berries as compared with untreated vines (Th_0).

Also, shoot topping (To_1) treatment produced the highest values of these parameters versus control (To_0). This trend was recorded in both seasons. The positive effect of sever pruning on berry characters might be due to the reduction of clusters number per vine which reduces the competition among clusters, where correlation (r) showed a highly negative relations between cluster number vs. weight and volume of 100 berries (-0.91 and -0.95, respectively). Also, shoot topping and cluster thinning treatments enhanced photosynthetic activity and encourage translocation of assimilates from leaves towards berries (Winkler, 1965). In this respect, Abd El-Wahab *et al.* (1997) on "King Ruby" and Sabbatini *et al.* (2015)reported that, summer pruning practices were effective in enhancing berries physical characters of"Niagara" grapevines. Also, Fawzi *et al.* (2015) and Khamis *et al.* (2017) reported that, increasing bud load per vine decreased berry weight. Also, Sarikaya and Akin (2016) concluded that, ‘Alphonse Lavallee’ grapevines loaded with18 buds/ vine produced the highest cluster weight (302.31g) as compared with that loaded with 23 and 28 buds/ vine.

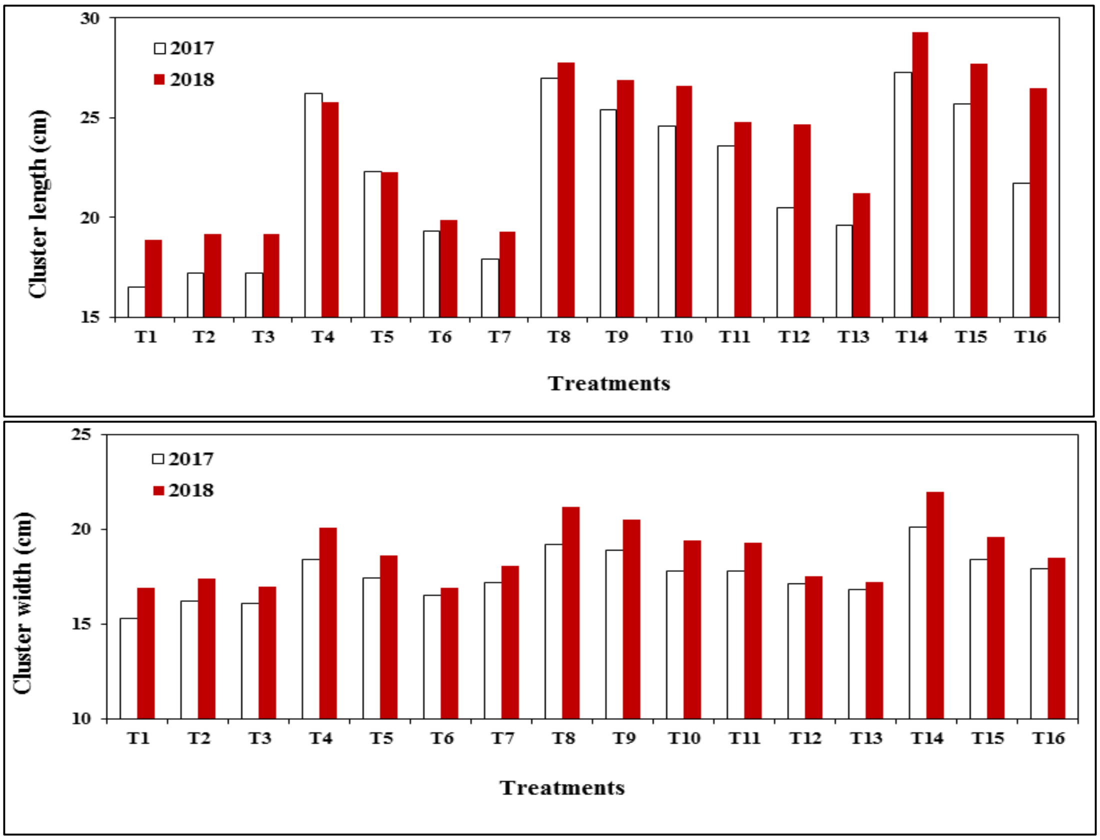

Figure 2. Effect of bud load levels, cluster thinning and shoot topping on cluster length and width of "Flame seedless" grapevine during 2017 and 2018 seasons

T_1=Control, T_2=Thinning, T_3=Topping, T_4=Bud load level 20, T_5=Bud load level 30, T_6=Bud load level 40, T_7=Thinning+ topping, T_8=Bud load level 20+ thinning, T_9=Bud load level 20+ topping, T_{10}=Bud load level 30+ thinning, T_{11}=Bud load level 30+ topping, T_{12}=Bud load level 40+ thinning, T_{13}=Bud load level 40+ topping, T_{14}=Bud load level 20+ thinning+ topping, T_{15}=Bud load level 30+ thinning+ topping and T_{16}=Bud load level 40+ thinning+ topping

Table 4. Effect of bud load levels, cluster thinning and shoot topping on berries physical characters of "Flame seedless" grapevine during 2017 and 2018 seasons

Treatments	Weight of 100 Berry (g)		Volume of 100 berry (ml)		Berry removal force (Newton)		Berry firmness (Newton)	
	2017	2018	2017	2018	2017	2018	2017	2018
T_1	230.5^{k}	220.6^{j}	210.5^{l}	200.3^{l}	2.7^{h}	3.1^{j}	1.2^{j}	1.5^{h}
T_2	265.4^{i}	287.5^{f}	240.4^{j}	253.5^{j}	2.8^{h}	3.4^{i}	1.4^{i}	1.9^{g}
T_3	258.6^{j}	255.3^{i}	225.5^{k}	240.3^{k}	2.9^{h}	3.4^{i}	1.4^{i}	1.9^{g}
T_4	327.7^{e}	362.4^{c}	354.7^{d}	362.4^{c}	3.8^{e}	4.3^{d}	3.2^{c}	2.8^{d}
T_5	325.2^{e}	354.6^{d}	335.2^{ef}	354.6^{d}	3.7^{e}	3.7^{gh}	2.2^{f}	2.3^{f}
T_6	275.5^{h}	262.7^{h}	301.5^{h}	312.7^{h}	3.2^{g}	3.6^{h}	1.6^{h}	1.4^{h}
T_7	262.6^{ij}	273.4^{g}	253.5^{i}	261.4^{i}	2.9^{h}	3.4^{i}	1.8^{g}	2.3^{f}
T_8	366.3^{b}	375.3^{b}	361.3^{c}	370.3^{b}	5.0^{b}	4.8^{b}	3.5^{b}	3.6^{b}
T_9	341.6^{d}	362.3^{c}	355.6^{d}	361.4^{c}	4.7^{c}	4.6^{c}	3.4^{b}	3.6^{b}
T_{10}	350.5^{c}	373.4^{b}	350.6^{d}	363.4^{c}	4.3^{d}	3.9^{ef}	2.5^{e}	2.6^{e}
T_{11}	341.5^{d}	352.2^{d}	337.5^{e}	342.2^{e}	4.4^{d}	4.0^{e}	2.4^{e}	2.4^{f}
T_{12}	286.3^{g}	277.3^{g}	321.3^{g}	335.3^{f}	3.3^{g}	3.9^{ef}	1.8^{g}	2.3^{f}
T_{13}	274.7^{h}	265.7^{h}	323.7^{g}	329.7^{g}	3.6^{ef}	3.8^{fg}	1.8^{g}	2.0^{g}
T_{14}	377.5^{a}	383.2^{a}	372.5^{a}	381.2^{a}	5.3^{a}	5.0^{a}	3.7^{a}	4.1^{a}
T_{15}	375.7^{a}	381.4^{a}	366.7^{b}	378.3^{a}	4.3^{d}	4.5^{c}	2.8^{d}	3.0^{c}
T_{16}	315.4^{f}	309.4^{e}	330.4^{f}	341.4^{e}	3.4^{fg}	4.3^{d}	2.1^{f}	2.3^{f}
Main effects								
Control	254.3^{c}	259.2^{c}	232.5^{d}	238.9^{d}	2.8^{d}	3.3^{d}	1.9^{c}	2.2^{c}
Bud load level 20 (B_{20})	353.3^{a}	370.8^{a}	361.0^{a}	368.8^{a}	4.7^{a}	4.7^{a}	3.5^{a}	3.5^{a}
Bud load level 30 (B_{30})	348.2^{a}	365.4^{a}	347.5^{b}	359.6^{b}	4.2^{b}	4.0^{b}	2.5^{b}	2.6^{b}
Bud load level 40 (B_{40})	288.0^{b}	278.8^{b}	319.2^{c}	329.8^{c}	3.4^{c}	3.9^{c}	1.8^{c}	2.0^{c}
Without thinning (Th_0)	296.9^{b}	304.5^{b}	305.5^{b}	313.0^{b}	3.6^{a}	3.8^{a}	2.2^{a}	2.3^{a}
Thinning (Th_1)	32٥.٠^{a}	332.6^{a}	324.6^{a}	335.6^{a}	3.9^{a}	4.2^{a}	2.5^{a}	2.8^{a}
Without topping (To_0)	303.4^{b}	314.2^{b}	309.4^{b}	319.1^{b}	3.6^{a}	3.8^{a}	2.2^{a}	2.3^{a}
Topping (To_1)	318.5^{a}	322.9^{a}	320.7^{a}	329.5^{a}	3.9^{a}	4.1^{a}	2.4^{a}	2.7^{a}

In a column under each category, means followed by the same letter are not significantly different at the 5% level by DMRT.

T_1=Control, T_2=Thinning, T_3=Topping, T_4=Bud load level 20, T_5=Bud load level 30, T_6=Bud load level 40, T_7=Thinning+ topping, T_8=Bud load level 20+ thinning, T_9=Bud load level 20+ topping, T_{10}=Bud load level 30+ thinning, T_{11}=Bud load level 30+ topping, T_{12}=Bud load level 40+ thinning, T_{13}=Bud load level 40+ topping, T_{14}=Bud load level 20+ thinning+ topping, T_{15}=Bud load level 30+ thinning + topping and T_{16}=Bud load level 40+ thinning+ topping

7. Berries chemical characters

Data of Table 5 clear that, berry SSC %, SSC/ acid ratio and anthocyanin pigment contents of "Flame seedless" grapevines enhanced as a result of all combination treatments as compared with control. The vines received T_{10} (Bud load level 30+ thinning) and T_{15} (Bud load level 30+ thinning+ topping) recorded the highest significant increase of SSC % as compared with the others in both seasons. However, berry acidity % was slightly decreased as a result of treatments comparing with control treatment which showed a significant increase in the second season only. Generally, the combination among thinning, topping and bud load levels treatments enhanced berries chemical quality in terms of SSC %, acidity %, and SSC / acid ratio and anthocyanin content as compared with control.

Data of the same Table (5) clear an increase in SSC %, SSC/ acid ratio and berries anthocyanin content as a result of increasing pruning severity. The vines that loaded by B_{30} (Bud load level 30) showed the highest values of SSC %, however SSC/ acid ratio and anthocyanin content were increased with B_{20} as compared to control. Also, berry juice acidity % tended to increase with increasing bud load/ vine, where the highest values of acidity % were recorded with control vines. Cluster thinning and shoot topping treatments (Th_1 and To_1, respectively), generally enhanced berry SSC %, acidity %, SSC/ acid ratio and anthocyanin content in most cases as compared with control (Th_0 and To_0, respectively) in both seasons. The positive effects of treatments might due to the sever pruning level reduces number of shoots that developed which reflected on enhancing light exposure through vine canopy. This enhancement reflected on berries quality for example; berries should be exposed to light during the first and second phase of growth for the biosynthesis to initiate anthocyanin and start of accumulate color at the third phase (Dokoozlian and Kliewer, 1996).Also, shoot topping promotes lateral shoots to grow from the nodes that closer to the removed shoot top these laterals developed rapidly and then become additive exporter's carbohydrates they provide an additional photo-assimilating surface supports their own growth and export the surplus to the main shoot, contributing to fruit ripening (Candolfi-Vasconcelos *et al.,* 1994). Generally, these results were in line with those of Naor et *al.* (2002), Keller *et al*. (200٥), Abd El-Wadoud (2015) and Landolt (2011) who concluded that, the sever pruning increased berries Brix, pH, SSC/ acid ratio, anthocyanin, and color density of "Syrah" grapes. Meanwhile, it decreased tartaric acid and yield/meter trellis. Also, Mahfouz (2007) reported that, anthocyanin content of berry skin that harvested from "Red Roumi" grapevines loaded with 60 eyes recorded higher values than those obtained from vines loaded with 80 eye/ vine.

Table 5. Effect of bud load levels, cluster thinning and shoot topping on SSC, total acidity, SSC/acid ratio and berries anthocyanin content of "Flame seedless" grapevine during 2017 and 2018 seasons

Treatments	SSC %		Titratable acidity %		SSC/acid ratio		Anthocyanin (mg/100 g F.W)	
	2017	2018	2017	2018	2017	2018	2017	2018
T_1	15.4^{f}	16.0^{e}	0.78^{a}	0.76^{a}	19.7^{k}	21.1^{k}	15.7^{j}	18.3^{l}
T_2	16.8^{b}	16.6^{cd}	0.71^{a}	0.67^{ab}	23.7^{f}	24.8^{f}	19.7^{f}	20.8^{ij}
T_3	16.2^{de}	16.4^{d}	0.76^{a}	0.73^{ab}	21.3^{j}	22.٥^{j}	17.1^{i}	19.5^{k}
T_4	16.0^{de}	16.4^{d}	0.71^{a}	0.70^{ab}	22.5^{gh}	23.4^{h}	18.8^{g}	21.0^{i}
T_5	16.4^{cd}	17.2^{b}	0.74^{a}	0.70^{ab}	22.2^{hi}	24.٦^{f}	17.9^{h}	21.6^{h}
T_6	15.8^{e}	16.2^{de}	0.72^{a}	0.70^{ab}	21.9^{i}	23.1^{i}	16.8^{i}	20.4^{j}
T_7	16.2^{de}	16.6^{cd}	0.69^{a}	0.64^{ab}	23.5^{f}	25.9^{d}	19.5^{f}	20.9^{ij}
T_8	16.4^{cd}	16.8^{c}	0.61^{a}	0.56^{b}	26.9^{b}	30.0^{a}	23.9^{c}	25.6^{d}
T_9	16.2^{de}	16.6^{cd}	0.68^{a}	0.65^{ab}	23.8^{ef}	25.5^{e}	20.4^{e}	24.4^{f}
T_{10}	17.2^{a}	17.6^{a}	0.71^{a}	0.65^{ab}	24.2^{d}	27.1^{c}	21.2^{d}	26.3^{c}
T_{11}	16.6^{bc}	17.2^{b}	0.66^{a}	0.72^{ab}	25.2^{c}	23.9^{g}	20.6^{e}	21.2^{hi}
T_{12}	16.2^{de}	16.6^{cd}	0.64^{a}	0.55^{b}	25.3^{c}	30.2^{a}	21.3^{d}	25.0^{e}
T_{13}	16.2^{de}	16.4^{d}	0.67^{a}	0.71^{ab}	24.2^{de}	23.1^{i}	20.2^{e}	20.7^{ij}
T_{14}	16.8^{b}	16.6^{cd}	0.60^{a}	0.55^{b}	28.0^{a}	30.2^{a}	25.7^{a}	30.8^{a}
T_{15}	17.2^{a}	17.8^{a}	0.62^{a}	0.60^{ab}	27.7^{a}	29.7^{b}	24.7^{b}	28.8^{b}
T_{16}	16.0^{de}	16.2^{de}	0.70^{a}	0.68^{ab}	22.9^{g}	23.8^{g}	20.3^{e}	22.6^{g}
Main effects								
Control	16.2^{c}	16.4^{c}	0.74^{a}	0.70^{a}	22.1^{d}	23.6^{d}	18.2^{d}	20.8^{d}
Bud load level 20 (B_{20})	16.4^{b}	16.6^{b}	0.65^{b}	0.62^{a}	25.3^{a}	27.3^{a}	22.2^{a}	25.5^{a}
Bud load level 30 (B_{30})	16.9^{a}	17.5^{a}	0.68^{b}	0.67^{a}	24.8^{b}	26.3^{b}	21.1^{b}	24.٥^{b}
Bud load level 40 (B_{40})	16.1^{c}	16.٤^{c}	0.68^{b}	0.66^{a}	23.٦^{c}	25.1^{c}	19.7^{c}	22.2^{c}
Without thinning (Th_0)	16.1^{b}	16.6^{b}	0.72^{a}	0.71^{a}	22.6^{b}	23.4^{b}	18.4^{b}	20.9^{b}
Thinning (Th_1)	16.6^{a}	16.9^{a}	0.66^{b}	0.61^{b}	25.3^{a}	27.7^{a}	22.0^{a}	25.1^{a}
Without topping (To_0)	16.3^{a}	16.7^{a}	0.70^{a}	0.66^{a}	23.3^{b}	25.5^{a}	19.4^{b}	22.4^{b}
Topping (To_1)	16.4^{a}	16.7^{a}	0.67^{a}	0.66^{a}	24.6^{a}	25.6^{a}	21.1^{a}	23.6^{a}

In a column under each category, means followed by the same letter are not significantly different at the 5% level by DMRT.

T_1=Control, T_2=Thinning, T_3=Topping, T_4=Bud load level 20, T_5=Bud load level 30, T_6=Bud load level 40, T_7=Thinning+ topping, T_8=Bud load level 20+ thinning, T_9=Bud load level 20+ topping, T_{10}=Bud load level 30+ thinning, T_{11}=Bud load level 30+ topping, T_{12}=Bud load level 40+ thinning, T_{13}=Bud load level 40+ topping, T_{14}=Bud load level 20+ thinning + topping, T_{15}=Bud load level 30+ thinning+ topping and T_{16}=Bud load level 40+ thinning+ topping.

CONCLUSION

Based on the obtained results, it could be concluded that, adjustment of bud load/ vines of "Flame seedless" depending on weight of pruning that produced in the preceding growing season combined with cluster thinning and shoot topping were effective for achieving the balance between vine vigor, productivity and cluster quality. The combination among these treatments suggested that bud load level 30+ cluster thinning to one cluster per fruitful shoot+ shoot topping leaving 20 leaves per shoot resulted in the best yield, cluster and berries quality, this suitable for growers income as well as local and exporting markets.

REFERENCES

A.O.A.C., (1995). Official Method of Analysis 16th Edition. Association of Official Analytical Chemists Washington D. C. USA.

Abd El-Ghany, A. A.; Y. A. M. Omran and H. A. Abd El-Galil (2005). Effect of summer pruning on “Thompson seedless” grapevine productivity. Assiut J. Agric. Sci., 36 (5):167-180.

Abd El-Wadoud, M. Z. (2015). Possibility of improving growth, yield and bunch quality of Melissa grapevines through the application of some summer pruning practices. Nature and Science, 13(12):28-34.

Abd El-Wahab, M. A. (1997). Effect of cane length on bud behavior, growth and production of "king Ruby" grapevines. M. Sc. Thesis, Fac. Agric., Cairo University Egypt.

Abdel-Mohsen, M. A. (2013). Application of various pruning treatments for improving productivity and fruit quality of Crimson seedless grapevine. World J. Agri. Sci., 9(5): 377-382.

Ahmad, W.; M. Junaid, M. Nafees, M. Farooq and B. A. Saleem (2004). Effect of pruning severity on growth behavior of spur and bunch morphology of grapes (*Vitis vinifera,* L.). Int. J. Agri. Biol., 6(1):160-161.

Ahmed, F. F. and M. H. Morsy (1999). A new method for measuring leaf area in different fruit species. Minia J. Agric. Res. Develop., 19(1):96-105.

Awad, M. (2003). Studies on pruning severity of Thompson Seedless grapes. M. Sc. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Bates, T. (2008). Pruning level affects growth and yield of Concord on two training system. *American J. Enol. Viticulture,* 59(3):276-286.

Berny, J. D.; P. A. Garancer and W. L. Greasy (2005). Influence of pruning on Overwintering carbohydrate reserves, vigor, and yield of mature Chardonnay grapevines. *American Society for Enology and Viticulture,* 56(4):370-374.

Bessis, R. (1960). Sur differents Models Dexpression Quantitative Dela fertile. Chezla vigne. Aca. Pp.828-882.

Bondada, B.; J. I. Covarrubias, P. Tessarin, A. C. Boliani, G. Marodin and A. D. Rombolà (2016). Post veraison shoot trimming reduces cluster compactness without compromising fruit quality attributes in organically grown sangiovese grapevines. Am. J. Enol. Vitic., 67(2):206-211.

Bouard, J. (1996). Recherches hysiologiques surla vigne et en particulier sur laoutment desserments. Thesis Sci. Nat. Bardeux, France p. 34.

Bowed, P. A. and W. M. Kliewer (1990). Influence of clonal variation, pruning severity, and cane structure on yield component development in ‘Cabernet Sauvignon’ grapevines. J. Amer. Soc. Hort. Sci. 115 (4):530-534.

Calugar, A.; N. Pop, M. Sarago, A. Babes, C. Bunea, D. Hodor and F. Ciobanu (2010). Influence of the bud load level at pruning on fertility elements, in Blaj wine-growing center. Journal of Horticulture, Forestry and Biotechnology, 14 (3): 17-22.

Camargo, U. A. (2005). Grape management techniques in tropical climates. XIV International GESCO Viticulture Congress, Geisenheim, Germany, pp. 251-256.

Candolfi-Vasconcelos M. C.; W. Koblet, G. S. Howell, W. Zweifel (1994). Influence of defoliation, rootstock, training system, and leaf position on gas exchange of Pinot noir grapevines. Am. J. Enol. Vitic., 45(2):173-180.

Dami I.; D. C Ferree, S. K. Kurtural and B. H. Taylor (2005). Influence of crop load on 'Chambourcin' yield, fruit quality, and winter hardiness under Midwestern United States environmental conditions. Acta Horticulture, 689: 203-208.

DiLorenzo, R.; S. Ferrante, and M. G. Barbagallo (2001). Modification of source/ sink ratios in Nero d'Avola (*Vitis vinifera,* L.) grapevines in a warm-dry environment. Advan. Hort. Sci., 15 (1/ 4):31-38.

Dokoozlian, N. K. and W. M. Kliewer (1996). Influence of light on grape berry growth and composition varies during fruit development. J. Amer. Soc. Hort. Sci. 121(5):869-874.

Dubois, M.; A. Gilles, J. K. Hamiltom, P. A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 28(3):350-356.

Duncan, B. D. (1955). Multiple test range and multiple F tests Biometrics, 11-142.

El-Baz, E. T.; A. M. Mansour; E. F. El-Dengawy and B. N.Samra (2002).Influence of pruning severity on bud behavior, yield, berry quality and some biochemical contents of the canes of 'Crimson seedless' grapes .Egyptian Journal of Horticulture, 29(1):39-60.

Fawzi, F.; F. H. Laila, M. F. M. Shahin, M. A. Merwad and E. A. E. Genaidy (2015). Effect of vine bud load on bud behavior, yield, fruit quality and wood ripening of superior grape cultivar. International Journal of Agricultural Technology, 11(5):1275-1284.

Fawzi, M. I. F.; M. F. M. Shahin and E. A. Kandil (2010). Effect of bud load on bud behavior, yield, cluster characteristics and some biochemical contents of the cane of Crimson seedless grapevines. Journal of American Science, 6 (12):187-194.

Ferree, D. C.; D. M. Scurlock, T. Steiner and J. Gallander (2004). 'Chambourcin' grapevine response to crop level and canopy shade at bloom. Journal-of-the-American Pomological Society, 58(3):135-141.

Huglin, P. (1958). Recherche's sur les bourgeons de la vigne. Initiation florale et development vegetatif. Annals de L'Amelioration de Plantes, Paris, 11:7.

Husia, C. L.; B. S. Lah and C. D. Chichester (1965). Anthocyanin in free stone peach. J. Food Science, 30:5-12.

Keller, M.; L. J. Mills, R. L. Wample and S. E. Spayd (2005). Cluster thinning effects on three deficit-irrigated *Vitis vinifera* cultivars. Am. J. Enol. Vitic., 56(2):91-103.

Khamis, M. A.; A. A. R. Atawia, H. E. M. El-Badawy and A. A. M. Abd El-Samea (2017). Effect of buds load on growth, yield and fruit quality of Superior grapevines. Middle East J. Agric. Res., 6(1):152-160.

Khamis, M. A.; K. H. A. Bakry, and A. A. Nasef (2008). Growth, yield and fruit quality of two grape cvs. in response to bud load and fruiting units length. 1- Effect of different levels of bud load and fruiting unit length on bud behavior, growth and yield of "Flame Seedless" and "Crimson Seedless". Annals of Agriculture Science, Moshtohor, 46(3):407-418.

Kurtural, S. K. and J. Masabni (2006). Dormant pruning of wine grapes in Kentuky. UK cooperative extension service, university of Kentuky-college Agriculture Horticulture Department Hort Fact-31-07.

Landolt, J. S. (2011). Effects of pruning level and canopy management practices on berry maturation rate and harvest parameters of Syrah wine grapes. Msc. Thesis, California Polytechnic State University, San Luis Obispo, USA.

Mahfouz, T. A. (2007). Studies on improving yield and berries quality of Red Roumi grape under different pruning severity. Ph.D. Thesis, Fac. Agric., Mansoura Univ. Egypt.

May, P.; P. R. Clingeleffer, P. B. Scholefield and C .J. Brien (2003). The response of the grape cultivar Crouchen (Australian synclare Riesling) to various trellis and pruning treatments. Aust. J. Agric. Res., 27(6): 845-856.

Naor, A.; Y. Gal and B. Bravdo (2002). Shoot and cluster thinning influence vegetative growth, fruit yield, and wine quality of 'Sauvignon blank' grapevine. Amer. Soc. Hort. Sci., 127(4): 628-634.

Pisciotta A.; M. G. Barbagallo, R. DiLorenzo, R. Lo Vetere and J. J. Hunter (2007). Effect of tipping and topping on shoot uniformity: preliminary results on single cordon trained Cabernet Sauvignon and Merlot. Acta Horticulturae, 754: 175-178

Porika, H.; M. Jagadeesha and M. Suchithra (2015). Effect of pruning severity on quality of grapes Cv. Red Globe for summer season. Adv. Crop Sci. Tech S1:004. doi:10.4172/2329-8863.

Radwan, E. M. A. and A. A. B. Masood (2017). Effect of Thinning Practices on Fruiting of Ruby Seedless Grapevine. Assiut J. Agric. Sci., 48(4):145-153.

Roberto, S. R.; C. H. Mashima, R. C. Colombo, and R. T. Souza (2017). Berry-cluster thinning to reduce compactness of 'Black Star' table grapes. Ciência Rural, Santa Maria, 47 (4):1-7

Sabbatini, P. K.; L. Wierba and G. S. Howell (2015). Impact of training system and pruning severity on yield, fruit composition, and vegetative growth of 'Niagara' grapevines in Michigan. International Journal of Fruit Science, 15 (3): 237-250.

Sahebrao, K. V. (2013). Effect of time and intensity of pruning on growth, yield and quality of sharad seedless grapes. PhD. Theses, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra State, (India).

Sarıkaya, A. and A. Akın (2016). The effect of different level crop load and humic substance applications on yield and yield components of Alphonse Lavallee grape cultivar. International Journal of Agricultural and Biosystems Engineering, 10 (5):289-292.

Snedecor, G. W. and W. G. Cochran (1980). Statistical Methods. 6th Ed. The Iowa state Univ. Press, Amer., Iowa, U.S.A.

Somkuwar, R. G.; and S. D. Ramteke (2007). Effect of bunch retention, quality and yield in Sharad seedless. Annual Report, National Research Centre for Grapes.

Striegler, K. R.; B. Chris and R. Justin (2002). Minimal input production systems affect yield and juice quality of 'Sunbelt' grape in California's San Joaquin Valley. Amer. Soc. for Hort. Sci., 37(6):10-15.

Uyak, C.; A. Doğan, S. Delikanlioğlu (2016). Effects of pruning intensity on grape yield and quality of Erciş Grape cultivar (*Vitis vinifera*, L.). Research Journal of Agricultural Sciences, 9 (1): 45-47.

Winkler, A. (1965). General Viticulture, Univ., Calif. Press Barkely and Loss Angeles.

Zhuang, S.; L. Tozzini, A. Green, D. Acimovic, G. S. Howell, S. D. Castellarin and P. Sabbatini (2014). Impact of cluster thinning and basal leaf removal on fruit quality of Cabernet Franc (*Vitis vinifera*, L.) grapevines grown in cool climate conditions. HortScience, 49 (6):750-756.

تأثير مستويات حمولة البراعم والتقليم الصيفي على قوة وإنتاجية كرمات عنب الفلايم سيدلس

صابـر سعد بسيـونى

قسم بحوث العنب- معهد بحوث البساتين – مركز البحوث الزراعية - الجيزة – مصر

أجريت هذه الدراسة خلال مواسم ٢٠١٦ و٢٠١٧ و٢٠١٨ على كروم العنب صنف فلايم سيدلس عمر ٨ سنوات النامية في تربة رملية على مسافات زراعة ٢ × ٣ متر بين الكرمات والصفوف على الترتيب وتروى بنظام الري بالتنقيط بمركز بدر-محافظة البحيرة. الكرمات كانت بنظام الكردون الثنائي الافقى مع نظام التدعيم جابل. تم تقليم الكرمات بأربع مستويات من حمولة البراعم و ذلك اعتمادا على قوة الكرمة ممثلة في وزن الخشب عمر سنة المزال أثناء التقليم الشتوي. وكانت المستويات المقترحة هي: مستوى التقليم المتبع في المزرعة (الكنترول) و م٢٠ (وزن خشب التقليم عمر سنة بالكيلو جرام x٢٠) و م٣٠ (وزن خشب التقليم عمر سنة بالكيلو جرام x ٣٠) و م٤٠ (وزن خشب التقليم عمر سنة بالكيلو جرام x ٤٠) و طبقت هذه المعاملات منفردة و كذا بالتداخل مع معاملتين لخف العناقيد (بدون خف – و الخف إلى عنقود واحد لكل فرخ مثمر) و كذا معاملتين لتطويش الأفرخ (بدون تطويش – و التطوبش مع ترك ٢٠ ورقة كاملة على الفرخ) كتقليم صيفي. أوضحت النتائج أنة كلما انخفضت حمولة البراعم من المستوى ٤٠ إلى ٢٠ فان نسبة تفتح البراعم وخصوبتها وكذا قياسات النمو الخضري تتحسن. هذا الاتجاه وجد أيضا مع معاملات تطويش الأفرخ وخف العناقيد. أظهرت المعاملة رقم ١٥ (حمولة براعم بالمستوى ٣٠+ خف العناقيد+ تطويش الأفرخ) أنها الأفضل للحصول على التوازن بين النمو الخضري و الإنتاج حيث حسنت كل من طول و قطر السلميات و وزن الخشب المزال أثناء التقليم الشتوي و الكتلة الحيوية للكرمة . كما أنتجت اعلي محصول للفدان و حسنت وزن العنقود و صفات الجودة الفيزيائية و الكيميائية للحبات.