Middle East Journal of Applied Sciences
ISSN 2077-4613

Volume : 08 | Issue :01 |Jan.-Mar.| 2018
Pages: 202-208

Effect of cane length on bud behaviour, growth and productivity of Autumn Royal grapevines

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Received: 21 Nov. 2017 / Accepted: 12 Feb. 2018 / Publication date: 15 Mar. 2018

ABSTRACT

This investigation was carried out for two successive seasons (2014 & 2015) on Autumn Royal grapevines grown in a private vineyard located at El-Beheira Governorate, to study the effect of cane length on bud behaviour, growth and productivity. The vines were seven-years-old, grown in a sandy loam soil and irrigated by a drip irrigation system. Vines were spaced at 2 X 3 meters apart, pruned during the third week of January with a bud load of 120 buds/vine and trellised by the Spanish Parron system. Five different levels of cane length were adopted as follows; 6, 8, 10, 12 and 15 buds per cane.

The results showed that vegetative growth traits, yield and bunch quality attributes were significantly affected by all different pruning levels of cane length in both seasons of this study. Longest canes represented by vines pruned at 15 buds per cane attained higher percentage of bud burst, coefficient of bud fertility and yield, but had a negative impact on berry quality. In contrast, shorter canes represented by vines pruned at 6 buds per cane had better vegetative growth traits and attained a more rapid maturation but both bunch numbers and yield were reduced. On the other hand, vines pruned with cane length of 12 buds per cane showed significantly the optimum results, as it achieved an appropriate balance between vegetative growth aspects, yield and bunch quality attributes including the physical characteristics of bunches and chemical characteristics of berries in both seasons.

Key words: Autumn Royal grapevine**,** cane length, bud behaviour, growth, productivity, bunch quality

Introduction

Pruning is considered the most important practice through which grape production and quality can be improved (Fawzi *et al*., 2010). Pruning the vines for optimum cropping according to the vigour is the most reliable method to maintain balance between growth and production (Senthilkumar *et al*., 2015). The haphazard application of some pruning systems has actually been the main reason for the undesired and unreliable obtained results (Abbas *et al*., 2008).

Adjusting the proper length of the fruiting units will undoubtedly affect the yield and bunch quality. In this respect, many researchers emphasized the importance of the pruning role for improving yield in terms of quality and quantity (Palma *et al.*, 2000; Terry and Rick, 2003; Dawn *et al*., 2004 Abd El-Ghany 2006; Ali, 2006; El-Mogy, 2006 a and b; Abbas, *et al*., 2008; Khamis *et al*., 2008, and Gaser *et al*., 2017).

Autumn Royal is medium-late ripening seedless table grape cultivar, with a large size bunch and berry. Berries are oval-shaped and purple-black to dark blue skin color. This cultivar was developed by USDA-ARS in Fresno, and released in 1996. It resulted from the cross of Autumn Black x C74-1 (Dokoozlian *et al*., 2000). Limited information concerning pruning aspects of this cultivar under Egyptian environmental conditions is available.

Thus, the ultimate target of this investigated was to find out the appropriate cane length of Autumn Royal grapevines to attain a supreme quality crop.

Materials and Methods

This investigation was carried out for two successive seasons (2014 & 2015) on Autumn Royal grapevines grown in a private vineyard located at El-Beheira Governorate, to study the effect of cane length on bud behaviour, growth and productivity. The vines were seven-years-old, grown in a sandy

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loam soil and irrigated by a drip irrigation system. Vines were spaced at 2 X 3 meters apart, pruned during the third week of January with a bud load of 120 buds/vine and trellised by the Spanish Parron system.

Sixty uniform vines were chosen. Each four vines acted as a replicate and each three replicates were pruned at the same cane length as treatment.

Five different levels of cane length were applied as follows; six, eight, ten, twelve or fifteen buds per cane.

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

1. Bud behaviour

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

2. Yield and physical characteristics of bunches

Representative samples of nine bunches/vine were harvested at maturity when TSS reached about 16-17% according to Tourky *et al*. (1995). The following characteristics were determined:
Yield/vine (kg) was determined by multiplying average bunch weight (g) X number of bunches/vine. Average bunch weight (g) and average bunch dimensions (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 determined.

4. Chemical characteristics of berries

Total soluble solids percentage (T.S.S.%) in berry juice was determined by hand refractometer and total titratable acidity expressed as tartaric acid (%) was determined according to A.O.A.C. (1985). TSS /acid ratio was calculated and total anthocyanin of the berry skin (mg/100g fresh weight) was determined according to Husia *et al*. (1965).

5. Morphological characteristics of vegetative growth

At growth cessation, the following morphological and chemical determinations were carried out on three fruitful shoots for each considered vine:

1- Average shoot length (cm)
2- Average number of leaves/shoot
3- Average leaf area (cm^2) of the apical 5^{th} and 6^{th} leaves was taken at full bloom using a CI-203-Laser Area-meter made by CID, Inc., Vancouver, USA.
4- Coefficient of wood ripening was taken on mid-October and calculated by dividing length of the ripened part of the shoot by the total length of the shoot according to Bourard (1966).

6. Leaf content of total chlorophyll and cane content of total carbohydrates

1- Leaf content of total chlorophyll (SPAD)

Samples of leaves were taken at full bloom and total chlorophyll was measured by using nondestructive Minolta chlorophyll meter SPAD 502 of the apical 5^{th} and the 6^{th} leaves (Wood *et al.,* 1992).

2- Cane content of total carbohydrates (%)

Samples of canes were taken at winter pruning (during the third week of January) and it was measured according to Smith *et al*. (1956).

Experimental design and statistical analysis:

The complete randomized block design was adopted for this experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the new L.S.D. values at 5% level.

Results and Discussion

1. Bud behaviour

Data presented in Table (1) show that bud behaviour measurements expressed as bud burst (%) and coefficient of bud fertility were significantly affected by different cane lengths in both seasons.

Concerning the effect of cane length on percentage of bud burst, data reveal that vines pruned with cane length of 15 buds resulted in significantly the highest significant percentage followed by vines pruned with cane length of 12 buds with insignificant differences observed between them. Whereas, cane length of 6 buds induced significantly the least percentage of this parameter in both seasons.

These results are in agreement with those mentioned by Abbas *et al*., (2008); Khamis *et al*., (2008) and Gaser *et al*., (2017) who found that the percentage of sprouted buds increased by increasing cane length.

Regarding the effect of cane length on coefficient of bud fertility, the highest significant value was attained from vines pruned with cane length of 15 buds followed by vines pruned with cane length of 12 buds. No significant differences were observed between them. While the cane length of 6 buds had significantly the least value of this parameter in both seasons.

The results in this respect are in harmony with Abbas *et al*., (2008); Khamis *et al*., (2008) and Gaser *et al*., (2017) who found that vines with long pruning resulted in a higher coefficient of bud fertility in comparison with short pruning.

Table 1: Effect of bud load on bud behaviour of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	Bud burst (%)		Coefficient of bud fertility	
	2014	2015	2014	2015
6	67.91	64.03	0.32	0.33
8	69.32	65.47	0.33	0.34
10	72.65	67.64	0.35	0.35
12	75.48	70.36	0.37	0.37
15	77.23	71.59	0.39	0.38
New LSD (0.05) =	1.89	1.83	0.03	0.02

2. Yield and physical characteristics of bunches

As shown in Table (2), data revealed that yield and bunch physical characteristics expressed as bunch weight and dimensions were significantly affected by different cane length in both seasons.

Concerning the effect of cane length on yield/vine, data revealed that vines pruned with cane length of 15 buds resulted in significantly the highest significant value followed

by vines pruned with cane length of 12 buds. No significant differences were observed between them, whereas the cane length of 6 buds induced significantly the least value of this parameter in both seasons.

These results are in agreement with those mentioned by Khamis *et al*., (2008) and Gaser *et al*., (2017) who displayed that vines with long pruning resulted in a higher significant yield per vine in comparison with short pruning.

Table 2: Effect of bud load on yield and bunch physical characteristics of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	Yield (Kg/tree)		Number of bunches		Bunch weight (g)		Bunch length (cm)		Bunch width (cm)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
6	24.82	26.01	38.02	39.06	652.8	665.8	24.38	24.89	17.52	17.89
8	25.25	26.38	39.48	40.37	639.6	653.6	24.27	24.76	17.43	17.81
10	26.08	26.81	41.99	42.23	621.2	634.9	24.13	24.61	17.27	17.68
12	27.00	27.13	44.54	43.85	606.3	618.6	23.98	24.53	17.11	17.56
15	27.99	27.75	46.81	45.54	598.1	609.2	23.93	24.46	17.03	17.43
New LSD (0.05) =	1.67	1.23	2.47	2.31	21.7	24.9	0.17	0.14	0.12	0.09

Regarding the effect of cane length on number of bunches, the highest significant value was attained from vines pruned with cane length of 15 buds followed by vines pruned with cane length of 12 buds. No significant differences were observed between them, while the cane length of 6 buds had significantly the least number in both seasons.

The results in this respect are in harmony with Abbas *et al*., (2008); Khamis *et al*., (2008) and Gaser *et al*., (2017) who displayed that vines with long pruning resulted in a higher significant number of bunches in comparison with short pruning.

Concerning the effect of cane length on bunch physical characteristics expressed as bunch weight and dimensions, data revealed that vines pruned with cane length of 6 buds resulted in significantly the highest significant value followed by vines pruned with cane length of 8 buds. No significant differences were observed between them, whereas the cane length of 15 buds induced significantly the least values of these parameters in both seasons.

These results coincided with those of Abd El-Ghany (2006); Abbas *et al*., (2008) and Gaser *et al*., (2017) who revealed that vines with long pruning caused a significant reduction in bunch weight and dimensions in comparison with short pruning.

3. Physical characteristics of berries

Data presented in Table (3) show that physical characteristics of berries i.e. berry weight, size and berry dimensions were significantly affected by different cane length in both seasons.

Table 3: Effect of bud load on physical characteristics of berries of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	Berry weight (g)		Berry size (cm^3)		Berry length (cm)		Berry diameter (cm)	
	2014	2015	2014	2015	2014	2015	2014	2015
6	6.65	6.67	6.09	6.33	2.71	2.69	2.08	2.10
8	6.57	6.60	6.02	6.25	2.69	2.68	2.06	2.09
10	6.47	6.52	5.94	6.17	2.67	2.67	2.04	2.08
12	6.38	6.45	5.87	6.06	2.64	2.65	2.03	2.06
15	6.32	6.41	5.83	5.99	2.63	2.64	2.02	2.05
New LSD (0.05) =	0.11	0.08	0.09	0.13	0.03	0.02	0.03	0.02

Vines pruned with cane length of 6 buds resulted in significantly the highest significant values of these characteristics followed by vines pruned with cane length of 8 buds. No significant differences were observed between them, whereas the cane length of 15 buds induced significantly the least values of these ones in both seasons.

The results in this respect are in harmony with Abd El-Ghany (2006); Abbas *et al*., (2008); Khamis *et al*., (2008) and Gaser *et al*., (2017) who showed that vines with short bearers yielded heavier berries in comparison with those with longer ones.

4. Chemical characteristics of berries

As shown in Table (4), data revealed that all berry chemical characteristics; i.e. TSS, Acidity, TSS/acid ratio and anthocyanin content of berry skin were significantly affected by different cane length in both seasons.

Highest significant values of TSS, TSS/acid ratio and anthocyanin content of berry skin and the least significant value of acidity was attained from vines pruned with cane length of 6 buds followed by vines pruned with cane length of 8 buds with insignificant differences observed between them. While the cane length of 15 buds had significantly the least values of these ones except acidity, which take opposite trends in both seasons.

These results coincided with those of Abd El-Ghany (2006); Abbas *et al*., (2008) and Gaser *et al*., (2017) who reveal that vines with long pruning showed a significant reduction in juice TSS percentage, TSS/acid ratio, anthocyanin content in berry skin and an increase in total acidity content of the berry juice in comparison with short pruning.

Table 4: Effect of bud load on chemical characteristics of berries of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	TSS (%)		Acidity (%)		TSS/acid ratio		Anthocyanin (mg/100g fresh weight)	
	2014	2015	2014	2015	2014	2015	2014	2015
6	16.7	17.3	0.63	0.62	26.5	28.0	724.3	774.3
8	16.6	17.1	0.64	0.63	26.1	27.4	653.2	716.9
10	16.4	16.9	0.64	0.64	25.6	26.5	619.8	647.2
12	16.4	16.8	0.65	0.64	25.4	26.2	574.9	593.4
15	16.2	16.7	0.66	0.65	24.7	25.9	491.2	532.8
New LSD (0.05) =	0.2	0.3	0.02	0.01	1.1	0.9	74.3	67.9

5. Morphological characteristics of vegetative growth

Data presented in Table (5) showed that vegetative growth aspects expressed as shoot length, number of leaves per shoot, leaf area/shoot and coefficient of wood ripening were significantly affected by different cane length in both seasons.

Vines pruned with cane length of 6 buds showed significantly the highest significant values of these parameters followed by vines pruned with cane length of 8 buds. No significant differences were observed between them, whereas the cane length of 15 buds induced significantly the least values of these ones in both seasons.

Thus, it could be postulated that the growth reduction due to cane length was in directly proportion to the number of buds per cane left after pruning. In other words increasing the cane length decreased the current season's shoot length, number of leaves per shoot and leaf area/shoot and then this may be attributed to the competition between the shoots in the treatments of long canes.

The results in this respect are in harmony with Abd El-Ghany (2006); Abbas *et al*., (2008); Khamis *et al*., (2008) and Gaser *et al*., (2017) who displayed that vegetative growth aspects was positively affected by level of pruning severity.

Table 5: Effect of bud load on morphological characteristics of vegetative growth of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	Shoot length (cm)		No. of leaves/shoot		Leaf area (cm2)		Coefficient of wood ripening	
	2014	2015	2014	2015	2014	2015	2014	2015
6	195.2	188.6	31.4	30.9	209.1	217.9	0.87	0.91
8	191.4	185.1	30.7	30.3	205.2	210.7	0.86	0.88
10	186.7	181.3	30.1	29.4	200.7	206.4	0.84	0.87
12	182.1	178.4	29.2	28.6	196.4	203.6	0.83	0.86
15	179.3	174.9	28.4	27.9	193.1	201.1	0.82	0.84
New LSD (0.05) =	4.1	4.7	0.9	0.8	6.4	7.6	0.02	0.03

6. Leaf content of total chlorophyll and cane content of total carbohydrates

As shown in Table (6), data revealed that leaf content of total chlorophyll and cane content of total carbohydrates were significantly affected by different cane length in both seasons.

Highest significant values of these contents were attributed to vines pruned with cane length of 6 buds followed by vines pruned with cane length of 8 buds with insignificant differences were observed between them. While the cane length of 15 buds had significantly the least values of these ones in both seasons.

These results coincided with those of Abd El-Ghany (2006); Abbas *et al*., (2008) and Gaser *et al*., (2017) who demonstrated that vines with long pruning units had decreased leaf contents of total chlorophyll and cane content of total carbohydrates in comparison with short pruning units.

Table 6: Effect of bud load on leaf content of total chlorophyll and cane content of total carbohydrates of Autumn Royal grapevines during 2014 and 2015 seasons

Cane length (No. of buds/cane)	Leaf content of total chlorophyll (SPAD)		Cane content of total carbohydrates (%)	
	2014	2015	2014	2015
6	29.7	29.8	31.6	32.1
8	29.5	29.7	31.5	31.9
10	29.3	29.5	31.3	31.7
12	29.1	29.2	31.2	31.5
15	28.8	29.0	30.8	31.2
New LSD (0.05) =	0.3	0.2	0.2	0.3

From the obtained results, it can be concluded that the moderate pruning with cane length of 12 buds can be recommended for the optimum results concerning percentages of bud burst, coefficient of bud fertility, yield/vine, fruit quality properties and vegetative growth traits of Autumn Royal grapevines.

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