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A STUDY ON THE POSSIBILITY OF IMPROVING COLORATION OF CRIMSON SEEDLESS GRAPES UNDER DESERT CONDITIONS VIA THE APPLICATION OF SOME TREATMENTS
B- SUMMER PRUNING AND GIRDLING

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ABSTRACT

Proper fruit maturity for commercial production, high yield with superior fruit quality are the assurance for profitability of grape vine orchards. Crimson Seedless plantations are currently blooming in the newly reclaimed desert areas. Lack of proper canopy management practices is frequently encountered; therefore the effects of summer pruning and girdling, pinching and leaf or shoot removal were evaluated.

Summer pruning increased cluster weight, yield per vine, berry length and diameter. It also brought about significant increments in berry adherence, firmness, leaf surface area, TSS, acidity, TSS/acid and anthocyanin content in berry skin, alone or when accentuated by girdling. However, pinching of the main shoots decreased berry length and diameter and coincided with the lowest values of TSS, acidity, TSS/acid and berry colour as well as the percentage of full coloured berries (F.C.B.). Summer pruning and/or girdling can be applied to improve berry colouration, conversely, leaf removal delayed its beginning. Hence, summer pruning help ameliorate fruit quality by more exposure to sunlight and resulting in high concentrations of sugars, lower acidity and high contents of anthocyanins. It proved to be an effective tool fulfilling a balance

between canopy density and air temperature, and further allowed more light penetration which resulted in enhancing an appropriate fruit maturity and colour.

words: *coloration, girdling ,grapes- summer pruning, yield.*

1. INTRODUCTION

Crimson seedless is the latest ripening red seedless table grape variety currently produced in Egypt. This variety has been favourably received by the retail trade due to its excellent eating characteristics. Crimson seedless berries are crisp and firm. This variety is highly vigorous when planted on its own roots. Lacking of sufficient berry colour is a very serious problem associated with the production of Crimson Seedless cultivar. Hence, the proper canopy management practices are essential for the successful production of this variety. Shading has been identified as a major factor in reducing grapevine yields and fruit quality (Smart, 1985). Leaf removal in the fruiting zone, facilitat- air movement and reduces disease incidence (Gubler and Marois, 1987). By ameliorating fruit exposure to sunlight, it also contributes to improving fruit quality (Smart, 1987). Fruits well-exposed to sunlight generally exhibit higher concentrations of sugars and lower acidity in grape juice compared to those ripened in dense canopy shade (Kliewer *et al.*, 1988). It is critical that clusters must be exposed to sunlight during ripening for maximum colouration (Dokoozlian *et al.*, 1995). Thus, leaf removal as a canopy management practice is an important tool for improving the microclimate inside the grapevine canopy especially in the fruiting zone.

Girdling at the beginning of ripening phase (veraison) has been reported to enhance fruit color and to advance fruit ripening of Crimson Seedless (Dokoozalian *et al.*, 1995).

The aim of this study was to improve the fruit quality and colour of Crimson Seedless grapes through approaching canopy management practices.

2. MATERIALS AND METHODS

This work was conducted for two consecutive seasons (2004 and 2005) in a private vineyard located at the76 Km of Cairo-

Alexandria desert road. The vines were 5-years-old growing in a sandy soil and irrigated *via* drip irrigation system and supported by Spanish parron. Ninety vines were specified for this study (6 treatments × 3 replicates × 5 vines/replicate). The vines were of normal growth, uniform in vigor and were subjected to the same horticultural practices. The bud load/vine was fixed to 8 canes each of 10 buds. The experimental design was randomized complete blocks. The treatments were : control, girdling (G) at veraison by removing a complete ring of the bark using 4mm wide girdling knife and pinching (P) main shoots after reaching 120-150cm. After fruit set the leaves beneath the clusters were removed (LR). Shoot removal (SR) must be done at the beginning of the season, when the green shoots have reached a 15-20cm length. At this stage, it is possible to define if the shoot is bearing bunch in a good position or if it is well located as a pruning material for the next year. If the green shoots are not under these conditions, then it must be removed. These treatments were carried out either alone or in combination : SPr = (P + LR + SR) and SPrG = (G + P + LR + SR). The number of clusters was adjusted to 32 cluster/vine.

Evaluation of the tested treatments was carried out through the following parameters: Average weight of cluster (g.), berry weight (g) as an average of 100 berries/replicate, berry length (cm) and diameter, yield/vine(kg), percentage of full coloured berries (F.C.B.%) calculated by dividing weight of full-coloured berries by total weight of berries, TSS and acidity according to A.O.A.C. (1985). Anthocyanin was determined by the method outlined by Yilidz and Dikmen 1990, and relationship between colour and TSS development were estimated at five day intervals beginning from veraison till harvest.

The total surface area of the leaves/vine was determined as follows : the mean leaf area was multiplied by the number of leaves/shoot and by number of shoots/vine, (using leaf area meter, Model CI 203, USA).

Microclimate data of the vine (canopy temperature and light intensity) were estimated by Schedular plant stress monitor Model R/O Consuitant made by Standard oil company, U.S.A. These parameters were recorded two weeks after the beginning of colouration at the harvest date.

Duncan's multiple range test at p=0.05 was followed to compare the averages as mentioned by Snedecor and Cochran (1980).

3. RESULTS AND DISCUSSION

3.1. Fruit physical characteristics

3.2. Yield/vine, cluster weight and weight of 100 berries

It is obvious from Table (1) that summer pruning alone or accompanied by girdling significantly increased cluster weight, weight of 100 berries and yield per vine. The increase in the yield in the combined treatments was due to the increase in cluster weight rather than weight of 100 berries since the number of clusters was adjusted to 32/vine. In the first season, it is interesting to mention that the combined treatment increased the yield by increasing the number of berries in the cluster as compared with summer pruning alone. These findings agreed with those reported by Lebedeva and Chabala (1971) , Tursunov (1975) and Elgendy (1995).

The considerable lower values of cluster weight observed in girdling treatment as compared to the other treatments could be assumed primarily to the low average weight of the berries per cluster. Similar results were reported by Omar and Girgis (2005) who noted that girdling at veraison had no effect on the yield.

3.3. Berry length and diameter

Berry length and diameter were significantly increased as a result of summer pruning plus girdling and/or summer pruning alone in comparison with the other treatments and the control, while, girdling the vines at veraison or leaf removal had significant low effect on berry length and diameter as compared with the other treatments, but its superiority was only over the control (Table 1). These results are in line with the those of Omar and Girgis (2005). However, pinching of the main shoots as well as shoot removal have significantly decreased the average of berry length and diameter for the two studied seasons. The increase in berry dimensions observed in most of summer pruning treatments can be attributed to the increase in the photosynthetic activity of the leaves, thus resulting in an increase in the rate of immigration of assimilates from the leaves towards clusters. Similar results were obtained by Elgendy (1995) and Ryabchum (1975).

Table (1) : Influence of summer pruning treatments and girdling on yield and fruit physical properties of Crimson Seedless grape during 2004 and 2005 seasons

	Yield (Kg/vine)		Cluster wt. (g)		Weight of 100 berries (g.)		Berry length (cm)		Berry diameter (cm)		Adherence strength (g.)		Firmness (g/cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
P	16.19 b	16.86 b	506 b	527 b	316 c	321 c	2.22 c	2.28 c	1.55 c	1.64 d	495 c	515 c	580 b	605 cd
SR	15.46 c	16.06 c	483 c	502 c	296 d	299 d	2.28 b	2.37 b	1.63 b	1.70 c	485 c	540 c	585 b	620 bc
LR	14.62 d	15.23 d	457 d	476 d	280 e	285 e	2.15 d	2.20 d	1.40 d	1.52 f	470 d	520 c	540 b	595 d
S.Pr	17.22 a	17.70 a	538 a	553 a	332 b	347 b	2.35 a	2.43 a	1.70 a	1.77 b	550 b	575 b	590 b	630 b
G	14.37 d	14.88 d	449 d	465 d	278 e	281 e	2.08 e	2.12 e	1.49 e	1.58 e	465 d	485 d	579 b	590 d
S.Pr + G	18.05 a	18.18 a	564 a	568 a	380 a	396 a	2.38 a	2.45 a	1.74 a	1.83 a	580 a	610 a	610 a	665 a
Control	12.96 e	13.28 e	405 e	415 e	258 f	261 f	2.00 f	2.05 f	1.37 f	1.40 g	435 e	450 e	480 d	550 e

P : Pinching
SR : Shoot removal
LR : Leaf removal
S.Pr. : Summer pruning (P+SR+LR)
G : Girdling at veraison
S.Pr. + G : Summer pruning + girdling

3.4. Adherence strength and firmness

Summer pruning plus girdling had significantly the highest increase in berry adherence and firmness in both seasons of the study (Table, 1). It was followed by summer pruning. However, no significant differences could be detected between shoot removal and pinching or girdling and leaf removal treatments. Yet, the lowest values of these parameters were significantly attained by the control.

3.5. Leaf surface area/vine

It is evident from Fig. (1) that, the average leaf surface area per vine of Crimson Seedless grapevine at the end of the studied seasons was significantly increased by summer pruning and its combination with girdling as compared to all other treatments and the control. They were followed by pinching and then leaf removal which came next, whereas the lowest values were obtained by the control. Conversely, girdling and shoot removal treatments in descending order significantly decreased the average leaf surface area/vine during the two seasons, although they were better than the control. The results of the present study are in parallel with those of Elgendy (1995) who found that summer pruning was superior in this respect and increased leaf area. Closely related to this topic is the work of Koblet *et al.* (1994) who stated that increasing leaf removal resulted in a significant reduction in the leaf area, which confirms our findings. A contradicting finding was found by Ryabchum (1975) who disclosed that, pinching applied on some grape varieties resulted in decreasing total the leaf surface area.

3.6. Fruit chemical characteristics

3.7. TSS, acidity and TSS/acid ratio

Data presented in Table (2) clearly indicate that, there was a tendency towards increases in TSS and TSS/acid ratio and significant decrease in the total acidity of berries attributed to summer pruning plus girdling treatment as compared to other tested treatments and control in the two seasons of study. Girdling proved to achieve the best results as compared to other treatments and control. In other

Table (2) : Influence of summer pruning treatments and girdling on fruit chemical properties and berry colouration of Crimson Seedless grape during 2004 and 2005 seasons

	TSS		Acidity		TSS/acid		Anthocyanin (mg/100g)		F.C.B %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
P	18.50 de	19.10 e	0.54 b	0.49 c	34.26 de	38.98 de	52.30 d	61.66 c	58 e	62 e
SR	18.80 d	19.70 d	0.53 bc	0.45 d	35.47 cd	43.78 cd	59.60 c	63.62 c	70 d	78 d
LR	18.00 e	18.80 e	0.57 b	0.53 b	31.58 e	35.47 e	50.98 e	54.93 d	46 f	58 f
S.Pr	19.20 c	20.40 c	0.49 c	0.42 d	39.18 c	48.57 c	66.72 b	70.81 b	77 c	86 c
G	20.80 b	21.60 b	0.40 d	0.38 e	52.00 b	56.84 b	75.85 a	78.56 a	85 b	91 b
S.Pr + G	21.50 a	22.30 a	0.38 d	0.34 f	56.58 a	65.59 a	78.90 a	80.30 a	92 a	95 a
Control	16.60 f	17.40 f	0.66 a	0.57 a	25.15 f	30.53 f	42.40 f	46.71 e	42 g	51 g

P : Pinching
SR : Shoot removal
LR : Leaf removal
S.Pr. : Summer pruning (P+SR+LR)
G : Girdling at veraison
S.Pr. + G : Summer pruning + girdling

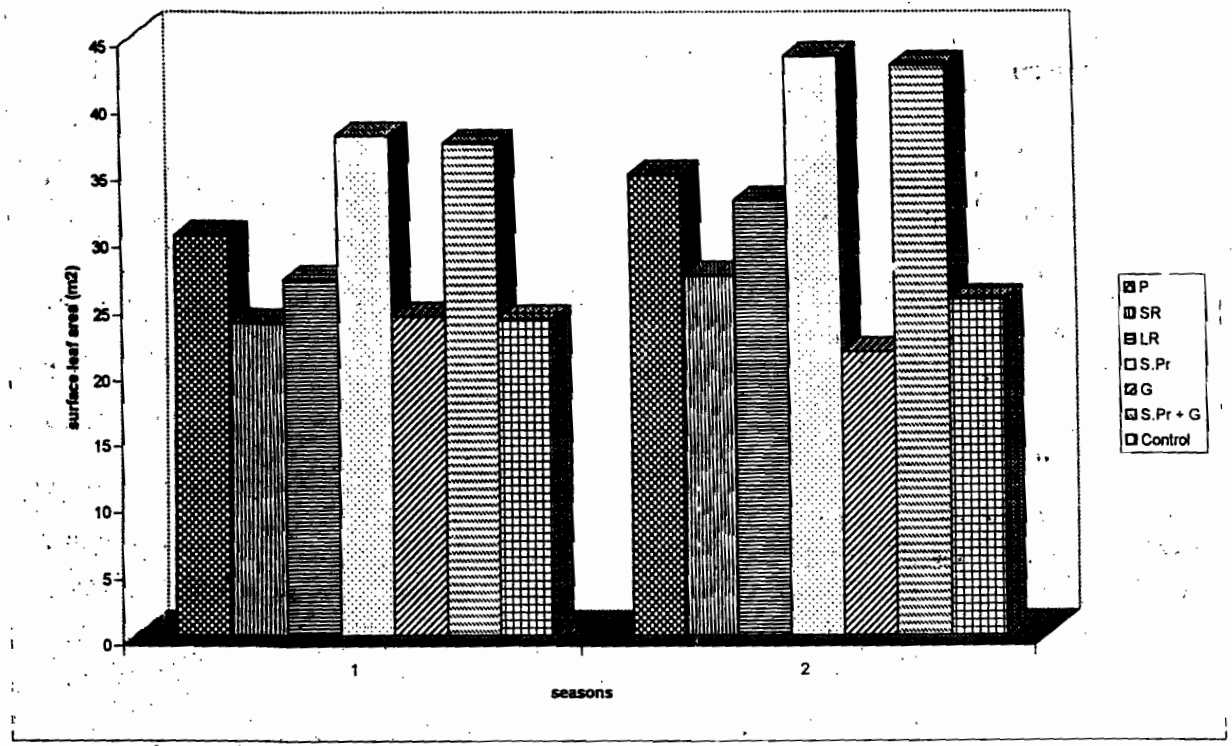

Fig. (1) : Influence of summer pruning and girdling on surface leaf area of Crimson Seedless grapevine during 2004 and 2005 seasons.

P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison,
S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

words, it can be stated that, girdling tended to prevent the movement of manufactured food from the fruiting area and thus resulted in an increase in sugar content of grape fruits. These results are in accordance with those obtained by Kim *et al.* (1991) and Kondrya *et al.* (1984) who found that carrying out girdling at veraison stage considerably enhanced the total soluble solids of Campball grape. Moreover, Weaver (1976) reported that girdling at veraison increased carbohydrates in the parts over the wound. On the other hand, summer pruning was superior to other treatments as it included pinching of the main shoots, shoot removal and leaf removal under cluster. Thus, the favorable influence of summer pruning was represented by the increase in TSS which could be explained in light of the fact that, summer pruning helps in promoting vigour of the remaining shoots, the number of their leaves and leaf surface area, thus clusters are well supplied with assimilates. Palma *et al.* (2000) found that improving the balance between vegetative and reproductive growth can improve the berry TSS concentration. Moreover, Tursunov (1975) , Wang (1989) and Elgendy (1995) found that summer pruning increased TSS and decreased acidity in the berry juice. In contrast, pinching alone or shoot removal and leaf removal gave the lowest significant values of TSS, acidity and TSS/acidity. This suggests that, pinching resulted in the increase of acidity. Such results are in harmony with those obtained by Sulukeri *et al.* (1971) and Castro *et al.* (1996) who mentioned that, the sugar of berries decreased and acidity increased with pinching.

3.8. Anthocyanin content

Summer pruning plus girdling or girdling alone at veraison significantly increased anthocyanin content in berry skin (Table, 2). On the contrary, leaf removal severely reduced anthocyanin in comparison to other tested treatments, but summer pruning was superior in this respect which inclined to increase anthocyamin. Accordingly, either girdling or summer pruning plus girdling can be applied to improve berry colouration. The role of girdling in increasing anthocyanin may be due to its enhancing effect on anthocyanin biosynthesis which begins at veraison and by accumulation of carbohydrates and natural hormones in the aboveground vine portions. Similar results were found by Dokoozlian *et al.* (1995) who noticed that girdling applied at veraison improves the colour and accelerates the maturation of Crimson Seedless fruits.

Such finding seems to agree with those reported by Omar and Girgis (2005).

3.9. Colour and TSS development

Visual colour expressed as the percentage of full coloured berries and TSS are considered as important attributes of coloured varieties. The application of girdling at veraison plus summer pruning enhanced TSS and colouration while girdling alone enhanced colouration (Table, 2). Leaf removal delayed the beginning of colouration. Pinching as well as shoot removal severely reduced berry colour and the percentage of full coloured berries. It is clear that the best results were gained from the application of summer pruning plus girdling followed by girdling alone. Yet, summer pruning treatment alone came next in this respect. Thus, on the basis of the obtained results, it could be stated that, shoot removal and pinching of the shoots resulted in an increase in the area of remaining leaves. Shading has been identified as a major factor in reducing grapevine fruit quality (Smart, 1985). On the other hand, summer pruning helps in ameliorating fruit quality by more exposure to sunlight and generally exhibiting higher concentrations of sugars and lower acidity in grape juice compared to those ripened in dense canopy shade. These results are in agreement with those of Kliewer *et al.* (1988).

An astonishing relationship was discovered between TSS and anthocyanin content. Total soluble solids and anthocyanin of berries were estimated at 7 day intervals from 29 July till 25 August during the two seasons under investigation. Hence, it can be noticed from Figs. (2 and 3) that, total soluble solids increased and anthocyanin content increased gradually from 29 July up to August 25 at the beginning of colouration during the two seasons. Also, it is obvious from the figure that, there were differences between the treatments under study. However, summer pruning plus girdling as well as girdling alone in both seasons gave the highest percentages of TSS and anthocyanin concentration in comparison with other treatments.

Alternatively, unpruned (control) vines showed the least percentage of TSS and anthocyanin in both seasons. These findings can be interpreted as summer pruning might increase the intensity of photosynthesis in the leaves situated in the section of clusters. This, by its turn, enhanced the immigration of assimilates from leaves towards clusters during the process of ripening. Closely related to the

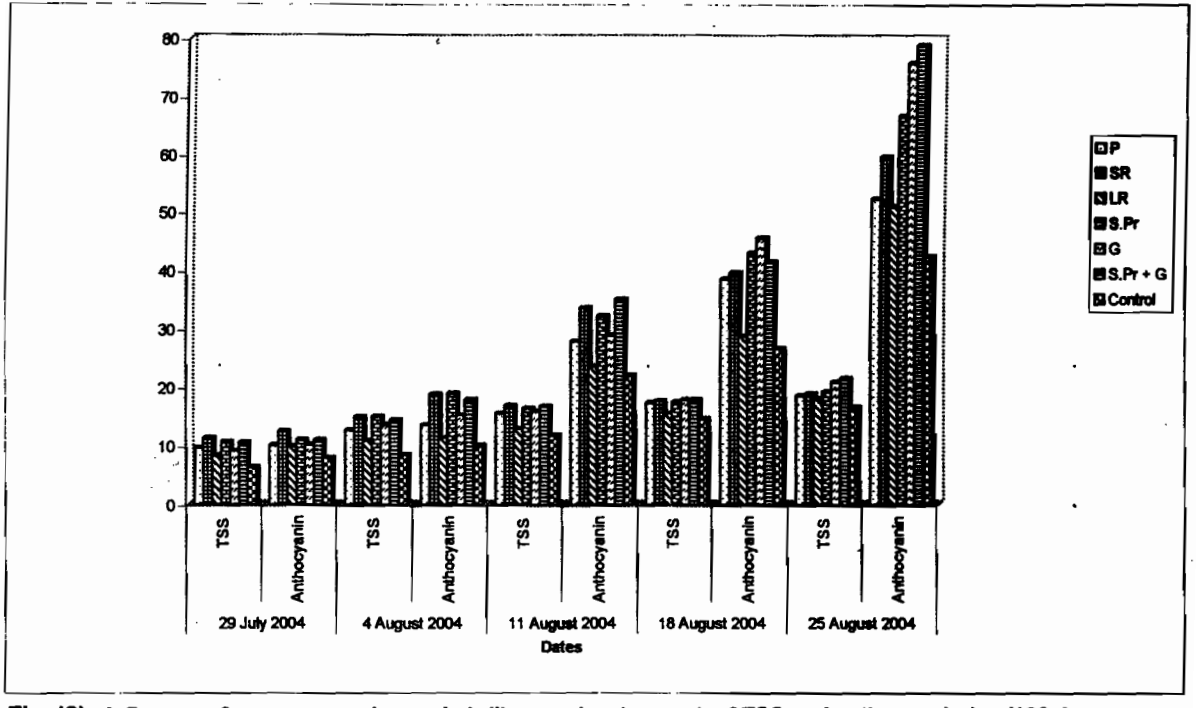

Fig. (2) : Influence of summer pruning and girdling on development of TSS and anthocyanin (mg/100g) during the first season 2004

P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison, S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

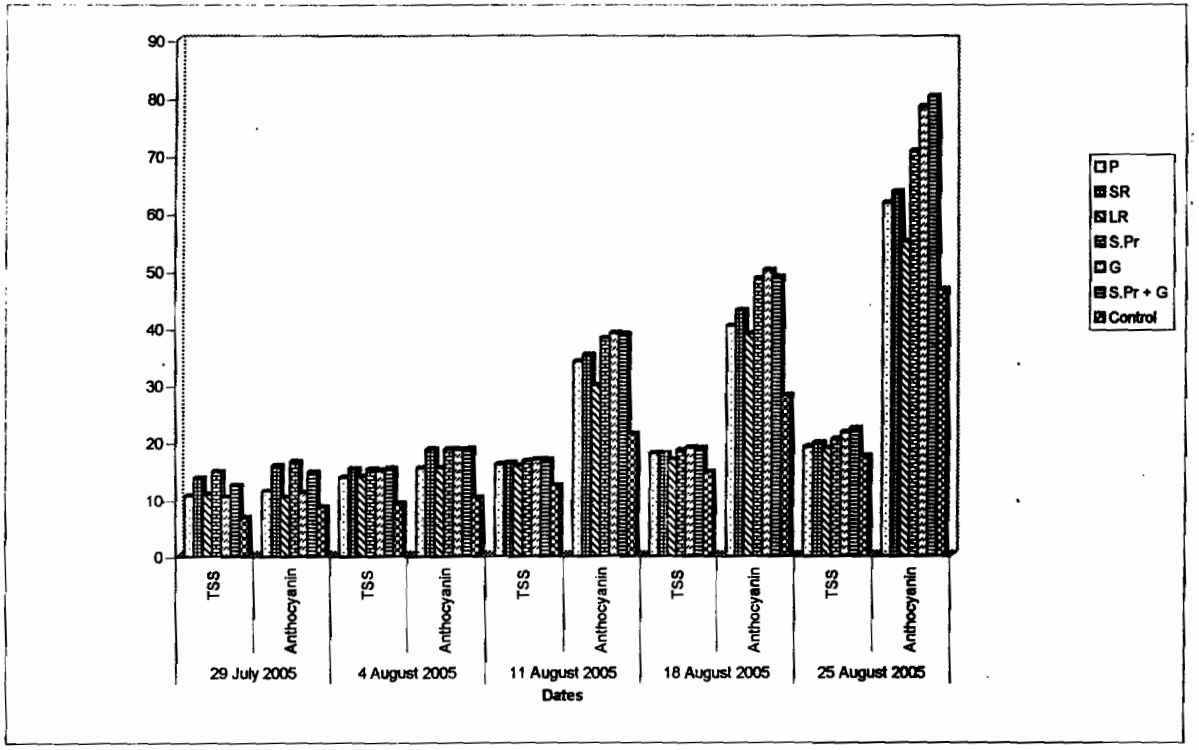

Fig. (3) : Influence of summer pruning and girdling on development of TSS and anthocyanin (mg/100g) during the second season 2005

P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison, S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

current finding is those found by El-Gendy (1995) who declared that the treatment of summer pruning led to the highest significant percentage of TSS. On the other side, Strelinikov *et al.* (1973) reported that, removal of all laterals resulted in reducing berry sugar content. Similar results were also obtained by Todorov and Zankov (1965). In this concern, the treatments including summer pruning and girdling at veraison significantly increased F.C.B.%. Also, girdling at berry softening was found to improve colour and accelerate ripening of Crimson Seedless fruits (Dokoozlian *et al.*, 1995).

In this respect, Carreno *et al.* (1995) on Don Mariono (Napolion) grapes reported that TSS was higher than 14 °Brix which is the minimum acceptable value for consumption although the colour of the fruit was still insufficient for it to be marketed.

Yokotsuka *et al.* (1999) found that total anthocyanin increased with an increase in total sugar content in the berry skin. The amounts were higher reaching their maximal at 18-20 °Brix, and the contents of anthocyanins per skin berry increased as ripening proceeded.

Based on the obtained results, it could be recommended to carryout summer pruning plus girdling, as well as girdling alone as they encouraged colour, TSS and berry quality.

3. 10. Microclimate factors effects on fruit quality and berry colour :

The data presented in Figs. (4 and 5) indicate that, leaf removal raised the temperature of Crimson Seedless canopy. This effect was associated with the severity of leaf removal and shoot removal which resulted in an increase in canopy temperature. On the contrary, pinching appeared to reduce the temperature in canopy because it allowed lateral shoots to increase shading. On the other hand, summer pruning tended to make a balance between canopy and air temperature.

Data of light intensity in Figs. (6 and 7) revealed that leaf removal and shoot removal treatments, led to an increase in light intensity inside the canopy of the vine.

The dense canopy of the control vines decreased the penetration of sunlight and ventilation inside the canopy, consequently, lowering the temperature and light intensity. The obtained results are in line with those of Gubler and Morios (1987), Kliewer *et al.* (1988), Percival *et al.* (1994) and Dokoozlian and Kliewer (1995).

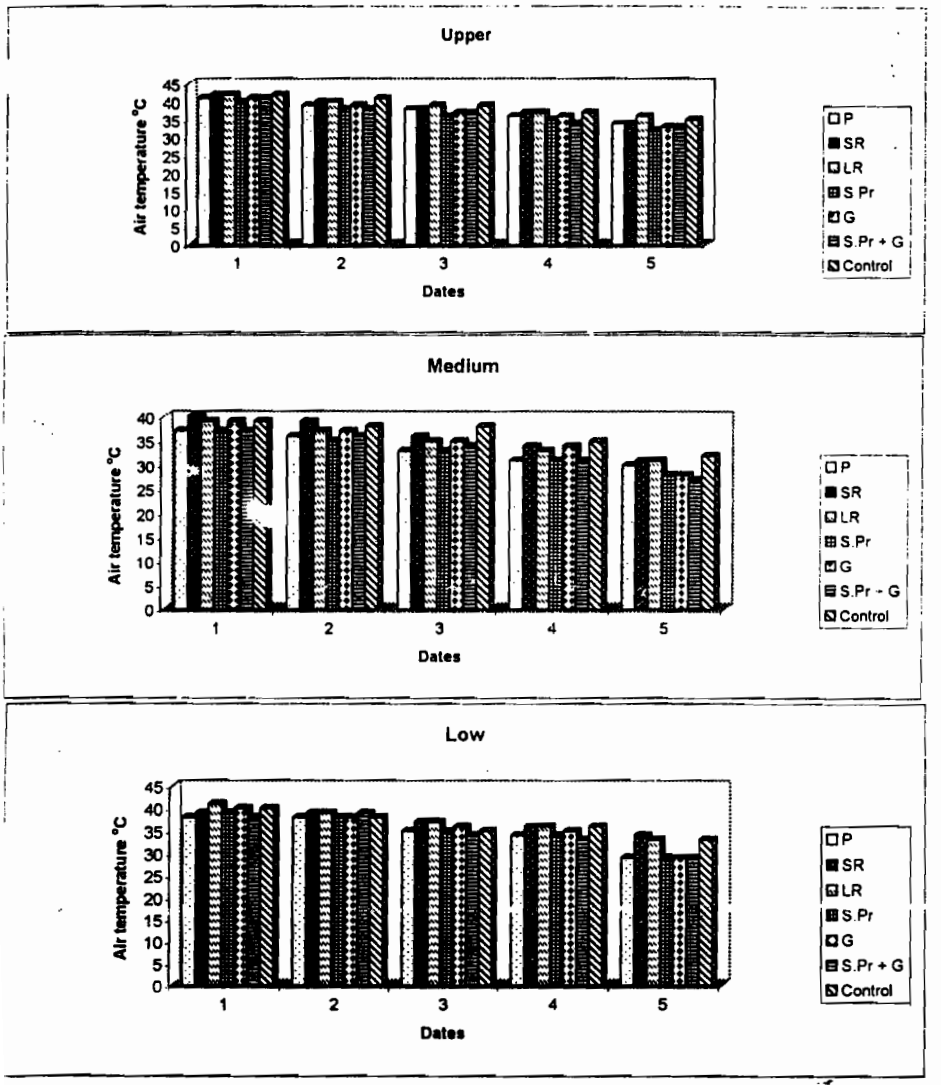

Fig. (4): Impact of air temperature on vine canopy during the first season 2004.

Dates : 1: 29/7, 2: 4/8, 3: 11/8, 4: 18/8, 5: 25/8
P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison, S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

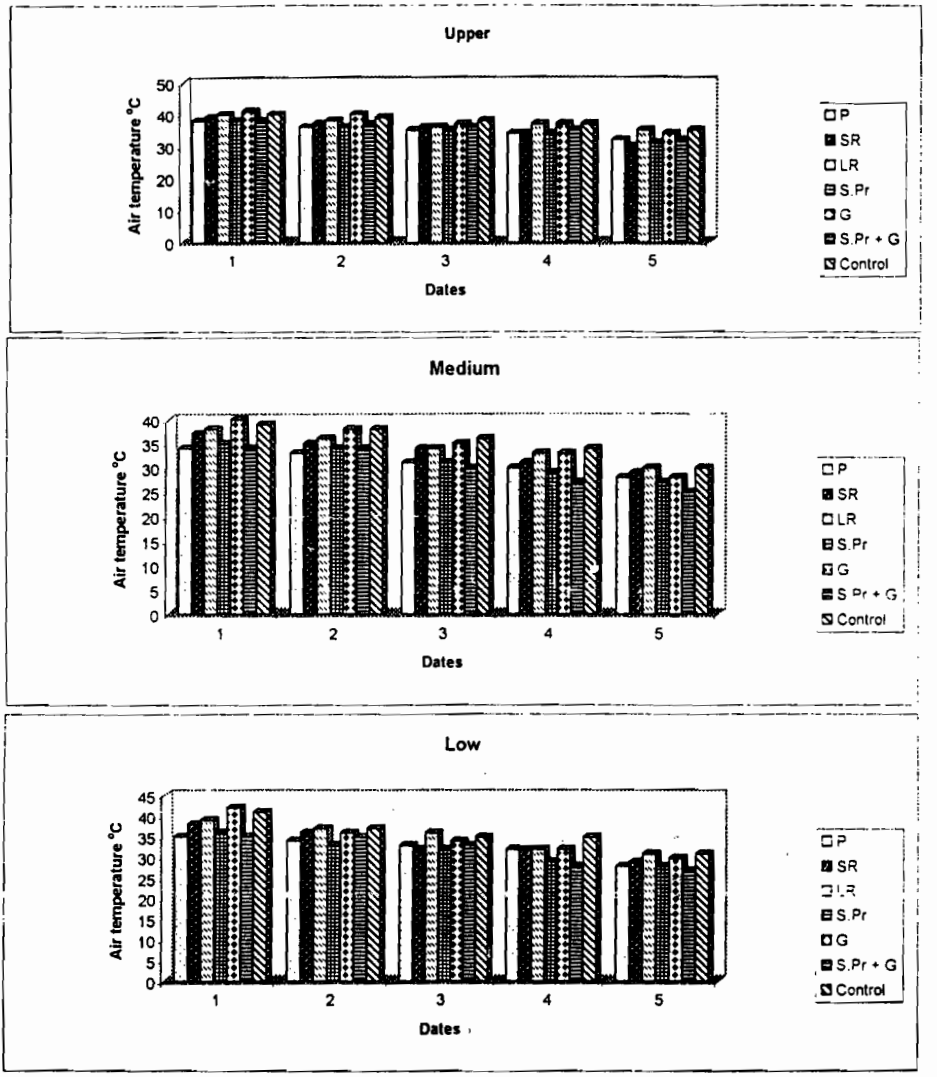

Fig. (5): Impact of air temperature on vine canopy during the second season 2005.

Dates : 1: 29/7, 2: 4/8, 3. 11/8, 4: 18/8, 5: 25/8
P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison, S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

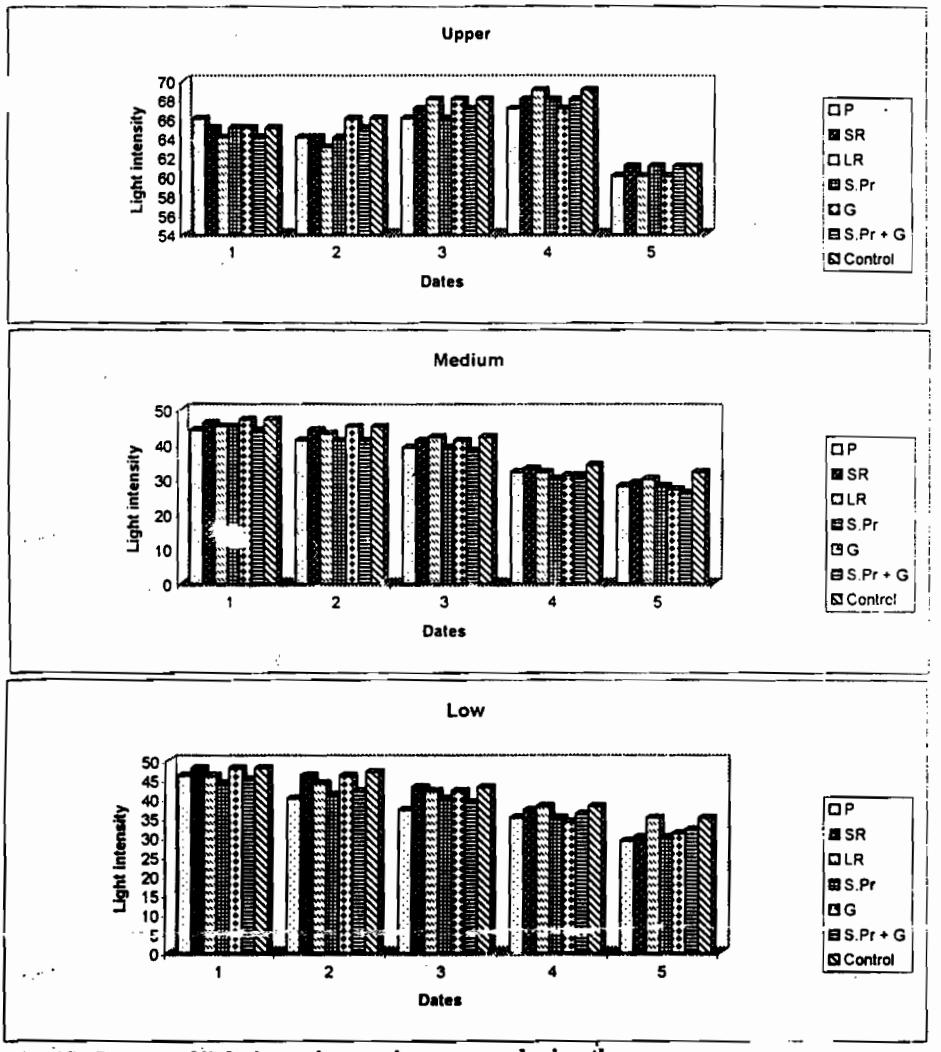

Fig. (6): Impact of light intensity on vine canopy during the first season 2004.

Dates : 1: 29/7, 2: 4/8, 3: 11/8, 4: 18/8, 5: 25/8
P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison,
S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

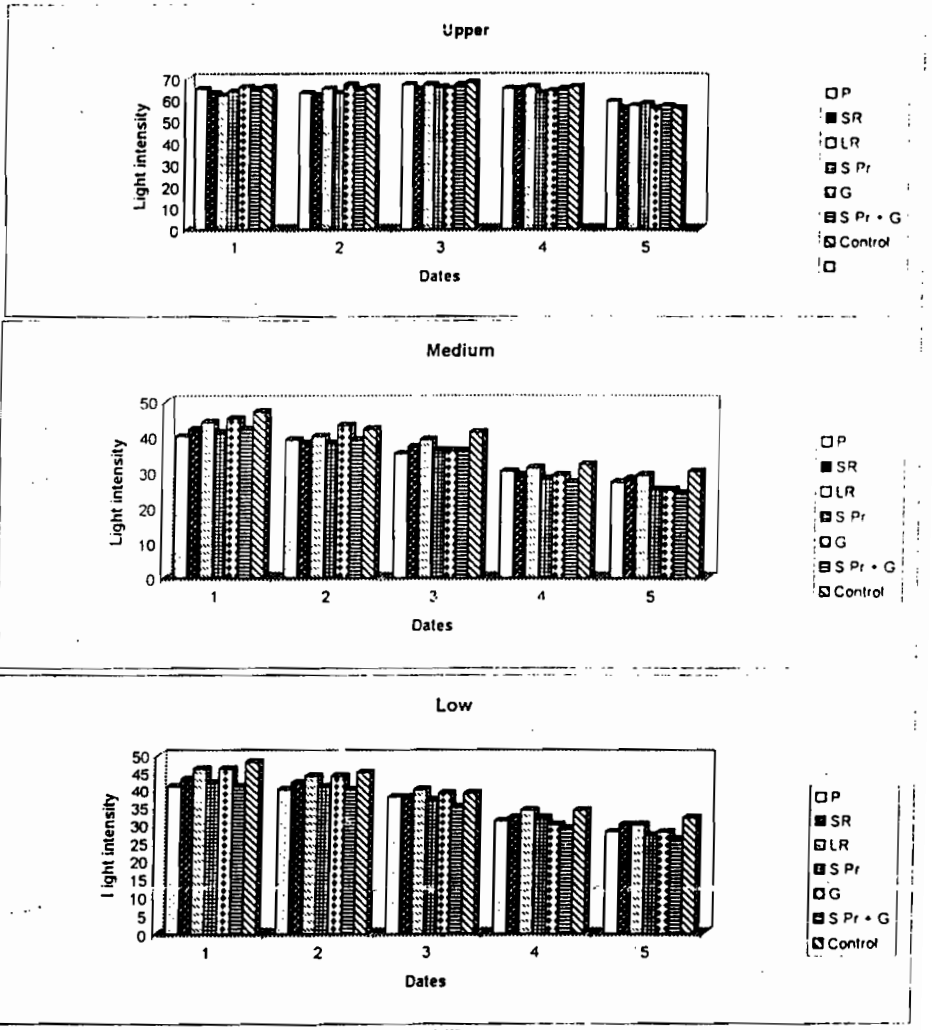

Fig. (7): Impact of light intensity on vine canopy during the second season 2005.

Dates : 1: 29/7, 2: 4/8, 3: 11/8, 4: 18/8, 5: 25/8
P : Pinching, LR : Leaf removal, SR : Shoot removal, G : Girdling at veraison, S.Pr. : Summer pruning (P+SR+LR) and S.Pr. + G : Summer pruning + girdling

Similar results were found by Raifer (1999) and Keller *et al.* (1999) who reported that when vegetative growth increased and accompanied by lower light level, it resulted in delaying fruit ripening. Moreover, Yokotsuka *et al.* (1999) reported that total anthocyanin increased with increasing total sugar content in the berry skin. The amounts were higher under the low temperature conditions than the higher temperatures. Furthermore, Jackson and Lomband (1993) suggested that a shaded microclimate reduces colour and reduces sugar levels which are usually interpreted as delayed maturity.

The forgoing results illustrate the reciprocal relationship among persued treatments and the eminent improvement of fruit quality of Crimson Seedless directly reflected on berry colour and fruit maturity. This work is a preliminary step to be followed more extensively in the future.

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دراسة حول إمكانية تحسين تلون الحبات في عناقيد العنب الكريمسون سيدلس تحت ظروف الأراضي الصحراوية بإستخدام بعض المعاملات
ب: التقليم الصيفي والتحليق

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ملخص

تزداد حاليا باضطراد المساحات المزروعه من صنف العنب كريمسون سيدلس في الأراضي الجديدة المستصلحة لكن هناك نقص بالمعرفة في كيفية إجراء بعض المعاملات التي يمكن إجراؤها علي النمو الخضري لهذا الصنف والتي تؤدي إلي حدوث توازن مناسب بين المجموع الخضرى والثمار لإنتاج ثمار ذات صفات عالية الجودة والتلوين. لذا فإن تأثيرات معاملات التقليم الصيفي والتحليق قد تم تقييمها في هذا البحث.

وقد أدت المعاملة بالتقليم الصيفي إلي زيادة وزن العنقود والمحصول للكرمة مع زيادة طول وقطر الثمار كما أنها أدت أيضاً إلي حدوث زيادة معنوية في إلتصاق الحبات وتماسكها مع زيادة في مساحة الأوراق والمواد الصلبة الذائبة الكلية والحموضة والنسبة بينهما مع المحتوي من صبغة الأنثوسيانين في قشرة الحبات حيث تمت المعاملة بمفردها أو مقرونة بالتحليق. ومع ذلك فقد أدت معاملة التطويش (إزالة القمم الطرفية للأفرع الرئيسية) إلي تقليل طول الحبة وقطرها جنباً إلي جنب مع أقل قيم للمواد الصلبة الذائبة الكلية والحموضة والنسبة

بينهما ولون الحبات والنسبة المئوية لتلوينها. وأدت المعاملة بالتقليم الصيفي بمفردها مع / أو التحليق إلي تحسين التلوين بينما أدت المعاملة بإزالة الأوراق إلي تأخير بداية التلوين ولذا فإن التقليم الصيفي يساعد في تحسين صفات الثمار من خلال تعريض أكثر لأشعة الشمس مما يؤدي إلي تكوين تركيزات أعلي من السكريات وحموضة أقل مع محتويات مرتفعة من الأنثوسيانين. كما اثبتت تلك المعاملة أيضاً أنها أداة فعالة تحقق توازناً بين كثافة نموات الكرمة وحرارة الهواء وسمحت بإختراق أكثر من الضوء والذي أدي بالتالي إلي إنتاج ثمار ذات صفات عالية الجودة والتلوين. ولذلك يجب التوصية بإجراء معاملات التقليم الصيفي بمفرده مع/أو التحليق عند بدأ الطراوة والليونه بالحبه(veraison) لتحسين التلوين في صنف العنب الكريمسون سيدلس.

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