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Improving yield quality and coloration by using canopy management effect on microclimate within Crimson Seedless grapevines

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ABSTRACT

This research was carried out for two seasons (2022 and 2023) in a private vineyard located at El-Khatatba, Monoufiya governorate. Ten years old Crimson Seedless grapevines supported by Gable trellis system, irrigated with drip irrigation were used for this investigation. All vines were cane pruned. Three levels of canopy density were used: the low canopy density (vines were pruned to 8 canes x 8 buds/vine + summer pruning), the moderate canopy density (vines were pruned to 12 canes x 10 buds/vine + summer pruning) and the high canopy density represented as control treatment (vines were pruned to 14 canes x 14 buds/vine + without summer pruning). The results revealed that a higher percentage of gaps, light intensity, aeration and moderate leaf area were recorded at the low canopy density (8 canes x 8 buds/vine + summer pruning). Moreover, the treatment of 8 canes x 8 buds/vine + summer pruning significantly increased the total yield/vine, bunch weight, TSS% and total anthocyanin in berry skin as well as reduced pruning weight and total acidity as compared to the treatment of 12 canes x 10buds/vine + summer pruning and control treatment. Economically, this treatment could be of good return for growers.

Keywords: Grapes- Crimson- Canopy- Microclimate- Yield.

INTRODUCTION

Canopy microclimate is a term that is frequently misinterpreted and confused with microclimate in the context of grape cultivation (Smart et al., 1982). The term "canopy microclimate" refers to the temperature inside and immediately surrounding the grapevine canopy, including the vine's leaf and shoot system, according to the definition, the size, form, arrangement, and density of the leaves within the canopy are the primary factors that distinguish the canopy microclimate from the ambient environment surrounding it. The variables that are mostly affected by grapevine canopies are the photosynthetic ratio, wind speed, evaporation rates, and light rate, while air temperature and humidity are significantly less affected (Smart et al., 1985).

The microclimate of the grapevine canopy is primarily determined by the quantity and arrangement of leaf area inside a specific volume, as well as its correlation with the above-ground climate. The key factors influencing the quantity of leaf area in a given size are shoot vigor, density, and winter pruning. In this context, shoot density is a measure of shoot crowding and is defined as the shoot number/meter of canopy length. The quantity of leaf area contained in a specific volume is known as canopy density. There are several approaches to construct canopy density indices: as the number of leaf layers, the ratio of leaf area to canopy surface area, the weight of pruning cane per unit, the length of the canopy, or the leaf area index (Shaulis,1982, Smart, 1982 and Smart and Smith, 1988).

Canopy management is now becoming recognized as an important tool for the viticulturist to influence yield, quality and cost of production over the last 60 years. Canopy management results in partial

microclimate alterations, which lessen the canopy's exposure to light and heat and delay down the process of ripening (Lu et al., 2021 and Micciche et al., 2023).

Highlighting the improper canopy management made by some growers, now canopies problem can be identified and given some practical techniques for canopy management and then the solution with summer pruning treatments to alter microclimate within the grapevines. It is critical that clusters must be exposed to sunlight throughout ripening for maximum coloration (Dokoozlione and Kliewer, 1995).

Hence, summer pruning helps in improving fruit quality through increased solar exposure resulting in higher concentration of sugars, lower acidity and higher content of anthocyanin. It was proved to be an effective tool to balance between canopy density and air temperature and further allowing more light penetration resulting in enhancing an appropriate fruit maturity and color (Ali et al., 2006)

Crimson seedless grape cultivar has high potentiality for exporting to Europe and Arab countries, but it is faced with some problems, namely the high density of vegetative growth, small berry size with very poor coloration. The scope of the present investigation is to enhance yield attributes via altering canopy microclimate through using three canopy densities.

MATERIALS AND METHODS

This investigation was conducted for two successive seasons (2022 and 2023) in a private vineyard located at El-Khatatba Menoufiya governorate, Egypt. Ten years old Crimson Seedless grapevines on freedom rootstock were considered. Vines were uniform as much as possible, supported by Gable trellis system, with drip irrigation used. Three levels of canopy density were applied: the low canopy density (vines were pruned to 8 canes x 8 buds / vine + summer pruning), the moderate canopy density (vines were pruned to 12 canes x 10 buds / vine + summer pruning) and the high canopy density represented as control treatment (vines were pruned to 14 canes x 14 buds / vine + without summer pruning.

Summer pruning was carried out by disbudding, removing crowded shoots, defoliating and removing all shoots born on the old wood.

Each density (treatment) was replicated 3 times and each replicate was made of 3 vines.

1) Canopy assessment (Score Card)

The Score Card was used on observation of high and low quality vineyards and experimental observations are made for all vines with two persons in front the vine one gives the observation and the other recorder the observations.

The canopy microclimate and the physiological state of the vines are of the main factors that influence berry quality. It turns out that both may be evaluated visually, which gave rise to the idea of a vineyard scorecard. Eight features can be evaluated; three are specifically related to the microclimate i.e. canopy gaps and density as well as berry exposure, while the remaining five are related to previous growth and physiological status expressed leaf size and color, shoot length, and lateral growth as well as growing tip presence. Out of ten points, each character is evaluated, for a total of eighty. More than 40% of canopy gaps, few, healthy leaves with a dull green color, an LLN of 1.0 or less, roughly 60% fruit exposure, 10–20 node length, shoots with little to no lateral growth, and 5% or less growing tips are all characteristics of ideal canopies.

Method as follow:

Standing away from the vine canopy and take.

1- Canopy Gaps
2- Canopy density
3- leaf size
4- leaf color
5- fruit exposure
6- Shoot length
7- Flouring tips
8- Lateral growth

Score Card Indicates Potential for Producing Qualify of Grapes

Table (1): Score Card Indicates Potential for Producing Qualify of Grapes

A. Standing away from canopy	
1. Leaf size (basal-mid leaves on shoot exterior). For this variety are the leaves relatively: • Slightly small 10 • average 8 • slightly large 6 • very large 2 • very small 2	**6. Lateral growth** (normally from about point where shoots trimmed. If laterals have been trimmed, look at diameter of stubs) • limited or zero lateral growth 10 • moderate vigour lateral growth 6 • very vigorous growth 2
2. Canopy gaps (from side to side of canopy, within area contained by 90% of canopy boundary) • about 40% 10 • about 50% or more 8 • about 30% 6 • about 20% 4 • about 10% or less 0	**7. Growing tips** (of all shoots the proportion with actively growing tips make due allowance for trimming). • about 5% or less 10 • about 10% 8 • about 20% 6 • about 30% 4 • about 40% 4 • about 50% or more 0
3. Leaf colour (basal leaves) • leaves green, healthy, and pale 10 • leaves dark green, shiny, healthy 6 • leaves yellowish green, 6 • leaves with mild nutrient deficiency symptoms 6 • Unhealthy leaves. 2	**8. Shoot length** • about 20-10 nodes 10 • about 8-10 nodes 6 • about 20-25 nodes 6 • less than about 8 nodes 2 • more than about 30 nodes 2
B. Standing at Canopy **4. Canopy density** (from side to side in fruit zone) • about 1 or less 10 • about 1.5 8 • about 2 4 • more than 2 2	Total pint score __ /80 = ___%
5. Fruit exposure (remember that the canopy has two sides normally-that fruit which is not exposed on your side may be exposed to the other side) • about 60% or more exposed 10 • about 50% 8 • about 40% 6 • about 30% 4 • about 20% or less 2	

Note: If majority of choose are less than 30 cm long, high these vines are clearly diseased or chlorotic or necrotic, or excessively stressed. Do Not Score Vineyard.

2) Vegetative growth measurements

- Light intensity inside the canopy of each vine was recorded using a Luxmeter light metre (Model Dx - 200).
- Leaf area (cm^2)**:** Using a CID, Inc. laser area metre manufactured in Vancouver, USA, mature leaves at position 5, 7 from the shoot tip were taken at veraison in order to measure the leaf area.
- Pruning weight (kg): At winter pruning time, the one year old wood per each vine was weighed per each treatment (kg per vine).

3) Yield and average bunch weight

At harvest season (mid-August), bunches/vine were harvested and weighed. The calculation of bunch weight in grams and yield in kilograms by multiplying the number of bunches by the average bunch weight.

4) Berry quality

Twenty bunches from each treatment were harvested and transferred to the lab.

- Average berry weight was measured as (gram).
- TSS and total acidity were determined as ascribed to (A.OA.C., 1995)
- Total anthocyanin was identified according to (Husia et al., 1965).
- **Experimental design and statistical analysis**

A complete randomized block design was conducted. The statistical analysis of the present data was performed (Snedecor and Cochran, 1980). Averages were compared by using LSD values at 5% level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1) Canopy assessment (Score card)

The sample score Card canopy density was used to describe Crimson seedless grape cultivar. The results are set out as fellow:

As shown in **(Table 2),** the scorecard data for T2 (8 canes x 8 buds/vine + summer pruning) are very near to the ideal (97%) followed by T1 (12 canes x 10 buds / vine + summer pruning) recorded (82%), whereas, control treatment (14 canes x 14 buds / vine + without summer pruning) recorded the lowest one, which it recorded (52%).

These results are in agreement with those obtained by Risk et al. (2006), Risk et al. (2008) and Shoaieb et al. (2011) who illustrated that the higher number of gaps results in sufficient fruit exposure to sunshine which encourages and improve bunch quality while lower number of gaps induced shaded canopies thus producing bunches with more acidity and reduced sugar and coloration.

Table (2). Effect of canopy management on Scoring canopy density of Crimson Seedless grapevines in 2022 and 2023 seasons

Character	T_1 (12 canes x 10 buds with summer pruning)	T_2 (8 canes x 8 buds with summer pruning)	T_3 (14 canes x 14 buds without summer pruning) (Control)
Leaf colour	8	10	6
Leaf Size	8	10	6
Canopy gaps	8	10	0
Canopy density	8	8	10
Shoot length	8	10	6
Fruit exposure	8	10	2
Growing tips	10	10	8
Lateral growth	8	10	4
Total/ 80	66	78	42

2) Vegetative growth aspects

Data presented in **(Table 3),** declare that light intensity, leaf area and pruning weight were affected by the canopy density in Crimson seedless grapevine at 2022 and 2023 seasons. The low canopy density (vines pruned to 8 canes x 8 buds / vine + summer pruning) achieved significantly the highest light intensity and leaf area, while the pruning weight was the least as compared to the moderate canopy density (vines were pruned to 12 canes x 10 buds / vine + summer pruning) and the high canopy density represented as control treatment (vines were pruned to 14 canes x 14 buds / vine + without summer pruning).

The results in this concern are in harmony with the findings of Shoaieb et al. (2011) and Lu et al. (2021), who found that high canopy density cause a lower leaf area and higher pruning weight.

Table (3). Effect of canopy management on vegetative growth aspects of Crimson Seedless grapevines in 2022 and 2023 seasons

Treatments	Light intensity (Lux-meter)		Leaf area (cm^2)		Pruning weight (g)	
	2022	2023	2022	2023	2022	2023
T1 (12 canes x 10 buds/vine with summer pruning)	210.0	235.0	188.0	169.0	90.0	85.0
T2 (8 canes x 8 buds/vine with summer pruning)	245.0	265.0	195.0	185.0	67.0	70.0
T3 (14 cans x 14 buds /vine without summer pruning)	155.0	170.0	140.0	133.0	180.0	144.0
L.S.D 5%	37.0	42.0	13.2	11.4	18.10	14.6

3) Yield and bunch weight

As shown in **(Table 4),** significantly the highest yield and bunch weight were attributed to the low canopy density (vines were pruned to 8 canes x 8 buds / vine + summer pruning) followed by the moderate canopy density (vines were pruned to 12 canes x 10 buds / vine + summer pruning), whereas the high canopy density represented as control treatment (vines were pruned to 14 canes x 14 buds / vine + without summer pruning) significantly attained the lowest values of these determinations in both seasons.

These results are in harmony with those obtained by Smart and Sharp (1989) and Lu et al. (2021), who found that the total crop yield increased at the high degree of light penetration into vine canopy as compared with the control without summer pruning. Also, they pointed out that increasing summer pruning treatment increased yield and improved fruit quality as a result of improving the microclimate of the vines (light and aeration).

Table (4). Effect of canopy management on yield and bunch weight of Crimson Seedless grapevines in 2022 and 2023 seasons

Treatments	Season 2022		Season 2023	
	Yield/ vine (kg)	Bunch weight (g)	Yield/ vine (kg)	Bunch weight (g)
T1 (12 canes x 10 buds vine with summer pruning)	10.44	390	11.31	410
T2 (8 canes x 8 buds/vine with summer pruning)	12.51	430	13.29	450
T3 (14 cans x 14 buds/vine without summer pruning)	6.45	280	8.71	290
L.S.D 5%	3.53	66	2.97	74

4) Berry quality

Data presented in **(Table 5),** show that average berry weight, TSS%, total acidity% and total anthocyanin were affected by the canopy density in Crimson seedless grapevine at 2022 and 2023 seasons. The low canopy density (vines were pruned to 8 canes x 8 buds / vine + summer pruning) significantly increased average berry weight, TSS% and total anthocyanin and reduced total acidity as compared to the moderate canopy density (vines were pruned to 12 canes x 10 buds/vine + summer pruning) and the high canopy density represented as control treatment (vines were pruned to 14 canes x 14 buds/vine + without summer pruning).

These results are in agreement with those obtained by Shaulis (1982), Smart et al. (1982), Jackson and Coombe (1988), Kliewer et al. (1991), Risk et al. (2006), Risk et al. (2008) and Shoaieb et al. (2011), who found that shading by the new shoots of the center zone reduces fruit sugar (T.S.S) and increases total acidity.

Table (5). Effect of canopy management on berry quality attributes of Crimson Seedless grapevines in 2022 and 2023 seasons.

Treatments	Season 2022				Season 2023			
	Berry weight (g)	T.S.S %	Acidity %	Total anthocyanin (mg/100g)	Berry weight (g)	T.S.S %	Acidity %	Total anthocyanin (mg/100g)
T1 (12 canes x 10 buds / vine with summer pruning)	**3.40**	**16.8**	**0.58**	**69.9**	**3.80**	**18.0**	**0.61**	**60.0**
T2 (8 canes x 8 buds / vine with summer pruning)	**3.88**	**18.4**	**0.54**	**84.5**	**4.10**	**18.8**	**0.53**	**76.0**
T3 (14 cans x 14 buds / vine without summer pruning)	**2.60**	**12.6**	**0.65**	**40.0**	**3.15**	**13.2**	**0.69**	**46.0**
L.S.D 5%	**0.41**	**1.6**	**0.01**	**8.1**	**0.40**	**1.4**	**0.02**	**12.4**

Conclusion

Considering the previous findings, it can be concluded that the yield and fruit quality attributes of Crimson Seedless grape could be enhanced by the low canopy density (vines pruned to 8 canes x 8 buds / vine + summer pruning) due to altering vine microclimate to a better one, which is reflect in increasing yield and improving bunch quality attributes and berry colouration. Economically, this treatment gives a better financial return to growers.

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الملخص العربى

تحسين جودة المحصول والتلوين باستخدام تأثير المسطح الخضرى على المناخ الداخلى لكرمات العنب الكريمسون سيدلس

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تم إجراء هذا البحث لمدة موسمين (2022 و 2023) في مزرعة خاصة بمنطقة الخطاطبة التابعة لمحافظة المنوفية على كرمات العنب الكريمسون سيدلس البالغة من العمر عشر سنوات مدعمة بنظام الجيبل، والرى بنظام التنقيط، وتقلم جميع الكرمات تقليما قصيبا. تم إجراء ثلاثة مستويات من المسطح الخضرى وهى: مسطح خضرى منخفض (تقليم الكرمات إلى 8 قصبات × 8 براعم / كرمة + تقليم صيفي)، مسطح خضرى معتدل (تقليم الكرمات إلى 12 قصبة × 10 براعم / كرمة + تقليم صيفي) ومسطح خضرى عالي وتمثلت فى معاملة الكنترول وهى معاملة المزرعة (تقليم الكرمات إلى 14 قصبة × 14 برعم / كرمة + بدون تقليم صيفي). أظهرت النتائج تسجيل نسبة أعلى من الفجوات وشدة الإضاءة والتهوية مع مساحة ورقية متوسطة عند مسطح خضرى منخفض (8 قصبات × 8 براعم / كرمة + تقليم صيفي). علاوة على ذلك أدت المعاملة المتمثلة فى 8 قصبات × 8 براعم / كرمة + تقليم الصيفي إلى زيادة معنوية في المحصول الكلي / كرمة ووزن العنقود ونسبة المواد الصلبة الذائبة الكلية وصبغة الانثوسيانين مع انخفاض فى كل من وزن القصاصة والحموضة الكلية فى عصير الحبات مقارنة بالمعاملة (12 قصبة × 10 براعم / كرمة + تقليم صيفي) ومعاملة الكنترول، وهذه المعاملات تعود اقتصاديا على المزارع بفائدة جيدة.

الكلمات الدالة: العنب، الكريمسون ، المسطح الخصرى، المناخ الداخلى ، المحصول