Arab Universities Journal of Agricultural Sciences
(2023) 31 (1) 131-138
Website: http://ajs.journals.ekb.eg

Effect of Pruning Levels on Yield and Fruit Quality of Melody (Blagratwo) Seedless Table Grape Cultivar

Ali Riad[1], Nazmy Abdle Hamid[1], Amin MGE Shaddad[2], Mohamed A Nasser[1]
1- Horticulture Dept, Fac of Agric, Ain Shams Univ, P.O. Box 68, Hadayek Shoubra 11241, Cairo, Egypt
2- Plant Production Dept, Desert Research Center, Cairo, Egypt

*Corresponding author: ali.riad2010@agr.asu.edu.eg

https://doi.org/10.21608/AJS.2023.161275.1495

Received 11 September 2022; Accepted 20 November 2022

Keywords:

Grapevine,
Pruning,
Bud load,
Melody,
Blagratwo,
Fruit quality

Abstract: Three years old uniform vines for cv. "*Melody syn*. Blagratwo" seedless table grape were selected, and three levels of bud load were trimmed, namely 60, 72, and 78 buds/ vine. The findings revealed that vegetative growth traits, characteristics of yield and bunch quality, were significantly affected by all different pruning levels of cane length in both seasons of this study. The highest bud load vines (78 buds/vine) produced the greatest yield and cluster number but had a negative effect on the percentage of bud behavior, shoot thickness, shoot length, weight of annual pruning (Kg/vine), cluster and berry quality parameters. In contrast, the lowest vine bud load (78 buds/vine) had better bud behavior, vegetative growth traits, cluster characteristics and berry characteristics but both bunch numbers and yield were reduced. In addition, vines pruned with a bud load of 72 buds per vine significantly showed the best outcomes, since it successfully struck a balance between features of vegetative growth, yield, cluster and berry physical and quality attributes in both seasons.

1 Introduction

As a result of their excellent nutritional and medicinal value, grapes are a highly well-liked fruit. All around the world, grapes are farmed, and farmers profit more from them than from other types of crops. Grapes include various vital components that are important in the prevention of some health problems. The grape is a very significant fruit in the globe and is occasionally referred to as the king of fruits (Khan et al 2020). Citrus is the most popular fruit crop in Egypt, and grapes are the second one. Numerous experts have been working to identify effective and dependable techniques to boost grape output and quality due to a rise in demand for premium grapes on a global scale (Abed EL-Hamied et al 2017). According to the most recent statistics from the (MALR 2020), the total cultivated area of grapevine in Egypt reached around (187358feddan), fruit area (133811feddan), yield (8.848ton/feddan) and producing about 1183968 tons. The grape is one of the world's tastiest, energizing, and healthiest fruits. The berries are an excellent source of nutrients and carbohydrates. In both seedless and seeded varieties, crop load has the greatest impact on yield, cluster quality, and vine vigour. Therefore, maintaining an optimal canopy size and bunch count per vine is necessary to provide superior fruit quality, which calls for a careful balance of vigour and capacity (Senthilkumar et al 2015). Pruning is regarded as the most crucial procedure for raising grape production and enhancing cluster quality (Fawzi et al 2010, Cangi and Kiliç 2011). For every grape cultivar to maximize potential output and quality, pruning must be standardized according to the variety. Local grape producers' practice of pruning all mature canes to fruit bud level leads in increased exploitation of food reserves, which lowers the quality and hastens the onset of senility in vines. Poor fruit quality with low TSS and high fruit acidity is the outcome of vines bearing heavily (SenthilKumar et al 2015). The ideal pruning severity needs to be assessed (Morris et al 1984).

Melody (Blagratwo) seedless table grape cultivar is one of the new cultivars which were introduced to Egypt. It is a Mid-late season black seedless, with strong vigor, medium-high fertility, good natural colour, elongated obvoid berry, and naturally accepted berry size. Due to its mid-late maturity date and seedless berries, this cultivar shows tremendous promise for Egyptian commercial producers and exporters. This study's goals are to ascertain the ideal bud load per vine for the Melody (Blagratwo) seedless table grape cultivar and investigate the impact of bud load on bud behavior and cluster quality.

2 Materials and Methods

Vines were 3 years old planted at 2.0 x 3.0 meters in sandy soil under a drip irrigation system, supported according to the Baron system under uncovered conditions and subjected to the normal horticulture managements. Vines were chosen to be nearly similar in growth and vigour and pruned during the second week of January to 10 canes X 6 bud/cane, 12 canes X 6 bud /cane and 13 canes X 6 bud /cane Thus, the bud load was 60 ,72 and 78 eyes/vine. The experimental vines were arranged as complete randomized blocks design with five replicates and each replicate was represented by 3 vines. The vines of the experiment were subjected to the following estimation

2.1 Bud behavior

The percentage of bud burst (opening buds); bud fertility; bud fruitfulness and vegetative eyes were calculated as follows:

Budburst (%) = $\frac{Number\ of\ bursted\ buds}{Total\ number\ of\ buds} * 100$

Bud fruitfulness (%) = $\frac{Number\ of\ fruitful\ buds}{Number\ of\ bursted\ buds} * 100$

Bud fertility (%) = $\frac{Number\ of\ clusters/vine}{Total\ number\ of\ buds} * 100$

2.2 Vegetative growth characteristics and weight of annual pruning (Kg/vine)

- Average shoot length: to be measured at growth cessation in the 4th week of August, the maximum shoot length (gained growth).
- Shoot thickness (mm): shoot thickness was recorded by measuring the thickness of the basal internodes of ten canes per vine by using a venire caliper in the first week of September
- Weight of one-year-old pruning wood (Kg/vine): was recorded at the pruning time in the second week of January.

2.3 Yield and cluster characteristics

Random samples of five clusters /vine were harvested at maturity when TSS reached about 16-17% and the complete dark color of berries, nearly in the first week of July for both seasons.

The number of clusters per vine were counted to determine the total yield per vine.

Total yield: weight of harvested mature clusters is expressed as (kg)/tree. Cluster physical characteristics (cluster weight (g), average clusters dimensions (length and width (cm)) were determined.

At harvest time representative samples per each replicate were harvested and taken to the laboratory in the Horticultural Department, Faculty of Agriculture, Ain Shams University to determine the following characteristics:

Cluster weight (g): was determined by using a digital balance.

Cluster length (cm) –Cluster width (cm) is measured at the cluster shoulders, the widest part of the cluster by using a regular ruler.

2.4 Physical and chemical characteristics of berries

Weight of 100 berries (g). The berry length (cm) and berry width (cm) were measured by using a venire caliper. Berry firmness (g/cm^2) and berry adherence strength as gram force (gf) were measured by using (fruit texture analyzer model “GS-15, serial No. FTA2).

2.5 Chemical characteristics of berries

From the captured clusters of each replicate, two clusters were randomly selected as a sample. for quality determination., as follows:

Total soluble solids (%TSS) by utilizing a hand refractometer (HR-110.) was established.

Titratable acidity (TA%) was determined as gm tartaric acid / 100 ml juice by titrating 10 ml of the juice against sodium hydroxide (0.1 N) and phenolphthalein 1% as indicator according to **(**AOAC 2019).

TSS: acid ratios berry juice: This ratio was calculated by dividing TSS percent by acidity.

The total anthocyanin of the berry skin (mg/100g fresh weight) was determined according to Hsia et al (1965).

2.6 Statistical analysis

The data were submitted to the proper statistical analysis of variance. Tukey test was used to compare treatment means carried out by Tukey (1977). Data were statistically analyzed using the analysis of variance adopting a SAS package.

3 Results and Discussion

3.1 Bud behaviors

Data in **Table 1** show that there was a significant difference between the number of eyes per vine as a load effect. In this respect, 60 and 72 bud/vine showed the greatest percentages of bud burst readings without significant differences between them. followed by 78 bud/vine which gives a low percentage of bud burst. The same table shows that bud load per vine influenced bud fruitfulness percentages. The highest values were recorded in vines loaded with 60 bud/vine in the two seasons. So, vines pruned to 78 buds/vine gave a lower bud fruitfulness percentage in both seasons. Concerning the data of bud fertility %, vines pruned to 60 buds/vine were the highest, while vines pruned to 72 and 78 buds/ vine were the lowest in the 1st and 2nd seasons.

Pruning weights and pruning severity are both decreased during winter pruning, and similar results were achieved by Main and Morris (2008). Also, according to Geller and Kurtural (2013) when vines are just minimally pruned, their pruning weights tend to be lower. Fawzi et al (2010) showed that increasing bud load for Crimson seedless grapevines affected bud fertility and fruitfulness. Singh et al (2014) recorded that maximum percent fruitful buds were recorded at 2-bud level followed by 3, 4 and 5-bud pruning levels. Node levels beyond 80 nodes reduced bud fruitfulness of Niagara (*Vitis labruscana* Bailey) (Sabbatini et al 2015). Abdle Hamid et al (2015) demonstrated that there was a considerable reduction in the percentage of burst buds by increasing the bud load /vine of Autumn Royal seedless grapevines. Bassiony (2020) cleared that, as bud load level decreased as bud burst and fertility improved on" Flame seedless" grapevines. Abo-ELwafa (2021) showed that Prime Seedless Grapevines were pruned at the lowest nodes number/vine) gave the highest significant values of burst buds and bud fertility percentages.

Table 1. Effect of vine bud load on bud burst, bud fruitfulness and bud fertility percentages of Melody (Blagratwo) seedless table grape cultivar during the 2018 and 2019 seasons

Bud load	Budburst %	Bud fruitfulness %	Bud fertility %
2018/2019			
Bud load 60 Buds	95.73a	93.01a	87.22a
Bud load 72Buds	94.44a	91.34b	84.26b
Bud load 78 Buds	92.59b	87.96c	84.19b
2019/2020			
Bud load 60 Buds	89.00a	89.90a	77.22a
Bud load 72Buds	88.67a	86.85b	74.36b
Bud load 78 Buds	84.43b	84.11c	74.07b

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

3.2 Vegetative growth characteristics and weight of annual pruning (Kg/vine)

It is obvious from **Table 2** that bud load 60 eyes/vine showed the highest significant average shoot thickness, shoot length, and weight of annual pruning in both seasons. On the other hand, canes with 78 buds per vine showed the lowest average shoot thickness, shoot length, and weight of annual pruning while a bud load of 72 buds per vine resulted in intermediate values for the same vegetative growth characteristics in the same studied seasons.

Similar results were observed by Diab (2015) on Early sweet grapes vines, vines pruned to a lower eyes /vine gave a higher internode thickness and weight of annual pruning (kg /vine) than the other pruning severities in the two seasons. While vines pruned to 72 eyes /vine produced the lowest significance. Shorter eye loads and canes showed better vegetative development features, according to Ghobrial (2018). As a result of effectively striking the proper balance between vegetative growth factors and the yield and bunch of Autumn Royal in both seasons, vines that have been pruned to have the ideal cane length generate the best results. Bassiony (2020) cleared that, as bud load level decreased, vegetative growth parameters improved on " Flame seedless" grapevines. Abo-ELwafa (2021) showed that the Prime Seedless Grapevines vines gave the highest significant values of shoot length when pruned at the lowest nodes number/vine.

Table 2. Effect of vine bud load on shoot thickness (mm), shoot length (cm) and weight of annual pruning (Kg/vine) of Melody (Blagratwo) seedless table grape cultivar during 2018 and 2019 seasons

Bud load	**Shoot thickness (mm)**	**Shoot length (cm)**	**Weight of annual pruning (Kg/vine)**
2018/2019			
Bud load 60 Buds	17.47a	345.00a	4.10a
Bud load 72Buds	17.01b	297.33b	3.49b
Bud load 78 Buds	16.99b	249.00c	3.83c
2019/2020			
Bud load 60 Buds	17.37a	345.00a	3.93a
Bud load 72Buds	17.27b	256.33b	3.60ab
Bud load 78 Buds	16.55c	296.00c	3.00c

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

3.3 Yield and cluster characteristics

From **Table 3** vines pruned to 72 and 78 buds/vine gave the highest significant values concerning the number of clusters per vine. These treatments recorded 50.67 and 54.67 clusters/vine during the 2018 season and 46.67 and 49.00 clusters/vine in the 2019 season respectively. In the same table, it appeared an increase in cluster weight by decreasing the bud load on the vine. The highest significant cluster weight was obtained with 60 bud/vine in both seasons (580 and 585) respectively. While vines that pruned to78 buds/vine maintained the lowest cluster weight value of 539.67g in the 1st season and 535g in the 2nd season but vines pruned to 72 bud/vine exhibited the intermediate cluster weight (565.00 g and 551g) in both successive seasons of study. Vines pruned to 60 buds/vine recorded the lowest yield (28.24 and 23.21 kg/vine**)** in both seasons, respectively. The highest significant yield/vine was recorded by 78 bud/vine in (29.5 and 26.2) in both seasons respectively.

Table 3. Effect of vine bud load on number of clusters per vine, cluster weight (g) and weight of annual pruning (Kg/vine) of Melody (Blagratwo) seedless table grape cultivar during 2018 and 2019 seasons

Bud load	**Number of clusters per vine**	**Cluster weight (g)**	**Total yield (kg/vine)**
Season 2018			
Bud load 60 Buds	48.67b	580.00a	28.24c
Bud load 72Buds	50.67a	565.00b	28.62b
Bud load 78 Buds	54.67a	539.67c	29.50a
Season 2019			
Bud load 60 Buds	39.67b	585.00a	23.21c
bud load 72Buds	46.67a	551.00b	25.72b
Bud load 78 Buds	49.00a	535.00c	26.22a

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

These results agreed with those of Fawzi et al (2010) on Crimson seedless "grapevines" with higher bud loads that had more clusters per vine and produced more fruit, but the weight of the clusters was lower. In addition, Abdle Hamid et al (2015) showed that For Autumn Royal seedless "grape vines," increasing the bud load increased the number of clusters per vine and the yield, but it decreased cluster weight. Sabbatini et al (2015) declared that Node levels above fixed nodes level decreased yield and cluster weight. Pruning vines at 20 and 40 nodes retained reduced vine yield. So long as vine health and long-term vineyard sustainability were not compromised, keeping 80 fixed nodes produced a sustainable yield of Niagara' (*Vitis labruscana* Bailey). On terminated grapevines, the number of clusters harvested per vine and yield increased as the pruning severity decreased, according to O'Danie et al (2012). The same was found with Ghobrial (2018) revealing that the highest bud/load per cane attained higher yield, in contrast, shorter eye load/ cane reduced both bunch numbers and yield. On the other hand, as it was possible to create an adequate balance between vegetative growth features and yield on Autumn Royal grapevines, vines pruned with the ideal cane length considerably produce the best results. According to Abo-ELwafa (2021) the vines were pruned at level 72 nodes/vine producing the highest significant yield per vine of Premium seedless grapevines.

Regarding cluster characteristics, data in **Table 4** indicated that increasing the bud load/ vine reduced the average length and width of clusters while the weight of 100 berries was increased with vines pruned to 60 buds/ vine in both seasons.

These results coincided with those of Fawzi et al (2010) mentioned that Moderate pruning for Crimson seedless "grapevines gave the greatest cluster length. Bassiony (2020) cleared that, as the bud load level decreased cluster physical characteristics improved. (Abbas et al 2008) who revealed that vines with long pruning caused a significant reduction in bunch dimensions in comparison with short pruning.

Table 4. Effect of vine bud load on cluster length (cm), cluster width (cm) and weight of 100 berries (g) of Melody (Blagratwo) seedless table grape cultivar during the 2018 and 2019 seasons

Bud load	Cluster length (cm)	Cluster width (cm)	Weight of 100 berries (g)
Season2018			
Bud load 60 Buds	18.00a	17.50a	666.67a
Bud load 72Buds	17.83b	17.17b	666.67a
Bud load 78 Buds	16.17c	17.17b	566.67b
Season2019			
Bud load 60 Buds	18.33a	18.00a	558.33a
bud load 72Buds	18.00a	17.00b	516.67b
Bud load 78 Buds	17.33b	16.67c	508.33c

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

3.4 Berry Physical and chemical characteristics of berries

Data of **Table 5** show the effect of different bud load/ vine on berry width (cm), berry length (cm) and berry firmness of "Melody seedless". Thus, it appears to increase by decreasing the bud load on the vine. In this respect, vines which were pruned to 60 buds/ vine maintained the highest value studied traits during both seasons of this study. On the other hand, there is a decrease with the same parameters by pruning vines to 78 eyes/vine. While 72 eyes/vine represented the intermediate values for all aspects in both seasons.

These results are similar to previous studies as found by Fawzi et al (2010). Moderate pruning for Crimson seedless "grapevines gave the greatest berry weight, and berry firmness. Abbas et al (2008) showed that vines with short bearers yielded heavier berries in comparison with those with longer ones. Bassiony (2020) cleared that as bud load level decreased berry physical characteristics improved in Flame seedless grapevines.

Table 5. Effect of vine bud load on berry width (cm), berry length (cm) and berry firmness (mm) of Melody (Blagratwo) seedless table grape cultivar during the 2018 and 2019 seasons

Bud load	Berry width (cm)	Berry length (cm)	Berry firmness (g/cm²)
Season2018			
Bud load 60 Buds	1.92a	2.60a	0.255a
bud load 72Buds	1.75b	2.45b	0.241b
bud load 78 Buds	1.71b	2.29c	0.241b
Season2019			
Bud load 60 Buds	1.57a	2.13a	0.265a
bud load 72Buds	1.53a	2.23a	0.251b
Bud load 78 Buds	1.47b	2.10a	0.251b

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

Regarding berry adherence strength (gf), %TSS and acid ratio (%) as shown in **Table 6**, data revealed that berry adherence strength and berry %TSS were significantly affected by different bud loads in both seasons. The highest significant values of berry adherence strength and acid %ratio were attained from vines pruned with 78 buds/vine followed by vines pruned with 72 bud/vine with significant differences observed between them. While vines of 60 bud/vine had significantly the least values except for %TSS, which take opposite trends in both seasons.

These results are in harmony with Fawzi et al (2010) who found that Moderate pruning for Crimson seedless grapevines gave the greatest berry adherence and TSS. Rahmani et al (2015) revealed that soluble solid content was significantly affected by bud pruning, moderate bud pruning can be considered for increasing table grape nutritional quality **of** red and white seedless table grapes. According to Sabbatini et al (2015), the pH and percentage of soluble solids in Niagara grapes fell as the number of nodes kept rising. In the same trend. Porika et al (2015) recorded that all the plants that were pruned at low bud levels had the greatest total soluble solids and the lowest titratable acidity of grapes from the red globe variety. Abdle Hamid et al (2015) declared that the highest pruned buds/vine showed a higher percentage of TA than the other levels of bud load of Autumn Royal seedless. Abo-ELwafa (2021) showed that the lowest levels of nodes/vine improved TSS while decreasing total acidity in berries of Prime Seedless grapevines. These results coincided with those of Abbas et al (2008) who reveal that vines with long pruning showed a significant reduction in juice TSS percentage, an increase in total acidity content of the berry juice in comparison with short pruning in Flame seedless grapevines.

Table 6. Effect of vine bud load on berry adherence strength (g), %TSS and Acid ratio percentage of Melody (Blagratwo) seedless table grape cultivar during the 2018 and 2019 seasons

Bud load	Berry adherence strength (gf)	%TSS	Acid ratio (%)
Season 2018			
Bud load 60 Buds	334.00c	17.72a	0.60c
Bud load 72 Buds	545.00b	17.55b	0.62b
Bud load 78Buds	567.33a	17.29c	0.65a
Season 2019			
Bud load 60 Buds	373.00c	17.67a	0.61c
Bud load 72 Buds	532.67b	17.50b	0.63b
Bud load 78 Buds	568.67a	17.00c	0.67a

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

Observing TSS/Acid ratio and total anthocyanin in berry skin**,** data presented in **Table 7** showed that the TSS/acid ratio and anthocyanin content of berry skin were significantly affected by different bud load/vine in both seasons. Vines pruned with 60 bud/vine showed significantly the highest values of these parameters (29.53 and 38.99) in the 1st season and (28.96 and 41.02) in the 2nd season, respectively followed by vines pruned with bud load of 72bud/vine (28.30 and 36.97) in 2018 season and (27.77 and 40.91) in 2019 season**.** whereas a bud load of 78 bud/vine significantly induced the least values in both seasons. Thus, it could be postulated that the TSS/acid ratio and anthocyanin content of berry skin least values due to increasing bud load /vine after pruning. In other words, decreasing bud load increased the current season's TSS/acid ratio and anthocyanin content of berry skin and then this may be attributed to the reduction of competition between bud load and vine yield.

Table 7. Effect of vine bud load on TSS/Acid ratio percentage, and total Anthocyanin (mg/100g fresh weight) of Melody (Blagratwo) seedless table grape cultivar during the 2018 and 2019 seasons

Bud load	TSS/Acid ratio (%)	Total Anthocyanin (mg/100g fresh weight)
Season 2018		
Bud load 60 Buds	29.53a	38.99a
Bud load 72 Buds	28.30b	36.97a
Bud load 78 Buds	26.60c	30.74b
Season 2019		
Bud load 60 Buds	28.96a	41.02a
Bud load 72 Buds	27.77b	40.91a
Bud load 78 Buds	25.37c	34.98b

* Values in each column under each season that are preceded by the same letter do not differ substantially according to the Tukey test at the 5% level.

The results are in harmony with Porika et al (2015) who revealed that, all the vines which were pruned at low bud level registered highest TSS/acid ratio. Ghobrial (2018) cleared that, the highest bud/load per cane had a negative impact on berry quality. On the other hand, vines pruned with optimum cane length gave significantly presented the optimum results, as it achieved an appropriate balance between vegetative growth aspects, yield, bunch and berries quality attributes on Autumn Royal. Abo-ELwafa (2021) showed that the vines pruned at the lowest levels of nodes /vine improved TSS/acid ratio in berries of Prime Seedless grapevines. Abbas et al (2008) revealed that vines with heavy bud load showed a significant reduction in TSS/acid ratio.

Whereas, increasing pruned vine bud/load give the least content of anthocyanin content. These results coincided with those of Abbas et al (2008), Abdle Hamid et al (2015) and Ghobrial (2018) who revealed that vines with heavy bud load showed a significant reduction in TSS/acid ratio and anthocyanin content in berry skin in comparison with short pruning and found that the greatest content of anthocyanin was associated with reducing bud load/vine.

4 Conclusion

From the present study, it could be recommended that Melody (Blagratwo) Seedless table grape cultivar vines could be pruned with a bud load of 72 buds per vine as it achieved an appropriate balance between vegetative growth aspects, yield, cluster, and berry physical and quality attributes.

References

Abbas ES, El-Helw HA, Abd El-Wahab MA, et al (2008) Effect of training system and fruiting unit length on bud behaviour, growth and productivity of flame seedless grapevines. *Journal of Plant Production* 33, 5921-5934. https://dx.doi.org/10.21608/jpp.2008.170393

Abdle Hamid N, Nasr SI, Korkar HM (2015) Effect of vine bud load on bud behavior, yield, and cluster characteristics of autumn royal seedless grapevines. *Arab Universities Journal of Agricultural Sciences* 23, 51-60. https://dx.doi.org/10.21608/ajs.2015.14559

Abed EL-Hamied SA, Zaen El-Deen EMA, El-Hagarey ME (2017) Management of irrigation systems to improve productivity and quality of grapevine under desert conditions. *IOSR Journal of Agriculture and Veterinary Science* 10, 77-90.

Abo-ELwafa TSA (2021) Effect of different levels of pruning on growth, yield and fruit quality of Prime seedless grapevines under gable supporting system. *Journal of Plant Production* 12, 1279-1283. https://dx.doi.org/10.21608/jpp.2021.219719

AOAC (2019) Association of Official Analytical Chemists International. 21st (ed) Gaithersburg, Maryland MD.

Bassiony SS (2020) Effect of bud load levels and summer pruning on vine vigor and productivity of "Flame Seedless" (*Vitis vinifera* L.) grapevines. *Journal of Plant Production* 11, 301-310. https://dx.doi.org/10.21608/jpp.2020.95611

Cangi R, Kiliç D (2011) Effects of bud loading levels and nitrogen doses on yield, physical and chemical properties of brined grape leaves. *African Journal of Biotechnology* 10, 12195-12201. https://www.ajol.info/index.php/ajb/article/view/96292

Diab SM (2015) Effect of bud load and cane length on yield and quality of "Early Sweet" grapes. Ph.D. in Pomology, Horticulture Department, Faculty of Agriculture, Ain Shams University. pp 58-100.

Fawzi MIF, Shahin MFM, Kandil EA (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, 187-194. http://www.dx.doi.org/10.7537/marsjas061210.22

Geller JP, Kurtural SK (2013) Mechanical canopy and crop-load management of pinot gris in a warm climate. *American Journal of Enology and Viticulture* 64, 65–73. https://doi.org/10.5344/ajev.2012.12045

Ghobrial SGhF (2018) Effect of cane length on bud behaviour, growth and productivity of autumn royal grapevines. *Middle East Journal of Applied Sciences* 8, 202-208. https://rb.gy/zu4plg

Hsia CL, Luh BS, Chichester CO (1965) Anthocyanin in freestone peach. *Journal of Food Science* 30, 5-12. https://doi.org/10.1111/j.1365-2621.1965.tb00253.x

Khan N, Fahad S, Naushad M, et al (2020) Grape production critical review in the world. Available at: SSRN 3595842. http://dx.doi.org/10.2139/ssrn.3595842

Main GL, Morris JR (2008) Impact of pruning methods on yield components and juice and wine composition of Cynthiana grapes. *American Journal of Enology and Viticulture* 59, 179–187. https://www.ajevonline.org/content/59/2/179

MALR (2020) Statistically Summer and Nile crop, Ministry of Agriculture and Land Reclamation, Egypt. pp 301- 366.

Morris JR, Cawthon DL, Sims CA (1984) Long-term effects of pruning severity, nodes per bearing unit, training system, and shoot positioning on yield and quality of "Concord" grapes. *Journal of the American Society for Horticultural Science* 109, 676-683. https://doi.org/10.21273/JASHS.109.5.676

O'Danie SB, Archbold DD, Kurtural SK (2012) Effects of balanced pruning severity on Traminette (*Vitis* spp.) in a warm climate. *American Journal of Enology and Viticulture* 63, 284-290. http://dx.doi.org/10.5344/ajev.2012.11056

Porika H, Jagadeesha M, Suchithra M (2015) Effect of pruning severity on quality of grapes Cv. red globe for summer season. *Advances in Crop Science and Technology* S1, 004. https://doi.org/10.4172/2329-8863.1000S1-004

Rahmani M, Bakhshi D, Qolov M (2015) Impact of pruning severity and training systems on red and white seedless table grape (*Vitis vinifera*) qualitative indices. *Australian Journal of Crop Science* 9, 55-61. https://search.informit.org/doi/abs/10.3316/INFORMIT.915205465429213

Sabbatini P, Wierba K, Clearwater L, et al (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, 237–250. https://doi.org/10.1080/15538362.2015.1009971

Senthilkumar S, Vijayakumar RM, Soorianathasundaram K, et al (2015) Effect of pruning severity on vegetative, physiological, yield and quality attributes in grape (*Vitis vinifera* L.): A review. *Current Agriculture Research Journal* 3, 42-54. http://dx.doi.org/10.12944/CARJ.3.1.06

Singh G, Arora NK, Gill MIS (2014) Effect of pruning intensity on bud fruitfulness, yield and anthocyanin content of grape (*Vitis vinifera*) hybrid H-516 trained on bower system. *Journal of Applied Horticulture* 16, 122-125. https://doi.org/10.37855/jah.2014.v16i02.20

Tukey JW (1977) Exploratory Data Analysis. Addison-Wesley. 868 p.