Effect of Bud Load and Fruiting Unit Length of the Autumn Crisp Grape variety on Growth, Yield, and Fruit Quality

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ABSTRACT

This study was carried out in a private vineyard located in the El-Nubaria region, El-Behira governorate, for two consecutive seasons (2019 & 2020) to study the effect of bud load and fruiting unit length on bud behavior, growth, yield and fruit quality of "Autumn Crisp" grapevines (*Vitis vinifera* L.). The vines were ten-year-old, spaced at 2 X 3 meters apart, grown in sandy loamy soil, and irrigated by the drip irrigation system. The vines were trained to quadrilateral cordon and spur pruned during the second week of January and trellised according to the Gable system. Nine pruning treatments were conducted as follows; three levels of bud loads/vine, namely 60, 84 or 108 buds/vine combined with three levels of spur length, namely 2, 4 or 6 buds/spur. The results showed that the moderate pruning with bud load at 84 buds/vine and fruiting unit length at 4 buds/spur under the Gable trellising system was preferable for ensuring the highest percentage of bud burst, as well as the reasonable yield with its components, improving fruit quality attributes i.e., the physical characteristics of bunches and the physical and chemical characteristics of berries, achieving the best vegetative growth aspects and increasing leaf content of total nitrogen, phosphorus and potassium as well as cane content of total carbohydrates of Autumn Crisp Grape variety.

Keywords: pruning, bud load, spur, yield, fruit quality, Autumn Crisp grapevines.

INTRODUCTION

Pruning is an essential practice in the management of grapevines, and it is done when selecting fruiting wood to maintain vine shape and form and regulate the number of buds retained per vine. Proper pruning always results in a maximum yield of highquality fruit (Gorden *et al.,* 1998). The haphazard application of some pruning systems has been the main reason for the undesired and unreliable results (Abbas *et al.,* 2008). Pruning the vines for optimum cropping according to the vigour is the most reliable method to maintain a balance between growth and production (Senthilkumar *et al.*, 2015).

Using the optimum bud load and adjusting the proper length of the fruiting units will undoubtedly affect the yield and bunch quality of the vines. In this respect, some researchers emphasized the importance of pruning in improving any vine cultivar's quantitatively and qualitatively (Palma *et al.*, 2000; Garic, 2001; Terry and Rick, 2003; Dawn *et al.*, 2004).

Optimal bud load per vine, as well as fruiting unit length for different grape varieties, has been a goal of many researchers to obtain the highest grape production along with the best fruit quality attributes (Omar and Abdel Kawi, 2000; Abd El-Ghany 2006; Ali, 2006; El-Helw, 2006; El-Mogy, 2006 a and b, Abbas, *et al.,* 2008; Khamis *et al.,* 2008; Fawzi *et al.*, 2010; Abo-Elwafa, 2018; Mekawy and Abo-Elail, 2021).

Autumn Crisp; Sugra35 is green-yellow seedless grapes, large berries, crisp-juicy texture and a sweet flavor. It was obtained by Sun World International, LLC, California owns the US Plant Patent. The US plant patent was granted in November 2009 (Fruit Dynamics, Inc. Grape Test Panel, September 2009).This study aims to determine the optimum bud load and adjust the proper length of the fruiting units of Autumn Crisp grapevines to obtain reasonable yield with high fruit quality attributes.

MATERIALS AND METHODS

This study was carried out in a private vineyard located in the El-Nubaria region, El-Behira governorate, for two consecutive seasons (2019 & 2020) to study the effect of bud load and fruiting unit length on bud behaviour, growth, yield and fruit quality of Autumn Crisp grapevines. The chosen vines were ten-year-old, spaced at 2 X 3 meters apart, grown in sandy loamy soil, and irrigated by the drip irrigation system. The vines were spur pruned during the second week of January and trellised according to the Gable system.

Eighty-one uniform vines were selected. Each of the nine treatments was replicated three times with three vines per replicate.

Nine pruning treatments were conducted as follows:

1. Bud load at 60 buds/vine + fruiting unit length at 2 buds/ spur
2. Bud load at 60 buds/vine + fruiting unit length at 4 buds/ spur
3. Bud load at 60 buds/vine + fruiting unit length at

6 buds/ spur
4. Bud load at 84 buds/vine + fruiting unit length at 2 buds/ spur
5. Bud load at 84 buds/vine + fruiting unit length at 4 buds/ spur
6. Bud load at 84 buds/vine + fruiting unit length at 6 buds/ spur
7. Bud load at 108 buds/vine + fruiting unit length at 2 buds/ spur
8. Bud load at 108 buds/vine + fruiting unit length at 4 buds/ spur
9. Bud load at 108 buds/vine + fruiting unit length at 6 buds/ spur

The following parameters were adopted to evaluate the tested treatments: -

1. Bud's behavior

During the spring of each season, the number of bursted buds/vine and fruitfulness buds were counted, then the percentage of bud burst, and coefficient of bud fertility were calculated according to Bessis (1960). Bud burstpercent was calculated by the number of bursted buds per vine divided by the total number of buds per vine left at pruning. Moreover, the coefficient of bud fertility was calculated by dividing the average number of bunches per vine by the total number of buds/vines.

2. Yield and physical characteristics of bunches

A representative random sample of six bunches/vine was taken at maturity when TSS reached about 16-17%, according to Tourky *et al*. (1995).

Yield/vine (kg) expressed as the number of bunches/vine X average bunch weight (g). In addition, average bunch weight (g), bunch length and width (cm) were determined.

3. Physical characteristics of berries

Average berry weight (g), average berry size (cm^3) and average berry dimensions (length and diameter) (cm) were measured.

4. Chemical characteristics of berries

Total soluble solids in berry juice (TSS) percent were measured using hand refractometer and total titratable acidity as tartaric acid (%) (A.O.A.C., 1985), then TSS /acid ratio were determined.

5. Morphological characteristics of vegetative growth

In the first week of August, morphological studies were conducted on four fruitful shoots/ vines; average shoot length (cm), the average number of leaves/shoot. The average leaf area (cm^2) of the apical fifth and sixth leaves were measured using a CI-203- Laser Area-meter made by CID, Inc., Vancouver, USA. In addition, samples of five mature canes were taken at the first week of November; the coefficient of wood ripening was calculated by dividing the length of the ripened part by the total length of the shoot according to Bouard (1966). During the dormancy period (winter pruning), the weight of prunings (Kg) was determined.

6. Chemical characteristics of vegetative growth

6.1. Leaf content of macro-elements content:

In the first week of May, samples of five mature and fresh leaves from those opposed to the basal clusters on the main shoot were taken. The leaf content of total nitrogen was estimated according to Pregl (1945) using the modified micro-Kjeldahl method. According to Snell and Snell (1967), phosphorus (%) was calorimetrically measured. Potassium (%) was determined according to Jackson (1967) using a Flame photometry instrument.

6.2. Cane content of total carbohydrates (%)

Samples of canes were taken at winter pruning (during the first week of January) and total carbohydrates percent were determined according to (Smith *et al.,* 1956).

- Experimental design and statistical analysis

The experiment was arranged in a randomized complete block design. According to Snedecor and Cochran (1980), the statistical analysis of the present data was performedusage the new LSD values at 5% level, and averages were compared (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1. Bud behaviour

As shown in Table 1, the bud behavior measurements expressed as bud burst (%) and coefficient of bud fertility were significantly affected by all different tested levels of bud load (60, 84 & 108 buds/vine) and fruiting unit length (2, 4 & 6 buds/spur) in both seasons.

Percentage of bud burst

Regarding the effect of bud load/vine, it was quite clear that the most remarkable increment of bud burst was obtained from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine. On the other hand, vines pruned with high bud load at 108 buds/vine had the lowest percentage of this one in both seasons.

Concerning the effect of fruiting unit length, data revealed that vines pruned with fruiting unit length at 2 buds/spur produced the highest percentage of bud burst, followed by vines pruned with fruiting unit length at 4 buds/spur, in comparison, the lowest percentage of this one was obtained with fruiting unit length at 6 buds/spur in the both seasons.

Concerning the interaction effect of various combinations between the bud load and fruiting unit length on the percentage of bud burst,

Table 1: Effect of bud load and fruiting unit length on bud behaviour of Autumn Crisp grape variety during the 2019 and 2020 seasons

		Bud burst (%)		Coefficient of bud fertility	
		2019	2020	2019	2020
(A): Bud load	(A1) 60 buds/vine	88.61	91.80	0.37	0.41
	(A2) 84 buds/vine	86.99	90.08	0.33	0.36
	(A3) 108 buds/vine	85.84	88.87	0.28	0.30
new LSD (A) =		0.28	0.30	0.01	0.02
(B): Fruiting unit length	(B1) 2 buds/spur	87.59	90.72	0.32	0.35
	(B2) 4 buds/spur	87.16	90.26	0.33	0.36
	(B3) 6 buds/spur	86.70	89.77	0.34	0.37
new L.S.D (B) =		0.28	0.30	0.01	0.02
(AXB): Interaction	A1 B1	89.16	92.38	0.37	0.39
	B2	88.66	91.85	0.37	0.41
	B3	88.02	91.17	0.38	0.42
	A2 B1	87.32	90.43	0.32	0.35
	B2	86.99	90.08	0.33	0.36
	B3	86.67	89.74	0.34	0.37
	A3 B1	86.29	89.34	0.27	0.29
	B2	85.84	88.86	0.28	0.30
	B3	85.41	88.41	0.29	0.31
new L.S.D (AXB) =		0.49	0.52	0.02	0.03

data showed that the highest significant percentage of bud burst was obtained from vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur resulted in the lowest percentage of this one in both seasons.

These results are in agreement with those mentioned by Ali (2006), El-Helw (2006), Khamis *et al.* (2008), Fawzi *et al.* (2010), Abo-Elwafa (2018) and Mekawy and Abo-Elail (2021). They revealed that the percentage of bud burst was negatively correlated with the number of buds left after pruning. Moreover, Abbas *et al.* (2008) and Abo-Elwafa (2018) showed that the percentage of bud burst increased with decreasing spur length.**Coefficient of bud fertility**

Regarding the effect of bud load, it is clear that the most significant increase in bud fertility coefficient was achieved from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine, while the high bud load at 108 buds/vine resulted in the lowest value of this one in both seasons (Table 1).

Concerning the effect of fruiting unit length, data indicated that vines pruned with fruiting unit length at 6 buds/spur scored the highest value of bud fertility coefficient, followed by vines pruned with fruiting unit length at 4 buds/spur. In comparison, the lowest value of this one was achieved from vines pruned with fruiting unit length at 2 buds/spur in both seasons.

Referring to the interaction effect of various combinations between the bud load and fruiting unit length on the coefficient of bud fertility, data indicated that the highest significant value of bud fertility coefficient was attained by vines pruned with low bud load at 60 buds/vine and fruiting unit length at 6 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 2 buds/spur had the lowest value of this one in both seasons (Table 1).

The results in this respect are in harmony with El-Helw (2006) and Abo-Elwafa (2018), who found that the vines pruned with high bud load had the lowest coefficient of bud fertility. On the other hand, Abo-Elwafa (2018) showed that the coefficient of bud fertility increased with increasing spur length.

2. Yield and physical characteristics of bunches

Data presented in Table 2 showed that bud load and fruiting unit length were accompanied with a pronounced effect on yield and bunch physical characteristics expressed in bunch weight and dimensions in both seasons.

Table 2: Effect of bud load and fruiting unit length on yield and physical characteristics of bunches of Autumn Crisp grape variety during the 2019 and 2020 seasons

			Yield/vine (kg)		Bunch weight (g)		Bunch length (cm)		Bunch width (cm)	
			2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
	(A1) 60 buds/vine		12.45	13.73	554.36	561.98	20.75	20.84	18.57	18.63
(A): Bud load	(A2) 84 buds/vine		14.07	15.61	505.25	515.17	20.37	20.42	18.46	18.52
	(A3) 108 buds/vine		14.95	16.28	495.14	501.35	20.08	20.31	18.37	18.44
new LSD (A) =			0.07	0.08	3.95	3.66	0.03	0.04	0.01	0.02
	(B1) 2 buds/spur		13.69	15.01	524.80	534.92	20.51	20.57	18.50	18.56
(B): Fruiting unit length	(B2) 4 buds/spur		13.84	15.22	518.21	525.21	20.38	20.44	18.47	18.53
	(B3) 6 buds/spur		13.94	15.40	511.75	518.37	20.31	20.55	18.43	18.51
new LSD (B) =			0.07	0.08	3.95	3.66	0.03	0.04	0.01	0.02
	A1	B1	12.33	13.43	561.39	568.69	20.81	20.92	18.59	18.66
		B2	12.44	13.76	554.51	562.34	20.74	20.83	18.57	18.63
		B3	12.57	14.01	547.18	554.91	20.69	20.76	18.54	18.61
	A2	B1	13.86	15.42	509.14	526.47	20.57	20.61	18.51	18.56
(AXB): Interaction		B2	14.15	15.65	507.74	514.86	20.31	20.37	18.46	18.52
		B3	14.18	15.77	498.87	504.17	20.23	20.29	18.42	18.49
	A3	B1	14.87	16.17	503.86	509.59	20.14	20.19	18.39	18.47
		B2	14.92	16.24	492.37	498.42	20.09	20.13	18.37	18.44
		B3	15.06	16.42	489.19	496.03	20.01	20.60	18.34	18.42
new LSD (AXB) =			0.12	0.14	6.84	6.34	0.05	0.07	0.02	0.03

Yield/vine

Regarding the effect of bud load/vine, it was quite clear that the most remarkable increment of yield/vine was attained by vines pruned with a high bud load at 108 buds/vine followed by vines pruned with a bud load at 84 buds/vine. On the other hand, vines pruned with low bud load at 60 buds/vine produced the lowest value of this one in both seasons.

Concerning the effect of fruiting unit length, data mentioned that vines pruned with fruiting unit length at 6 buds/spur had the highest value of yield/vine, followed by vines pruned with fruiting unit length at 4 buds/spur, while the lowest value of this one was attained by with fruiting unit length at 2 buds/spur in both seasons.

Concerning the interaction effect of various combinations between the bud load and fruiting unit length on the yield/vine, data showed that the highest significant value of yield/vine was achieved from vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur as compared to other combinations, whereas vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur produced the lowest value of this one in both seasons.

These results are in agreement with those mentioned by Ali (2006), El-Helw (2006), Khamis *et al.* (2008), Fawzi *et al.* (2010) and Mekawy and Abo-Elail (2021), they revealed that the yield/vine progressively increased by increasing bud load. On the other hand, Abo-Elwafa (2018) reported that the yield per vine increased with increasing spur length.

Physical characteristics of the bunch

Regarding the effect of bud load/vine, it was quite clear that the most significant increase of bunch physical characteristics expressed in bunch weight and dimensions were obtained from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine. On the other hand, vines pruned with high bud load at 108 buds/vine had the lowest values of these ones in both seasons.

Concerning the effect of fruiting unit length, data revealed that vines pruned with fruiting unit length at 2 buds/spur produced the highest values of bunch weight and dimensions, followed by vines pruned with fruiting unit length at 4 buds/spur. The lowest values were obtained from the fruiting unit length at 6 buds/spur in both seasons.

For the interaction effect of various combinations between the bud load and fruiting unit length on the bunch weight and dimensions, data showed that the highest significant values of bunch weight and dimensions were obtained from vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur resulted in the lowest values of these ones in both seasons.

These results coincided with those of Ali (2006), El-Helw (2006), Fawzi *et al.* (2010) and Mekawy and Abo-Elail (2021),. They found that bunch weight and dimensions were reduced by increasing bud load. Moreover, Abbas *et al.* (2008) and Abo-Elwafa (2018) showed that bunch weight and dimensions increased with decreasing spur length.

3. Physical characteristics of berries

As shown in Table 3, data revealed that the physical characteristics of berries, i.e., berry weight, size, and berry dimensions were significantly affected by bud load and fruiting unit length in both seasons.

Regarding the effect of bud load, it is clear that the most remarkable increment of berry weight, size and dimensions was achieved from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine, while the high bud load at 108 buds/vine resulted in the lowest value of these ones in both seasons (Table 3).

Concerning the effect of fruiting unit length, data indicated that vines pruned with fruiting unit length at 2 buds/spur scored the highest value of berry weight, size and dimensions, followed by vines pruned with fruiting unit length at 4 buds/spur, while the lowest value of these ones was achieved from vines pruned with fruiting unit length at 6 buds/spur in both seasons.

Referring to the interaction effect of various combinations between the bud load and fruiting unit length on the berry weight, size and dimensions, data indicated that the highest significant value of berry weight, size and dimensions was attained by vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur had the lowest value of these ones in both seasons (Table 3).

The results in this respect are in harmony with Ali (2006), El-Helw (2006), Fawzi *et al.* (2010) and Mekawy and Abo-Elail (2021), who found that the berry weight and size increased by decreasing bud load.

Table 3: Effect of bud load and fruiting unit length on physical characteristics of berries of Autumn Crisp grape variety during the 2019 and 2020 seasons

			Average berry weight (g)		Average berry size (cm³)		Average berry length (cm)		Average berry diameter (cm)	
			2019	2020	2019	2020	2019	2020	2019	2020
(A): Bud load	(A1) 60 buds/vine		3.09	3.12	2.86	2.90	2.99	3.03	2.14	2.17
	(A2) 84 buds/vine		2.97	2.99	2.73	2.75	2.87	2.90	2.01	2.05
	(A3) 108 buds/vine		2.86	2.91	2.61	2.65	2.78	2.83	1.94	1.96
new LSD (A) =			0.02	0.03	0.01	0.02	0.02	0.03	0.01	0.02
(B): Fruiting unit length	(B1) 2 buds/spur		3.00	3.03	2.76	2.79	2.90	2.94	2.05	2.08
	(B2) 4 buds/spur		2.98	3.01	2.74	2.76	2.89	2.92	2.03	2.07
	(B3) 6 buds/spur		2.95	2.99	2.70	2.74	2.85	2.90	2.01	2.03
new LSD (B) =			0.02	0.03	0.01	0.02	0.02	0.03	0.01	0.02
(AXB): Interaction	A1	B1	3.12	3.16	2.89	2.94	3.01	3.06	2.17	2.19
		B2	3.09	3.12	2.86	2.89	2.99	3.03	2.14	2.17
		B3	3.07	3.09	2.83	2.86	2.96	3.01	2.12	2.14
	A2	B1	2.99	3.01	2.75	2.77	2.89	2.92	2.03	2.07
		B2	2.98	2.99	2.74	2.74	2.89	2.90	2.01	2.07
		B3	2.95	2.98	2.69	2.73	2.84	2.89	2.00	2.02
	A3	B1	2.89	2.93	2.64	2.67	2.81	2.84	1.95	1.99
		B2	2.87	2.92	2.61	2.66	2.78	2.84	1.95	1.96
		B3	2.83	2.89	2.57	2.62	2.75	2.80	1.91	1.93
new LSD (AXB) =			0.03	0.05	0.02	0.03	0.03	0.05	0.02	0.03

On the other hand, Abbas *et al.* (2008) and Abo-Elwafa (2018) showed that berry weight and dimensions increased with decreasing spur length.

4. Chemical characteristics of berries

Results presented in Table 4 showed that all berry chemical characteristics, i.e. TSS, acidity, and TSS/acid ratio were significantly affected by bud load and fruiting unit length in both seasons.

Regarding the effect of bud load/vine, it was quite clear that the highly significant increase of TSS and TSS/acid ratio with a decrease in acidity was attained by vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine. On the other hand, vines pruned with high bud load at 108 buds/vine produced the lowest value of TSS and TSS/acid ratio with an increase in acidity in both seasons.

Concerning the effect of fruiting unit length, data mentioned that vines pruned with fruiting unit length at 2 buds/spur had the highest value of TSS and TSS/acid ratio with a decrease in acidity, followed by vines pruned with fruiting unit length at 4 buds/spur,. In comparison, the lowest value of TSS and TSS/acid ratio with an increase in acidity was attained with fruiting unit length at 6 buds/spur in both seasons.

For the interaction effect of various combinations between the bud load and fruiting unit length on the berry chemical characteristics, data showed that the highest significant value of TSS and TSS/acid ratio with a decrease in acidity was achieved from vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur produced the lowest value of TSS and TSS/acid ratio with an increase in acidity in both seasons (Table 4).

These results coincided with those of Ali (2006), El-Helw (2006), Fawzi *et al.* (2010) and Mekawy and Abo-Elail (2021) who found that increasing bud load decreased TSS and increased total titratable acidity. Moreover, Abd El-Ghany (2006), Abbas *et al.* (2008) and Abo-Elwafa (2018) revealed that vines with long pruning caused a significant reduction in TSS% and TSS/acid ratio and an increase in total acidity content of the berry juice in comparison with short pruning.

Table 4: Effect of bud load and fruiting unit length on chemical characteristics of berries of Autumn Crisp grape variety during the 2019 and 2020 seasons

			TSS (%)		Acidity (%)		TSS/acid ratio	
			2019	**2020**	**2019**	**2020**	**2019**	**2020**
(A): Bud load	(A1) 60 buds/vine		16.59	16.65	0.65	0.61	25.40	27.46
	(A2) 84 buds/vine		16.42	16.44	0.69	0.66	23.69	25.05
	(A3) 108 buds/vine		16.21	16.23	0.74	0.71	22.01	22.98
new LSD (A) =			0.02	0.03	0.01	0.02	0.24	0.27
(B): Fruiting unit length	(B1) 2 buds/spur		16.43	16.47	0.68	0.64	24.23	25.86
	(B2) 4 buds/spur		16.40	16.44	0.69	0.65	23.74	25.26
	(B3) 6 buds/spur		16.37	16.40	0.71	0.68	23.12	24.37
new LSD (B) =			0.02	0.03	0.01	0.02	0.24	0.27
(AXB): Interaction	A1	B1	16.61	16.69	0.64	0.59	25.95	28.29
		B2	16.58	16.65	0.65	0.61	25.51	27.30
		B3	16.57	16.62	0.67	0.62	24.73	26.81
	A2	B1	16.45	16.48	0.68	0.64	24.19	25.75
		B2	16.42	16.44	0.69	0.65	23.80	25.29
		B3	16.38	16.39	0.71	0.68	23.07	24.10
	A3	B1	16.24	16.25	0.72	0.69	22.56	23.55
		B2	16.21	16.23	0.74	0.70	21.91	23.19
		B3	16.17	16.2	0.75	0.73	21.56	22.19
new LSD (AXB) =			0.03	0.05	0.02	0.03	0.42	0.47

5. Morphological characteristics of vegetative growth

As shown in Table 5, data revealed that bud load, as well as fruiting unit length were accompanied by a pronounced effect on vegetative growth aspects expressed as shoot length, the number of leaves/shoot, leaf area/shoot, coefficient of wood ripening and weight of prunings in both seasons.

Regarding the effect of bud load/vine, it was quite clear that the most remarkable increment of vegetative growth traits was obtained from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine. On the other hand, vines pruned with high bud load at 108 buds/vine had the lowest values of these ones in both seasons.

Concerning the effect of fruiting unit length, data revealed that vines pruned with fruiting unit length at 2 buds/spur produced the highest values of vegetative growth traits, followed by vines pruned with fruiting unit length at 4 buds/spur. The lowest values of these ones were obtained with fruiting unit length at 6 buds/spur in both seasons.

Concerning the interaction effect of various combinations between the bud load and fruiting unit length on the vegetative growth traits, data showed that the highest significant values of vegetative growth traits were obtained from vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur resulted in the lowest values of these ones in both seasons.

Thus, it could be postulated that the growth reduction due to bud load treatments was directly correlated to the number of buds left after pruning. In other words, increasing the bud load/vine decreased the current season's shoot length, the number of leaves per shoot, and leaf area/shoot. This may be attributed to the competition between the shoots in the treatments of high bud loads or spur length.

The results in this respect are in harmony with Ali (2006), El-Helw (2006), Khamis *et al.* (2008) and Mekawy and Abo-Elail (2021) who found that increased bud load limited individual shoot growth and reduced annual shoot growth increment which led to a weight loss of wood pruning and mature wood. Moreover, Abd El-Ghany (2006) and Abbas *et al.* (2008), Khamis *et al.* (2008) and Abo-Elwafa (2018) who displayedshowed that vegetative growth aspects were positively affected by increasing pruning severity.

Table 5: Effect of bud load and fruiting unit length on morphological characteristics of vegetative growth of Autumn Crisp grape variety during the 2019 and 2020 seasons

		Average shoot length (cm)		Average number of leaves		Average leaf area (cm2)		Coeffeicient of wood ripening		Average prunings weight (kg)	
		2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
	(A1) 60 buds/vine	216.7	226.6	31.73	31.84	186.3	190.1	0.91	0.94	3.57	3.68
(A): Bud load	(A2) 84 buds/vine	184.2	195.4	30.36	30.85	166.9	171.4	0.87	0.89	3.30	3.35
	(A3) 108 buds/vine	166.2	170.7	29.54	29.84	155.6	158.3	0.82	0.86	3.03	3.08
new LSD (A) =		2.9	3.1	0.04	0.05	2.4	2.5	0.01	0.02	0.04	0.06
	(B1) 2 buds/spur	194.7	203.8	30.65	31.05	173.4	178.0	0.88	0.91	3.39	3.46
(B): Fruiting unit length	(B2) 4 buds/spur	189.4	197.1	30.55	30.83	169.4	173.1	0.87	0.90	3.29	3.37
	(B3) 6 buds/spur	183.1	191.9	30.43	30.65	166.0	168.7	0.85	0.88	3.21	3.28
new LSD (B) =		2.9	3.1	0.04	0.05	2.4	2.5	0.01	0.02	0.04	0.06
	A1 B1	223.1	231.7	31.83	31.96	189.7	194.3	0.93	0.95	3.67	3.79
	B2	217.4	226.3	31.74	31.85	185.3	189.6	0.91	0.94	3.54	3.68
	B3	209.7	221.9	31.62	31.71	183.9	186.4	0.90	0.92	3.49	3.57
	A2 B1	191.6	204.6	30.49	31.03	171.2	177.8	0.88	0.91	3.35	3.42
(AXB): Interaction	B2	183.2	194.2	30.33	30.87	167.6	171.2	0.87	0.89	3.31	3.34
	B3	177.9	187.5	30.25	30.65	161.8	165.1	0.85	0.88	3.24	3.29
	A3 B1	169.3	175.1	29.64	30.17	159.4	161.9	0.84	0.87	3.14	3.17
	B2	167.5	170.8	29.57	29.76	155.2	158.5	0.82	0.86	3.03	3.08
	B3	161.8	166.3	29.41	29.59	152.3	154.6	0.81	0.84	2.91	2.98
new LSD (AXB) =		5.0	5.4	0.07	0.09	4.2	4.3	0.02	0.03	0.07	0.10

6. Chemical characteristics of vegetative growth

Results in Table 6 showed leaf macro-elements content, i.e., total nitrogen, phosphorus and potassium as well as the total carbohydrates content of the cane

Leaf content of macro-elements

Regarding the effect of bud load, it was quite clear that the highly significant increase of total nitrogen, phosphorus and potassium was achieved from vines pruned with low bud load at 60 buds/vine followed by vines pruned with bud load at 84 buds/vine, while the high bud load at 108 buds/vine resulted in the lowest values in both seasons.

Concerning the effect of fruiting unit length, data indicated that vines pruned with fruiting unit length at 2 buds/spur scored the highest value of total nitrogen, phosphorus and potassium, followed by vines pruned with fruiting unit length at 4 buds/spur,. While the lowest values were achieved from the vines pruned with fruiting unit length at 6 buds/spur in both seasons.

Referring to the interaction effect of various combinations between the bud load and fruiting unit length on leaf content of total nitrogen, phosphorus and potassium, data indicated that the highest significant value of total nitrogen, phosphorus and potassium was attained by vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur had the lowest value of these estimations in both seasons (Table 6).

Cane content of total carbohydrates

Regarding the effect of bud load/vine, it was quite clear that the most remarkable increment of total carbohydrates was attained by vines pruned with low bud load at 60 buds/vine buds/vine followed by vines pruned with bud load at 84 buds/vine. On the other hand, vines pruned with a high bud load at 108 produced the lowest values in both seasons.

Concerning the effect of fruiting unit length, data mentioned that vines pruned with fruiting unit length at 2 buds/spur had the highest value of total carbohydrates, followed by vines pruned with fruiting unit length at 4 buds/spur. While the lowest values was attained with fruiting unit length at 6 buds/spur in both seasons.

Concerning the interaction effect of various combinations between the bud load and fruiting unit length on cane content of total carbohydrates, data showed that the highest significant value of total carbohydrates was achieved from vines pruned with low bud load at 60 buds/vine and fruiting unit length at 2 buds/spur as compared to other combinations, whereas vines pruned with high bud load at 108 buds/vine and fruiting unit length at 6 buds/spur produced the lowest values in both seasons.

These results coincided with those of Ali (2006), El-Helw (2006) and Mekawy and Abo-Elail (2021). They found that leaf content of total nitrogen, phosphorus, and potassium and cane content of total carbohydrates were reduced by increasing bud load. Moreover, Abd El-Ghany (2006), Abbas *et al.* (2008) and Abo-Elwafa (2018) who revealed that vines with long pruning units decreased leaf content of total nitrogen, phosphorus and potassium and cane content of total carbohydrates in comparison with short pruning units.

From the obtained results, it can be concluded that moderate pruning with bud load at 84 buds per vine and fruiting unit length at 4 buds/spur under the Gable trellising system can be recommended for the best results concerning percentages of bud burst, coefficient of bud fertility, yield/vine, fruit quality attributes, vegetative growth aspects and nutritional acquisition of Autumn Crisp grapevines.

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تأثير حمولة البراعم وطول وحدات الإثمار في صنف العنب الأوتم كرسب على النمو والمحصول وجودة الثمار

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تم إجراء هذا البحث بإحدى المزارع الخاصة بمنطقة النوبارية التابعة لمحافظة البحيرة لمدة موسمين متتاليين (2019، 2020) لدراسة تأثير حمولة البراعم وطول وحدات الإثمار على سلوك العيون والنمو والمحصول وجودة الثمار لكرمات عنب الأوتم كرسب. وكانت الكرمات عمرها عشر سنوات، متباعدة على مسافة 2 × 3 متر، نامية في تربة طميية رملية، وتروى بنظام الري بالتنقيط، تم تقليم الكروم خلال الأسبوع الثاني من يناير تقليمًا دابريًا ومرباة تحت نظام تدعيم الجيبل. وقد تم إجراء تسعة معاملات تقليم على النحو التالي: ثلاثة مستويات من حمولة البراعم وهي 60 أو 84 أو 108 برعم لكل كرمة بالإشتراك مع ثلاثة مستويات من طول وحدة الاثمار وهي 2 أو 4 أو 6 برعم لكل دابرة.

أشارت نتائج الدراسة إلى أن التقليم المعتدل بترك حمولة براعم عند 84 برعم لكل كرمة وطول وحدة الاثمار عند 4 براعم لكل دابرة تحت تدعيم نظام الجيبل هو الأفضل لضمان أعلى نسبة من العيون المتفتحة، وكذلك الحصول على محصول جيد ومكوناته، بالاضافة إلى تحسين صفات جودة الثمار والمتمثلة فى الصفات الطبيعية للعناقيد والصفات الطبيعية والكيماوية للحبات مع الحصول على أفضل قياسات خضرية بالإضافة إلى زيادة محتوى الأوراق من النتروجين والفوسفور والبوتاسيوم ومحتوى القصبات من الكربوهيدرات لكرمات العنب الأوتم كرسب.

الكلمات الدالة: تقليم، حمولة البراعم، دابرة، محصول، جودة الثمار، كرمات عنب الأوتم كرسب.