Journal of Agriculture and Crops
ISSN(e): 2412-6381, ISSN(p): 2413-886X
Vol. 9, Issue. 4, pp: 533-539, 2023
URL: https://arpgweb.com/journal/journal/14
DOI: https://doi.org/10.32861/jac.94.533.539

Academic Research Publishing Group

Original Research **Open Access**

Alleviation of Heat Stress Effects on Canino Apricot (*Prunus Armeniaca*, l.) by Using Shade Net

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Article History
Received: 20 July, 2023
Revised: 18 September, 2023
Accepted: 21 October, 2023
Published: 30 October, 2023

Abstract

Rise in temperature prior to and during flowering can be detrimental to trees and occur irregularity of apricot varieties productivity. We could overcome the problem by using coloured shade net on the trees. Therefore, this work was done through two seasons to reduce the impact of temperature stress on the growth, productivity and quality of Canino Apricot trees grown in El Kanater Station of the Horticulture Researches at El Kalubeia province, Egypt. It can be recommended to use both of shade nets, which, improved the growth and led to an increase in the yield and preservation of a higher quality of the resulting fruits. A relative superiority was also observed for the use of black shade net.

Keywords: Canino apricot; Colour shade netting (white or black); Growth; Yield; Fruit quality.

How to Cite: Saied Kamel Mohamed Abd El-Naby, Yahia. Ibrahim Mohamed El-Naggar, Amr. Abdelkhalek, 2023. "Alleviation of Heat Stress Effects on Canino Apricot (*Prunus Armeniaca*, l.) by Using Shade Net." *Journal of Agriculture and Crops*, vol. 9, pp. 533-539.

1. Introduction

Climatic events considered as crucial factors for cultivation temperature sensitive crops as grapes, berries, citrus, and stone fruits [1] especially for apricot which any changes in these climate events will be reflected vegetative growth and yield .The response of apricot trees to temperature stress depends upon some factors, such as the crop growth stage, the plant tissue type ;and bud development stage ,and the nature of temperature stress ,which ,rise in temperature accelerates initiation reactions, and reduce of existing and augmented antioxidant activities [2] and influenced fruit set and, consequently, productivity [3]. Warm temperature at early winter can be led to flower bud drop also early frosts can reduce flower buds 'number [4] For some cultivars ;happening of warm temperatures then , low temperatures can have promoting or rapid dormancy breaking comparing with the effect of exclusively low temperatures, [5]. Gunduz, *et al.* [6], reported that choosing suitable apricot variety and protecting the apricot farms with particular tools to reduce adverse effects of fluctuations of climatic events .Also, Campoy, *et al.* [7] found that the main cause of poor bud break is the daytime temperatures and not the lack of low night-time temperatures, thus, shading of trees reduces the incidence of direct solar exposure and improve dormancy breakage .

Netting is used to protect agricultural crops in Mediterranean region from excessive solar radiation, improving the temperature conditions and resulted in less disorder of fruit crops this may change phytochemical of fruits and vegetables [8]. These phytochemicals are accumulation under spectra created by different coloured nets that plant species respond differently to growth and development and shade net can modify environmental conditions inside the canopy [9]. Covering with clear polyethylene is used to produce vegetables and cut flowers and recently increasing interest for their use on perennial crops [10] Thus ,shading especially coloured shade netting is an efficient tool can be used by horticulturists for crop production in bad climate condition ,which reduces solar radiation, air velocity ,temperature ,evapotranspiration and increase air relative humidity and therefore affecting light quality and thus affected on plant growth ,production and quality [11] reduce heat stress [12]. Rodrigo and Herrero [13] showed that using of polyethylene cage during pre-flower development of apricot flower buds can increase maximum temperatures by 6-7^0 C in field conditions, this accelerates flower bud development ,flowering time and reduce fruit set .While Egea and Burgos [14] noted that high temperature at pre-blossom of bagged branches had no affect almond fruit set .Thus, Jackson, *et al.* [15] found a reverse correlation between crop weight and warm pre-flower temperatures in apple.

On the other hand, there are some beneficial aspects of colour nets to produce Kiwifruits [16] Also ,there is ,no effect of autumn shading on apricot flowering or yield [7].

This work was designed to evaluate covering Canino apricot trees with coloured shade net, which may overcome the unsuitable climatic events and to produce Canino apricot without affecting yield and quality characteristics.

2. Materials and Methods

2.1. Plant Materials

This work was done on 13 years old 'Canino' apricot trees (*Prunus armeniaca* L.) grafted on a local apricot rootstock during the two consecutive seasons of 2017 and 2018., planted 5 × 5 meters apart, grown in El Kanater Station of the Horticulture Researches at El Kalubeia province, Egypt. The chosen trees for the study were similar in vigour and undergo to other traditional operations.

Shade net is manufactured from knitted polyethylene fabric by private net company, El-Gharbia province, its diameter and cell size were 0.28 mm3x7.4 mm., respectively. Shade netting was done by digging holes, placing Woven trees columns, then tighten the wire on them, -The trees were covered with a different colour shade, either white net (about 25% shading) or black net (about 50 %shading) on all sides and horizontally above the trees which it was rolled up to a height of 5 m to improve ventilation. The use of shade netting was a moveable shade during certain period from through the winter (the first of Nov.) until flowering (the first of March) to protect the fruit set and then growth and production thus, the shade has been folded after the end of the fruit set. Other trees at the same phenological stage were left unshaded control.

2.2. Growth

3 two -year -old homogeneous branches per tree were chosen with a similar length (100 120-cm.) and diameter (20 25-cm.), respectively which located at a similar height and different orientations .Shoot length (cm.) and number of leaves were record at the first of June in each season .At full bloom" completion of flowering" when75 %of the flower buds were opened, total numbers of flower buds were counted then percentage of buds opening were determined total number vegetative buds opening, and its percentage were recorded and determined 30 days after bud burst stage .Fruit set" after 30 days of full bloom "was calculated as the percentage of fruits per total flower buds (fruits/buds).

2.3. Yield

Fruit picking was recorded on mid- June in each season when the control fruits reached suitable maturity of colour, firmness, and taste ,fruits were counted and weighed for all trees.

2.4. Fruit Physical Properties

20 random fruits from each tree were cut in polyethylene bags and brought to the laboratory for analyses . Average weight was expressed in grams per fruit (g) ,.average diameter of fruits was measured with Vernier callipers and expressed in centimetre .Fruit firmness: Flesh-firmness of fruits was determined by pressure tester (Magness-Taylor Pressure tester, Model FT 327) which was expressed in Lb./inch $^{.2}$

2.5. Fruit Chemical Properties

In fruit juice ;Total soluble solids (TSS) :were determined by Carl Zeiss hand refractometer .Titratable acidity (TA) was estimated by titrating the fruit pulp extract with 0.5N NaOH using phenolphthalein as an indicator. This was expressed as anhydrous citric acid percentage according to A.O.A.C. [17].

2.6. Statistical Analysis

All result of both seasons were subjected to analysis of variance according to Snedecor and Cochran [18] and to distinguished p of significant differences among means as according to the Duncan's multiple test range [19] Means followed by the same letter within each column in any figure did not significantly differ at 5% level .

Table-1a. The climate data for El Kanater El Khayreia region were collected from August 2017 to May 2018

climate data Date	Solar radiation Dgt [MJ/m2]	Wind direction dig [deg]	Wind speed [m/sec]	Leaf Wetness [min]	Air temperature [°C]	Relative humidity [%]	Dew Point [°C]
Aug. (2017)	14.51	161.15	0.12	492.74	30.12	57.84	19.80
Sep.	12.85	151.51	0.11	537.50	27.91	57.50	17.75
Oct.	9.37	154.94	0.14	547.74	24.02	55.74	13.54
Nov.	5.76	164.71	0.10	630.33	19.04	64.57	11.43
Dec.	4.26	186.96	0.10	597.10	16.90	69.29	10.59
Jan. (2018)	5.73	162.01	0.29	406.77	14.70	63.68	7.23
Feb.	9.44	192.46	0.10	307.32	17.64	60.79	8.76
Mar.	12.60	195.49	0.23	105.32	21.17	48.42	7.82
Apr.	15.26	204.15	0.22	103.83	23.24	47.43	9.59
May	17.05	191.49	0.25	104.03	27.69	45.55	12.89

Table-1b. The climate data for El Kanater El Khayreia region were collected from August 2018 to May 2019

climate data Date	Solar radiation Dgt [MJ/m2]	Wind direction dig [deg]	Wind speed [m/sec]	Leaf Wetness [min]	Air temperature [°C]	Relative humidity [%]	Dew Point [°C]
Aug. (2018)	15.29	187.93	0.13	284.52	30.04	56.77	19.50
Sep.	13.36	185.29	0.09	392.50	28.65	56.67	18.20
Oct.	9.00	181.99	0.11	485.00	24.96	55.94	14.66
Nov.	7.07	172.66	0.02	498.50	20.13	65.77	12.66
Dec.	6.57	148.60	0.17	260.81	15.90	64.16	8.57
Jan. (2019)	7.23	157.78	0.32	229.52	13.26	53.74	3.09
Feb.	9.91	173.31	0.25	253.04	15.02	57.61	5.66
Mar.	13.09	184.61	0.34	159.19	17.49	56.61	7.58
Apr.	14.31	187.74	0.30	75.50	20.87	49.23	8.31
May	15.93	203.40	0.22	24.52	27.33	38.77	9.74

3. Results and Discussion

3.1. Growth

Fig-1. Growth and the fruit set of Canino apricot during 2017 /2018 season as affected by coloured shade net through the winter

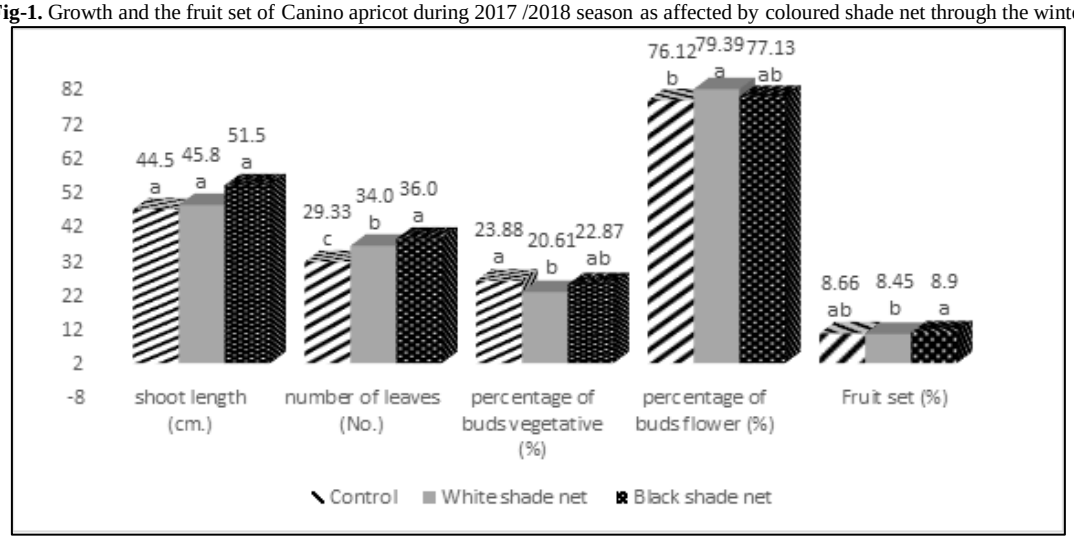
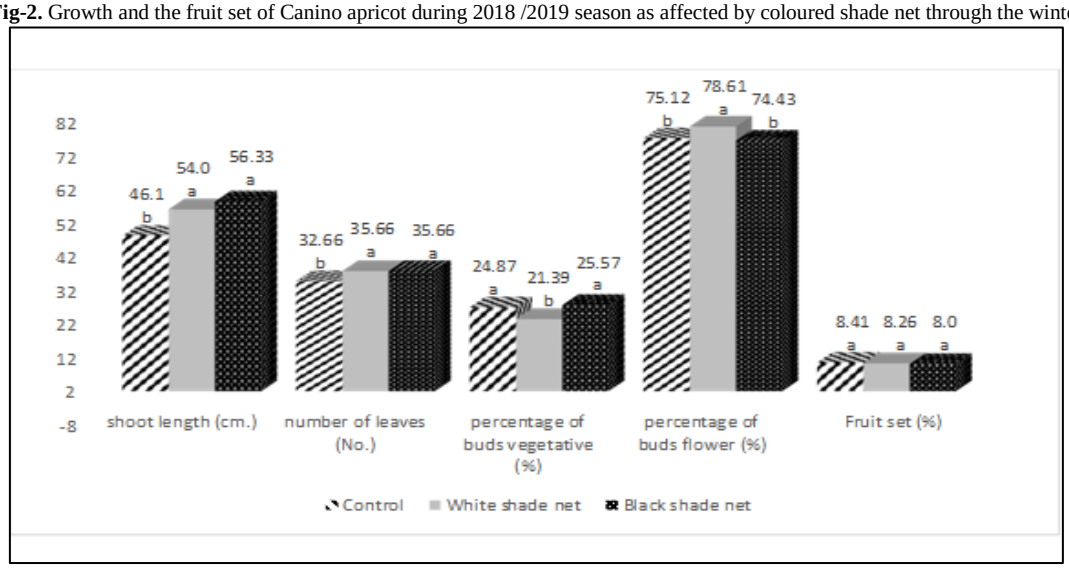


Fig-2. Growth and the fruit set of Canino apricot during 2018 /2019 season as affected by coloured shade net through the winter



In Figures 1 and 2 it was found that the shade nets used did not show in the first season of growth, any improvement in the length of the growing shoot, but in the following season it gave a significant improvement than the control. Also, the use of these methods gave more leaves number on the shoot compared to the control and black shade net was superior, especially in the first growing. White shade net gave the highest percentage of vegetative buds and the lowest percentage of flower buds in the two growing seasons. Thus, this treatment gave the lowest percentage especial in 2017-2018 season only, as in 2018-2019 season there was no significant difference between two shade nets comparing with the control.

Improved vegetative growth of trees when used shading might be attributed to the increase of uptake water and nutrients by trees which led to increase the rate of growth. Thus, Mata and Botto [20] found that light quality manipulation is a tool as the application of plant growth regulators in commercial production systems. As well as, [21] showed that shading mango trees avoid undesirable effects of excess solar irradiation in hot climate. Ilic and Fallik [9], found that shading led to more coverage of leaves on fruits. Also, Léchaudel, *et al*. [22] reported that growth performance of mango trees and fruit size mainly depend on climate conditions. Thus, [23] observed accelerate vegetative growth of orange tree with using netting tools.

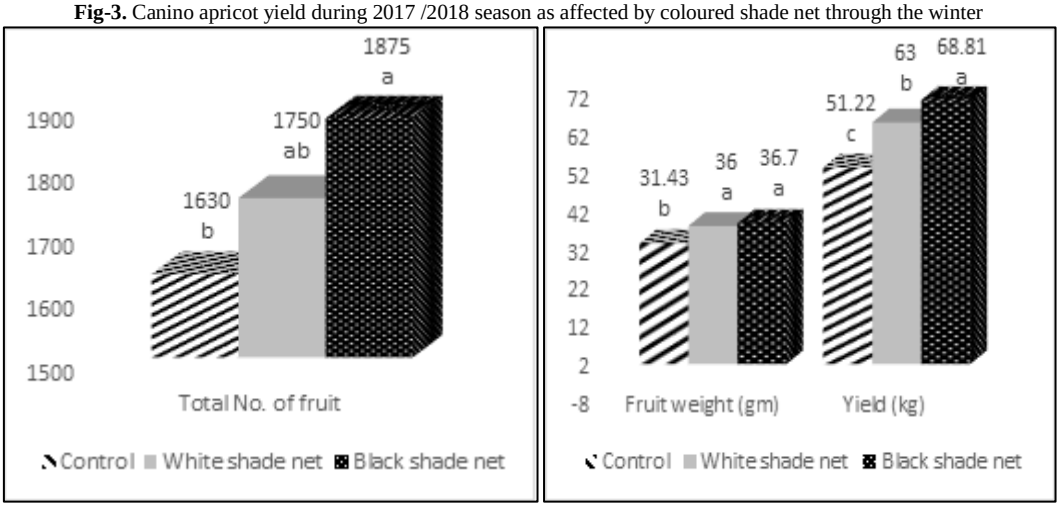
3.2. Flowering and Fruit Set

Results suggest that netting tools no led to lower fruit set significantly than the control especially in the second season, this may be differences in the level of dormancy for vegetative and floral buds with cultivars and within the same cultivar, depending on their location on the branches and their age.

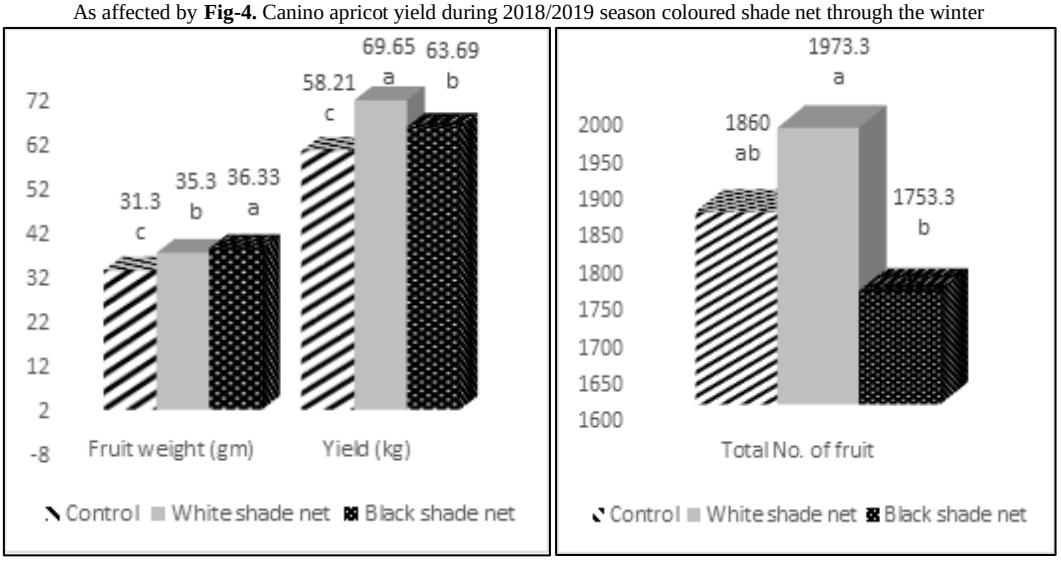
Flowering of Hermosa peaches was increased by five net (white,12% shading; blue, pearl, red, and yellow,30%shading) and fruit set increased by two nets compared with the no-net control [12]. warm temperatures during flower bud development led sensitive to separation of bud scales to anthesis; consequently, effect on flower quality and fruit set [13].

3.3. Fruit yield.

Fig-3. Canino apricot yield during 2017 /2018 season as affected by coloured shade net through the winter



As affected by **Fig-4.** Canino apricot yield during 2018/2019 season coloured shade net through the winter



Figures 3 and 4 shows that shading with black net gave the highest number of fruits / tree as well as the largest weight of the fruit, which led to the production of the highest yield, followed by using white shade net. This was true in the 2017-2018 season, while in the 2018-2019 season the use of white shade net was higher. Yield from using white shade net, was due to the trees 'production of more fruits number, followed by the yield resulting from the use of black shade net, where its yield produced from fruits of greater weight compared to the other treatments. It can be determined that the yield resulting from the use of the two shade nets in both seasons was higher than the control yield, which is due in the first season to producing a greater number of fruits with greater weight, while it is due in the following season to increase fruit weight only.

Thus, fruit growth depends on transpiration through its effect on photosynthesis and carbohydrate status. Total yield under shading. may be attributed to changes in fruit weigh rather than fruit number. And affected by temperature fluctuations in late winter and in early spring causing the flower buds to soften. In addition, fruit set, fruit drops, and yield in apricots can be affected by many environmental and physiological factors [4, 24, 25] However, problems related to poor yields are more pronounced in apricot than in other fruits. It is well known that some factors such as the number of flower buds produced before flowering influence productivity [24]. Shade under the hot climates gave a beneficial affect due to increases flower number, fruit set and yield. Léchaudel, *et al.* [22] reported that climate conditions and genetic component of cultivar has affected on flowering; fruit set and yield of apricot trees.

3.4. Fruit Characteristics

Fig-5. Fruit quality of Canino apricot during 2017 /2018 season as affected by coloured shade through the winter net

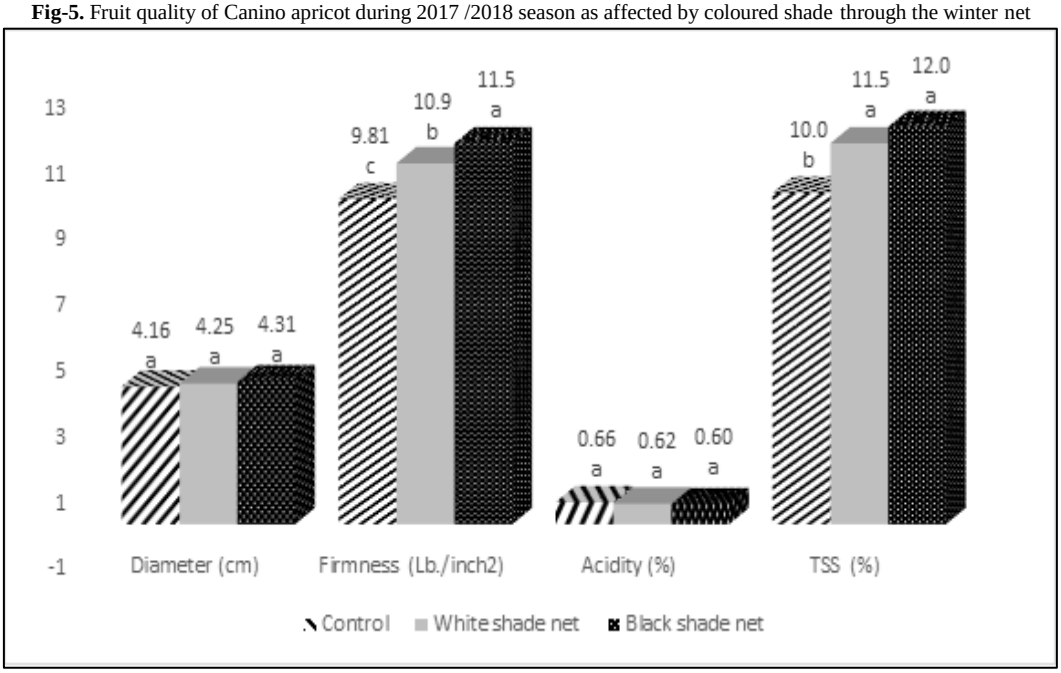
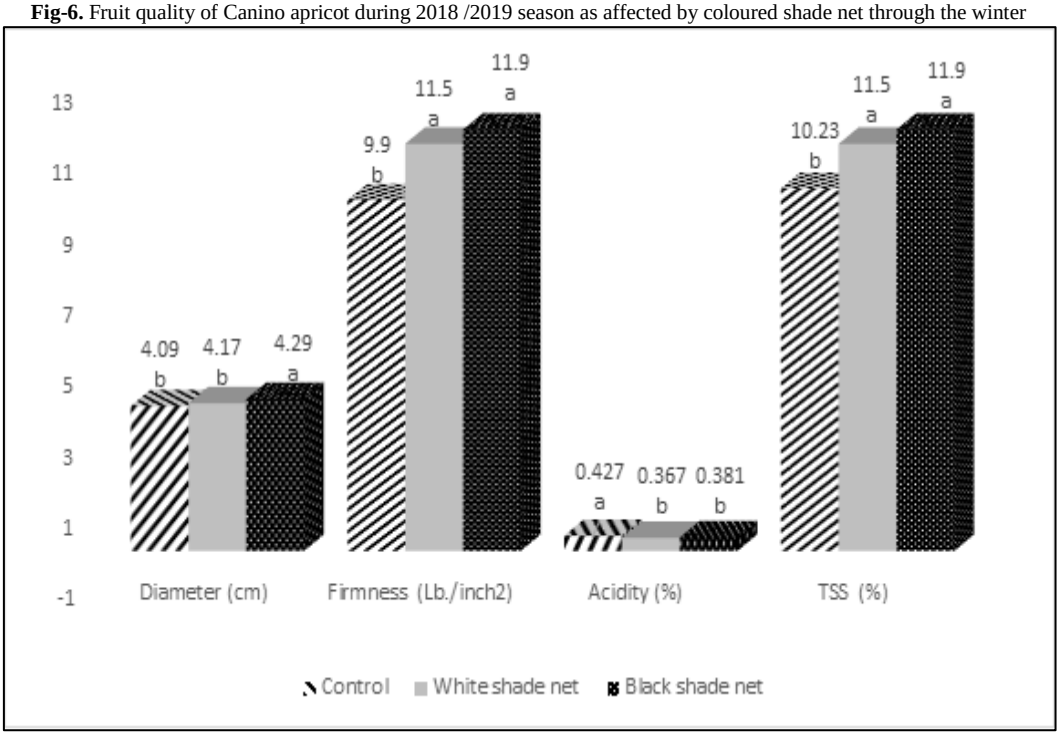


Fig-6. Fruit quality of Canino apricot during 2018 /2019 season as affected by coloured shade net through the winter



From Figures 5 and 6 All fruits were of good qualities, as the diameter of the fruit did not change with those methods used in 2017-2018 season, but it was greater in 2018-2019 season with the use of black shade net. Also, the firmness of the fruits growing under those shade nets was higher compared with the fruits of the control in the two seasons. Whereas the acidity of the fruits decreased with both of shade nets used and showed significant only in the

second season. The fruits resulting from the use of different shade nets showed the highest percentage of total soluble solids than the fruits of control in the two years, with insignificance between the two both of shade nets.

Shading gave better nutrient uptake, and photosynthesis rates consequently had a greater number and weight fruit [12]. Gent [26], showed that, shade may increase quality without reducing fruit size and increase flower number per tree and yield which attributable to the response to irradiance rather than to temperature. On the other hand, the increase in fruit weight under shade could not related to an increase in its diameter as observed by Mata and Botto [20]. Such, no negative effect on apple fruit quality and maturation as noted [27]. Also, no significant differences in total soluble solids in fruit and the retention of sensory qualities at harvest with different coloured shade nets as showed by Ilic and Fallik [9].

Moreover, Abd El-Naby, *et al.* [28] found that when covered orange trees during flowering and set period, it was very effective at protecting trees and maintain the fruit quality, which affect nets on radiation, humidity, evapotranspiration, and temperature. Shade screenhouse texture, can significantly affect the evapotranspiration as in banana plantation Haijun, *et al.* [29] and in table-grape vineyard [30] as compared with open field. Traditional black nets reduce light intensity, without effect on light quality [31]. Rodrigo and Herrero [13], showed that warm pre-flowering temperature is a physiological problem very frequent in apricot and reduce fruit set and productivity. Control on dormancy acts limitation to temperate-zone deciduous fruit trees production especial apricot in warm areas, shading of trees reduces the incidence of radiation and the temperature. This led to improvement in fruit qua lity without differences were observed in percentage of firmness and total soluble with increasing the production when colored shading screens have been used [32]. Important quality factors affecting apricot fruit value and customer preferences are fruit weight and firmness.

4. Conclusion

One of the suitable ways to alleviate the heat stress is shading with coloured net, which used to overcome on microclimate in the field to improve plant growth and yield. It was found that used agricultural treatments as a colour shade net provide cooling to sensitive crops and improved the yield and apricot fruit quality. It can be concluded that application of colour shads that trigger dormancy have been examined on Canino apricot where positive results were appeared. It can be recommended to use both of shade nets, which, improved the growth and led to an increase in the yield and preservation of a higher quality of the resulting fruits. A relative superiority was also observed for the use of black shade net.

Conflict of interest

The authors hereby declare that there is no conflict of interest

Acknowledgement

We thank National Research Centre in Egypt for the financial support to this study through the project of Mitigation of heat stress on some horticultural crops by using melatonin and agricultural treatments.

Author Contributions

All authors participated in the field work and chemical analysis, Also, Yehia performed data collection in the field; Amr performed the statistical analysis; Abd El-Naby designed this work and supervised the experiment; Abd El-Naby and Amr read and approved the final manuscript.

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