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Impact of bud load on vegetative growth, cluster characteristics and yield of Attika Seedless grapevines

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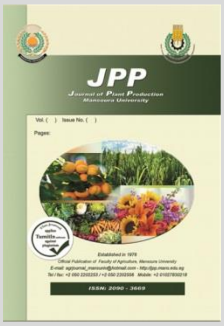

ABSTRACT

This study examined the impact of varying bud load levels 45, 53, 61, 69, 77, and 85 buds per vine of Attika Seedless grapevines on the cluster characteristics, berry quality, bud behavior, and vegetative development characteristics over the 2022 and 2023 growing seasons. The experiment was conducted on vines grown in sandy soil, trained using a Gable supporting system, and spaced at intervals of two by three meters. In all treatments, spur-pruning was done by fixing two eyes per spur during the second week of December in both seasons. The results showed that while the bud fertility was adversely affected by high bud load levels in two seasons, the percentages of bud burst increased as the bud load levels/vine decreased. Additionally, while the yield/vine to pruning weight ratio (measured by the Ravaz index) increased, the high bud load levels markedly reduced vegetative growth characteristics and fruit quality. Furthermore, the chemical components of berries, including total soluble solids, the ratio of total soluble solids to acidity, total anthocyanin, and antioxidant activity, were negatively impacted by both low and high bud load levels. However, both the number of clusters per vine and the total acidity of grape berries had maximum values at high bud load levels. The findings suggest that maintaining a bud load of 53 or 61 buds per vine is optimal for Attika Seedless grapevines, balancing good yield with high fruit quality.

Keywords: Grapevines, Attika Seedless, bud load.

INTRODUCTION

The grape (*Vitis vinifera* L.) is one of the most important fruit crops worldwide, valued for its biochemical composition, including sugars, organic acids, vitamins, and phenolic compounds. Additionally, grapes include anti-inflammatory, cataract-preventive, antioxidant, anti-cancer, anti-allergic, and anti-microbial properties that make them beneficial to human health (Hasbal-Celikok *et al*., 2024). An important part of the Egyptian economy is the table grape sector. Egypt has the natural resources necessary to grow table grapes that ripen early. In addition, one of the grape varieties that have recently been introduced to Egypt is the Attika Seedless cultivar.

Attika Seedless (*Vitis vinifera* L.) is the early commercial black Seedless variety in Egypt. Because of their early maturity date, Attika Seedless grapevines have potential for local commercial producers and exporters in Egypt. Additionally, the berries are black, oval-shaped and excellent eating quality. One of the most attractive aspects of Egyptian Attika Seedless growers is their ability to maintain the perfect correlation among high berry quality and early harvest timing at optimal sugar levels through horticultural practices like pruning and adjusting the Attika Seedless bud load to increase production while maintaining high berry quality results.

Determining the optimal bud load to achieve high-quality grape berries remains a key focus in viticulture management. Remarkably, Hunter and Volschenk (2024) noted that pruning can balance the vine canopy, vigor, and productivity; the vine should have a moderate number of winter buds that reflect the balance of fruiting growth and of vegetative vines to maintain uniform vigor for the best grape quality. Additionally, they stated that pruning is a clear practical method that appears to be crucial for striking an optimal balance between grapevine crop load and vegetative growth. Additionally, Kliewer and Dokoozlian, (2005) reported that the Ravaz index crop load, which is the ratio of fruit yield/vine to pruning weight/vine, links the fruit, which is a photosynthesis sink, to the vine photosynthetic capability, which is represented by canes pruning weight. Also, the impact of direct light on leaf photosynthetic activity and carbohydrate availability makes the significance of light in bud fruitfulness practically evident, according to Monteiro *et al.* (2021). Conversely, Keller (2015) reported that low light intensity decreases the amount of carbohydrates that are provided to the developing buds by reducing the amount of photoassimilates. Meanwhile, Yavari *et al.* (2021) mentioned that bud load at moderate levels enhances the amount of light that spreads into the canopy; as a result, chlorophyll is particularly abundant in light-harvesting complexes and mostly concentrated around the Photosystem (PSII). Furthermore, according to Iyanagi (2022), the light-responsive photosynthetic process on the photosystem side releases electrons through a water-splitting reaction. This process is followed by the reduction of NADP to NADPH and the flow of protons into the lumen to produce ATP, which in turn produces NADPH, and ATP serves as an energy source for the carbon fixation process. This rise in carbohydrates positively impacts grape berry quality by providing essential energy and resources for their development.

Kliewer and Dokoozlian (2005) indicated that the Ravaz index is regarded as a good indicator for determining the balance between crop load and vegetative growth of grapevines. Ravaz (1930) originally defined the Ravaz index as the ratio of total yield per vine to pruning weight per vine, suggesting that a balanced vine should have a Ravaz index between 5 and 10 (values below 5 indicate under-cropping,

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while values above 10 indicate over-cropping). Pruning plays a crucial role in reducing the number of clusters to achieve a proper balance between vine vigor and productivity (Almanza-Merchan et al., 2014). Moreover, Al-Saif et al. (2023) emphasized that in order to produce high-quality grapes, crop size must be carefully controlled to balance fruit quality, vegetative development, and the quantity of fruit per vine for steady productivity. Therefore, low fruit quality results from high fruit production. Lastly, the impact of Attika Seedless grapevines bud load and pruning severity on yield, berry quality, and vegetative growth parameters has received some consideration.

Eventually, this study aims to identify the ideal bud load per vine for Attika Seedless grapevines in order to achieve a respectable yield with excellent fruit quality characteristics.

MATERIALS AND METHODS

This study was conducted in 2022 and 2023 on 6-year-old Attika Seedless grapevines cultivated in a private vineyard located in the Samalut district of Minia Governorate, Egypt. The vines, grown in sandy soil, were trained using the Gable supporting system and spaced 2 meters by 3 meters apart. During the second week of December, the vines were pruned and a predetermined amount of buds per spur (2 buds per spur). The selected vines were given standard horticultural treatment.

Ninety standardized grapevines were selected in a completely randomized block design, included six different treatments. Five replicates of each treatment were made, with three vines in each replication. The selected vines (90 vines) were of uniform vigor, healthy, in good physical condition, free from insect damage and disease, and are dedicated to this study. There are six possible pruning treatments with varying levels of bud load: 45, 53, 61, 69, 77, and 85 buds per vine.

The following parameters were used to assess the treatments under test:

Bud behavior:

The bud burst and bud fertility percentages were calculated using the following formulas in accordance with El-Sharkawy (1995):

$$\textbf{Bursted buds}\ \% = \frac{\textbf{No. of bursted buds/vine}}{\textbf{total number of buds/ vine}}\ \textbf{x 100.}$$

$$\textbf{Fertility buds}\ \% = \frac{\textbf{No. of fruited buds/vine}}{\textbf{total buds per vine}}\ \textbf{x 100.}$$

Parameters of vegetative growth:

Five vegetative shoots/the conducted vines were the subject of the following morphological investigations:

- The average length of the shoots (cm).
- The average leaf area (cm^2) was measured using a leaf area meter (Model CI 203, U.S.A.) by removing 10 leaves from each vine apical vegetative shoots.
- Cane thickness (cm): a vernier caliper was used to measure the basal internodes of five vegetative canes per vine during the last week of November.

Chemical components of canes and leaves:

- Ten leaves were taken from the fifth to seventh apical leaves on the top of the shoot during the second week of June in order to measure the following characteristics during the growing season:
- According to Wood (1993), the nondestructive Minolta chlorophyll meter model SPAD 502 was used to measure the total amount of chlorophyll in the leaves.
- Leaf N, P, and K values were calculated following the methods outlined by A.O.A.C. (1995).
- Total carbohydrates: five vegetative canes were chosen during winter pruning, and the total carbohydrates in the canes were calculated using the A.O.A.C. (1995) methods.

Yield and physical attributes of berries and clusters:

- Five clusters per vine were taken at the ripening stage when the juice TSS% reached around 17–18% on the harvest day (the second week of June) in both seasons, as per Tourky *et al.* (1995), in order to estimate the following parameters:
- Yield: the number of clusters per vine was multiplied by the cluster weight, and the result was stated in weight (kg).
- Cluster width and length averages (cm).
- The average cluster weight (g) on each vine.
- The average number of clusters on per vine.
- The average weight of berries (g).
- Determine the average berry diameter and length (in centimeters) by using a vernier caliper.
- The average berry firmness (g/cm^2) was measured with an Italian penetrometer (Model FT 011).

The chemical analysis of berries:

- Total soluble solids (TSS %) grape in juice were measured with a hand refractometer.
- Acidity: the A.O.A.C. (1995) method was used to measure titratable acidity.
- Total soluble solids (TSS %) / acid ratio.
- Antioxidant activity determination in grape juice (DPPH%): using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method, the antioxidant activity was assessed in accordance with Chen *et al*. (2008) method.
- Total content of anthocyanins (g/100g): the amount of anthocyanins in berry skin was measured by combining 0.5 grams of berry skin with 10 milliliters of an acidified alcohol solution, centrifuging for three minutes, and then filtering, then using a spectrophotometer to test the extracts absorbance at 535 nm as described by Ranganna (1979).

Weight of wood ripening and pruning:

- Pruning weight was determined for each vine during winter pruning.
- The following formula was used to determine the ripening of wood:

$$\textbf{Ripening wood} = \frac{\textbf{length of ripening part}}{\textbf{total length of shoot}}\textbf{X100}$$

Ravaz index

The Ravaz index was determined by rating the pruning weight and total yield per vine. Balanced vines should have a Ravaz index between 5 and 10 (less than 5 under-cropped, more than 10 over-cropped). In accordance with Ravaz (1930), the Ravaz index was calculated using the following formula:

$$\textbf{Ravaz index} = \frac{\textbf{total yield/vine}}{\textbf{pruning weight/vine}}$$

Statistical analysis and experimental design:

Randomized complete block design (RCBD) was used to set up the experiment. In accordance with Snedecor and Cochran (1980), the statistical analysis of the current data was conducted. At a 5% level, averages were compared using New L.S.D. values (Mead *et al*., 1993).

RESULTS AND DISCUSSION

Bud behavior:

The data displayed in Table 1 demonstrated that throughout the 2022 and 2023 seasons, increasing the bud loads per vine considerably reduced the percentage of bud burst. In contrast, the highest bud burst values were recorded at 45 buds per vine, followed by bud load levels at 61 and 53 buds per vine during the two seasons. The highest bud load (85 buds per vine) produced the lowest percentage of bud burst. In general, the maximum percentages of bud burst may occur at low bud load levels since the buds depend on the vines to release stored nutrients. Moreover, bud burst was reduced by raising bud load levels because there were fewer nutrients available for each bud to burst out.

Furthermore, according to Monteiro *et al.* (2021), bud burst is influenced by several types of elements, including signals from the vine that act as stimulants. The apoplast could play a key role in transmitting long-distance signals from the mother vine to buds that cause bud burst. Meanwhile, an excessive number of buds causes weak signals that might not be enough to cause every bud to burst on a single vine. Consequently, the high bud load decreased the bud burst percentage. Conversely, the percentage of bud fertility was adversely impacted by changes in the bud load levels per vine, whilst the maximum values of the aforementioned characteristics were found in the 2022 and 2023 seasons at moderate bud load levels. In this regard, bud load levels of 61 and 53 buds per vine over two seasons produced the greatest results for the aforementioned characters. These findings support those of Al-Saif *et al.* (2023), who noted that the poor fruitfulness may be caused by the high vigor vine of the H4 Strain cultivar, whereas intermediate vigor vines often generated more productive buds.

These findings are consistent with previous research by Di-Lorenzo and Pisciotta (2019), Ali *et al.* (2023), and Al-Saif *et al.* (2023).

Table 1. show the impact of bud load on the bud behavior of Attika Seedless grapevines during the 2022 and 2023 seasons.

Bud load/vine	Bud burst (%)		Bud fertility (%)	
	2022	2023	2022	2023
45	94.00	93.50	59.10	62.97
53	85.78	90.58	61.40	65.44
61	88.40	91.80	63.82	69.49
69	86.60	89.17	59.91	62.23
77	82.37	85.02	49.87	47.96
85	80.08	79.10	47.60	46.81
New L.S.D at 5 %	1.40	1.30	1.05	1.09

Parameters of vegetative growth

Shoot length, cane thickness, and leaf area were the vegetative development characteristics that showed changes between the two seasons at different bud load levels, according to the data in Table 2. The declining bud load per vine in both seasons was correlated with the increasing values of vegetative characteristics. In this regard, bud load levels of 45 buds for each vine, followed by bud load level treatment at 53 and 61 buds per vine during the 2022 and 2023 seasons, produced the best results for enhancing the vegetative growth characteristics. In contrast, the lowest values of the aforementioned characters were recorded at bud load levels of 85 buds per vine. In the meantime, Kliewer and Dokoozlian (2005) stated that the low bud load produces vigorous shoots because only a small number of growth sites may access the entire stored energy in the roots, arms, and trunks. On the other hand, they said that the highest bud load number causes weak shoots because it reduces the energy stored in the roots, arms, and trunks, making it impossible to produce greater shoot growth. Furthermore, Ali *et al.* (2023) found that when bud load levels increased per vine, shoot length reduced. This could be explained by competition amongst the shoots in high bud load treatments. Likewise, Al-Saif *et al.* (2023) found that shoots growing on shaded canes typically exhibit lower vegetative development compared to shoots on illuminated canes. In the meantime, the higher leaf densities brought on by the high bud load levels may result in a worse photosynthetic efficiency for the Attika Seedless grapevine, which would have a detrimental effect on the characteristics mentioned previously.

The same conclusions were reached by Di-Lorenzo and Pisciotta (2019), Ali *et al.* (2023), and Al-Saif *et al.* (2023), who reported that declining vegetative growth characteristics were associated with higher bud load.

Table 2. show the impact of vine bud load on some vegetative development characteristics of Attika Seedless grapevines during the 2022 and 2023 seasons

Bud load/vine	Shoot length (cm)		Leaf area (cm^2)		Cane thickness (cm)	
	2022	2023	2022	2023	2022	2023
45	161.1	161.9	156.5	161.4	1.34	1.17
53	154.7	158.3	155.8	159.3	1.02	1.04
61	153.7	157.2	154.1	158.0	1.01	1.02
69	151.3	153.5	147.2	150.3	0.97	1.01
77	130.1	132.7	141.0	138.9	0.81	0.81
85	124.9	125.3	132.8	129.1	0.71	0.68
New L.S.D at 5 %	2.3	2.4	1.8	1.7	0.01	0.01

Chemical components of canes and leaves

Regarding how the number of buds per vine affected the amount of N, P, and K in the petioles of the leaves, the data in Table 3 demonstrated that the chemical composition of the leaves was impacted by varying levels of bud load in the 2022 and 2023 seasons. The pruned vines with 61 buds per vine had the highest levels of N, P, and K in their leaf petioles. However, with 85 buds per vine, the pruned vine had the lowest values of the aforementioned characters in both planting seasons. According to Choi *et al.* (2021), there is a positive correlation between nitrogen and photosynthetic capacity in petioles of leaves. This relationship is due to the canopy spread light that enhances the incorporation of nitrogen content through leaf cellular proteins like ribulose-bisphosphate carboxylase.

In addition, the concentration of ribulose-1,5-bisphosphate carboxylase oxygenase was significantly lower in shaded leaves than in sun-exposed leaves. For this reason, Attika Seedless grapevine leaves may have higher N content for two seasons with moderate bud load levels treatment. Moreover, grapevine leaf P and K contents are rising at moderate bud load pruning levels. This may be because bright light is spreading into the canopy, enhancing photosynthesis in the leaves, which in turn improves the chemical content of the leaves for Attika Seedless grapevines.

Indeed, total chlorophyll in leaves and the total carbohydrates in vegetative cane are affected by bud load levels per vine. The results in Table 3 showed that there are notable variations in bud load levels both in the 2022 and 2023 seasons. In this regard, throughout the 2022 and 2023 seasons, the greatest values of the aforementioned features were noted in 53 buds per vine, followed by 61 buds per vine. Interestingly, Yavari *et al.* (2021) reported that bud load at moderate levels enhances the amount of light that spreads into the canopy; as a result, chlorophyll is particularly abundant in light-harvesting complexes and mostly concentrated around the Photosystem (PSII).Because of this, the leaves of Attika Seedless grapevines may have more chlorophyll at the moderate bud load level. Likewise, as stated by Iyanagi

(2022), the light-responsive photosynthetic process on the photosystem side releases electrons through a water-splitting reaction. This process is followed by the reduction of NADP to NADPH and the flow of protons into the lumen to produce ATP, which in turn produces NADPH, and ATP serves as an energy source for the carbon fixation process. This may have a beneficial effect on increasing total carbohydrates in Attika seedless grape canes.

These findings are consistent with those of Di-Lorenzo and Pisciotta (2019), Ali *et al.* (2023), and Al-Saif *et al.* (2023).

Table 3. Impact of vine bud load on chemical composition of canes and leaves for Attika Seedless grapevines during the 2022 and 2023 growing seasons

Bud load/vine	N(%)		P(%)		K(%)		Total carbohydrates (g/100g)		Total chlorophyll (SPAD)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
45	2.09	2.11	0.36	0.38	1.32	1.31	33.49	33.79	43.1	45.6
53	2.07	2.08	0.36	0.40	1.33	1.30	33.09	33.69	42.9	44.1
61	2.11	2.12	0.37	0.42	1.35	1.37	34.68	35.28	44.0	46.0
69	2.04	2.07	0.35	0.37	1.33	1.34	34.18	34.88	43.8	44.9
77	1.95	1.97	0.29	0.31	1.28	1.25	26.57	26.77	38.7	39.0
85	1.89	1.88	0.28	0.28	1.19	1.17	24.15	24.25	36.2	36.1
New L.S.D at 5%	0.01	0.01	0.01	0.01	0.01	0.02	0.10	0.10	0.2	0.2

Berry and cluster physical attributes and yield:

Physical characteristics of berries and cluster:

The cluster characteristics, which include cluster length, cluster width, and cluster weight, as well as berry parameters, which include berry weight, berry firmness, berry diameter, and berry length were clearly impacted by varying bud load levels per vine. This is evident from the data presented in Tables 4 and 5. Thus, the vines with the greatest values of the aforementioned traits were those that were pruned to 61 buds per vine, followed by those with 53 buds per vine. The lowest results in this context over the course of two seasons were obtained with high bud load levels (85buds/vine). According to Bai *et al*. (2020), the improvement in mentioned characters is a result of the early stages of development as well as open canopies, which increase photosynthetic activity by exchanging gases with leaves. This may have a favorable effect on Attika Seedless berries quality. Additionally, Di-Lorenzo and Pisciotta (2019) observed that cluster weight behavior that was inversely connected with Grillo grapevines high bud load provides a more compelling explanation.

The number of clusters and yield:

Based on the data in Table 4, during both seasons, the cluster numbers as well as yield of each vine are increased with higher bud load levels. In this regard, bud load levels of 85 buds per vine across two seasons produced the highest number of clusters on each vine. Moreover, in the 2022 and 2023 seasons, the highest yield per vine was recorded at 61 buds per vine, whilst the lowest yield per vine was recorded at low bud load levels at 45 buds per vine. Moreover, the data obtained were consistent with the findings of Sabry *et al.* (2020), and Ali *et al*. (2023) who found that increasing the bud/vine load resulted in an increase in the number of clusters.

Table 4. Impact of vine bud load on physical attributes of cluster and yield per vine for Attika Seedless grapevines during 2022 and 2023.

Bud load/vine	Yield / vine (kg)		Cluster length (cm)		Cluster width (cm)		Cluster weight (g)		No. of clusters /vine	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
45	14.86	15.56	23.20	23.80	13.96	14.80	530.8	531.2	28.0	29.3
53	20.84	23.23	23.25	23.90	14.17	15.10	587.2	600.5	35.5	38.7
61	25.71	29.04	24.00	24.50	14.40	16.60	607.9	622.0	42.3	46.7
69	24.79	26.53	23.11	24.00	14.04	14.93	540.3	547.2	45.9	48.5
77	22.80	22.53	22.75	22.80	12.83	13.90	470.3	476.5	48.5	47.3
85	23.54	23.71	22.70	22.78	12.20	12.30	450.1	460.5	52.3	51.5
New L.S.D at 5 %	0.70	0.90	0.02	0.02	0.01	0.02	20.8	22.1	1.8	1.9

Table 5. Impact of vine bud load on berry physical attributes for Attika Seedless grapevines during the 2022 and 2023 growing seasons

Bud load/vine	Berry weight (g)		Berry length (cm)		Berry diameter (cm)		Berry firmness (g/cm²)	
	2022	2022	2022	2023	2022	2023	2022	2023
45	5.30	5.35	2.21	2.22	1.70	1.78	528.3	529.3
53	5.89	6.08	2.33	2.43	1.88	1.96	533.5	537.3
61	6.07	6.28	2.36	2.45	1.90	1.98	539.9	549.9
69	5.68	6.01	2.26	2.32	1.78	1.78	526.7	536.9
77	5.07	5.28	2.17	2.20	1.64	1.68	503.2	509.2
85	4.54	4.65	2.04	2.08	1.62	1.67	500.0	504.4
New L.S.D at 5 %	0.11	0.13	0.04	0.05	0.01	0.01	5.2	6.1

The chemical properties of berries:

As can be seen from the results in Table 6, the total soluble solids, total acidity, total soluble solids /acidity ratio, total anthocyanin, and antioxidant activity (DPPH) of Attika Seedless berries were impacted by varying degrees of bud load per vine in the 2022 and 2023 seasons. It is evident that bud load of 53 or 61 buds per vine produced the highest values of total soluble solids percentage, total soluble solids/acid ratio, total anthocyanin, and antioxidant activity; however, in this respect, total acidity had the lowest values when compared to other treatments during both seasons. Nevertheless, in comparison to other treatments during the 2022 and 2023 seasons, Attika Seedless berries with a bud load of 85 buds per vine had the lowest values of total soluble solids percentage, total soluble solids/acidity ratio, total anthocyanin, and antioxidant activity, while total acidity had the highest values in this context. The total soluble solids percentage and total soluble solids/acidity ratio were reduced by high bud load levels, which could be because of lower water absorption and accessible sugar per berry (Rogiers and Clarke, 2013). Furthermore, a moderate bud load per vine was linked to rising antioxidant activity percentages.

This is consistent with the findings by Baianoa and Terraconeb (2012), who found that a decrease in bud load increased the pulp antioxidant activity of Thompson Seedless grapes. Abdle-Hamid *et al.* (2015) found a similar response to bud load levels. They found that changing the bud load levels changed the total acidity, the total soluble solids percentage, and the total soluble solids/acidity ratio. Consequently, they also stated that increasing the number of buds per vine of Autumn Royal Seedless grapes decreased the total soluble solids percentage and total soluble solids/acidity ratio.

Table 6. Impact of vine bud load on berry chemical properties for Attika Seedless grapevines during the 2022 and 2023 growing seasons

Bud load/vine	TSS (%)		Acidity (%)		TSS/ acid ratio		Total anthocyanin (g/100g)		Antioxidants (DPPH %)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
45	18.42	18.58	0.558	0.551	33.01	33.72	0.0198	0.0201	57.14	57.02
53	18.89	19.00	0.542	0.537	34.85	35.38	0.0279	0.0297	56.22	56.42
61	19.91	20.00	0.523	0.517	38.06	38.68	0.0304	0.0313	59.22	59.92
69	19.72	19.83	0.531	0.521	37.13	38.06	0.0213	0.0246	58.13	58.72
77	18.40	18.53	0.572	0.570	32.16	32.50	0.0189	0.0195	56.82	55.72
85	18.23	17.83	0.580	0.583	31.43	30.58	0.0179	0.0181	54.92	54.52
New L.S.D at 5 %	0.18	0.16	0.006	0.004	0.30	0.50	0.002	0.001	0.40	0.50

Pruning weight and wood ripening:

The data presented in Table 7 makes it evident that the wood ripening and pruning weights over the two seasons varied according to the bud load levels. As the bud load per vine decreased in both seasons, both the percentage of wood ripening and pruning weight values increased. In the 2022 and 2023 seasons, bud load levels of 45 buds per vine produced the best results for increasing pruning weight. These were followed by treatments of 53 and 61 buds per vine. However, bud load at 53 buds per vine produced the highest results for the percentage of wood ripening, followed by 61 buds per vine. Conversely, it was found that the bud load levels at 85 had the lowest values of the aforementioned characteristics in this regard.

As explained by Kliewer and Dokoozlian (2005), a low bud load causes vigorous shoots because only a very limited amount of growth points may access the entire stored energy in the roots, arms, and trunks. The low bud load this season resulted in a higher winter pruning weight in the first and second seasons. However, they declared that weak shoots are the result of high bud load because it means that all of the energy stored in the trunks, arms, and roots is not enough to achieve better shoot growth. This could be due to a lower pruning weight and wood ripening coefficient in the 2022 and 2023 seasons. In general, the findings of this study were consistent with those of Sabry *et al*. (2020) and Ali *et al.* (2023) who found that for other grape varieties, bud load increased in harmony with a decrease in the wood ripening coefficient and pruning weight.

Table 7. shows the impact of vine bud load on the Ravaz index, pruning weight, and wood ripening of Attika Seedless grapevines during the 2022 and 2023 growing seasons.

Bud load/vine	Wood ripening (%)		Pruning weight (kg)		Ravaz index	
	2022	2023	2022	2023	2022	2023
45	94.88	94.64	3.32	3.14	4.47	4.95
53	94.94	95.12	3.94	3.81	5.29	6.09
61	95.67	96.83	3.85	3.97	6.67	7.31
69	94.97	96.21	2.86	2.91	8.67	9.12
77	76.67	76.28	2.22	2.23	10.27	10.10
85	70.23	69.83	2.13	2.15	11.05	11.03
New L.S.D at 5 %	0.01	0.02	0.02	0.04	0.80	0.90

Ravaz index:

Yield fluctuations were the primary cause of the change in the ratio between yield and winter pruning weight (represented as the Ravaz index), as described in Table 7. Vine pruning at 45 buds per vine resulted in undercropping (4.47 & 4.95) over two seasons, while pruning at 77 & 85 buds per vine resulted in overcropping (10.27 & 10.10) and (11.05 & 11.03) over two seasons, respectively, according to the Ravaz index values. Further, in the 2022 and 2023 seasons, respectively, the Ravaz index values of (5.29 & 6.09) and (6.67 & 7.31) for treatments of 53 and 61 buds per vine indicate that the vines produced sufficient vegetative growth (Table 7) to maintain the harvest. Clearly, in the 2022 and 2023 seasons, bud load levels of 53 and 61 buds per vine produced the best Ravaz index values.

Attika Seedless grapevines are believed to balance crop load with vegetative growth effectively through the use of the Ravaz index. The Ravaz index is a ratio of pruning weight to total yield per vine; balanced vines should have a Ravaz index between 5 and 10 (less than 5 undercropped, more than 10 overcropped) as described by Ravaz (1930). Therefore, pruning is employed to reduce the number of clusters and create a good balance between plant vigor and productivity, according to Almanza-Merchan et al. (2014). Additionally, as indicated by Al-Saif *et al.* (2023), careful crop size management is necessary to balance the quantity of fruits per vine with vegetative growth, fruit quality, and sufficient vine growth for steady output in order to produce high-quality grapes. Overproduction of fruit results in low-quality fruit, but it also reduces vegetative growth, which lowers yield.

CONCLUSION

In order to achieve a good balance between crop load and vegetative growth, the study data indicated that moderate bud load levels, such as 53 or 61 buds per vine, produced the best results on the yield/vine to pruning weight/vine ratio (Ravaz index). This, in turn, led to an improvement in the quantitative and qualitative yield of Attika Seedless grapevines.

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تأثير حمولة البراعم على النمو الخضري ، خصائص العنقود والمحصول لكرمات العنب أتيكا سيدليس

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الملخص

تناولت هذه الدراسة مستويات حمولة البراعم عند مستويات 45، 53، 61، 69، 77، و 85 برعمًا لكل كرمة من كرمات العنب أتيكا سيدليس على خصائص العنقود والحبة وسلوك البراعم وخصائص النمو الخضري .وقد أجريت هذه الدراسه خلال موسمي النمو 2022 و 2023. حيث كانت الكرمات نامية في تربة رملية، وكان نظام التدعيم للكرمات بنظام الجيبل، وكانت مسافة زراعة 2 x 3 في جميع المعاملات ، وتم تقليم الكرمات تقليم دابري مع تثبيت عدد اثنين عين للدابرة في كل المعاملات في الاسبوع الثاني من شهر ديسمبر في كلا الموسمين. أظهرت النتائج أن خصوبة البراعم تأثرت سلبًا بمستويات حمولة البراعم العالية في موسمين، حيث زادت نسب تفتح البراعم مع انخفاض مستويات حمولة البراعم / الكرمة. بالإضافة إلى ذلك، بينما زادت نسبة المحصول / الكرمة إلى وزن التقليم (مقاسة بمؤشر رافاز)، فإن مستويات حمولة البراعم العالية قللت بشكل ملحوظ من خصائص النمو الخضري وجودة الثمار. علاوة على ذلك، تأثرت المكونات الكيميائية للحبة، بما في ذلك المواد الصلبة الذائبة الكلية، ونسبة المواد الصلبة الذائبة الكلية إلى الحموضة، والأنثوسيانين الكلي، ونشاط مضادات الأكسدة سلبًا بمستويات حمولة البراعم المنخفضة والعالية .ومع ذلك، كان لكل من عدد العناقيد لكل كرمة والحموضة الكلية لثمار العنب قيم قصوى عند مستويات حمولة البراعم العالية. تشير النتائج إلى أن الحفاظ على حمولة البراعم 53 أو 61 برعمًا لكل كرمة هو الأمثل لكرمات العنب أتيكا سيدليس، مما يعطى توازن جيد بين انتاج محصول جيد وجودة ثمار عالية.