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The beneficial effects of overhead shading net on fruit cracking control, productivity and quality of pomegranate fruits

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Abstract: - A field experiment was carried out during 2020 and 2021 seasons to examine the effects of different overhead shading net colors (white and blue) on fruit cracking percentage, productivity, leaf chlorophyll and leaf mineral content, also fruit quality of M 116 pomegranate trees grown under sandy soil conditions compared with the farm treatment (coving fruits with Kraft paper) and the untreated trees (control). The obtained results showed that shading pomegranate trees with blue or white net significantly increased number of fruits per tree, the total yield (kg), fruit weight (g) and reduced fruit cracking percentage when compared with the control and farm treatments. Blue and white colors surpassed the other treatments including the untreated trees in the most parameters under investigation. Finally, it could be recommended that shading pomegranate trees with blue followed by the white one are beneficial for maintaining good fruit quality with high yield. Additionally these treatments reduced the fruit cracking percentage compared with the other ones.

Key words: pomegranate, fruit cracking, fruit quality, yield, overhead net shading.

I. Introduction

Pomegranate (*Punica granatum* L.) is one of the preferred fruits in the world and the promising exportation fruits in Egypt during the last years **(Nazmy *et al*., 2012)**. Because of its high nutritional and therapeutic qualities, a good source of natural antioxidants **(María *et al.*, 2000)** such as anthocyanin, flavonoids, and phenolic acids **(Faten *et al.*, 2012)**. In addition, it is rich in the usual nutrients such as vitamins and minerals **(Olaniyi and Umezuruike, 2013)**.

Pomegranate is an intriguing fruit tree in dry and semiarid regions, even in desert environments, because it has drought tolerance traits and the capacity to manage with water stress **(Alejandro *et al*., 2014)**.

Thus the cultivated area of pomegranate is increasing continuously recently in Egypt, especially in the new reclaimed areas where the total cultivated area reached about 11067 hectare with fruiting area about 4093 hectare, which produced about 89035 ton **(Agriculture Economic of Egypt Statistics, 2017)**.

Cracking in pomegranate fruits is a serious problem facing marketing in local and foreign markets. The main reasons of fruit cracking are imbalanced nutrition, variation of cultivars, irregular irrigation, climatic and environmental conditions and pest infestation **(Taiz and Zeiger, 2010; Baby *et al*., 2010)**.

A significant physiological issue that results in significant economic loss for the pomegranate is the cracking of ripe fruit. Pomegranate losses have been observed to reach 65%. It affects all types globally and is a widespread issue in all of its growing regions. Fruit cracking may be brought on by incorrect irrigation, environmental conditions, and nutritional deficiencies, particularly those involving boron, calcium, and potash. Additionally, during the growth and development of fruit, it has been reported to be correlated with excessive evapotranspiration, low humidity, water imbalance, and abrupt temperature changes during the day and night. When the fruits are at their mature stage, the cracking becomes more noticeable. No one component can be recommended as effective enough to prevent fruit cracking. Understanding the behaviour of fruit cracking in relation to internal fruit composition and quality traits, dynamics of water uptake, and the interactions between water, gibberellins, abscisic acid, boron, calcium, and the cell wall biosynthesis will provide clearer insights in developing strategies for decreasing fruit cracking **(Akath *et al.*, 2020)**.

Jutamanee and Onnom (2016) reported that the loss in photosynthetic activity caused by excessive sun radiation in a hot climate can have a negative impact on mango development and production. On the other hand, writers from many different nations have extensively reported on the modification of orchard climate by the shade of trees with net and its beneficial effects.

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Harhash and Rashid (2010) recommended that bunch bagging with blue color is beneficial for maintaining high yields and fruit quality. In this concern, **Heidi and Runkle (2014)** mentioned that wave length of the light may be a key factor in controlling plant development. They demonstrated that altering and adjusting the light quality may help young plants develop as desired. Additionally, producing impatiens under red waves at a pace greater than occurred under blue or green lights might result in an increase in flower buds. Also, **Jutamanee and Onnom (2016)** indicated that shading mango trees considered as an effective technique to avoid undesirable effect of excess solar radiation under hot climate conditions.

Dayioglu and Hepakosoy (2016) showed that black or white shading nets reduced sunburn of fruits without negative impact on fruit quality and maturation.

Mustafa *et al.* (2018) showed that using 9 drippers per tree either under blue or white net gave better results concerning the yield and fruit physical and chemical properties of Keitte mango trees.

The aim of this study was to examine the effect of different shading net colors i.e. white and blue in overcoming fruit cracking as well as improving the yield and fruit quality of M 116 pomegranate trees grown under sandy soil conditions compared with the traditional farm treatment (cover fruit with Kraft paper) and the untreated trees (control).

II. Materials and Methods

This experiment was conducted during two successive seasons of 2020 and 2021 on M 116 pomegranate trees grown in a private orchard situated at Cairo – Alexandria desert road (about 60 Kilometers farther than Cairo). The trees are planted in sandy soil at 3.5*3.5 meters apart. Drip irrigation system using well water was adopted. Regular horticultural managements were applied to all experimental trees as recommended. This investigation included the following four treatments:

1- Control (untreated trees).
2- Farm treatment (cover fruits with Kraft paper).
3- White net overhead tree shading.
4- Blue net overhead tree shading.

This experiment was arranged in a randomized complete block design with four treatments, each replicated three times as one tree per each.

Data were analyzed with the analysis of variance (ANOVA) procedure of MSTATIC program **(Steel and Torrie, 1980)**.

Means of the treatments were compared by Duncan's multiple range tests at 5% level of probability.

At harvest time in the two seasons, the physical and chemical fruit parameters were determined as follows:

1- Fruit physical properties:
   Fruit weight (g), percentage of cracked fruits (%), and skin weight per fruit (g), aril weight per fruit (g), also juice volume per fruit (cm^3).
2- Fruit chemical properties:
   - TSS percentage by using hand refractometer, total acidity percentage (expressed as malic acid) was determined by titrating 5 ml juice against 0.1N sodium hydroxide using phenolphthalein as an indicator **(A.O.A.C., 2000)**.
   - Total anthocyanin (mg/100g FW): Total anthocyanin in the fruit juice were measured colorimetrically using 535 nm wave length, according to the methods described by **Flueki and Francis (1968)**.
   - Leaf chemical components namely pigments such as total chlorophylls (mg/100g FW), according to the method of **Wellburn (1994)**. As well as leaf mineral content of N, P, and K as percentage using the methods described by **Cottenie *et al.* (1982)**.

III. Results

Number of fruits, cracking percentage and the yield per tree:

Results in Table (1) showed that the fruit numbers /tree were affected in both seasons of the study. However, due to the irregular results through the two seasons, the average results of the two seasons showed that using white net shading produced the highest fruit number followed by the shading treatment with blue net. In this concern, the farm treatment showed the lowest number of fruits per tree.

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As for fruit cracking percentage, there was a positive effect for using the net treatments either as white or blue colors on reducing the cracking percentage of the fruits. In this respect, the white net color shading gave the lowest percentage followed without significant difference by the blue net color, while the untreated trees recorded the highest cracking percentage.

Regarding the yield as kilogram per tree, the obtained results showed that blue net color increased the yield and gave the heaviest yield per tree, followed in decreasing order by the shading with white net color. In the contrast, the control treatment gave the least value of the yield weight per tree.

Table 1. Number of fruits, fruit cracking percentage and yield per tree of M 116 pomegranate trees as affected by different shading net colors

Treatments	No. of fruits			Fruit cracking %			Yield/tree (kg)		
	1st season	2nd season	Average of the two seasons	1st season	2nd season	Average of the two seasons	1st season	2nd season	Average of the two seasons
Control	63 a	42 b	52.5	14.6 a	14.3 a	14.45	20.12 c	17.37 b	18.75
Farm treatment	64 a	31 c	47.5	11.1 ab	10.7 b	10.90	28.12 b	15.42 b	21.77
White net	54 b	54 a	54.0	9.5 b	10.4 b	9.95	19.10 c	27.10 a	23.10
Blue net	60 a	43 b	51.5	9.7 b	10.3 b	10.0	32.40 a	26.62 a	29.51

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

Fruit physical properties

Results in table (2) showed the effects of color net shading on some fruit physical properties. Concerning the fruit weight, it is clear that the blue net color gave the highest fruit weight as gram in the two seasons, followed in decreasing order by the farm treatment and the blue net shading. The lightest fruit was obtained in the control treatment in the two studied seasons.

Regarding the skin weight, it is clear that the blue net shading and the farm treatment gave the highest weight of the skin in the two seasons, while the untreated trees recorded the lowest skin weight.

As for the weight of 100 aril, there were no differences between the treatments in the two seasons of the study.

The juice volume results in Table (2) showed that the blue net shading recorded the highest value of juice volume as average of the two seasons. The other treatments gave more or less the same results.

Table 2. Fruit physical properties of M 116 pomegranate trees as affected by different shading net colors

Treatments	Fruit wt. (g)		Skin wt. (g)		Wight of 100 aril (g)		Juice volume (cm^3)		
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	Average of the two seasons
Control	324 c	411 b	32.4 c	38.6 c	39.1 a	33.7 a	17.0 c	21.7 b	19.35
Farm treatment	448 ab	497 ab	56.7 a	50.3 b	40.4 a	33.9 a	18.2 c	19.8 bc	19.00
White net	357 bc	516 ab	42.6 b	39.8 c	39.4 a	33.6 a	24.9 b	13.8 c	19.35
Blue net	539 a	621 a	54.2 a	72.0 a	39.2 a	29.2 a	33.9 a	29.2 a	31.55

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

Fruit chemical properties

Table (3) shows some fruit chemical properties as affected by overhead shading net color. Total soluble solids percentage (TSS) was affected significantly in the first season only. In this concern, the blue net color gave the highest value of the TSS; this value was significant compared with all other treatments in the first season. The same treatment gave the highest value in the second season.

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Regarding the fruit juice acidity, it is clear in the first season that the control treatment gave the lowest value of the acidity in the fruit juice in both studied seasons. On the other hand, the farm treatment recorded the highest acidity value in the first season, while the white net shading gave the highest value in the second season.

The TSS/ acid ratio results, in general it is noticed that the maximum value of this parameter was recorded in the first season by the untreated trees, while in the second season, the same treatment and the blue net shading recorded higher values, the other treatments gave intermediate values.

As for ascorbic acid content in the fruit juice, the obtained results indicate that the control treatment recorded the highest value of ascorbic acid in the first season followed without significant difference by the white net treatment, while as in the second season; the control treatment gave the maximum value compared with the other treatments.

Concerning the total anthocyanin, the blue net treatment recorded the highest significant value followed by the white net treatment, while the lowest value was obtained due to the control and the farm treatment. This was true in the two seasons.

Table 3. Fruit chemical properties of M 116 pomegranate trees as affected by different shading net colors

Treatments	TSS%		Acidity %		TSS/acid ratio		Ascorbic acid (mg/100 g FW)		Total anthocyanin (mg/100 g FW)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	2nd season	1st season
Control	14.1 b	14.2 a	0.39 c	0.55 c	36.2 a	25.9 a	22.4 a	18.5 a	27.1 c	25.2 c
Farm treatment	14.4 b	15.7 a	1.34 a	0.71 b	10.8 c	22.2 b	17.1 b	14.0 b	29.0 c	27.8 bc
White net	13.9 b	15.3 a	0.69 bc	1.26 a	20.2 b	12.1 c	19.5 ab	13.5 b	32.0 b	29.2 b
Blue net	16.2 a	16.7 a	0.82 b	0.58 c	19.8 b	28.8 a	17.3 b	14.9 b	35.2 a	33.1 a

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

Leaf chlorophyll and NPK content in the leaves

Results in Table (4) show the effect of overhead shading net color on leaf chlorophyll and NPK content in the leaves of M116 pomegranate trees. Total chlorophyll results show that white net and blue net shading recorded the highest values of this parameter in both studied seasons followed by the farm and control treatments.

The results of leaf mineral content of M116 pomegranate trees are shown in Table (4). Concerning the nitrogen percentage, the results show that all treatments except the control gave more or less the same results of nitrogen percentage and no significant change was detected between them. As for the phosphorus, results in the first season show that the untreated trees gave the highest significant value followed by the blue net treatment, while the other treatments gave lower significant percentages. The results among the treatments in the second season showed no significance. Concerning potassium content in the leaf, it clear that the blue net treatment gave the highest significant value in the two studied seasons, and the control gave the lowest significant value, while the other treatments gave intermediate results.

Table 4. Leaf chlorophyll and NPK content in the leaves of M 116 pomegranate trees as affected by different shading net colors

Treatments	Total chlorophyll (SPAD)		N%		P%		K%	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	50.6 b	53.8 b	1.99 b	1.97 b	0.196 a	0.195 a	1.76 c	1.51 c
Farm treatment	51.8 b	33.7 c	2.22 a	2.36 a	0.155 c	0.145 a	2.98 b	2.39 ab
White net	62.5 a	58.3 ab	2.03 ab	2.26 a	0.160 c	0.170 a	2.40 b	2.22 b
Blue net	53.5 ab	60.2 a	2.31 a	2.51 a	0.180 b	0.190 a	3.59 a	2.46 a

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

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IV. Discussion

High evapotranspiration, low humidity, water imbalance, and rapid fluctuations in temperature during the day and night during fruit growth and development are all considered to be factors that contribute to fruit cracking **(Akath *et al.*, 2020)**. So, using overhead net shading may has a positive effect on overcoming this phenomenon.

The obtained results concerning the effect of overhead net shading on the yield and fruit properties of 116 M pomegranate was confirmed with those obtained by **Gent (2007)** who found that for the plants planted in 50% shade, the proportion of marketable fruit was highest. In 2003, this percentage was 9% higher than in a greenhouse with no shade, and it was 7% higher in 2004 and 2005. Also **Mustafa *et al.* (2018)** on mango trees found that either the blue or the white net with 9 drippers per tree produced superior results; however, the yield and the majority of the physical and chemical fruit qualities were greater for the plants with 9 drippers under blue net than they were for the trees with 9 drippers under white net. **Samira *et al.* (2022)** reported that comparing trees with 50% green net shade to control non-shading trees, a substantial decrease in aril whitening, as well as fruit burning and cracking, was seen. Fruits with net shade exhibited considerably greater levels of bioactive substances (such as ascorbic acid, phenolics, and anthocyanin, which have antioxidant activity), less weight loss, and less chilling injury during storage than fruits without shading. Additionally, SA and other postharvest practices had a positive effect on preventing chilling injury and maintaining the freshness and nutritional content of pomegranate fruits. As for the effect of shading on fruit cracking percentage, **Gent (2007)** reported that when sensitive tomato cultivars were grown in greenhouses without any shade, up to 35% of the fruit developed cracked skin, whereas only 24% to 26% of the tomatoes did in greenhouses with 50% shade.

Regarding the effect of overhead net shading on chlorophyll and NPK in the leaves, **Mustafa *et al.* (2018)** on mango trees found that both blue and white nets with 9 drippers per tree had better results, however the trees with 9 drippers under blue net were followed insignificantly by 9 drippers under white net, which had greater levels of NPK and chlorophyll in the leaves.

V. Conclusion

Form the obtained results, it could be concluded that using the overhead net shading has a positive effect on reducing the fruit skin cracking of M116 pomegranate and improving the yield weight and fruit quality. In this respect, the blue net color followed by the white one were more effective on reducing the fruit cracking percentage and increasing the tree yield, also improving the fruit properties. The same positive effect was observed on the chlorophyll and NPK percentages in the leaves. This was true under this experiment conditions.

References

1. Akath Singh, A. K. Shukla and P. R. Meghwal (2020). Fruit Cracking in Pomegranate: Extent, Cause, and Management – A Review, International Journal of Fruit Science, 20:sup3, S1234-S1253, DOI: 10.1080/15538362.2020.1784074.
2. Alejandro Galindo, Ángel Calín-Sánchez, Jacinta Collado-González, Sara Ondoño, Francisca Hernández, Arturo Torrecillas, Ángel A Carbonell-Barrachina (2014). Phytochemical and quality attributes of pomegranate fruits for juice consumption as affected by ripening stage and deficit irrigation. Sci. Food Agric., 94: 2259–2265.
3. Association of Official Analytical Chemists (A.O.A.C.) (2000). "Official Methods of Analysis". 17th Edition, The Gaithersburg, MD, USA, 490-510.
4. Baby Joseph, D. Jini and S. Sujatha (2010). Insight into the role of exogenous salicylic acid on plants grown under salt environment. Asian Journal of Crop Science, 2: 226-235.
5. Cottenie, A., Verloo M., Kiekens L., Velgle G. and Amerlynuck R. (1982). Chemical Analysis of Plant and Soil, Laboratory of Analytical and Agroch. State Univ. of Belgium, Gent. pp. 63.
6. Dayioglu, A. and Hepaksoy, S. (2016). Effects of shading nets on sunburn and quality of 'Granny Smith' apple fruits. Acta Hortic. 1139, 523-528. DOI: 10.17660/ActaHortic.2016.1139.90. https://doi.org/10.17660/ActaHortic.2016.1139.90
7. Faten Zaouaya, Pedro Mena, Cristina Garcia-Viguera and Messaoud Mars (2012). Antioxidant activity and physico-chemical properties of Tunisian grown pomegranate (*Punica granatum* L.) cultivars. Industrial Crops and Products, 40, 81-89.
8. Fuleki, T. and Francis F.J. (1968). Quantitative methods for anthocyanins I. Extraction and determination of total anthocyanin in cranberries. J. Food Sci., 33: 72-77.
9. Gent, M.P. (2007). Effect of degree and duration of shade on quality of greenhouse tomato, HortScience, 42 (3): 514-520. Retrieved May 22, 2023, from https://doi.org/10.21273/HORTSCI.42.3.514.
10. Harhash, M.M. and Rashid Sultan Alobeed (2010). Effect of bunch bagging color on yield and fruit quality of date palm. American-Eurasian J. Agric. & Environ. Sci., 7 (3): 312-319.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue VI, June 2023

11. Heidi Marie Wollaeger and Erik S. Runkle (2014). Growth of impatiens, petunia, salvia, and tomato seedlings under blue, green, and red light-emitting diodes. American Society for Horticultural Science, 49 (6): 734–740.
12. Jutamanee, K., Onnom, S. (2016). Improving photosynthetic performance and some fruit quality traits in mango trees by shading. Photosynthetica, 54, 542–550. https://doi.org/10.1007/s11099-016-0210-1.
13. María, I. Gil, Francisco A. Tomás-Barberán, Betty Hess-Pierce, Deirdre M., Holcroft and Adel, A. Kader (2000). Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. J. Agric. Food Chem., 48 (10): 4581–4589.
14. Mustafa, N.S., M.M.A. Merwad, M.M.S. Saleh and E.A.M. Mostafa (2018). Improving drop water efficiency, yield and fruit properties of Keitte mango using different shading net colors. Bioscience Research, 15 (4): 4335-4344.
15. Nazmy, A. Abd-elghany, Samah I. Nasr and Hassan. M. Korkar (2012). Effects of polyolefin film wrapping and calcium chloride treatments on posthravest quality of "Wonderful" pomegranate fruits. Journal of Horticultural Science & Ornamental Plants, 4 (1): 07-17.
16. Olaniyi, A. Fawole, Umezuruike Linus Opara (2012). Changes in physical properties, chemical and elemental composition and antioxidant capacity of pomegranate (cv. Ruby) fruit at five maturity stages. Scientia Horticulturae, 150 (4): 37-46.
17. Samira Moradi, Zabihollah Zamani, Mohammad-Reza Fatahi Moghadam, Mahmoud Koushesh Saba (2022). Combination effects of pre harvest tree net-shading and postharvest fruit treatments with salicylic acid or hot water on attributes of pomegranate fruit. Scientia Horticulturae, Vol. 304, 111257.
18. Steel, R. G. D. and Torrie, J. H. (1980). Principles and procedures of statistics, a biometrical approach (No. Ed. 2). McGraw-Hill Kogakusha, Ltd.
19. Taiz, L. and Zeiger, E. (2010). Plant physiology, 5th edn. Sunderland, MA: Sinauer Associates, Inc., Publishers.
20. Wellburn, A.R. (1994). The Spectral Determination of Chlorophylls A and B, as well as Total Carotenoids, Using Various Solvents with Spectrophotometers of Different Resolution, J. Plant Phys., 144: 307-313.