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PARTIAL LEAF REMOVAL AND ITS INFLUENCE ON MICROCLIMATE AND CHARACTRISTICS OF SUPERIOR SEEDLESS GRAPES

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ABSTRACT

Superior Seedless grapevines were subjected to early leaf removal after fruit set (6-7 mm berry diameter) or late leaf removal at véraison. Treatments comprised control, removal of three leaves before cluster, removal of six leaves (three before cluster + three after cluster) and of nine leaves (three before cluster + six after cluster). Clusters from positions directly exposed to sunlight were collected. The results indicated that leaf removal increased canopy temperature, light intensity and lowered relative humidity. This was proportionate to the number of removed leaves. Early treatments, produced light clusters with lower berry weight and size. Consequently, yield/vine was decreased. TSS and TSS/acid ratio were decreased while acidity was increased. Late treatments significantly increased cluster weight, berry weight, size and yield/vine. TSS and TSS/acid were increased while acidity was decreased. Generally, leaf removal decreased leaf area and chlorophyll content. The removal of six leaves (three before cluster + three after cluster) at véraison stage was suitable for Superior Seedless cultivar.

INTRODUCTION

The upright growth and dense canopy of *Vitis vinifera* cultivars make it necessary to apply canopy management techniques such as leaf removal. The study of Smart, 1987 showed that grapevine leaves are strong absorbers of solar irradiation, especially in photosynthetically active range of 400 to 700 µm, and observed that grapevine leaves reflect 6% of incoming light. In addition, photosynthetic photon flux density in the interior of grapevine canopies with high leaf densities may be as little as 1% or less of ambient (Smart, 1985). Although interior leaves can adjust to reduced light levels of lowering the light compensation point (Ashton and Admiral, 1990) they remain competitive sinks for nutrients and specific hormones (Hunter *et al.*, 1991). Shading has been identified as a major factor in reducing grapevine yields and fruit quality (Smart, 1985). Leaf removal in the fruiting zone, facilitates air movement and reduces disease incidence (Gulber *et al.*, 1981). By ameliorating fruit exposure to sunlight, it also contributes to improved 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 and Smart, 1989). 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. Nevertheless, severity of leaf removal and its proper time still needs to be determined for Superior Seedless grapevine. Thus, the aim of this experiment was to determine the suitable time of leaf removal and its severity for Superior Seedless grapevines.

MATERIALS AND METHODS

Superior Seedless grapevines of six years old supported by Y system were used in this experiment for two seasons, 1993 and 1994. The vines were grown in a sandy soil in a private vineyard located in Berkash region. Uniform grapevines were chosen at winter pruning (December). The vines were cane-pruned to 60 buds per vine (6 canes × 10 buds/cane). Pinching the main shoots was applied 10 days before anthesis. Seven treatments of three replicates were applied. Each replicate contained five grapevines. Number of clusters was adjusted to 12/vine. Leaf removal treatments were carried out in two separate times. The early leaf removal was after fruit set (6-7 mm berry diameter) and the late one was at véraison stage. Leaf removal was carried out as follows : removal of 0, 3, 6 and 9 main leaves acropetally from the shoot base. The removal of the leaves was : three leaves before cluster, three leaves before cluster + three leaves after cluster and three leaves before cluster + six leaves after cluster. Clusters and leaves from positions exposed to direct sunlight were collected. Tipping of clusters was carried out one week after the application of early leaf removal treatments. GA3 at 25 ppm was sprayed on clusters when berry diameter reached 10 mm. The design of the experiment was randomized complete blocks.

Microclimate of the vine (air and canopy temperature, relative humidity and light intensity) was estimated by Scheduler plant stress monitor model R/O consultant made by Standard Oil Company, USA. These parameters were recorded a week after leaf removal and a week later. Mature leaves grown after leaf removal treatments were collected to measure the individual leaf area using CI-203- laser Area meter made by CID, Inc., Vancouver, Washington state, USA. Total chlorophyll was determined as described by Wettstein, 1957. Cluster weight, berry weight & size and yield/vine were also recorded. TSS (with hand refractometer), acidity according to A.O.A.C (1985), then TSS/acid ratio was calculated.

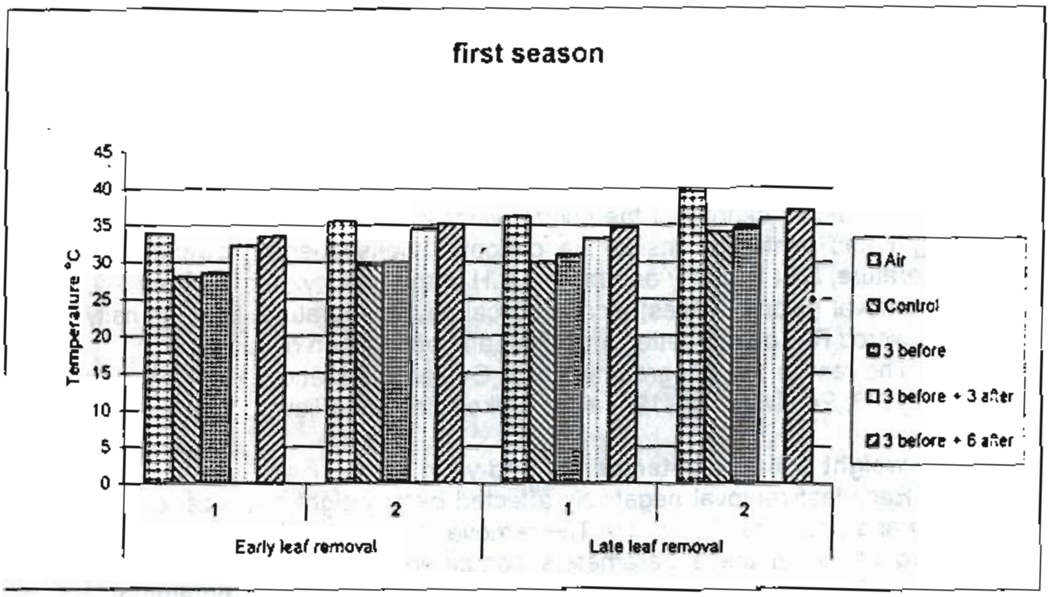
Duncan's multiple range test at p=0.05 was followed to compare the averages as mentioned by Snedecor and Cochran (1980).

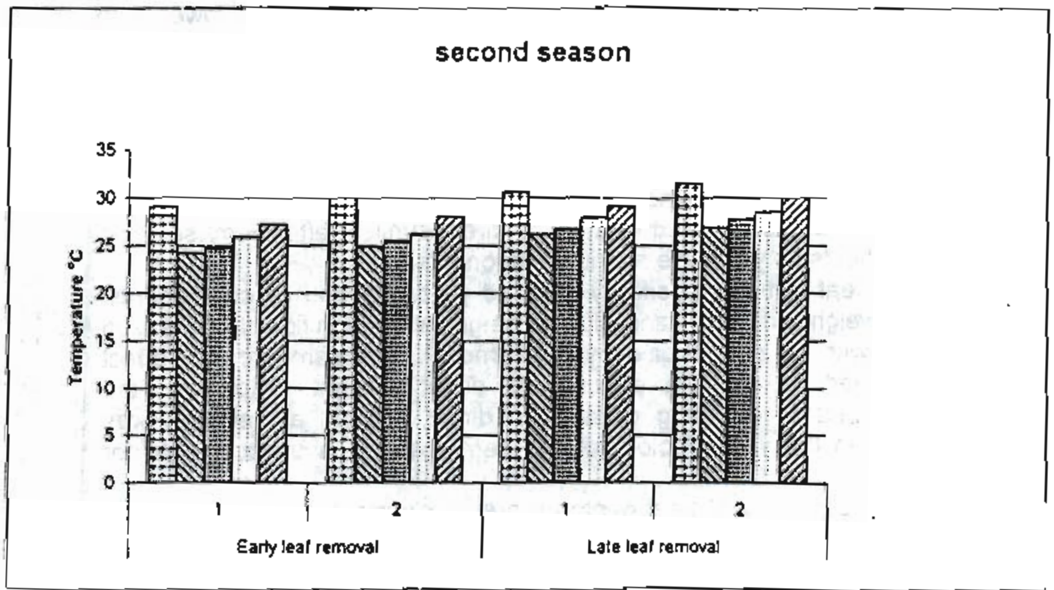
RESULTS AND DISCUSSION

Microclimate :

Leaf removal raised the temperature of Superior Seedless canopy (Fig.1).This effect was associated with the severity of leaf removal; increasing number of the removed leaves resulted in an increase in canopy temperature. Recording air temperature showed that it increased as the season advanced. It is worthmentioning that air temperature in the second season was lower than the first one, and that by its turn lowered canopy temperature.

Relative humidity (R.H) was found to be higher in the canopy of the control vines compared with the (R.H) of air as well as in the canopy of the other treatments.





1= one week after application
2= two weeks after application
Fig. (1) : Effect of partial leaf removal on canopy temperature of Superior Seedless grapevines

This was true for the early or late leaf removal through the two years of the study (Fig. 2). The removal of nine leaves made R.H of the canopy almost equal to R.H of the air.

Reading of light intensity showed a progressive increase according to the severity of leaf removal, in other words, increasing the number of removed leaves led to an increase in light intensity inside the canopy of the vine. The highest light intensity in the canopy was recorded as nine leaves were removed (Fig. 3).

The dense canopy of the control vines decreased the penetration of sunlight and ventilation inside the canopy. Consequently, lowering the temperature, light intensity and raising R.H in the canopy. On the contrary, leaf removal (6 or 9 leaves) increased canopy temperature, light intensity and lowered R.H due to better ventilation and penetration of sunlight.

The results are in agreement with Gubler and Marios, 1987; Kliewer *et al.*, 1988; Percival *et al.*, 1994a and Dokoozlian and Kliewer, 1995.

Berry weight & size, cluster weight and yield :

Early leaf removal negatively affected berry weight and size, cluster weight and yield/vine (Table, 1). The removal of three leaves before cluster had no affect on these parameters compared with control. Increasing number of the removed leaves significantly decreased those parameters. In the first season, cluster weight was 500 g. in control vines lowered to 410; 380 and 300 g. after the removal of six; nine or for the clusters exposed to direct sunlight, respectively. Berry weight was 82 and 76% of the control when six and nine leaves were removed, whereas it was 60% of the control in clusters exposed to direct sunlight. A similar trend was observed for berry size. Yield/vine followed the trend of cluster weight. Similar results were obtained in the second season. Thus, early leaf removal, as well as exposed clusters to direct sunlight after berry set, had negative effects on yield/vine and its components.

Late leaf removal positively affected yield/vine and its components, i.e. berry weight and size, and cluster weight were significantly increased compared with the control or early leaf removal. The same positive effect was observed for clusters exposed to direct sunlight. However, the negative effect of exposing clusters to direct sunlight at véraison was manifested in the yellow colour of the berries which is unacceptable for export.

Early leaf removal treatments as previously mentioned were applied when berry diameter reached 6-7 mm, that ensured no loss in berry number through berry drop. Adjusting the number of clusters to 15/vine, makes it logic to explain that yield/vine is due to cluster weight. The decrease in yield/vine in early treatments was due to the reducing of number of leaves and that by its turn produced cluster with berries of lower weight and size. Koblet *et al.*, (1995) found that leaf removal at berry pea-size, decreased yield and its quality. Late leaf removal (at véraison) increased the formation of leterals and production of photosynthetically and physiologically efficient leaf area which increased root density (Hunter and Le Roux, 1992) resulting in an appreciable increase in nutrient absorption and translocation of more carbohydrates to clusters, hence yield was increased (Hunter and Visser, 1990). The large size of berries as a result of late leaf removal treatments is related to the activation of photosynthesis inside the canopy through increasing light penetration and temperature, which induced an increase in sugars in the berries raising its osmotic pressure and attracting water, thus increasing berry size.

The results are in harmony with Percival *et al.*, 1994b and Koblet *et al.*, 1994 who found that leaf removal at pea-size stage produced lower yield/vine compared with leaf removal at véraison.

Berry TSS, acidity and TSS/acid ratio :

TSS was significantly decreased by early leaf removal in comparison with the control (Table 1). TSS of the control was 14.5 reduced to 12.0, for the removal of six and nine leaves. At the same time, the removal of three leaves before cluster had no effect on TSS. More significant decrease in TSS of berry juice was observed in clusters exposed to direct sunlight. An opposite trend was observed for acidity. TSS/acid ratio was too low to reach 20 : 1* in early leaf removal treatments as well as in clusters exposed to direct sunlight.

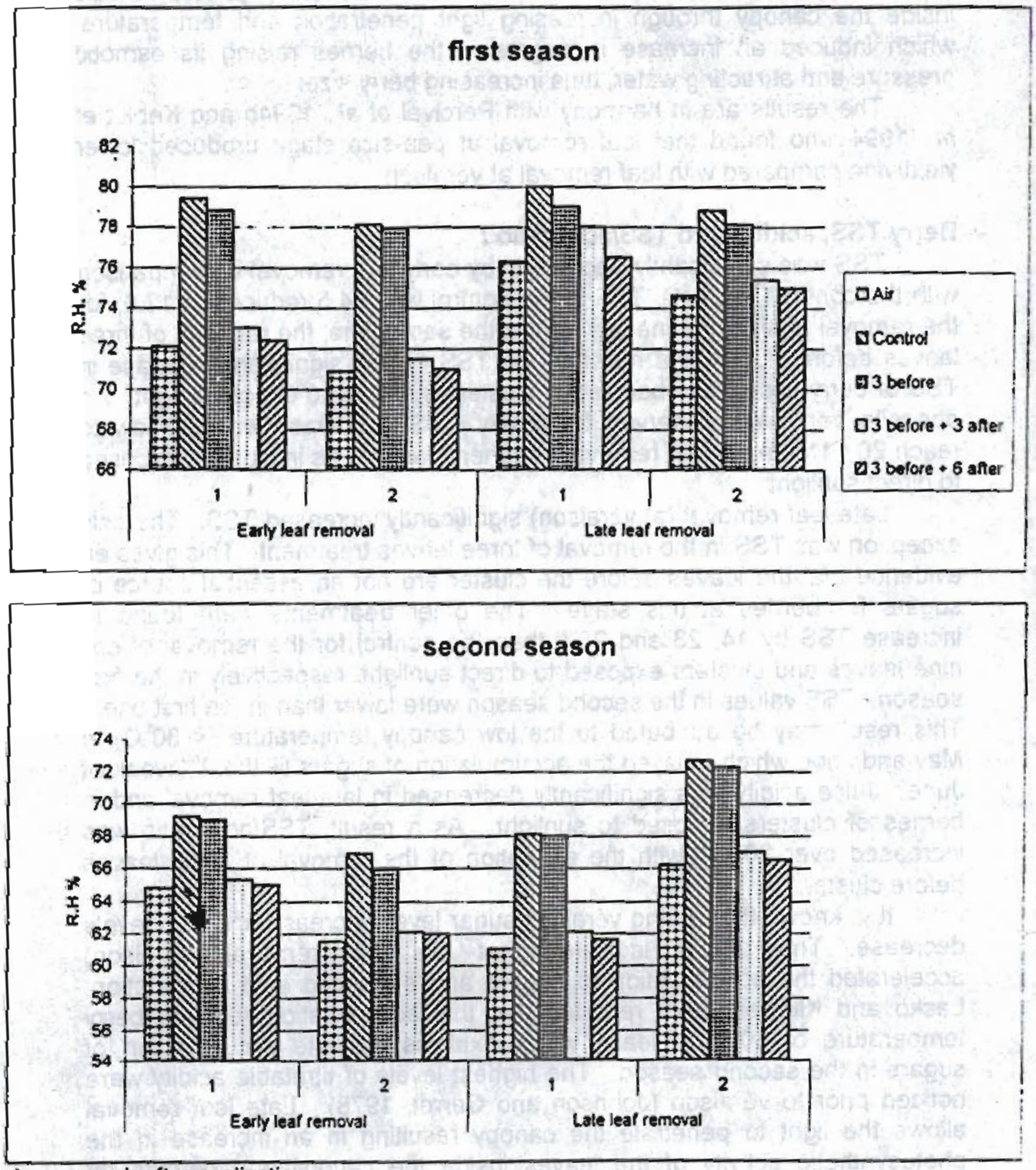
Late leaf removal (at véraison) significantly increased TSS. The only exception was TSS in the removal of three leaves treatment. This gives an evidence that the leaves before the cluster are not an essential source of sugars for berries at this stage. The other treatments were found to increase TSS by 14, 23 and 25% than the control for the removal of six, nine leaves and clusters exposed to direct sunlight, respectively in the first season. TSS values in the second season were lower than in the first one. This result may be attributed to the low canopy temperature (< 30°C) in May and June which delayed the accumulation of sugars till the 2nd week of June. Juice acidity was significantly decreased in late leaf removal and in berries of clusters exposed to sunlight. As a result, TSS/acid ratio was increased over 20 : 1 with the exception of the removal of three leaves before cluster.

It is known that during véraison sugar levels increase and acid levels decrease. The results indicated that late leaf removal (véraison) accelerated the accumulation of sugars and enhanced acid degradation. Lasko and Kliewer, 1975 reported that this accumulation requires berry temperature of 30°C at least, which explains the late accumulation of sugars in the second season. The highest levels of titratable acidity were noticed prior to véraison (Johnson and Carrol, 1978). Late leaf removal allows the light to penetrate the canopy resulting in an increase in the photosynthetic activity of the leaves inside the canopy and permits air circulation raising temperature inside the canopy, consequently, berry temperature was raised and that by its turn promotes ripening through the positive influence in grape composition i.e. increasing TSS and decreasing acidity.

The results are inconsistent with the trend outlined by Uhlig (1998).

* The minimum value for harvest time (Weaver, 1976)

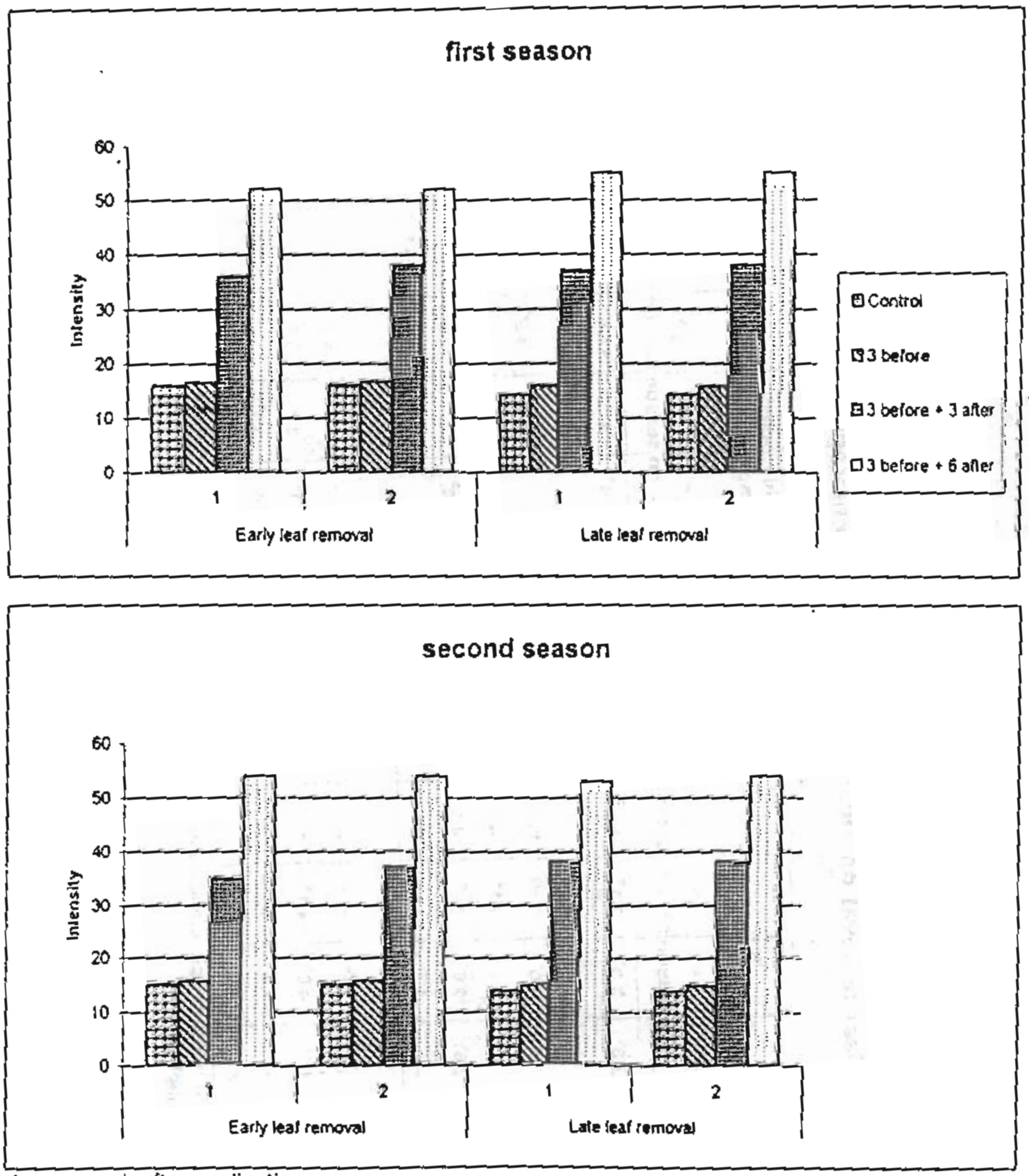
Fig2



1= one week after application

2= two weeks after application

Fig. (2) : Effect of partial leaf removal on canopy relative humidity of Superior Seedless grapevines



1= one week after application
2= two weeks after application
Fig. (3) : Effect of partial leaf removal on canopy sunlight intensity of Superior Seedless grapevines

Table (1): Effect of partial leaf removal on cluster characteristics, chlorophyll and leaf area of Superior Seedless grapevines

Treatment	Cluster weight (g.)		Berry weight (g.)		Berry size (cm^{3})		Yield/vine (Kg)		Leaf area (cm^{2})		Chlorophyll mg/g d.w.		TSS		Acidity		TSS/acid	
	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	1st season	2nd season	1st season	2nd season
Control	**500^{c}**	**510^{b}**	**3.5^{c}**	**3.8^{c}**	**3.0^{c}**	**3.1^{c}**	**6.0^{b}**	**6.1^{b}**	**170.1^{a}**	**160.6^{a}**	**4.4^{a}**	**4.3^{a}**	**14.5^{c}**	**14.0^{c}**	**0.85^{d}**	**0.9^{d}**	**17.1^{c}**	**15.6^{c}**
Fruit set																		
3	500^{c}	510^{b}	3.6^{c}	3.8^{c}	3.0^{c}	3.1^{c}	6.0^{b}	6 1^{b}	170.1^{a}	160.6^{a}	4.4^{a}	4.3^{a}	14.5^{c}	14.0^{c}	0.85^{d}	0.9^{d}	17.1^{c}	15.6^{c}
6	410^{d}	450^{c}	3.0^{d}	3.1^{d}	2.0^{d}	2.1^{d}	4.9^{c}	5.4^{c}	155.2^{b}	150.9^{b}	3.9^{b}	3.9^{b}	12.0^{d}	12.1^{d}	0.90^{c}	0.95^{c}	13.3^{d}	13.4^{d}
9	380^{d}	400^{d}	2.5^{e}	2.6^{d}	2.0^{d}	2.0^{d}	4.6^{c}	4.8^{d}	150.3^{b}	145.1^{c}	3.8^{b}	3.7^{b}	12.0^{d}	12.2^{d}	1.0^{b}	1 0^{b}	12 0^{d}	12.2^{de}
Expos*	300^{e}	310^{f}	2.0^{f}	2.2^{e}	1.7^{e}	1.6^{e}	3.6^{d}	3.7^{e}	140.0^{c}	135.1^{d}	2.5^{c}	2.4^{c}	10.0^{e}	10.6^{e}	1.1^{a}	1.1^{a}	9.1^{e}	9.6^{e}
Véralson																		
3	500^{c}	510^{b}	3.6^{c}	3.8^{c}	3.0^{c}	3.1^{c}	6.0^{b}	6.1^{b}	170.1^{a}	160.6^{a}	4.4^{a}	4.3^{a}	14.5^{c}	14 0^{c}	0.85^{d}	0.90^{d}	17.1^{c}	15.6^{c}
6	575^{a}	600^{a}	4.2^{a}	4.3^{a}	4.0^{a}	4.1^{a}	6.9^{a}	7 2^{a}	160.2^{ab}	154.6^{b}	4.1^{b}	3.9^{b}	16.5^{b}	15.3^{b}	0.70^{e}	0.69^{e}	23.6^{b}	22.2^{b}
9	560^{a}	580^{a}	4.2^{a}	4.3^{a}	3.9^{a}	4.1^{a}	6.7^{a}	7.0^{a}	155.3^{b}	149.2^{c}	4.0^{b}	3.9^{b}	17.8^{a}	16.2^{a}	0.63^{f}	0.65^{e}	28.3^{a}	24.9^{b}
Expos*	530^{b}	535^{b}	4.0^{b}	4.1^{b}	3.6^{b}	3.7^{b}	6.4^{ab}	6.4^{b}	140 0^{c}	135.1^{d}	2.5^{c}	2.4^{c}	18.1^{a}	17.0^{a}	0.61^{f}	0.60^{f}	29.7^{a}	28.3^{a}

Values with the same letter (s) do not differ significantly at $p = 0.05$

* Expos = Exposed to direct sunlight.

Leaf area and total chlorophyll :

Individual leaf area was significantly reduced as six or nine leaves were either early or late removed as well as leaves exposed to direct sunlight.It seems that the high temperature and low R.H. increased transpiration which induced stress on the growing leaves, leading to a decrease in their area. Koblet *et al.*, (1994) found that increasing leaf removal resulted in a significant reduction in leaf area.

Total chlorophyll was higher in shaded leaves than those situated in diffuse light or exposed to direct sunlight. This is due to enhancing the ability of shaded leaves to capture the light with wavelengths suitable for photosynthesis (Cartehini and Palliotti, 1995). Moreover, shading impede chlorophyll degradation (Uhlig, 1998).

Thus grapevine canopy should be managed to allow light penetrating the canopy and increase ventilation for enhancing ripening and protecting clusters from exposure to direct sunlight. The results of this study indicated that the removal of six leaves (three before cluster + three after cluster) at véraison can be considered as a suitable practice for Superior Seedless grapevines.

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عدد الأوراق المزالة وتأثير ذلك علي المناخ الدقيق وصفات عنب المائدة سوبريور عديم البذور

أحمد حسين عمر
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ازيل عدد من أوراق العنب السوبريور في ميعادين : الأول مبكر عند وصول الحبة لقطر ٦-٧ مللي ، والثاني متأخر عند بداية ليونة الحبات. وكانت الإزالة كالآتي : بدون إزالة، إزالة ثلاثة أوراق قبل العنقود ، إزالة ٦ أوراق (ثلاثة قبل العنقود + ثلاثة بعد العنقود) ، إزالة ٩ أوراق (ثلاثة قبل العنقود + ٦ بعد العنقود) ، كما جمعت العناقيد التي تعرضت إلي أشعة الشمس المباشرة لدراستها.

وقد وجد أن إزالة الأوراق أدي إلي رفع درجة الحرارة داخل المجموع الخضري ، وزيادة الكثافة الضوئية وإنخفاض الرطوبة النسبية. وقد تناسب هذا طردياً مع عدد الأوراق المزالة. وقد نتج عن الإزالة المبكرة أو تعرض العناقيد المباشر لأشعة الشمس ، عناقيد خفيفة الوزن ، ذات حبات صغيرة الحجم والوزن وبالتالي انخفض المحصول معنوياً عن المقارنة ، كذلك إنخفضت النسبة المئوية للمواد الصلبة الذائبة الكلية في عصير الحبات كما إرتفعت حموضة العصير ، وبالتالي إنخفضت نسبة المواد الصلبة الذائبة الكلية إلي الحموضة. أما في حالة الإزالة المتأخرة أو عند تعرض العناقيد المباشر لأشعة الشمس فقد نتج عنها عناقيد أكبر وزنا ذات حبات كبيرة الحجم والوزن تحتوي علي عصير مرتفع في محتواه من المواد الصلبة الذائبة الكلية ، وكذلك نسبة المواد الصلبة الذائبة الكلية إلي الحموضة ذو محتوي منخفض من الحموضة كما كان المحصول مرتفعاً معنوياً بالنسبة للمقارنة أو الإزالة المبكرة. أما فيما يختص بمساحة الأوراق فقد أدت الإزالة في أي موعد أو التعرض المباشر لأشعة الشمس إلي وجود نقص معنوي في مساحة الورقة وكذلك الكلوروفيل. وقد وجد أن إزالة ستة أوراق (ثلاثة قبل العنقود + ثلاثة بعد العنقود) عند بداية ليونة الحبات هي عملية مناسبة لعنب السوبريور.