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IMPROVING QUALITY OF "THOMPSON SEEDLESS" GRAPES BY MEANS OF CANOPY MANAGEMENT

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ABSTRACT

This research was carried out for three successive seasons: (2005, 2006 and 2007) on 10-year old Thompson Seedless grapevines supported by telephone system in a private vineyard located at Namol (Kalubia Governorate). Bud load was 10 canes × 14 buds per vine. The vines were characterized by having crowded vegetative growth, considerably, low yield and inferior quality of grapes. During January 2005 weight of one year old wood was measured as an indicator for vine vigor. Sixty vines were chosen for this study, twelve vines (4 vines replicated 3 times). The treatments included bud load of (6 canes × 12 buds /vine) with summer pruning and without summer pruning, (8 canes × 12 buds /vine) with summer pruning or without and the control (10 canes × 14 buds /vine) (vineyard pruning treatments) without summer pruning. The same vines were used at the three seasons of the study. Canopy measurements were used to determine the vegetative density by inserting the point quadrant into the vegetative growth. Results of 2006 and 2007 seasons showed a higher percentage of gaps, higher chlorophyll content, greater leaf area and higher light intensity at the treatments having a low number of canes accompanied with summer pruning (disbudding, pinching and defoliation). Percentage of bud burst, percentage of fruitful buds and fertility coefficient were increased at the treatments with 6 canes × 12 buds, 8 canes × 12 buds and the control (10 canes × 14 buds /vine). Total yield/vine, bunch weight and total soluble solids % were increased at the treatment of 6 canes × 12 buds with summer pruning in comparison with the other treatments and the control. Pruning weight, and acidity of berry juice were found to decrease in these treatments. This could be due to the positive effect of canopy management on improving microclimate of the vines and decreasing number of crowded shoots as to permit aeration and light to enter in to the center of the vines.

INTRODUCTION

Grapevines vary greatly in their capacity and vigour due to the environment, cultural practices, and management.

When the canopy microclimate is altered by canopy management techniques, it is not only sunlight levels that change, temperature, humidity, wind speed and evaporation are also modified (Smart, 1986).

Currently, there is a worldwide interest in using various canopy management practices to improve vine microclimate, crop yields, and grape quality, as has been recently reviewed (Smart, 1985a). Canopy microclimate influences many physiological functions such as photosynthesis, transpiration, respiration, translocation of assimilates and physiological functions which ultimately determine crop yield and fruit composition.

Recent researches carried out concerning canopy management have provided techniques to avoid shade. Shaulis and Smart, 1974 stated that canopy, is defined as the leaf and shoot system of the vine. It is described by dimensions of the boundaries in space (i.e. width, height, length, etc.) and the amount of shoot system within this volume (Typically leaf area). Also, researches indicated that shade at the center of the vine growth causes a reduction in the yield and bunch quality and number of clusters per vine (Rizk *et al.,* 2006).

Indices of canopy density can be developed as leaf layer umber (LLN) or the number of leaves contacted by a fine rod passing through a canopy cross-section in the bud renewal or fruiting area (Smart and Smith, 1988) or as leaf area to canopy surface area ratio (LA/SA) as described by (Smart *et al.,* 1982) or as weight of cane prunings per unit canopy length (Shaulis, 1982).

Recent reviews (Smart 1985a and Kliewer and Smart 1988) have emphasized three means of canopy microclimate management these being training system design, shoot number control and vigour manipulation.

Researches studied the partial leaf removal and its influence on microclimate and characteristics of grapes (Omar, 2005).

The relationships among canopy density, fruit zone light environment, and several potential indices for the rapid evaluation of canopy density and light environment have also been developed (Dokoozlian and Kliewer, 1995 and Omar, 2005). High density canopy increased vegetative shoots than fruiting ones by shading buds of the shoots at the growing season. Low shoot vigour helps create open canopies (Smart, 1985b and Rizk *et al.,* 2006).

Canopy management techniques can be used to improve production and quality, reduce disease incidence and facilitate mechanization and winter pruning (Kliewer, 1986 and Rizk *et al.,* 2006).

For low to moderate vigour vineyards, summer pruning on fruit zone and leaf removal may be sufficient to improve the microclimate (Freese, 1988).

Simple measurements at winter pruning of cane number, retained node number, total cane mass, and yield and bunch number at harvest are useful indices of vine balance between yield and vegetative growth (Bravdo, 1985; Howell *et al.,* 1991; Dokoozlian and Kliewer, 1995 and Ali *et al.,* 2000). Shade is avoided by reducing leaf area and increasing the proportion of canopy gaps (Rizk, 1982; Smart, 1988 and Rizk *et al.,* 2006).

This research is a complementary study for many trials in the field of canopy management to improve microclimate and identify the vineyard problems and how to be solved.

The techniques developed for diagnosing canopy problems are designed for practical field use by researchers and growers. The techniques are easy to learn and interprete quick to use and are also inexpensive.

MATERIALS AND METHODS

This work was carried out for three successive seasons 2005, 2006 and 2007 in a private vineyard located at Namol, Kalubia Governorate where the soil was clay silty. Ten-years-old of Thompson Seedless vines were used in this study. The vines were trained to the Telephone trellis system (double

T) according to the cane pruning system, irrigated by the flood system and spaced 250 × 1.75 meters apart. This vineyard was shown to have higher vegetative growth and crowded shoots with small leaves and low yield with inferior bunch quality. The study was carried out as to keep a balance between the vegetative and the fruiting shoots. In January 2005 at winter pruning, four treatments were applied to improve the yield per vine and grape quality in addition to the control (untreated) through improving the microclimate of these vines. Summer pruning (disbudding, pinching and defoliation) and winter pruning are means to improve canopy management. At winter pruning 60 vines were chosen as to be of similar vigour and were used at the three seasons of the study. Weight of prunings per vine was recorded in January 2005 before starting the investigation as an indicator of vegetative growth density (vine vigour). The treatments included cane length, bud no. in addition to or without summer pruning as follows :

T1 : 6 canes × 12 buds/cane + summer pruning
(Disbudding, pinching and defoliation)

T2 : 6 canes × 12 buds/cane without summer pruning

T3 : 8 canes × 12 buds/cane + summer pruning
(Disbudding, pinching and defoliation)

T4 : 8 canes × 12 buds/cane without summer pruning

T5 : The vineyard treatment (control)
10 canes × at least 14 buds/cane

Each treatment consisted of 12 vines in three replicate, 4 vines for each.
The same vines were used in the studied seasons

The following parameters were determined as follows :

Bud behaviour :

During the spring of 2006 and 2007 seasons, number of bursted, and fruitful buds were counted. Then percentages of these values were calculated. Number of clusters originating from the bud at different positions of the cane were also recorded for each vine then percentages of fruitful buds and bud burst were calculated as follows :

$$\text{Percentage of budburst} = \frac{\text{No. of bursted buds}}{\text{Bud load / vine}} \times 100$$

$$\text{Percentage of fruitful buds} = \frac{\text{No. of fruitful buds}}{\text{No. of bursted buds}} \times 100$$

Fertility coefficient was calculated by dividing number of bunches per vine by total number of buds per vine as mentioned by Bessis (1960).

Vegetative measurements :

1- Point quadrant and canopy gap measurements in the fruit zone:

Point quadrant and canopy gap measurements were performed three weeks prior to harvest using the method of Smart, (1988). The sharpened tip of a 1.2-m rod (3mm diameter) was positioned perpendicularly to the canopy surface at the height of the fruit zone. The rod was inserted into the canopy interior at an angle of 90º with respect to the canopy exterior, and the number of leaves intercepted by the tip of the rod were recorded.

The measurement was terminated when the tip of the rod reached the fruit zone. Shoot stems were ignored. We generally used 50-100 insertions at 5cm intervals on both sides of the vine, this normally is a sample of 5-10 vines. The needle was inserted at random, without looking at the canopy before insertion. The following parameters could be readily calculated.

Key L : Leaf contact – C: Cluster contact – G : Canopy gap

A: LLN : Leaf layer number

B: Percent interior leaves

C: Percent interior clusters

D: Percent gaps

(Smart and Smith, 1988).

2- Light intensity inside the canopy was measured using Illumination Meter-Luxmeter-Model DX-200.

3- Leaf area (m^2) :

At veraison, mature leaves at 5-7th position from shoot tip were collected to measure the individual leaf area using CI-203 Laser Area meter made by CID, Inc, Vancouver, Washington state, USA. Total leaf area/vine (m2) was determined by multiplying average number of leaves/shoot by average leaf area then by the number of shoots per vine.

4- Total chlorophyll content was determined as described by Wettstein (1957).

5- Weight of one-year-old wood prunings in kg:

At winter pruning time (January of each season), the one year old wood per each vine was weighed at each location including 12 vines per each treatment (kg per vine).

Yield/vine (Kg):

Bunches/vine were picked at harvest time (mid of July) and weighed. Bunch weight was recorded in gm.

Bunch quality and berry characteristics :

Samples of 20 clusters from each treatment were brought to the laboratory for chemical and physical properties (TSS and acidity were determined in the juice according to A.O.A.C. (1985).

The completely randomized design was followed.

Data were subjected to analysis of variance and New LSD was used for comparison between means (Snedecor and Cochran, 1974).

RESULTS AND DISCUSSION

Bud behaviour :

Bud burst, fruitful buds% and fertility coefficient :

As shown in Fig. (1). It is clearly evident that the longer cane length gave the highest values of percentage of bud burst T5 (control) at the two seasons of the study, in comparison with the other treatments. As for the fruitful buds percentage and fertility coefficient, treatments 1, 2, 3 and 4 were affected by No. of bud load left per cane and by the summer pruning treatments, as compared with the control. Fertility coefficient significantly increased at T1 and 3 which consisted of (6 canes × 12 buds) and (8 canes × 12 buds + summer pruning) in comparison with T2 and T4 and the control, also, there were significant differences between (T1 and T2) and (T3 and T4) without summer pruning as compared with the control in which vines were loaded by (10 canes × 14 buds without summer pruning). Fertility coefficient was highly significant compared to the control at the two seasons of the study. This increase may be due to that the chosen canes were with less bud no. where they were stronger than those of the control which had some weak vegetative canes having buds of low fruiting capacity (Fawzi *et al.,* 1984a and Rizk 1996). The results obtained revealed that the high density of vegetative growth shaded the buds at the stage of initiation, these unfavourable conditions might be responsible for increasing vegetative buds over those of fruiting ones.

Point quadrant measurements:

Data in Table (1) show point quadrant values (means of the two seasons, 2006 and 2007). This simple method describes the distribution of leaves and fruit in space, and provides quantitative canopy description (Smart, 1982 and Smart *et al.,* 1990). Canopy gaps were expressed as the percentage of insertions in which no leaf contacts. Table (1) show typical data for canopies of higher density with a greater No. of gaps at different treatments and lower density and lower No. of gaps number, the highest of these parameters were evidently shown in treatments 1 and 3. These results could by ascribed to the canopy management through training of 6 canes or 8 canes each comprised of 12 buds in addition to summer pruning practices, shade was avoided by reducing leaf area and increasing the proportion of canopy gaps to improve the microclimate (Smart, 1988) between the shoots and the vines to permit light and prevent canopy shade especially at the center of the vine for the clusters at the renewal zone. Leaves and fruit should have uniform microclimate as possible (Rizk *et al.,* 2006). Control treatment showed the highest values of leaf layer number (LLN) associated with shading, and higher percentage of interior 92% clusters where gaps were zero, the other treatments (2, 4 and the control) recorded medium number of gaps and low percentage of interior clusters and exterior leaves (showing low yield and bunch quality) this may be due to shading where no summer pruning were carried out (Smart and Smith, 1988 and Rizk *et al.,* 2006). Also, Dokoozlian and Kliewer (1995) pointed out that canopies with relatively high sunlight exposure (fruit zone) contained gaps over 20% to 25% of their canopy surface in the fruit zone. They added that ideal canopies have more than 40% canopy gaps, slightly small and slightly dull green healthy leaves LLN of 1.0 or leaves about 60%, fruit exposure, 10-20 node length, shoots with limited or zero lateral growth and 5% or less growing tips.

By this method of canopy density measurements, it was possible to reduce the high density canopy by different means of agricultural practices (winter pruning, cane lengths, number and summer pruning).

hlorophyll content, leaf area and light intensity :

Concerning chlorophyll content, it is clearly evident from Table (2) that it increased significantly in treatment (1) where it recorded the highest chlorophyll content in the two seasons (5.4 mg and 4.8 mg), respectively.

$T1_{+2}$

These results can be interpreted in view of the partial defoliation which could improve photosynthetic efficiency by increasing chlorophyll in the remaining leaves (Hunter and Visser, 1988 and Omar, 2005).

The other treatments were found to show also higher chlorophyll content than the control. The results in this respect are in line with those obtained by Rizk *et al.,* (2006) who stated that more side gaps of the canopy allowed light to penetrate into the center of the foliage.

The values for various expressions of leaf area density for Thompson Seedless grapevines two weeks before harvest are presented in Table (2). Leaf area per vine varied significantly among treatments. This estimate was increased in treatment 1, where it ranged from 188 to 194 cm^2 while in the control it ranged from 138 to 145 cm^2. Significant differences were also found between the other treatments and the control. These results indicate that leaf area per vine was decreased at higher degrees of vegetative growth (Omar, 2005 and Rizk *et al.,* 2006).

As for as light intensity is concerned it is apparent that it was significantly increased in treatments (1 and 3) where the leaves and the crowded shoots were removed at the center of the vine by summer pruning practices. These values were (260, 220 and 220, 205) luxmeter at the two seasons respectively in comparison with the control, where crowded leaves and shoots had the least values (130 and 145) luxmeter at the two seasons, respectively. These results are in agreement with those obtained by Omar (2005) who found that the dense canopy of the vines decreased the penetration and ventilation inside the canopy.

Berry characteristics :

Berry weight :

Data concerning berry weight (Table 3) show that in the treatments where no summer pruning was carried out and which had a higher density of vegetative growth, berry weight were decreased, this was obvious in the control treatment followed by treatment (4) and (2). The highest values of berry weight were found at the treatments with low number of canes and buds/cane + summer pruning. The same treatments were found to have the highest values of bunch weight. These results are in harmony with Kliewer (1982) and Smart *et al.,* (1990) who found that the decrease in berry weight was induced by higher canopy density due to the shading effect of bunches and berries and for the higher No. of buds left at winter pruning (bud load).

Table (3): Effect of canopy managment on berry characteristics (seasons 2006 and 2007)

Treatments	First season			Second season		
	Av. berry weight (gm)	TSS%	Acidity (%)	Av. berry weight (gm)	TSS%	Acidity (%)
T1	1.9	18.8	0.54	2.2	18.4	0.58
T2	1.6	17.4	0.63	1.4	17.0	0.60
T3	1.6	18.6	0.58	1.8	18.0	0.61
T4	1.5	17.2	0.64	1.8	16.6	0.64
Control	1.2	16.0	0.69	1.1	15.6	0.71
New L.S.D. at 5%	0.14	1.11	0.08	0.21	0.92	0.04

The same results were previously found by Howell *et al.,* (1991), Abdel Fattah *et al.,* (1993) and Rizk *et al.,* (2006).

Concerning berry characteristics, it was observed that sugar accumulation was delayed for the treatment with high canopy density. Data in Table (3) clearly show these results where treatment 1 (6 canes × 12 buds + summer pruning) had the highest percentages of TSS (18.8 and 18.4) at the two seasons 2006 and 2007, respectively followed by treatment 3 (8 canes × 12 buds + summer pruning) recording 18.6 and 18.0 in comparison with the control (high bud load without summer pruning). Acidity decreased in the treatments where TSS % increased. In the other treatments including control which high vegetative growth (more dense canopies). The results in this respect are in accordance obtained by with those (Kliewer, 1986; Smart *et al.,* 1990 and Rizk *et al.,* 2006) who proved that fruits of dense canopy had higher values of acidity than low and balanced canopy.

Shaded fruits showed variation in fruit composition. Since fruit composition responded to microclimate, this was evident of veraison. Smart, 1982 reported that microclimate had a significant impact at fruit quality.

Total yield, bunch weight and weight of prunings :

As illustrated in Fig. (2), yield per vine and bunch weight, increased significantly at treatment (1) (6 canes × 12 buds + summer pruning) where these estimates were found to record the highest values at the two seasons, respectively followed in a descending order by treatment (3) and treatment (2). The least yield per vine and bunch weight were given by the control (with high bud load and without summer pruning). These results are in the same line with those obtained (Dokoozlian and Kliewer, 1995).

As shown in Fig. (2) vine (Dec. 2005) had higher values of prunings weight ranging from 3.1-3.4 kg per vine before starting the present investigation (control i.e the vineyard treatments).

It is worthy to note that pruning weight was deceased in treatment 1 (6 canes × 12 buds + summer pruning) at 2006 and 2007 seasons, respectively. Vines with higher growth density and greater leaf area resulted in higher values of pruning weight, the highest weight of prunings was found in the control (10 canes × 14 buds) followed by treatment 4 (8 canes × 12 buds) with no summer pruning. Data also revealed significant differences in this aspect between treatments with summer pruning and the other two treatments 2, 4 in addition to the control.

These results are in agreement with those of (Reynolds and Wardle, 1989) who mentioned that shoot growth should be regulated by summer pruning. The results concerning of prunings agreed with those of (Smart, 1974; Shaulis, 1982; Smart *et al.,* 1982b; Shaulis and Smart, 1984 and Dokoozlian and Kliewer, 1995) who reported that this estimate ranged from 0.7 to 1.1kg for canopies with low leaf area density to nearly 3k for canopies with leaf area densities. They also stated that shading of this zone caused a reduction in cluster initiation, bud break percentage, fruit set and berry size.

Figure (3, 4 & 5) revealed the existence of a highly positive correlation between total leaf area per vine and bunch weight; between total leaf area and yield and between total leaf area and TSS % of berry juice in both seasons.

f

f

Canopy management techniques should be carried out according to vine vigour. Summer pruning practices at fruit zone and ideal bud load keeping a balance between vegetative shoots and fruiting ones are required to improve vine microclimate which by its turn results in higher quality of grapes and higher yield/vine, the costs of carrying out summer pruning practices are compensated by increase in the yield and the improvement of bunch and berry quality.

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تحسين جودة العنب الطومسون سيدلس ببعض معاملات تنظيم المسطح الخضري

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أجري هذا البحث لمدة ثلاثة مواسم 2005-2006 و 2007 بمزرعة خاصة – مركز نامول محافظة القليوبية علي كرمات عنب طومسون سيدلس عمرها 10 سنوات مرباة بطريقة التليفون. هذه المزرعة كرماتها عالية في النمو الخضري وكثافتة مع قلة الإنتاجية وقلة جودة العناقيد وكان مستوي التقليم تقريباً لكل الكرمات بعدد 10 قصبات مع زيادة عدد العيون إلي 14 عين للقصبة دون تنظيم إجراء معاملات التقليم الصيفي لذا طبقت معاملات لتحسين المناخ الداخلي حول وداخل الكرمات لتحسين جودة المحصول بتنظيم المسطح الخضري. أخذت وزن القصاصة في يناير 2005 لتقدير حالة وقوة النمو لكرمات المزرعة وطبقت المعاملات بعد التقليم وأختيرت 60 كرمة متماثلة تقريباً نفذت فيها 5 معاملات كل معاملة 4 كرمات مكررة 3 مرات واستخدمت نفس الكرمات في الموسمين التاليين 2006 و 2007 فأخذت 6 قصبات بطول 12 عين مع إجراء معاملات التقليم الصيفي وبدون ، والمعاملة الأخري 8 قصبات × 12 عين مع إجراء التقليم الصيفي أو بدونه ومعاملة المزرعة السائدة 10 قصبات × 14 عين وأوضحت النتائج أنه بإستخدام معاملات تنظيم المسطح الخضري أدي ذلك إلي زيادة الفجوات كما وجد زيادة في نسبة العيون الثمرية ومعامل الخصوبة وزيادة المحصول ووزن العنقود والمواد الصلبة الذائبة الكلية وزيادة محتوي الأوراق من الكلوروفيل والمساحة الورقية مع زيادة الكثافة الضوئية في المعاملات التي استخدم فيها عدد قصبات 6 وعدد عيون 12 عين مع إجراء التقليم الصيفي من إزالة نموات علي الخشب القديم والتطويش وإزالة المحاليق والتوريق عن باقي المعاملات والمقارنة – وزادت نسبة التفتح في المعاملات ذات القصبات الطويلة وزيادة كثافة النمو الخضري بها قلل من هذه المقاييس مع تقليل الفجوات بالمسطح الخضري – وهذا يرجع لأنها تتيح الإضاءة والتهوية بداخل الكرمات.

كما قل وزن القصاصة في المعاملات جميعها عن المقارنة وأكثرها تميزاً معاملة 1 – ولذا نري أنه لابد لتحسين جودة العناقيد مع زيادة المحصول تحميل الكرمات لعدد محدود من العيون وعدد محدود من القصبات مع إجراء معاملات تحسين وتنظيم المسطح الخضري لتقليل التظليل وتزاحم الأفرع لتحسين مناخ الكرمات الداخلي.

Table (1) : Sample point quadrat data for the five treatments (means of the two seasons 2006 and 2007)

Percentage	T1	T2	T3	T4
Percent gaps	13/50=26%	8/50=16%	14/50=28%	3/50=6%
LLN (Leaf Layer No.)	43/50=0.86	65/50=1.3	42/50=0.84	145/50=2.9
Percent interior leaves	4/43=9%	9/65=14%	6/44= 0.14	66/150=44%
Percent interior clusters	6/23=26%	17/29=58%	7/28=25%	31/33=90%

Key : L = Leaf contact C = Cluster contact G= Canopy gap

Table (2) : Effect of canopy managment on chlorophyll content , leaf area and light intensity (seasons 2006 and 2007)

Treatments	First season				Second season		
	Chlorophyll (mg/g d.w.)	Leaf area (cm^2)	Total leaf area (m2)	Light intensity expressed as luxmeter	Chlorophyll (mg/g d.w.)	Leaf area (cm^2)	Total leaf area (m2)
T1	5.4	194	17.0	260	4.8	188	18.4
T2	4.8	186	13.0	210	4.3	180	15.0
T3	4.0	180	11.6	220	4.0	175	14.0
T4	306	166	9.5	170	3.6	160	11.0
Control	205	145	8.8	130	2.2	138	9.6
New L.S.D. at 5%	1.2	13.0	5.1	43.0	0.40	21.0	4.7