



Article

Effect of Shading and Spray with Some Natural Materials on the Productivity and Quality of Mango Fruits (*Mangifera indica* L. cv. Keitt Under Heat Stress Conditions

Sahar A. Farid*; Amin M. G. E. Shddad and Fahmy E. Fahmy

Plant Production Department, Desert Research Center, Cairo, Egypt.



*Corresponding author: dr_s.faried@yahoo.com

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Abstract: This investigation was carried out during two successive seasons (2020 and 2021) on the 5 -year- old of Keitt Mango cultivar grown in a private orchard located at El-Farafrah Oasis in the New Valley Governorate, Egypt, to study the effects of three levels of shading net (no shading, shading net 30% and shading net 60%) and five different rates of some natural materials (0, 4 & 6% kaolin) and (1 & 3% CaCO₃) and their interactions on vegetative growth, yield and fruit quality of Keitt mango tree under heat stress conditions. The best results were recorded with kaolin treatment at 6% level and shading net at 30% which improved fruit set, number of fruits per tree, fruit weight, yield kg/ tree, yield ton/ feddan, fruit length, fruit diameter, fruit volume, fruit firmness, flesh weight, flesh %, fruit TSS fruit T.S.S./acid ratio, vitamin C and total sugar. While, reducing sunburn fruits %, fruit drop, seeds weight, shell weight, seeds % and fruit total acidity content. So this treatment was proved to be the most efficient in enhancing, the yield and fruit quality of Keitt mango cultivar.

Key words: Mango, Keitt, kaolin, calcium carbonate, shading net, sunburn, yield, fruit quality.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important fruit in the worldwide due to its favorite fruit, unique and attractive flavor with high nutritive value. Mango trees planted under Egyptian condition production was about 240794 tons (FAOSTAT, 2021).

Keitt is a new mango cultivar that has introduced recently in Egypt from Florida, USA. Its late maturing cultivar (harvest time from Sept. to Oct. in Egypt) and it has a large fruit size (Olando *et al.* 2005). Due to its late - season ripening cultivar, it exposes to during the summer with excessively of light and heat load. Which cause often sunburn in leaves and fruits. Sunburn (solar injury) causes important economic losses in a large number of fruits which caused by the interaction of high

temperature and light in various crops (Schrder *et al.*, 2003). Wind and excess solar radiation one of the factors affecting growth yield and quality of mango in the hot climate, also affect appearance of the fruits. In this concern, (Medany *et al.* 2009) evaluated the effects of white net on the growth and production of mango cv. Keitt trees from the interception of light, temperature, humidity and plant growth. The use of white net resulted in a significant increase of plant height and stem diameter of plant compared to open field orchard. The net was superior for plant growth, flowering and yield. Data revealed that microclimate under the white net make proper micro climate for tropical fruits under Egyptian conditions. (Medany, 2009) showed that using of white net increase the number of leaves, plant height and stem diameter per plant compared to open field orchard. So net was superior for plant growth, flowering and yield under Egyptian conditions on mango (*Mangifera indica*. L.) cv. Keitt cultivar was tested at the El-Bosaily governmental farm at the North West of the Nile Delta. The results cleared that mango Keitt cv. trees grown under white net shading condition significantly increased yield (kg) tree, number of fruit set/ panicle, fruit weight, TSS and ascorbic acid content (Ola Abdel Satar *et al.*, 2013). Assem *et al.* (2023) used to five different coloured shade nets (white, yellow, red, blue and black) on mango (*Mangifera indica*. L.) cv. Keitt when compared to open field conditions, they revealed that the use of white or yellow nets increase in the number of fruits and total yield per plant.

Abd-Allah *et al.* (2013) recorded that Keitt Mango trees were sprayed with kaolin and magnesium carbonate at three concentrations 3, 4 and 5% for each to prevent the injury of sunburn on fruits which causes economic losses, they were applied once during the summer and they were compared with the control (spraying water only) to study their effects on sunburned drop fruits percentage as well as yield and fruit quality, kaolin and magnesium carbonate at 5% had a positive effect on reducing sunburned skin area and fruit drop percentage. Abd-Allah *et al.* (2013). Fivaz & Lonsdale (2001) and Jutamanaee & onnom (2016) noticed that using spraying with white protective wetable powders such as Kaolin for sun protection and improve appearance of the fruits. The reflective films were applied at three concentrations 1%, 2% and 3% from kaolin clay sprayed on “Anna” apple cultivar grafted on MM/ 106 rootstocks decreased the percentages of fruit sunburn and show high positive leaf and fruit contents of N, Ca and Mg response to reflective films than trees no reflective films also it seemed to be increased fruit weight as well as yield as compared with no reflective films treatments (Mahmoud *et al.*, 2010).

EL-Gioushy *et al.* (2017), showed that due to the high temperature and sunlight the fruits exposed to certain mechanical and physiological disorders which reduce the fruit quality and marketability. In this respect, foliar application with CaCO₃ and green miracle is a necessary to protect fruits from direct sun light, but the fruit quality improvement compensates this cost in particular when the fruits are exported.

Therefore, the present study aimed to investigate effects of shading net and using spraying white protective wetable powders such as kaolin and calcium carbonate applications to decrease the negative effect of sunburn on the growth and fruit quality of mango fruits (*Mangifera indica* L. cv. Keitt) under heat stress conditions.

MATERIALS AND METHODS

The experiment was carried out during two successive seasons of 2020 and 2021 at a private orchard located at El- Farafrah Oasis in the New Valley Governorate, Egypt, to study the response of Keitt Mango trees to different concentrations of Kaolin and crystalline limestone (calcium carbonate) spraying levels under open field and shading conditions. Mango Keitt Five- years- old grafted on Succary seedling rootstock and planted at 2.5 X 2.5 meters apart, grown in sandy soil (approximately 672 tree/feedan) and subjected to irrigation with drip irrigation system from a well. Physical and chemical analyses of the experimental soil were shown in Table (1) and the chemical analyses of the used irrigation water is recorded in Table (2).

Forty-five healthy trees, nearly uniform in shape, size and productivity, received the same horticultural practices were used in this experiment.

The present study was a factorial experiment with two factors. The first factor consisted of three levels of shading (no shading, shading net 30% and shading net 60%). The second factor involved five rates of kaolin and calcium carbonate spray (0.4, 6% kaolin, and 1, 3% CaCO₃). The experiment was designed as a randomized complete block design with three replicates for each treatment and each replicate was represented by one tree.

Table (1). Analysis of experimental soil

Soil Depth (cm)	Texture Class	pH Soil past	EC ppm	CaCO ₃ %	Soluble cations (meq/l)				soluble anions (meq/l)		
					Ca ⁺⁺	K ⁺	Na ⁺	Mg ⁺⁺	Cl ⁻	SO ₄ ⁼	C ₀₃ +Hco ₃
0-30	Sand	7.99	1910	8.05	7.6	1.3	14.0	3.6	17.1	9.8	0.3
30-60	Sand	7.85	1960	7.15	8.1	1.6	12.5	3.1	20.8	10.0	0.2

Table (2). Chemical analysis of water used for irrigation

pH	E.C. dSm ⁻¹	Soluble cations (meq/l)				soluble anions (meq/l)		
		Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	Cl ⁻	CO ₃ ⁻	HCO ₃
6.56	0.33	1.47	2.18	3.16	0.61	4.98	*	1.18

The following parameters were measured to evaluate the tested treatments.

Initial fruit set (%) and Fruit drop (%)

Number of tagged four shoots had flowers were labeled at full bloom (first week of April), thereafter number of set fruitlets was recorded. Fruit set percentages were calculated at (last week of April), in the first and second seasons, as follows:

$$\text{Initial fruit set (\%)} = \frac{\text{No. of set fruitlets}}{\text{Total No. of flowers at full bloom}} \times 100$$

$$\text{Fruit retention \%} = \frac{\text{Initial number of fruit - retention fruit at harvest time}}{\text{Initial number of fruit/tree}} \times 100$$

Furthermore, number of dropped fruits was counted then fruit drop percentages were calculated as follows:

$$\text{Fruit drop (\%)} = \frac{\text{No. of set fruitlets - No. of present retained fruitlets}}{\text{Number of setting fruitlets}} \times 100$$

Yield

Number of fruits / tree, yield (Kg / tree) and yield (ton / feddan)

At harvest time at (last week of October) the number of fruits per each replicate was counted and reported then yield (kg) per tree and ton per feddan was estimated and recorded.

Sunburned fruit measurements

Trees were observed for fruit sunburn degrees. Sunburned fruit percentages were calculated relative to the total number of fruits per tree.

Fruit physical and chemical properties

Three mango fruits of each replicated maturity stage were taken at harvest time on (last week of October) during two seasons from each replicate for determination of the following physical and chemical properties. Fruit weight (g), fruit length (cm), fruit diameter (cm), fruit shape index (F.L./F.D.), fruit volume (cm³), fruit firmness, flesh weight (g), seeds weight/fruit (g), shell weight (g), flesh (%), and seed flesh weight (%) were determined by separating pulp from the peel and the juice is extracted from the pulp by centrifugation. Fruit total soluble solids (TSS) % was determined by Hand refractometer, total acidity percentage was determined in fruit juice according to, TSS/acid ratio and pulp content of fruit vitamin C (mg/100g f. w.) according to **A.O.A.C. (2000)** was determined. Total sugars (%) were determined in fruit juice (100 ml juice) photo metrically at 490 nm to the phenol method and using ethyl alcohol for 1 hour at 70°C as described by **Dubois *et al.* (1956)**.

Statistical Analysis

The obtained data in 2020 and 2021 seasons were subjected to analysis of variance according to **Clarke and Kempson (1997)**. Means were differentiated using Range test at the 0.05 level **Duncan (1955)**.

RESULTS AND DISCUSSION

Data in table (3) showed the effect of shading and spray with some natural materials on initial fruit set, fruit retention and fruit drop of Keitt mango fruits during 2020 and 2021 seasons.

Initial fruit set %

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant initial fruit set in both seasons. On the other hand, control (spray with water) was the lowest significant initial fruit set. Concerning shading treatments, shading with 30% show to be the highest significant value of initial fruit set, which was observed in both seasons. The interaction of the two studied factors revealed that kaolin 6% with 30% shading gave highest initial fruit set in both seasons.

Fruit drop %

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the lowest significant fruit drop in both seasons. As well as, control (spray with water) was the lowest significant fruit drop. Concerning shading treatments, shading with 30% cleared the lowest significant value of fruit drop, which was observed in both seasons. The interaction of the two studied factors revealed that kaolin 6% with 30% shading had lowest fruit drop in both seasons.

Fruit retention %

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant fruit retention in both seasons. While, control (spray with water) was the lowest significant fruit retention. Concerning shading treatments, shading with 30% recorded the highest significant value of fruit retention, which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 4%, and/or 6% with 30% shading showed highest fruit retention in both seasons.

Table (3). Effect of shading and spray with some natural materials on initial fruit set, fruit relation and fruit drop of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Initial fruit set (%)				Fruit drop (%)				Fruit retention (%)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020												
Control	19.67h	23.33g	22.67g	21.89C	36.22b	38.90a	36.33b	37.15A	63.78gh	61.10h	63.67gh	62.85E
Kaolin 4 %	28.00f	35.00ab	31.33de	31.44B	30.87e	18.85j	26.53g	25.42D	69.13de	81.15a	73.47c	74.58B
Kaolin 6 %	30.00e	36.00a	32.67cd	32.89A	26.13g	17.93k	20.17i	21.41E	73.87c	82.07a	79.83ab	78.89A
Calcium carbonate 1 %	22.67g	35.00ab	29.75e	29.14C	33.67c	30.77b	33.07cd	32.50B	66.33fg	69.23de	66.93ef	67.50D
Calcium carbonate 3 %	23.67g	34.00bc	30.00e	29.22C	32.67d	22.37h	28.60f	27.88C	67.33ef	77.63b	71.40cd	72.12C
Mean	24.80C	32.67A	29.28B		31.91A	25.76C	28.94B		68.09C	74.24A	71.06B	
Second season; 2021												
Control	14.00h	16.00g	16.00g	15.33D	33.00b	30.52d	35.73a	33.08A	67.00f	69.48ef	64.27g	66.92E
Kaolin 4 %	16.83g	24.75b	20.00d-f	20.53B	28.60e	19.50k	27.27g	25.12D	71.40de	80.50a	72.73d	74.88B
Kaolin 6 %	19.00f	26.67a	23.00bc	22.89A	22.21j	17.48l	28.30ef	22.66E	77.79b	82.52a	71.70de	77.34A
Calcium carbonate 1 %	15.17gh	21.67cd	19.67ef	18.84C	32.33bc	26.23h	32.50bc	30.35B	67.67f	73.77cd	67.50f	69.65D
Calcium carbonate 3 %	16.30g	24.00b	20.83de	20.38B	32.03c	23.73i	27.70fg	27.82C	67.97f	76.27bc	72.30d	72.18C
Mean	16.26C	22.62A	19.90B		29.63B	23.49C	30.30A		70.37B	76.51A	69.70B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Yield parameters

Data in table (4) showed the effect of shading and spray with some natural materials on No. of fruits/tree and Fruit weight of Keitt mango fruits during 2020 and 2021 seasons.

Number of fruits per tree

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant number of fruits per tree in both seasons. On the other hand, control (spray with water) was the lowest significant number of fruits per tree. Concerning shading treatments, shading with 30% show to be the highest significant value of number of fruits per tree which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest number of fruits per tree in both seasons.

Fruit weight

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment showed the highest significant fruit weight in both seasons. While, control (spray with water) was the lowest significant fruit weight. Concerning shading treatments, shading with 30% recorded the highest significant value of fruit weight, which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 4%, 6% with control in first season and calcium carbonate 3% with 30% shading highest fruit weight respectively.

Table (4). Effect of shading and spray with some natural materials on No. of fruits/tree and Fruit weight of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	No. of fruits/tree				Fruit weight (g)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	90.3i	103.0f	95.0g	96.1D	375.5j	518.4g	411.4i	435.1D
Kaolin 4 %	108.3e	121.7ab	103.7f	111.2B	614.3a	537.4e	573.4c	575.0B
Kaolin 6 %	112.3d	122.3a	106.7e	113.8A	616.6a	610.4b	609.5b	612.2A
Calcium carbonate 1 %	89.7i	117.3c	108.3e	105.1C	517.2g	534.9e	528.2f	526.8C
Calcium carbonate 3 %	93.0h	120.0b	107.0f	105.7C	538.0e	561.0d	484.2h	527.7C
Mean	98.7C	116.9A	103.5B		532.3B	552.4A	521.3C	
Second season; 2021								
Control	101.2i	93.3i	98.7j	97.73D	340.8k	637.0c	450.1h	475.9D
Kaolin 4 %	103.1g	118.3c	105.3f	108.9C	568.3e	666.3b	566.9e	600.5B
Kaolin 6 %	104.1fg	121.7b	108.7e	111.5A	579.1d	665.6b	576.5d	604.1A
Calcium carbonate 1 %	101.9h	123.3a	105.0f	110.1B	513.5f	636.c	415.1i	521.5C
Calcium carbonate 3 %	95.6k	123.7a	110.0d	109.8B	490.6g	681.8a	390.2j	520.9C
Mean	101.2C	116.1A	105.5B		498.5B	657.3A	479.7C	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (5) showed the effect of shading and spray with some natural materials on yield kg/tree and yield ton/fed of Keitt mango fruits during 2020 and 2021 seasons.

Yield (kg/tree)

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant yield (kg/tree) in both seasons. While, control (spray with water) was the lowest significant yield (kg/tree). Concerning shading treatments, shading with 30% recorded the highest significant value of yield (kg/tree), which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest yield (kg/tree) in first season but calcium carbonate 3% with 30% shade had highest significant value.

Yield ton/feddann

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant yield (ton/fed.) in both seasons. While, control (spray with water) was the lowest significant yield (ton/fed.). Concerning shading treatments, shading with 30% recorded the highest significant value of yield (ton/fed.), which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 6% with 30% shading highest yield (ton/fed.) in both seasons.

Table (5.) Effect of shading and spray with some natural materials on yield kg/tree and yield ton/fed of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Yield (kg/tree)				Yield (ton/fed.)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	33.92l	53.39h	39.08k	42.13D	9.50j	14.95f	10.94i	11.80D
Kaolin 4 %	66.54cd	65.41d	59.45f	63.80B	18.63c	18.31cd	16.64e	17.86B
Kaolin 6 %	69.26b	74.65a	65.01d	69.64A	19.39b	20.90a	18.20cd	19.50A
Calcium carbonate 1 %	46.40j	62.74e	57.22g	55.45C	12.99h	17.57d	16.02e	15.53C
Calcium carbonate 3 %	50.03i	67.32c	50.35i	55.90C	14.01g	18.85bc	14.10g	15.65C
Mean	53.23C	64.70A	54.22B		14.90B	18.12A	15.18B	
Second season; 2021								
Control	34.49k	59.45e	44.41i	46.11D	9.66i	16.65e	12.43g	12.91D
Kaolin 4 %	58.59ef	78.84c	59.71e	65.72B	16.41e	22.08c	16.72e	18.40B
Kaolin 6 %	60.29e	80.98b	62.64d	67.97A	16.88e	22.67b	17.54d	19.03A
Calcium carbonate 1 %	52.32g	78.44c	43.58ij	58.11C	14.65f	21.96c	12.20g	16.27C
Calcium carbonate 3 %	46.90h	84.32a	42.92j	58.05C	13.13fg	23.61a	12.02h	16.25C
Mean	50.52B	76.41A	50.65B		14.15B	21.39A	14.18B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (6) showed the effect of shading and spray with some natural materials on sunburn of Keitt mango fruits during 2020 and 2021 seasons.

Sunburn fruits percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% in first season and kaolin at 4% treatment recorded the lowest significant sunburn fruit % in both seasons. As well as, control (spray with water) was the highest significant fruit sunburn. Concerning shading treatments, shading with 60% cleared the lowest significant value of sunburn fruit %, which was observed in both seasons. The interaction of the two studied factors, revealed that Calcium carbonate 1 %, 3% with 60% shading in first season and kaolin at 6% with 60% shading in second season had lowest sunburn fruit %.

Table (6). Effect of shading and spray with some natural materials on sunburn of Keitt mango fruits during 2020 and 2021 seasons.

Natural materials	Sun burn (%)			
	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020				
Control	25.05a	18.90c	13.55e	19.17A
Kaolin 4 %	15.95d	13.80e	10.65h	13.47C
Kaolin 6 %	12.60f	11.70fg	10.00hi	11.43D
Calcium carbonate 1 %	19.45b	15.85d	8.85j	14.72B
Calcium carbonate 3 %	18.50c	18.10c	8.10jk	14.90B
Mean	18.31A	15.67B	10.23C	
Second season; 2021				
Control	25.33a	19.08cd	15.53f	19.98A
Kaolin 4 %	16.62e	15.98ef	12.88g-j	15.16D
Kaolin 6 %	14.72fg	13.28gh	10.43k	12.81E
Calcium carbonate 1 %	21.50b	16.73e	13.87g	17.37B
Calcium carbonate 3 %	20.56c	19.98c	10.1	16.86C
Mean	19.75A	17.01B	12.55C	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (7) showed the effect of shading and spray with some natural materials on fruit length & diameter and fruit shape index of Keitt mango fruits during 2020 and 2021 seasons.

Fruit length

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment showed the highest significant fruit length in both seasons. While, control (spray with water) was the lowest significant

fruit length. Concerning shading treatments, shading with 30% found the highest significant value of fruit length, which observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading gave highest fruit length in both seasons.

Fruit diameter

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the highest significant fruit diameter in both seasons. While, control (spray with water) was the lowest significant fruit diameter. Concerning shading treatments, shading with 30% recorded the highest significant value of fruit diameter, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest fruit diameter in both seasons.

Fruit shape index

Regarding spray with kaolin and calcium carbonate concentrations, insignificant differences between most treatments and control of fruit shape index in both seasons. Concerning shading treatments, control and shading with 60% gave the same results of fruit shape index, which was observed in both seasons. The interaction of the two studied factors, there are insignificant differences among most of the concentrations of fruit shape index in both seasons.

Data in table (8) showed the effect of shading and spray with some natural materials on Fruit volume and Fruit firmness of Keitt mango fruits during 2020 and 2021 seasons.

Fruit volume

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant fruit volume in both seasons. While, control (spray with water) was the lowest significant fruit volume. Concerning shading treatments, shading with 30% recorded the highest significant value of fruit volume, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with control (spray with water) in first season and calcium carbonate 3% with 30% shading in second season gave highest significant fruit volume.

Fruit firmness

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant fruit firmness in both seasons. While, control (spray with water) was the lowest significant fruit firmness. Concerning shading treatments, shading with 30% found the highest significant value of fruit firmness, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest fruit firmness in both seasons.

Table (7). Effect of shading and spray with some natural materials on fruit length, fruit diameter and fruit shape index of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Fruit length (cm)				Fruit diameter (cm)				Fruit shape index (F.L./F.D.)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020												
Control	10.93h	11.63g	10.97h	11.18E	7.23i	8.97g	8.27h	8.16E	1.512ab	1.297cd	1.326bc	1.378A
Kaolin 4 %	13.20d	13.57c	13.13de	13.30B	10.10d	12.10c	9.80e	10.67B	1.307cd	1.121de	1.340bc	1.256B
Kaolin 6 %	13.17de	14.50a	13.97b	13.88A	13.23a	13.37a	12.95b	13.18A	0.995e	1.085e	1.079e	1.053C
Calcium carbonate 1 %	13.00de	13.17de	12.83e	13.00C	9.30f	9.67e	9.37f	9.45C	1.398a-c	1.362bc	1.369a-c	1.376A
Calcium carbonate 3 %	11.90g	12.50f	12.93de	12.44D	9.33f	8.93g	8.30f	8.85D	1.275cd	1.400a-c	1.558a	1.411A
Mean	12.44C	13.07A	12.77B		9.84B	10.61A	9.74B		1.297AB	1.253B	1.334A	
Second season; 2021												
Control	9.90g	11.53f	11.37f	10.93E	7.77i	8.93g	8.40h	8.37E	1.274ab	1.291ab	1.354ab	1.306A
Kaolin 4 %	13.33cd	13.63bc	13.73b	13.56B	9.60d	12.92a	9.33e	10.62B	1.389a	1.055c	1.472a	1.305A
Kaolin 6 %	13.90b	15.33a	13.60bc	14.28A	10.98c	13.08a	9.63d	11.23A	1.266ab	1.172bc	1.412a	1.283A
Calcium carbonate 1 %	13.30cd	13.30cd	13.00d	13.20C	9.23ef	12.47b	9.03fg	10.24C	1.441a	1.067c	1.440a	1.316A
Calcium carbonate 3 %	12.53e	13.00d	12.30e	12.61D	9.07fg	9.20ef	8.83g	9.03D	1.381ab	1.413a	1.393a	1.396A
Mean	12.59C	13.36A	12.80B		9.33B	11.32A	9.04C		1.350A	1.200B	1.414A	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Table (8). Effect of shading and spray with some natural materials on Fruit volume and Fruit firmness of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Fruit volume (cm ³)				Fruit firmness (N/m ²)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	537.8m	515.5j	405.0l	429.4E	24.81i	26.55h	24.10j	25.15D
Kaolin 4 %	609.3ab	530.5h	565.0d	568.3B	25.13i	32.02b	27.26g	28.13B
Kaolin 6 %	612.5a	605.0bc	603.0c	606.8A	31.13c	33.58a	31.13c	31.94A
Calcium carbonate 1 %	543.4f	528.0h	520.0i	530.5C	24.77i	28.91e	27.80f	27.16C
Calcium carbonate 3 %	535.2g	555.0e	474.3k	521.5D	28.15f	29.71d	26.68h	28.18B
Mean	533.6B	546.8A	513.5C		26.79C	24.37A	27.39B	
Second season; 2021								
Control	335.0m	625.0c	445.0j	468.3E	24.68l	27.44g	25.22k	25.78D
Kaolin 4 %	560.0f	655.0b	460.0i	558.3B	26.64i	32.24b	27.93f	28.93B
Kaolin 6 %	570.0g	657.0b	565.0e	597.3A	29.31d	33.67a	30.20e	31.06A
Calcium carbonate 1 %	507.0g	625.0c	410.0k	514.0C	25.48k	31.22d	25.97j	27.55C
Calcium carbonate 3 %	479.0h	675.0a	380.0l	511.3D	27.97f	31.71c	26.99h	28.89B
Mean	490.2B	647.4A	452.0C		26.81B	31.25A	27.26B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (9) showed the effect of shading and spray with some natural materials on flesh weight, seed weight and shell weight of Keitt mango fruits during 2020 and 2021 seasons.

Flesh weight

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the highest significant flesh weight in both seasons. While, control (spray with water) was the lowest significant flesh weight. Concerning shading treatments, shading with 30% recorded the highest significant value of flesh weight, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest flesh weight in both seasons.

Seed weight

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the lowest significant seed weight in both seasons. While, control (spray with water) was the highest significant seed weight. Concerning shading treatments, shading with 30% recorded the lowest significant value of seed weight, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading had lowest seed weight in both seasons.

Shell weight

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the lowest significant shell weight in both seasons. While, control (spray with water) gave the highest significant shell weight. Concerning shading treatments, shading with 30% recorded the lowest significant value of shell weight, which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading lowest shell weight in both seasons.

Table (9). Effect of shading and spray with some natural materials on flesh weight seed weight and shell weight of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Flesh weight (g)				Seed weight (g)				Shell weight (g)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020												
Control	247.7k	421.4g	293.2j	320.8D	47.60ab	36.17fg	37.40f	40.39B	80.20a	60.83h	80.77a	73.93A
Kaolin 4 %	496.6c	457.3e	461.6d	471.9B	47.63ab	33.50h	37.15f	39.43B	70.00f	46.63k	74.63d	63.75C
Kaolin 6 %	504.9b	540.5a	505.9b	517.1A	46.00bc	34.67gh	30.17i	36.95C	65.67g	35.25l	73.41e	58.11D
Calcium carbonate 1 %	401.5h	434.6f	400.8h	412.3C	42.57de	42.27e	48.47a	44.44A	73.20e	58.07i	78.90b	70.06B
Calcium carbonate 3 %	418.8g	460.3d	360.2i	413.1C	42.80de	44.33cd	47.88ab	45.00A	76.33c	56.37j	76.10c	69.60B
Mean	413.9B	462.8A	404.4C		45.32A	35.19C	40.21B		73.08B	51.43C	76.76A	
Second season; 2021												
Control	223.3n	540.1d	331.7k	365.0D	44.85bc	38.05e	37.15ef	40.02C	72.70c	58.77g	81.20a	70.89A
Kaolin 4 %	459.5g	576.2c	451.8h	495.8B	46.880ab	36.70ef	35.60f	39.70C	61.97f	53.43j	79.50b	64.97D
Kaolin 6 %	484.8f	593.5a	473.0f	513.7A	43.10cd	30.80g	30.57g	34.82D	61.23f	41.30k	72.93c	58.49E
Calcium carbonate 1 %	400.6i	536.5e	284.8l	407.3C	42.20d	41.75d	48.25a	44.07B	70.70d	57.77h	81.97a	70.15B
Calcium carbonate 3 %	382.0j	581.3b	261.3m	408.2C	45.30b	45.20b	47.43a	45.98A	63.27e	55.30i	81.45a	66.67C
Mean	388.0B	565.5A	360.5C		44.45A	38.50C	39.80B		65.97B	53.31C	79.41A	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (10) showed the effect of shading and spray with some natural materials on Flesh percentage and Seed/Flesh weight of Keitt mango fruits during 2020 and 2021 seasons.

Flesh percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant flesh (%) in both seasons. While, control (spray with water) was the lowest significant flesh (%). Concerning shading treatments, shading with 30% recorded the highest significant value of flesh (%), which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 6% with 30% shading highest flesh (%) in both seasons.

Seed/Flesh weight percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the lowest significant seed/Flesh weight (%) in both seasons. While, control (spray with water) was the highest significant seed/Flesh weight (%). Concerning shading treatments, shading with 30% recorded the lowest significant value of seed/Flesh weight (%), which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 6% with 30% shading lowest seed/flesh weight (%) in both seasons.

Table (10). Effect of shading and spray with some natural materials on flesh and seed/flesh weight of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Flesh (%)				Seed/Flesh weight (%)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	65.96k	81.29d-f	71.28j	72.84D	19.22a	8.58i	12.75c	13.52A
Kaolin 4 %	80.85ef	85.09b	80.51f	85.15B	9.59g	7.33k	8.05j	8.32D
Kaolin 6 %	81.89de	88.55a	83.01f	84.48A	9.11h	6.41l	5.96m	7.16E
Calcium carbonate 1 %	77.62g	81.24d-f	75.89h	78.25C	10.60e	9.73g	12.09d	10.81C
Calcium carbonate 3 %	77.86g	82.05cd	74.39i	78.10C	10.22f	9.63g	13.29b	11.05B
Mean	76.84B	83.64A	77.01B		11.75A	8.34C	10.43B	
Second season; 2021								
Control	65.51k	84.80c	73.70h	74.67D	20.09a	7.04j	11.20e	12.78A
Kaolin 4 %	80.86e	86.47b	79.80f	82.34B	10.18g	6.37k	7.88i	8.14D
Kaolin 6 %	81.99d	89.17a	82.05d	84.40A	9.08h	5.19l	6.46k	6.91E
Calcium carbonate 1 %	78.01g	84.35c	68.63i	77.00C	10.53f	7.78i	16.94c	11.75C
Calcium carbonate 3 %	77.87g	85.26c	66.97j	76.70C	11.86d	7.78i	18.15b	12.60B
Mean	76.85B	86.01A	74.21C		12.35A	6.83C	12.13B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (11) showed the effect of shading and spray with some natural materials on TSS and total acidity of Keitt mango fruits during 2020 and 2021 seasons.

TSS percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant TSS (%) in both seasons. While, control (spray with water) was the lowest significant TSS (%). Concerning shading treatments, shading with 30% recorded the highest significant value of TSS (%), which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading had highest TSS (%) in both seasons.

Total acidity percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment cleared the lowest significant acidity (%) in both seasons. While, control (spray with water) was the highest significant acidity (%). Concerning shading treatments, shading with 30% recorded the lowest significant value of acidity (%), which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading gave lowest acidity (%) in both seasons.

Table (11). Effect of shading and spray with some natural materials on TSS and acidity of Keitt mango fruits during 2020 and 2021 seasons.

Natural materials	TSS (%)				Total acidity (%)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	10.50i	14.33c	12.33h	12.39D	1.60ab	1.47cd	1.64a	1.570A
Kaolin 4 %	13.83de	14.00d	13.00f	13.61B	1.49c	1.30g	1.48c	1.423C
Kaolin 6 %	13.00f	15.33a	13.67e	14.00A	1.30g	1.28g	1.36f	1.313D
Calcium carbonate 1 %	12.67g	14.33c	12.67g	13.22C	1.55b	1.41ef	1.56b	1.507B
Calcium carbonate 3 %	12.83fg	14.67b	13.00f	13.50B	1.60ab	1.42de	1.59ab	1.437B
Mean	12.57C	14.53A	12.93B		1.508A	1.376B	1.526A	
Second season; 2021								
Control	13.17ef	13.66d	11.50g	12.78E	1.61ab	1.45ef	1.65a	1.571A
Kaolin 4 %	14.00c	14.17c	13.70d	13.96B	1.48de	1.36gh	1.49de	1.443C
Kaolin 6 %	15.00b	16.50a	14.00c	15.17A	1.29h	1.29h	1.30h	1.293D
Calcium carbonate 1 %	13.00f	13.75d	13.67d	13.47D	1.53cd	1.43e-g	1.55b-d	1.503B
Calcium carbonate 3 %	13.67d	14.00c	13.33e	13.67C	1.58a-c	1.40fg	1.58a-c	1.520B
Mean	13.77B	14.42A	13.24C		1.498A	1.386B	1.514A	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (12) showed the effect of shading and spray with some natural materials on TSS/acidity ratio and vitamin C of Keitt mango fruits during 2020 and 2021 seasons.

TSS/acidity ratio

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant TSS/acidity ratio in both seasons. While, control (spray with water) was the lowest

significant TSS (%). Concerning shading treatments, shading with 30% recorded the highest significant value of TSS/acidity ratio, which was observed in both seasons. The interaction of the two study factors, revealed that kaolin 6% with 30% shading highest TSS/acidity ratio in both seasons.

Vitamin C (mg/100g. f. w.)

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant vitamin C (mg/100g. f. w.) in both seasons. While, control (spray with water) was the lowest significant vitamin C (mg/100g. f. w.). Concerning shading treatments, shading with 30% recorded the highest significant value of vitamin C (mg/100g. f. w.), which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest vitamin C (mg/100g. f. w.) in both seasons.

Table (12). Effect of shading and spray with some natural materials on TSS/acidity ratio and vitamin C of Keitt mango fruits during 2020 and 2021 seasons

Natural materials	TSS/acidity ratio				Vitamin C (mg/100g. f. w.)			
	Control	Shading 30 %	Shading 60 %	Mean	Control	Shading 30 %	Shading 60 %	Mean
First season; 2020								
Control	6.56j	9.75e	7.52i	7.94D	1.45d	1.62d	1.59d	1.55C
Kaolin 4 %	9.28f	10.77b	8.78g	9.61B	1.95bc	2.22a	1.91c	2.03A
Kaolin 6 %	10.00d	11.98a	10.05d	10.68A	1.93c	2.25a	1.85c	2.01A
Calcium carbonate 1 %	8.17h	10.16d	8.12h	8.82C	1.82c	2.13ab	1.63d	1.86B
Calcium carbonate 3 %	8.02h	10.33c	8.18h	8.84C	1.88c	2.20a	1.84c	1.97A
Mean	8.41C	10.60A	8.53B		1.81B	2.08A	1.76B	
Second season; 2021								
Control	8.18j	9.42fg	6.97k	8.19D	1.73c	1.95b	1.59c	1.76C
Kaolin 4 %	9.46f	10.42d	9.19g	9.69B	1.93b	2.27a	1.98b	2.06A
Kaolin 6 %	11.63b	12.79a	10.77c	11.73A	1.90b	2.29a	1.93b	2.04A
Calcium carbonate 1 %	8.50i	9.62f	8.82h	8.98C	1.91b	2.16a	1.92b	2.00AB
Calcium carbonate 3 %	8.65hi	10.00e	8.44i	9.03C	1.89b	2.25a	1.67c	1.94B
Mean	9.28B	10.45A	8.84C		1.87B	2.18A	1.85B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

Data in table (13) showed the effect of shading and spray with some natural materials on Total sugars Keitt mango fruits during 2020 and 2021 seasons.

Total sugars percentage

Regarding spray with kaolin and calcium carbonate concentrations, kaolin at 6% treatment recorded the highest significant total sugars (%) in both seasons. While, control (spray with water) was the lowest significant total sugars (%). Concerning shading treatments, shading with 30% showed the highest significant value of total sugars (%), which was observed in both seasons. The interaction of the two studied factors, revealed that kaolin 6% with 30% shading highest total sugars (%) in both seasons.

Table (13). Effect of shading and spray with some natural materials on Total sugars Keitt mango fruits during 2020 and 2021 seasons

Natural materials	Total sugars (%)			Mean
	Control	Shading 30 %	Shading 60 %	
First season; 2020				
Control	12.80h	13.15g	13.65f	13.20D
Kaolin 4 %	14.12d	14.77b	13.83e	14.24B
Kaolin 6 %	14.55c	15.05a	14.22d	14.61A
Calcium carbonate 1 %	13.83e	14.22d	14.10d	14.05C
Calcium carbonate 3 %	14.07d	14.43c	14.07d	14.19B
Mean	13.87C	14.32A	13.97B	
Second season; 2021				
Control	13.07k	13.50j	13.75d	13.44D
Kaolin 4 %	14.48cd	14.61bc	14.07h	14.39B
Kaolin 6 %	14.68b	15.10a	14.24fg	14.67A
Calcium carbonate 1 %	14.07h	14.41de	14.16f-h	14.21C
Calcium carbonate 3 %	14.29ef	14.45d	14.11gh	14.28C
Mean	14.12B	14.41A	14.07B	

Means having the same letter (s) in each row, column or interaction are insignificantly different at 5% level.

These results were in a harmony with those found by (Medany *et al.*, 2009) who found that the use of white net on mango cv. Keitt trees production trees from the interception of light, temperature, humidity and increase of plant height and stem diameter per plant, flowering and yield compared to open field orchard. Moreover, the use of white or yellow nets on mango cv. Keitt increase in the number of fruits and total yield per when compared to open field conditions, (Assem *et al.*, 2023). Furthermore, kaolin and magnesium carbonate at 5% had a positive effect on reducing sunburned skin area and fruit drop percentage, (Abd-Allah *et al.*, 2013). The results cleared that mango Keitt cv. trees grown under white net shading condition significantly increased yield (kg) tree, number of fruit set/ panicle, fruit weight, TSS and ascorbic acid content (Ola Abdel Satar *et al.*, 2013).

Conclusion

Finally, spraying with kaolin treatment at 6% level and shading net at 30% could be recommended as the most appropriate treatment for decrease the negative effect sunburn on fruit quality of mango Keitt fruits were studied under heat stress conditions, where improved natural and chemical properties of fruits. On the other side, reduced fruit drop, seeds weight, shell weight, seeds% and fruit total acidity content. This treatment was proved to be the most efficient in enhancing, the yield and fruit quality of cultivar had been studied.

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