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Influence of some Shoots Removal After Harvest Period on Carbohydrates Content, Wood Ripening of Canes, Growth and Yield of Flame Seedless Grapevines

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ABSTRACT

This investigation was conducted for two successive seasons (2017 & 2018 and 2018 & 2019) on Flame seedless grapevines in a private vineyard at El-deer village, Aga, Dakahlia Governorate, Egypt. The chosen vines were 6-years-old, planted in a clay loam soil under surface irrigation system, spaced at 1.5 x 3 meters using spur pruning with quadrilateral cordons training and supported by Gable system. The total load was 48 eyes. The aim of this study was determined the influence of removal of some shoots after harvest period on carbohydrates content, wood ripening, C/N ratio in canes, growth and yield of Flame seedless grapevines. The design treatments was complete randomized blocks and involved four treatments, which included control (without shoots removal), 15% shoots removal, 25% shoots removal and 35% shoots removal after harvest period, by removal the shoots which developed from spurs during the growth seasons. The results showed that there were significant differences between the various shoots removal treatments after harvest period. Removal of shoots at 35% application and control treatment had negative effect on most parameters which were studied. On the other contrary, both of 15% followed by 25% application gave the best results in most parameters which were studied such as total carbohydrate content in cans, wood ripping %, length and diameter of cans, C/N ratio, vegetative growth measurements such as shoot length and leaf surface area, total chlorophyll content in the leaves, yield and its components as well as chemical properties in grape berries.

Keywords: Grape, Flame seedless, summer pruning after harvest and shoots removal

INTRODUCTION

Grape fruit (*vitis vinifera L.*) is considered as one of the greatest fruits for local consumption and export, for being of an excellent savor, lovely taste and high nutritional value. In Egypt, grape fruit is count the second main fruit crop after citrus. The planted area has grown rapidly in the last two decades reaching 196993 feddans producing about 1,686,706 tons according to the statistics of the Ministry of Agriculture (2016). Flame seedless grape is count one of the major varieties important and early cultivars in Egypt.

Summer pruning after harvest period, such as thinning of some shoots after harvesting, is a agricultural process excessively used by some grape growers in Delta region of Egypt with aim improve the lighting with purpose intercropping the farm with other crops, Subsequently grape producers needs to have enough information of grapevines management during the growing season to achieve the preferable yield from a grapevines.

Summer pruning is one of the most important agricultural processes that carried out in vineyards. The importance of summer pruning is that it's complementary to previous winter pruning and an initial practice of subsequent winter pruning. Disregard or carrying out summer pruning incorrectly leads to most the shoots of the current season do not ripen well. Perhaps due to the consumption of assimilates manufactured in the leaves for the continuity of shoot growth instead of being stored in some vine parts as canes for the subsequent winter pruning Samra, *et al.* (2007) Also, impact on the production and physical and chemicals properties on berries of the current season in addition to the following season. (Ikinci 2014 and El- Boray *et al.* 2018)

In some grape cultivars high crop loads such as Flame seedless lead to inconstancy in production in the next year Scholefield *et al.* (1978). Consequently, this may even reduce or limit vines growth such as root growth and shoot development Holzapfel *et al.* (2006).This statement highlights the importance of after harvesting period for preserving the productivity of high-yielding grapevines Scholefield *et al.* (1978).

Technical viticulture process, such as shoot thinning, defoliation, branch tipping, and topping can be used to decrease the shadow inside the vines Raath and Du Plessis (2012). Using the above practices will led to enhance in the growth of the residual shoots and reducing canopy shade and improving light intensity, improve solar radiation interception, resistant diseases and pests and photosynthetic activity that can led to an enhancement in bud fertility of grapevines (Hunter and Visser 1988; Hunter *et al.* 1995; Poni *et al.* 2006; Strydom 2006 and Human 2010).

Summer pruning such as shoots thinning on postharvest period, is a technical practice greatly used by some grape growers in the Orange River region of South Africa. This practice will increase the sunlight received by the leaves in inside the vines and increase accumulation of carbohydrates in canes consequently improve bud fertility in the next season. Links (2014).

Fruitfulness is also affected by factors, such as the carbohydrate content in vines and vegetative growth management, such as shoots thinning Bennett *et al.* (2005).

Shoot thinning is a common and well viticulture practice for (*Vitis vinifera L.*) Reynolds *et al.* (2005). It is generally an effective and inexpensive method for reducing yields and increasing canopy openness Reynolds, (1989) often leading to increased canopy photosynthesis and bud fruitfulness Cahoon and Nonnecke (1982) When shoots spacing is optimized, the vine is more efficient at radiation interception Smart (1988).

Reynolds *et al.* (2005) reported that when shoots are removed at postharvest period, the carbohydrate content of the vine reduced which, leads in a reduction in crop load and vegetative growth in the next season.

The target of this investigation was determining the impact of removing some shoots after harvest on carbohydrates content, wood ripening, growth and yield of Flame seedless grapevines.

MATERIALS AND METHODS

This study was conducted during two successive seasons (2017 & 2018 and 2018 & 2019) in a private vineyard at El-deer village, Aga, Dakahlia Governorate,

Egypt. The experiment was carried out on 6-years-old Flame seedless grapevines cultivar. Vines were planted at 1.5 x 3 m. in a clay loam soil with surface irrigation system. Vines were trained to quadrilateral cordon trellised using Gable supporting system. During January of each experimental season, the selected vines were spur-pruned by leaving 6 spurs with 2 eyes on each cordon. The total load was 48 eyes. Forty eight vines were selected for this investigation uniform in vigor as possible, all vines treated with the cultural practice, such as dormex spraying, fertilization, irrigation, diseases and pests resistant that usually used in this region.

After harvesting clusters of grapes in the third week of July during the two season of study, shoots removal process were done on the tested vines by removing about 15, 25 and 35% from shoots which developed from spurs (48 eyes) during the growth seasons. Also, shoots in unfavorably positions were removed and then the final dose of the mineral fertilizers was added, which represents about 25% of the recommended fertilizer then the farm was irrigated. The experiment consists of four treatments arranged in a complete randomize blocks design, each treatment include 3 replicates, each contain 4 vines.

The treatments were conducted as the following:

1- Control (without shoots removal)
2- 15 % shoots removal after harvesting
3- 25 % shoots removal after harvesting
4- 35 % shoots removal after harvesting

The following measurements were recorded during the two experimental seasons:

1- Measurements at dormancy time

At winter pruning time in the second week of January during the two years (2018 and 2019), the following morphological and chemical properties of canes were carried out as follow :

a- Internodes length (cm): b- Internodes diameter (cm):
c- Trunk diameter (cm): d- Weight of wood pruning (kg).
e- Wood ripening (%): Twelve shoots for each replicated were taken to determine the rate of wood ripening which calculated by dividing length of the mature part on the total shoot length.
f- Total carbohydrates in canes (%): were estimated according to Schaffer and Hartman (1921).
g- Total Nitrogen in canes**:** was estimated by the micro-kieldahl method according to Cottenie *et al.* (1982).
h- C/N ratio: It was estimated by the data obtained of C and N

2- Coefficient bud fertility:

Coefficient of bud fertility was calculated as follows according to Bessis, (1960).

$$\text{Coefficient of bud fertility} = \frac{\text{No of clusters per vine}}{\text{No of Total buds left at winter pruning}}$$

3-Vegetative growth parameters

Vegetative growth parameters were determined at full bloom from non-fruiting shoots as follows:

- Average shoots length (cm).
- Average leaf surface area (cm^2): The apical 6^{th} and 7^{th} leaves of the growing shoot were taken for leaf surface area determination according to Montero *et al.* (2000).

4- Chlorophyll content in the leaves (mg/g fresh weight).

The apical 6^{th} and 7^{th} leaves of the growing shoots were picked for the estimated of total chlorophyll content in the leaves at full bloom according to Mackinny (1941).

5- Yield and its components:-

Total number of clusters per vine was recorded and at harvesting time when SSC % in berry recorded about 16-17 % in control treatment Sabry *et al.* (2009), six clusters /vine was weighted and the average cluster weight was multiplied by number of clusters/vine and hence average yield/vine was calculated.

6- Physical properties of cluster and berries:

A sample of 6 clusters / vine was taken for measurement:

- Average cluster weight (g).
-Average of 100 berry weight (g).

7- Chemical properties of berries:

- Percentage of soluble solids content (SSC %) was measurement by using a hand refractometer.
- Percentage of total acidity (as g tartaric acid /100 ml juice) by titration against 0.1 N Na OH using phenolphthalein as described by A.O.A.C. (1980).
- Total anthocyanin of the berry skin (mg/100g fresh weight) was calculated according to Husia *et al.* (1965).
- Percentage of total sugars % was carried out according to the modified methods of Sadasivam and Manickam (1996).

Statistically analysis

The obtained results were statistically analysis according to Snedecor and Chocran (1980).Using the new L.S.D. values at 5% level to compare the differences among various treatments.

RESULTS AND DISCUSSION

1- Measurements at dormancy time:

Internodes length and diameter, trunk diameter and pruning wood weight

It is revealed from (Table, 1) that, all the used treatments either without shoots removal (control) or 15, 25 and 35 % shoots removal after harvest at summer period gave non-significant differences on internodes length in both seasons and trunk diameter in the first season. Also, there were non-significant differences between control, 25 and 35 % shoots removal on internodes diameter in the two seasons of this study and trunk diameter in the second year. The maximum values of internodes length and diameter and trunk diameter were obtained from applications of 15 and 25 % shoots removal with non-significant differences between of them. Also, the data showed that control and 15 % shoots removal treatments gave the maximum significant values of pruning wood weight at winter pruning and non-significant differences between of them while, 35% shoots removal application gave the minimum significant values of pruning wood during the two seasons of study where, density of shoots removal (35%) after harvest at summer time may be reduced of pruning wood weight at winter pruning.

The highest values of internodes length, internodes diameter and trunk diameter as result of applications of 15 and 25 % shoots removal after harvest at summer time may be lead to improve the sunlight that received by the leaves in inside of the vines, leading to enhance the process of photosynthesis of the leaves thus, increasing carbohydrates content in the shoots Kliewer (1981) which led to enhance the intensity and activity of the roots Hunter and Le Roux (1992) and increase their absorption of nutrients which reflected on vine vigor growth consequently the previous parameters.

Table 1. Effect of shoots removal after harvest on internodes length and diameter, trunk diameter and pruning wood weight of Flame seedless grapevines during 2018 and 2019 seasons

Measurements / Treatments	Internode length (cm)		Internode diameter (cm)		Trunk diameter (cm)		Pruning wood weight (Kg)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (without shoots removal)	9.00	9.60	1.23	1.26	4.30	4.93	2.49	2.70
15% shoots removal	9.50	10.3	1.43	1.33	4.60	5.46	2.36	2.46
25% shoots removal	9.20	10.2	1.33	1.28	4.53	5.16	2.10	2.25
35% shoots removal	9.10	9.8	1.20	1.16	4.26	4.82	1.76	1.92
New L.S.D at 5%	N.S	N.S	0.16	0.14	N.S	0.42	0.31	0.30

These results are in agreement with those mentioned that (Marini 1985 and Ikinci 2014) they found that summer pruning increased shoot diameter and trunk enlargement

Wood ripening, total carbohydrates (C), total nitrogen (N) and C/N ratio in canes:

Data in (Table, 2) cleared that the application of 15 % shoots removal after harvest at summer period followed by 25 % shoots removal treatment significant increased the rate of wood ripening %, total carbohydrates (C) %, and C/N ratio in canes as compared with control and 35 % shoots removal treatments while, 15% shoots removal and control treatments significantly reduced total nitrogen (N) %, in canes as compared to 25 and 35 % shoots removal applications which, gave the maximum significant values in total nitrogen (N) in canes. Also, the data showed that the maximum significant values of wood ripening, total carbohydrates (C) and C/N ratio in canes and the lowest values of total nitrogen (N) in canes were obtained from 15% shoots removal in both seasons after harvest at summer time.

The increment in total carbohydrate content and C/N ratio of canes as results of removing some shoots after harvest may be attributed to enhance the light rays that received by the leaves into the vines, leading to enhance the photosynthesis activity of the leaves and therefore increase the accumulation of carbohydrates in cans Kliewer (1981). Where there is a positive relationship between the accumulation of carbohydrates in the cans and the rates of wood ripping Winkler (1965), this explains the increased of wood ripening %. Also, the increment in total nitrogen (N) in canes as results application of 25 and 35% shoots removal could be due to fewer remaining shoots (cans) on vine and increase their absorption of nutrients, especially nitrogen.

These data are in line with these obtained by Ghada (2015) and El-Boray *et al.* (2018) they reported that carbohydrates content in the canes and rate of wood ripening significant increased by applications of shoots thinning. Also, Abd El-Razek *et al.* (2010) found that the excrescent of leave thinning may be decreased accumulation of carbohydrates in cans

Table 2. Effect of shoots removal after harvest on wood ripening%, total carbohydrates (C) %, total nitrogen (N) % and C/N ratio in canes of Flame seedless grapevines during 2018 and 2019 seasons

Measurements / Treatments	Wood ripening (%)		C (%)		N (%)		C/N ratio	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (without shoots removal)	79.1	79.5	23.4	24.2	0.85	0.90	27.53	26.89
15% shoots removal	86.4	86.7	27.3	28.8	0.80	0.87	34.13	33.13
25% shoots removal	84.4	85.3	26.8	27.9	0.93	1.00	28.82	27.90
35% shoots removal	80.4	81.0	22.9	23.4	1.06	1.02	21.60	22.94
New L.S.D at 5%	2.15	2.41	0.45	0.60	0.06	0.05	1.67	1.87

(2, 3 and 4) Bud fertility, vegetative growth and chlorophyll content in the leaves parameters

The results in (Table, 3) revealed that, all the used applications either without shoots removal (control) or 15, 25 and 35% shoots removal applications after harvest at summer time gave non-significant differences on bud fertility in first year while, in the second year 35% shoots removal application gave the minimum rates of bud fertility as compared with 15 and 25 % shoots removal treatments which, gave the maximum significant rates in bud fertility and non-significant differences between of them.

The increment in bud fertility as a results of using summer pruning after harvest especially at 15 and 25 % shoots removal applications may be attributed to that shoots thinning lead to increase the sunlight received by the leaves in inside the vines, leading to increase the process of photosynthesis of the leaves consequently increases of carbohydrate accumulation Kliewer (1981) this reflected on increasing C/N ratio in cans consequently this is positive effect on bud fertility on the following season whereas, studies previous assure that there is a positive correlation between carbohydrate accumulation, fertility and yield also, the number and size of inflorescence primordial within the buds are positively affected by the carbohydrate levels in cans (Candolfi-Vasconcelos and Koblet 1990; Hunter *et al.* 1995 and Sommer *et al.* 2000).

Also, data showed that shoot length, leaf surface area and total chlorophyll in leaves were significant increased with 15 and 25% shoots removal applications as compared with control (without shoots removal) and 35 % shoots removal applications which, gave the lowest rates in this regard in both seasons of study with non-significant differences between of them.

These results are in harmony with those obtained by Bennett (2002) who found that vegetative growth parameters was reduced by increasing intensities of defoliation in the previous season.

The positive impact of shoots thinning after harvesting on improving shoot length and leaf surface area in addition, increasing total chlorophyll in leaves as shown in 15 and 25% shoots removal applications may be clarify through that shoots removal lets more light to enter into the vines and increase the photosynthetic intensity of the leaves consequently increases of carbohydrate accumulation in the remained shoots which, increase root density (Hunter and Le Roux (1992) and enhance elements absorption and

transmission of more carbohydrates which reflects on the enhancement in vegetative growth parameters in the following season. (Hunter and Visser (1990).

The obtained results are in agreement with the findings of El-Boray *et al.* (2018). Also, Ghada (2015) found that shoots thinning of Black Monukka and Red Globe grapevines improved morphological characteristics of vegetative growth, leaf content of total chlorophyll as compared to without shoot thinning (control).

Table 3. Effect of shoots removal after harvest on coefficient of bud fertility, shoot length, leaf area and total chlorophyll in leaves of Flame seedless grapevines on 2018 and 2019 seasons

Measurements Treatments	Coefficient of bud fertility		Shoot length (cm)		Leaf area (cm^2)		Total chlorophyll (mg/g F.W)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (without shoots removal)	0.49	0.50	168	174	118	120	9.11	9.23
15% shoots removal	0.49	0.52	178	182	129	136	9.44	9.52
25% shoots removal	0.51	0.51	182	188	126	130	9.57	9.60
35% shoots removal	0.47	0.49	164	172	108	110	8.90	9.12
New L.S.D at 5%	N.S	0.02	8.0	7.0	8.0	10.0	0.52	0.21

(5 and 6) Yield and its components as well as physical properties of clusters and berries:

The obtained result in (Table, 4) proved that all removing some shoots applications after harvest gave non-significantly effect on No. of clusters as compared to control (without shoots removal) in first year while, in the second year 15 and 25 % shoots removal treatments gave the highest significant values of No. of cluster as compared to control (without shoots removal) and 35 % shoots removal applications which, recorded the lowest significant values in this regards. Also, data showed that cluster weight (g), yield/ vine (Kg) and average 100 berries weight (g) were significant increased with 15 and 25 % shoots removal applications as compared with control (without shoots removal) and 35% shoots removal applications during the two years of this investigation. Also, the results indicated that 15 % shoots removal application was superior over the rest of treatments on enhanced cluster weight, yield/ vine and average 100 berries weight in the two years of study. Also, the data showed non-significant differences between 15 and 25 % shoots removal treatments and between control (without shoots removal) and 35% shoot removal treatments on yield/ vine and 100 berries weight in both seasons.

The positive effect of removing some shoots after harvest on yield and its components as well as 100 berries weight especially in the second seasons could be attributed to increasing bud fertility and number of cluster where, previous studies proved that there is relationship among carbohydrates content, bud fertility and yield (Candolfi-Vasconcelos and Koblet 1990; Hunter *et al*., 1995 and Sommer *et al*., 2000). Also, enhancing of leaf area and total chlorophyll as shown in (Table, 3) led to enhance in photosynthetic activity of leaves consequentially increased carbohydrate accumulation then transmission its from leaves to berries which encourage an increase in sugars in the berries, subsequently elevating its osmotic pressure and attraction force of water consequently improving physical berries and cluster characteristics

These data are agree to the mentioned by (Reynolds *et al*. 1994; Morris *et al*. 2004;Ghada, 2015 and El-Boray *et al*. 2018) they reported that shoots thinning improved yield and its components and physical properties of cluster and berries.

Table 4. Effect of shoots removal after harvest on No. of clusters, cluster weight, yield/vine and average 100 berry weights of Flame seedless grapes on 2018 and 2019 seasons

Measurements Treatments	No. of clusters		Cluster weight (g)		Yield/vine (Kg)		average 100 berry weight (g)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (without shoots removal)	23.3	24.0	458	466	10.69	11.17	244	252
15% shoots removal	23.7	25.0	492	495	11.66	12.37	280	284
25% shoots removal	24.3	24.7	475	485	11.54	11.97	270	276
35% shoots removal	22.7	23.3	452	458	10.24	10.68	239	247
New L.S.D at 5%	N.S	0.7	16.0	12.0	0.78	0.52	11.0	16.0

(7) Soluble solids content, total acidity, total sugar and anthocyanin content %:

It is obvious from the results in (Table, 5) that the applications of 15 and 25 % shoots removal after harvest recorded the highest significant values of soluble solids content%, total sugar % and total anthocyanin and the lowest significant values of total acidity % in berries as compared to control (without shoot removal) and 35 % shoots removal in the two years. In this concern, maximum significant values were obtained due to 15% shoot removal application in both seasons. On the other hand, the minimum significant values of soluble solids content, total sugar % and total anthocyanin and the maximum values of total acidity% in berries were obtained from 35 % shoots removal application in both seasons.

The beneficial effects of removing some shoots after harvest at summer time especially at 15 and 25 % shoots thinning applications on SSC, total acidity, total sugar and total anthocyanin of Flame seedless grapes have been attributed to improving of shoot length and leaf surface area in addition, total chlorophyll in leaves as shown in (Table 3) which, led to the enhance in photosynthetic activity of leaves consequentially increased carbohydrate accumulation surely reflected on improving chemical properties in berries. These findings are in harmony with (Morris *et al.* 2004; Ghada 2015 and El-Boray *et al.* 2018) they ensured that thinning some shoots improved chemical properties in the berries.

Table 5. Effect of shoots removal after harvest on SSC, total acidity, total sugar and total anthocyanin of Flame seedless grapes berries during 2018 and 2019 seasons

Measurements	SSC (%)		Total Acidity (%)		Total sugars (%)		Total anthocyanin (mg/100g F.W)	
Treatments	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Control (without shoots removal)	16.7	16.6	0.65	0.66	14.70	14.80	47.2	47.90
15% shoots removal	17.9	18.4	0.60	0.57	15.90	16.40	49.80	49.20
25% shoots removal	17.5	18.2	0.62	0.58	15.50	16.20	49.50	48.90
35% shoots removal	16.4	16.5	0.68	0.67	14.4	14.50	46.90	47.38
New L.S.D at 5%	0.30	0.20	0.04	0.02	0.31	0.27	0.12	0.19

CONCLUSION

From this investigation, it can be concluded that partial shoots removal after harvest period such as 15-25 % shoots removal from shoots which developed from spurs during the growth seasons are considered to be very important practice in Flame seedless vineyards in Delta region of Egypt, this practice accelerated of carbohydrate accumulation and ripening of wood which, was positive reflected on the enhancement in vegetative growth parameters, yield and quality in the following season.

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تأثير إزالة بعض الأفرع بعد الحصاد على المحتوى الكربوهيدراتى ونضج الخشب والنمو والمحصول لعنب الفليم سيدلس

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أجريت هذة الدراسة خلال موسمى 2017-2018 & 2018- 2019 فى مزرعة خاصة فى قرية الدير التابعة لمركز أجا محافظة الدقهلية على كرمات عنب فليم سيدلس عمرها 6 سنوات ومنزرعة فى تربة طينية وتروى بالغمر ومنزرعة على مسافة 3x1.5 م ومرباه بالطريقة الكردونية وتحت نظام تدعيم الجيبل. وكان الهدف من الدراسة هو دراسة تأثير إزالة بعض الأفرع بعد جمع المحصول على نضج الخشب والمحتوى الكربوهيدراتي والنمو والمحصول التالى لعنب الفليم سيدلس. حيث تم إزالة 15&25&35% من الأفرع النامية من الدوابرخلال موسم وكذلك إزالة الافرع النامية فى أماكن غير مرغوب فيها وذلك بعد الانتهاء من جمع المحصول وقبل إضافة الجرعة الأخيرة من التسميد المعدنى . وقد أظهرت النتائج أن هناك إختلافات كبيرة بين معاملات التقليم الصيفى المختلفة حيث أن إزالة عدد كبير من الأفرع مثل إزالة 35% من الأفرع وكذلك عدم ازالة أى أفرع (الكنترول) كان لة تأثير سلبى على معظم الصفات المدروسة. وكان على العكس تماما المعاملة بازالة 15% من الأفرع يليها معاملة إزالة 25 % من الأفرع حيث أعطت هاتين المعاملتين أفضل النتائج فى الصفات المدروسة مثل الكربوهيدرات الكلية فى القصبات ونضج الخشب وطول وسمك السلامية ونسبة الكربوهيدرات الكلية الى النتروجين الكلى فى القصبات وكذلك قياسات النمو الخضرى مثل طول الأفرع والمساحة الورقية وكذلك الكلورفيل الكلى فى الأوراق وأيضا المحصول ومكوناتة وكذلك صفات الجودة فى الحبات . ولذلك يوصى بإزالة من 15- 25% من الأفرع النامية من الدوابرخلال موسم وذلك بعد جمع المحصول على صنف الفليم سيدلس فى منطقة الدلتا حيث أدى ذلك الى زيادة الكربوهيدرات الكلية فى القصبات وزيادة نضج الخشب وقد إنعكس ذلك على تحسن فى قياسات النمو الخضرى والمحصول والجودة فى الموسم التالى.