

Influence of CaCO₃ and green miracle foliar application on preventing sunburn injury and quality improvement of Keitt mango fruits

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ABSTRACT

The Present investigation was carried out in a private farm located at Kafr El-Sohbi village, Qalubia governorate, Egypt. To study the influence of CaCO₃ and green miracle foliar application on reducing Keitt mango fruit disorders and improving fruit quality during 2015 and 2016 experimental seasons. The foliar applications treatments were, T1- control (tap water spray), T2 - CaCO₃ at 1%, T3 - CaCO₃ at 2%, T4- CaCO₃ at 3%, T5- Green miracle at 1cm/L, T6- Green miracle at 2 cm/L and T7 - Green miracle at 3 cm/L. However, The complete randomized block design with three replications was employed for arranging the seven investigated foliar application treatments taking into consideration that the abovementioned treatments were applied on 21 trees spared once at mid of June and other 21 trees spared twice at mid of June and mid of July in each seasons. The obtained results showed that, green miracle at 3 cm/L with twice spray increased number of fruits per tree, fruit weight, yield per tree and vitamin C content. While, the number and weight of sunburn fruits /tree was reduced as compared to the other investigated treatments. Moreover, the response of abovementioned parameters to CaCO₃ at 3 % + twice spray came statistically in the second rank. Generally, it can be recommended from this study that, green miracle at 3 cm/L with twice spray had statistically the highest productivity measurements and it was the best in reducing fruit disorders with improving fruit quality during 2015 and 2016 experimental seasons.

Key words: Keitt mango, CaCO₃, green miracle, sunburn, yield, and fruit quality

Introduction

Mango (*Mangifera indica* L.) is a very delicious tropical fruit belongs to family Anacardiaceae, it is also considered as the queen of the fruits as it is very popular world-wide. Mango fruit is an abundant source of vitamins, minerals and is famous for its excellent flavour, attractive fragrance and nutritional value. It is as an emerging tropical export crop and is produced in about 90 countries in the world with a production of over 820,877 MT, Abbasi *et al.*, (2011). In Egypt, mango is considered the most popular fruit. The area of mango orchards reached 241101 feddan, producing about 712537 tons of fruits annually (Ministry of Agriculture and Land Reclamation Statistics, Egypt, 2013). Keitt mango cultivar grown successfully under the Egyptian conditions and its yield production comes in the late season ripening (The fruit generally has typically ripened from August until September in Florida, often into October as well, making it one of the more valued late-season varieties.), especially in the newly reclaimed areas. However, due to the high temperature and sunlight in Egypt, 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.

The sunburn injury is sunburn browning. This sunburn does not cause tissue death but does cause loss of pigmentation resulting in a yellow, bronze, or brown spot on the sun exposed side of the fruit. Cells remain alive, cell membranes retain their integrity, cells do not leak, but pigments such as chlorophyll, carotenes, and xanthophylls are denatured or destroyed. This type of sunburn browning

occurs at a temperature about 5°F lower than sunburn necrosis (115 to 120° F in apples). Light is required for sunburn browning. Fruits may be marketable but will be a lower grade

Many studies showed the efficiency of foliar Ca²⁺ sprays as nitrate and chloride, but there is less information on the effects of foliar sprays of Ca²⁺ as calcium carbonate (CaCO₃). Guerra *et al.*, (2011) used CaCO₃ as organic production and confirmed that pre-harvest foliar treatments of CaCO₃ decreased BP incidence only after 90 days of storage, but that the fruit Ca concentration remained unchanged. Foliar Ca application also affected the K, Mg and N concentrations in fruit. While, eight-time foliar Ca sprays decreased the K concentration and K/Ca ratio of fruit skin. Six- or twelve-time Ca sprays decreased the N/Ca, K/Ca, (K+Mg)/Ca ratios in fruit. Hence, the conclusion that these ratios reflected the effects of Ca application better than the fruit Ca concentration Casero, *et al.*, (2009)

Green Miracle functions primarily on the principle of reflecting the sun's rays. Applied as a foliar spray, it forms a thin glassy film-coat, which reflects incident light more than it would occur under normal conditions. This prevents the thermic effect of light on plant tissue

Thus, this study aimed to investigate CaCO₃ and green miracle foliar application on preventing sunburn injury and improve yield, fruit quality and skin color of fruitful Keitt mango tress.

Material and Methods

This study was carried out during two successive seasons (2015 and 2016) on five years old Keitt mango trees grafted on Succary seedlings as rootstocks and planted at 2×3 meters in sandy soil under drip irrigation system in Kafr El-Sohbi village, Qalubia Governorate, Egypt. The soil of the experimental field was sandy in texture with pH 7.3. Soil mechanical and chemical analysis are shown in Table (1).

Table 1: Soil mechanical and chemical analysis of the used soil.

Physical analysis		Chemical analysis			
		Cations meq/l		Anions meq/l	
Coarse sand	18.3%	Ca ⁺⁺	8.9	CO ₃ ⁻	Zero
Fine sand	36.8%	Mg ⁺⁺	3.15	HCO ₃ ⁻	4.5
Silt	27.5%	Na ⁺	4.20	Cl ⁻	6.35
Clay	18.4 %	K ⁺	1.18	SO ₄ ⁻	8.10
Texture class	Sandy				
Soil pH	7.3	Available N		23.9 mg/kg	
E.C, dS/m	1.87	Available P		12.6 mg/kg	
Organic matter	2.6%	Available K		183 mg/kg	

Experiment lay out:

The complete randomized block design with three replications was employed for arranging the seven investigated foliar application treatments, whereas each replicate was represented by a single tree. Consequently, 42 healthy fruitful Keitt mango trees were carefully selected, as being healthy and disease free. Chosen trees were divided according to their growth vigour into three categories (blocks) each included seven similar trees for receiving the investigated treatments.

All trees were subjected to the same horticultural practices (irrigation, fertilization, weeds & pest control) adopted in the region according to the recommendation of the Ministry of Agriculture. It was devoted to investigate the influence of different foliar application treatments. In addition, 21 trees were spared once at mid of June in each seasons. Moreover, the other 21 trees were spared twice at mid of June and mid of July in each seasons.

The following seven foliar application treatments were included in this experiment:

- T1 – control (tap water spray).
- T2 - CaCO₃ at 1%.
- T3 - CaCO₃ at 2%.
- T4- CaCO₃ at 3%.

T5- *Green miracle at 1cm/ L.
T6- *Green miracle at 2cm/ / L.
T7 - *Green miracle at 3cm/ L.

Taking into consideration that the abovementioned treatments were applied on 21 trees spared once and other 21 trees spared twice.

* Green Miracle is a new-generation, reflective type of anti-transpirant cum anti-stress product. It is based on long chain fatty alcohol derived from non-edible vegetable oil.

The following characters were measured:

Yield:

In each season, at harvest time (first of November), the numbers of fruits per tree and fruit yield per tree were counted for each treatment. All fruits were picked and weighted for each tree in different treatments, tree yield in kilograms was estimated by multiplying the number of fruits per tree and the average fruit weight.

Sunburned fruit measurements:

- Number of sunburned fruits /tree.
- Weight of sunburned fruits /tree.
- Sunburned fruit weight % as comparing with weight of yield = sunburned fruits weight per tree (Kg) / weight of yield per tree (Kg) x 100.

Fruit quality:

Fruit physical properties:

In this regard average fruit weight (g); dimensions (length, diameter and thickness in cm); fruit shape index (length: diameter) and Fruit firmness was determined using Shatilon's instrument for measuring firmness of (Lb/Inch) were the fruit physical characteristics investigated in this regard.

Fruit chemical properties:

Fruit juice total soluble solids percentage (TSS %) was determined using hand refractometer. Total acidity as grams of citric acid per 100 ml fruit juice, total soluble solids/acid ratio was also estimated. Ascorbic acid (vitamin C) content was determined using 2, 6 dichlorophenol indophenol indicator for titration after A.O.A.C., (1995).

Fruit skin Color Parameters:

Color is a matter of perception and subjective interpretation. By analyzing the color conditions and adding adjectives such as “bright”, “dull” and “deep”, we can describe the color as a little more precisely. So, any given color is located as point of three-dimensional space (Fig 1). When color is classified, it can be expressed in terms of their hue (color), lightness (brightness) and chroma (vividness, or saturation). The world of color is a combination of these three aspects (McGuire, 1992).

Skin color measurements:

In this regard, L* indicates lightness, C* represents chroma, and h is the hue angle (L* = lightness, C* = chroma and h° = hue) are the color skin measurements of Keitt mango fruits. (L, C and h) color was determined using a Minolta CR-300 colorimeter.

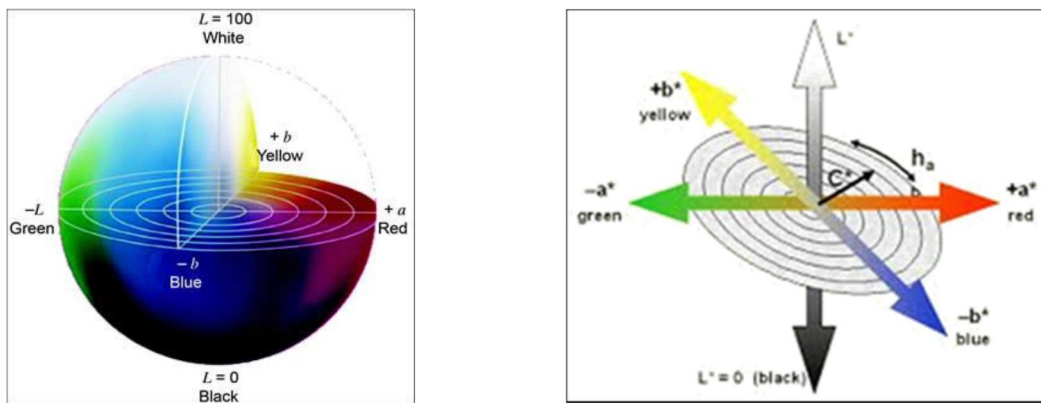


Fig. 1: CIE Lab color space; L is always positive and represents brightness: $a > 0$ represents red component, $a < 0$ green component, $b > 0$ represents Yellow component and $b < 0$ blue component

Statistical analysis:

All data obtained during both seasons were subjected to analysis of variance according to Snedecor and Cochran (1989). In addition, significant differences among means were differentiated according to the Duncan, multiple test range (Duncan, 1955) where capital letters were used for distinguishing means of different treatments for each investigated characteristic.

Results and Discussion

Some fruiting aspects in response to foliar application with CaCO_3 , Green miracle and number of times spray of Keitt mango fruits.

Data obtained of number of fruits per tree, fruit weight and yield per tree as productivity measurements in response to specific effect of (CaCO_3 and Green miracle with different concentration) and number of foliar spray times (once or twice), the two investigated factors during 2015 and 2016 experimental seasons are presented in Table (2).

Specific effect:-

It is quite clear that all the above-mentioned fruiting measurements responded specifically to each investigated factor. However, the grade of response varied not only from one fruiting measurement to another, but also the rate of differences in each investigated measurement exhibited by green miracle was more pronounced than CaCO_3 . However, the three green miracle spray solutions (1, 2 and 3 cm/L) increased significantly all fruiting aspect as compared to control (water spray). Such trend was true during two experimental seasons. Moreover, the highest increase over control was always in concomitant to the highest green miracle concentration (3 cm/L). As for the specific effect of CaCO_3 concentration, the obtained data presented in Table (2) revealed that the rate of response was relatively no so pronounced to the previously discussed with green miracle concentration. Hence, the increase in the three productively parameters were significant over control. Moreover, the highest increase over control was always in concomitant to the highest CaCO_3 concentration (3%). Such trend was true during 2015 and 2016 experimental seasons.

Interaction effect:-

Interaction effect between different CaCO_3 and green miracle concentrations and number of times spray (once or twice). Data presented in Table (2) revealed that all investigated fruiting parameters increased significantly when twice spray were used during two experimental seasons. Herein, green miracle at 3 cm/L with two spray times had statistically the highest productivity measurements during 2015 and 2016 experimental seasons.

Anyhow, the promoting effect of these anti-transpirants on growth (Davenport *et al.*, 1972) as well as their positive action on reducing pre-harvest fruit dropping surely reflected on enhancing the yield as number of fruits and weight (kg.). These results are in agreement with those obtained by Glenn *et al.*, (2001); Green *et al.*, (2003) and Aly-Mahmoud *et al.*, (2010).

Table 2: Effect of CaCO₃, Green miracle and number of times spray (once or twice) on No. of fruits/tree, fruit weight (g), and yield/tree (Kg) of Keitt mango fruits during two experimental seasons 2015&2016.

Parameters	No. of fruits/tree			Fruit weight (g)			Yield/tree (Kg)		
First Season									
Spray	Once	Twice	Mean	Once	Twice	Mean	Once	Twice	Mean
Treatments									
T1: control	15.67 k	16.33 jk	16.00 F	585.0 i	485.7 hi	485.4 F	7.60 j	7.93 ij	7.77 G
T2:CaCO ₃ at 1%	16.67 ij	18.00gh	17.33 E	486.5 hi	500.0 f	493.2 E	8.11 hi	9.00 g	8.56 F
T3:CaCO ₃ at 2%	17.33 hi	19.67 f	18.50 D	488.9 h	500.3 f	494.6 E	8.47 h	9.84 f	9.16 E
T4:CaCO ₃ at 3%	18.33 g	19.67 f	19.00 D	493.8 g	519.6 e	506.7 D	9.06 g	10.22 ef	9.64 D
T5:Green M at 1cm/L.	20.33 ef	21.67 d	21.00 C	519.5 e	537.0 b	528.3 C	10.56 de	11.64 c	11.10 C
T6:Green M at 2cm/L.	20.67 e	23.67 b	22.17 B	527.2 d	539.8 b	533.5 B	10.90 d	12.78 b	11.84 B
T7:Green M at 3cm/L.	22.67 c	25.00 a	23.83 A	530.9 c	545.2 a	538.0 A	12.04 c	13.63 a	12.83 A
Mean	18.81 B	20.57 A		504.6 B	518.2 A		9.53 B	10.72 A	
Second Season									
T1: control	16.33 h	16.67 h	16.50 G	487.4 j	488.3 j	487.9 G	7.96 i	8.14 i	8.05 G
T2:CaCO ₃ at 1%	17.67 g	19.00 ef	18.33 F	489.7 ij	497.4 h	493.5 F	8.65 h	9.45 fg	9.05 F
T3:CaCO ₃ at 2%	18.33fg	20.67 d	19.50 E	491.2 i	502.3 g	496.8 E	9.01 gh	10.38 e	9.70 E
T4:CaCO ₃ at 3%	19.67 e	20.67 d	20.17 D	495.9 h	518.2 f	507.0 D	9.75 f	10.71 de	10.23 D
T5:Green M at 1cm/L.	21.33cd	22.00 c	21.67 C	523.7 e	535.4 c	529.5 C	11.18 d	11.78 c	11.48 C
T6:Green M at 2cm/L.	21.00 d	24.33 a	22.67 B	531.3 d	540.5 b	535.9 B	11.16 d	13.15 a	12.16 B
T7:Green M at 3cm/L.	23.33 b	24.33 a	23.83 A	534.0 c	544.7 a	539.3 A	12.46 b	13.26 a	12.86 A
Mean	19.67 B	21.10 A		507.6 B	518.1 A		10.02 B	10.98 A	

Values within each column followed by the same letter/s are not significantly different at 5% level.

Effect of CaCO₃, green miracle and number of times spray (once or twice) on number of sunburned fruits per tree, sunburned fruits weight and sunburned fruit weight /weight of yield (%) of Keitt mango fruits.

Specific effect:-

Data obtained during both seasons revealed that number of sunburned fruits per tree, sunburned fruits weight and sunburned fruit weight/weight of yield (%) responded specifically to CaCO₃, green miracle concentrations. Herein, sprayed trees with green miracle at (1, 2 and 3 cm/L) decreased all the above-mentioned parameters during 2015 and 2016 experimental seasons. The reverse was true with CaCO₃ concentrations. Such trend was true during both experimental seasons.

Interaction effect:-

Data obtained during two seasons displayed that the specific effect of each investigated factor had been reflected directly on their combinations. Herein, the least number of sunburned fruits per tree, sunburned fruits weight and sunburned fruit weight/weight of yield (%) was usually in concomitant to those fruits sprayed with green miracle at 2 and 3 cm/L twice spray. In addition, the response of abovementioned parameters to CaCO₃ at 3 % + twice spray came statistically in the second rank.

Moreover, using anti- sunburn compounds containing calcium carbonate and Aluminum silicates for different fruit trees growing under hot-dry climates effectively counteracted the adverse effects of high temperature and UV radiation on yield and fruit quality (Attri, 1999; Kerns and Wright, 2000; Glenn *et al.*, 2001 and 2003; Curry *et al.*, 2004; Melgarejo *et al.*, 2004 and Morsy *et al.*, 2008).

Table 3: Effect of CaCO₃, Green miracle and number of times spray (once or twice) on No. of sunburned fruits/tree, Sunburned fruits weight (kg) and Sunburned fruit weight /weight of yield (%) of Keitt mango fruits during two experimental seasons 2015&2016.

Parameters	No. of sunburned fruits/tree			Sunburned fruits weight (kg)			Sunburned fruit weight /weight of yield (%)		
First Season									
Spray (A)	Once	Twice	Mean	Once	Twice	Mean	Once	Twice	Mean
Treatments (B)									
T1: control	4.67 b	5.33 a	5.00 A	2.26 a	2.59 a	2.43 A	29.72 a	32.60 a	31.16 A
T2:CaCO ₃ at 1%	3.00 c	1.67 e	2.33 B	1.46 b	0.83 cd	1.15 B	18.01 b	9.17 d	13.59 B
T3:CaCO ₃ at 2%	2.33 d	1.00 f	1.67 C	1.14 bc	0.50 def	0.82 C	13.51 c	5.09 e	9.30 C
T4:CaCO ₃ at 3%	2.00 de	0.67 fg	1.33 CD	0.99 c	0.35 ef	0.67 CD	10.92 cd	3.42 ef	7.17 C
T5:Green M at 1cm/L.	1.00 f	1.00 f	1.00 DE	0.52 def	0.54 de	0.53 DE	4.92 e	4.62 e	4.77 D
T6:Green M at 2cm/L.	0.67 fg	0.67 fg	0.67 E	0.35 ef	0.36 ef	0.36 E	3.18 ef	2.78 ef	2.98 D
T7:Green M at 3cm/L.	1.00 f	0.33 g	0.67 E	0.53 de	0.18 f	0.36 E	4.41 ef	1.33 f	2.87 D
Mean	2.10 A	1.52 B		1.04 A	0.77 B		12.10 A	8.43 B	
Second Season									
T1: control	4.00 a	4.33	4.17 A	1.95 a	2.12 a	2.03 A	24.39 a	26.10 a	25.25 A
T2:CaCO ₃ at 1%	2.67 b	1.33 de	2.00 B	1.31 b	0.66 de	0.99 B	15.07 b	7.03 de	11.05 B
T3:CaCO ₃ at 2%	2.33 bc	1.33 de	1.83 B	1.15 bc	0.67 de	0.91 B	12.67 bc	6.43 de	9.55 B
T4:CaCO ₃ at 3%	1.67 cd	0.67 ef	1.17 C	0.83 cd	0.35 ef	0.59 C	8.44 cd	3.18 ef	5.81 C
T5:Green M at 1cm/L.	0.67 ef	1.33 de	1.00 CD	0.35 ef	0.72 cde	0.53 CD	3.10 ef	6.00 de	4.55 CD
T6:Green M at 2cm/L.	0.67 ef	0.67 ef	0.67 CD	0.36 ef	0.36 ef	0.36 CD	3.18 ef	2.72 ef	2.95 CD
T7:Green M at 3cm/L.	1.00 de	0.00 f	0.50 D	0.53 de	0.000 f	0.27 D	4.29 def	0.00 f	2.15 D
Mean	1.86 A	1.38 B		0.93 A	0.70 B		10.16 A	7.35 B	

Values within each column followed by the same letter/s are not significantly different at 5% level.

Effect of CaCO₃, green miracle and number of times spray (once or twice) on some fruiting aspects of Keitt mango fruits.

Some fruiting aspects in response to foliar spray application and number of spray times. Data obtained that fruit quality pertaining their characteristics (fruit thickness, fruit length, fruit diameter, fruit shape index and fruit firmness) and (T.S.S%, acidity %, T.S.S/acidity ratio and V.C mg/100 ml F.W) in response to specific effect and interaction effect to the two investigated factors during 2015 and 2016 experimental seasons are presented in Tables (4,5 and 6).

Specific effect:

It is quite clear that all the above-mentioned fruit quality measurements responded specifically to CaCO₃ and green miracle concentrations. However, the grade of response varied not only from one fruiting measurement to another, but also the rate of differences in each investigated measurement exhibited by green miracle was more pronounced than the analogous ones resulted by CaCO₃. However, the three green miracle concentrations (1, 2 and 3cm/L) increased significantly all the above-mentioned fruit quality measurements as compared to control (water spray). Such trend was true during 2015 and 2016 experimental seasons with only one exception in fruit juice total acidity which its trend took the other way around. Anyhow, the response of fruiting measurements to the specific effect of green miracle concentration pointed out clearly that the greatest values of such

measurements were significantly in closed relationship to the highest green miracle concentration (3 cm/L). Moreover, green miracle spray at (2 cm/L) concentration ranked statistically 2nd followed by (1 cm/L) concentration. However, the lightest increase over control was always in concomitant to CaCO₃ at 1% concentrations. Hence, the increase in most fruit quality measurements over control was significantly in such parameters with 3% CaCO₃ sprayed of Keitt mango trees. Moreover, differences between lower CaCO₃ concomitant and control were few to be taking into consideration during both seasons.

Interaction effect:

Concerning the interaction effect of different concentrations among green miracle and CaCO₃ & number of spray times (once or twice) on the differential investigated fruit quality parameters of Keitt mango fruits. Data presented in Tables (4, 5 and 6) revealed that each investigated factor reflected directly a significantly increase over control (water spray). Consequently, the combination of green miracle at 2 and 3 cm/L + twice spray exhibited statically the greatest values of such measurements during both 2015 and 2016 experimental seasons. Meanwhile, CaCO₃ at 2% or 3% + one spray time or two spray times ranked statistically second. The highest increase over control was always in concomitant to the lowest concentration of CaCO₃ used or sprayed once. Such trend was true during both 2015 and 2016 seasons.

The present results are in general accordance with those previously found by Frommer and Sonnewald (1995), who observed that CaCO₃ spraying affected leaf photosynthesis, leading to less accumulation of TSS. Moreover, the beneficial of these anti-transpirants on increasing plant water potential and stimulating cell division and growth characters could result in enhancing growth of fruits. These results are in harmony with those obtained by Glenn *et al.*, (2001) and (2003).

Table 4: Effect of CaCO₃, Green miracle and number of times spray (one or two sprays) on fruit length (cm), fruit diameter (cm) and fruit shape index of Keitt mango fruits during two experimental seasons 2015&2016.

Parameters	Fruit length (cm)			Fruit diameter (cm)			Fruit shape index		
First Season									
Spray (A) \ Treatments (B)	Once	Twice	Mean	Once	Twice	Mean	Once	Twice	Mean
T1: control	11.94 j	11.96 i	11.95 F	9.00 g	9.00 g	9.00 F	1.327 de	1.329 cde	1.328 BC
T2:CaCO ₃ at 1%	11.93 j	12.02 h	11.98 E	9.02 f	9.03 f	9.03 E	1.322 e	1.332 bcde	1.327 C
T3:CaCO ₃ at 2%	11.98	11.98 i	11.98 E	9.04 ef	9.06 cd	9.05 CD	1.325 de	1.322 e	1.324 C
T4:CaCO ₃ at 3%	12.03 h	12.05 g	12.04 D	9.05 de	9.07 c	9.06 C	1.330 cde	1.329 cde	1.329 BC
T5:Green M at 1cm/L.	12.11 f	12.29 c	12.20 C	9.03 ef	9.06 cd	9.05 D	1.341 abcd	1.357 a	1.349 A
T6:Green M at 2cm/L.	12.19 e	12.33 b	12.26 B	9.06 cd	9.17 b	9.12 B	1.345 abc	1.345 abc	1.345 A
T7:Green M at 3cm/L.	12.21 d	12.41 a	12.31 A	9.16 b	9.21 a	9.19 A	1.333 bcde	1.347 ab	1.340 AB
Mean	12.05 B	12.15 A		9.05 B	9.09 A		1.332 A	1.337 A	
Second Season									
T1: control	11.94 i	11.95 i	11.95 G	9.04 f	9.05 ef	9.05 E	1.320 de	1.321 de	1.321 C
T2:CaCO ₃ at 1%	11.98 h	12.03 f	12.00 E	9.04 f	9.00 g	9.02 F	1.325 cde	1.337 abcd	1.331 BC
T3:CaCO ₃ at 2%	12.01 g	11.95 i	11.98 F	9.07 e	9.09 d	9.08 D	1.324 cde	1.315 e	1.320 C
T4:CaCO ₃ at 3%	12.04 f	12.04 f	12.04 D	9.04 f	9.11 c	9.08 D	1.331 bcde	1.322 de	1.326 C
T5:Green M at 1cm/L.	12.15 e	12.25 c	12.20 C	9.06 ef	9.12 c	9.09 C	1.341 abc	1.343 ab	1.342 AB
T6:Green M at 2cm/L.	12.20 d	12.32 b	12.26 B	9.06 ef	9.16 b	9.11 B	1.346 b	1.346 ab	1.346 A
T7:Green M at 3cm/L.	12.25 c	12.35 a	12.30 A	9.20 a	9.14 b	9.17 A	1.332 bcd	1.351 a	1.341 AB
Mean	12.08 B	12.13 A		9.07 B	9.10 A		1.331 A	1.333 A	

Values within each column followed by the same letter/s are not significantly different at 5% level.

Table 5: Effect of CaCO₃, Green miracle and number of times spray (once or twice) on fruit thickness (cm), fruit firmness (Lb/Inch) and V.C (mg/100ml F.W) of Keitt mango fruits during two experimental seasons 2015&2016.

Parameters	T.S.S (%)			Acidity (%)			T.S.S/Acid ratio		
First Season									
Spray (A) \ Treatments (B)	Once	Twice	Mean	Once	Twice	Mean	Once	Twice	Mean
T1: control	13.51 k	13.55 k	13.53 G	0.751 a	0.752 a	0.751 A	17.98 j	18.03 j	18.01 F
T2:CaCO ₃ at 1%	15.92 j	16.56 h	16.24 F	0.721 b	0.685 cde	0.703 BC	22.08 i	24.18 g	23.13 E
T3:CaCO ₃ at 2%	16.01 ij	16.68 gh	16.34 E	0.719 b	0.698 cd	0.709 B	22.25 i	23.88 g	23.07 E
T4:CaCO ₃ at 3%	16.08 i	17.05 e	16.57 D	0.701 c	0.684 de	0.692 C	22.95 h	24.94 f	23.95 D
T5:Green M at 1cm	16.73 fg	16.86 f	16.80 C	0.680 ef	0.647 g	0.664 D	24.59 f	26.05 d	25.32 C
T6:Green M at 2cm	17.35 d	17.61 c	17.48 B	0.676 ef	0.641 gh	0.659 D	25.67 e	27.47 b	26.57 B
T7:Green M at 3cm	17.94 b	18.13 a	18.04 A	0.665 f	0.626 h	0.646 E	26.98 c	28.95 a	27.97 A
Mean	16.22 B	16.63 A		0.702 A	0.676 B		23.22 B	24.78 A	
Second Season									
T1: control	14.01 g	14.01 g	14.01 C	0.745 a	0.747 a	0.746 A	18.81 i	18.76 i	18.78 F
T2:CaCO ₃ at 1%	15.98 f	17.59 bcd	16.78 B	0.722 b	0.668 de	0.695 B	22.13 h	26.32 cd	24.23 D
T3:CaCO ₃ at 2%	16.05 f	17.09 de	16.57 B	0.715 b	0.692 c	0.703 B	22.44 h	24.71 f	23.58 E
T4:CaCO ₃ at 3%	16.17 f	17.28 cde	16.73 B	0.682 cd	0.675 cd	0.679 C	23.71 g	25.61 de	24.66 D
T5:Green M at 1cm/L.	16.95 e	16.92 e	16.93 B	0.668 de	0.635 gh	0.652 D	25.36 ef	26.65 c	26.00 C
T6:Green M at 2cm/L.	17.79 abc	18.00 ab	17.90 A	0.658 ef	0.634 gh	0.646 D	27.04 c	28.41 b	27.73 B
T7:Green M at 3cm/L.	18.00 ab	18.26 a	18.13 A	0.647 fg	0.618 h	0.633 E	27.84 b	29.53 a	28.68 A
Mean	16.42 B	17.02 A		0.691 A	0.667 B		23.90 B	25.71 A	

Values within each column followed by the same letter/s are not significantly different at 5% level.

Table 6: Effect of CaCO₃, Green miracle and number of times spray (once or twice) on T.S.S (%), acidity (%) and T.S.S/Acid ratio of Keitt mango fruits during two experimental seasons 2015&2016.

Parameters	Fruit thickness (cm)			Fruit firmness (Lb/Inch)			V.C (mg/100ml F.W)		
First Season									
Spray (A) \ Treatments (B)	Once	Twice	Mean	Once	Twice	Mean	Once	Twice	Mean
T1: control	7.72 gh	7.74 fg	7.73 F	3.96 d	3.97 d	3.96 D	41.57 g	41.73 g	41.65 E
T2:CaCO ₃ at 1%	7.79 e	7.85 c	7.82 C	4.00 c	4.01 c	4.01 C	43.06 ef	42.87 f	42.97 D
T3:CaCO ₃ at 2%	7.80 e	7.87 b	7.84 B	4.03 b	4.05 b	4.04 B	43.64 def	44.28 cd	43.96 C
T4:CaCO ₃ at 3%	7.83 cd	7.91 a	7.87 A	4.09 a	4.10 a	4.09 A	43.97 de	44.54 bcd	44.25 BC
T5:Green M at 1cm/L.	7.71 h	7.78 e	7.75 E	3.66 e	3.47 h	3.56 E	43.65 def	44.90 abc	44.28 BC
T6:Green M at 2cm/L.	7.75 f	7.82 d	7.78 D	3.59 f	3.46 h	3.53 F	44.38 cd	45.35 ab	44.86 AB
T7:Green M at 3cm/L.	7.79 e	7.84 c	7.82 C	3.55 g	3.37 i	3.46 G	44.12 cd	45.71a	44.92 A
Mean	7.77 B	6.83 A		3.84 A	3.76 B		43.48 B	44.20 A	
Second Season									
T1: control	7.74 h	7.75 h	7.75 F	3.93 f	3.94 f	3.93 D	42.62 g	43.03 f	42.83 E
T2:CaCO ₃ at 1%	7.79 g	7.96 b	7.88 B	3.98 e	4.04 c	4.01 C	44.90 e	45.11 cde	45.01 D
T3:CaCO ₃ at 2%	7.80 g	8.01 a	7.91 A	4.02 d	4.07 b	4.04 B	45.12 cde	45.35 cd	45.24 CD
T4:CaCO ₃ at 3%	7.86 d	7.71 i	7.79 E	4.12 a	4.07 b	4.10 A	45.91 b	45.30 cd	45.60B
T5:Green M at 1cm/L.	7.74 h	7.84 e	7.79 E	3.59 g	3.35 j	3.47 E	45.00 de	45.99 b	45.50 BC
T6:Green M at 2cm/L.	7.79 g	7.86 d	7.83 D	3.55 h	3.29 k	3.42 F	45.39 c	46.37 a	45.88 A
T7:Green M at 3cm/L.	7.82 f	7.90 c	7.86 C	3.49 i	3.25 l	3.37 G	45.30 cd	46.63 a	45.96 A
Mean	7.79 B	7.386 A		3.81 A	3.72 B		44.89 B	45.40 A	

Values within each column followed by the same letter/s are not significantly different at 5% level.

Effect of CaCO₃, green miracle and number of times spray on color measurements (L, C and H) of Keitt mango fruits.

Fruit skin color measurements:

In this regard L* = indicates lightness, C* represents chroma and h is the hue angle (L* = lightness, C* = chroma and h° = hue angle) are the color skin measurements of Keitt mango fruits in response to differential treatments. Data obtained during both 2015 & 2016 experimental seasons are presented in (Fig 2-7).

Specific effect:

Regarding to the specific effect of differential investigated foliar spray treatments, it is quite clear that all the above-mentioned measurements response to different spray treatments. Moreover, the superiority of CaCO₃ or green miracle could be explained on the base of their physiological role. However, CaCO₃ foliar spray gave the greatest values in lightness (52.77 and 55.43) in the first and second season, respectively. Meanwhile, water sprayed (control) gave the lowest values in lightness parameters (45.24 and 45.92) in the first and second season, respectively. Moreover, it is quite evident that the response of C* = chroma parameters followed different trend previously discussed with (L*) lightness parameters. Meanwhile, the superiority of green miracle was clearly during both 2015 & 2016 experimental seasons. Generally, Keitt mango fruits revealed non-significant increase of chroma parameters in skin color, due to different spray treatments compared with the untreated fruits (control) in both seasons of study. The highest chrome values (27.93 and 28.13) were noticed in Keitt mango fruits treated with green miracle at (1 cm / L) in the 1st and 2nd season, respectively. On the other hand, results in (Fig.4) cleared an evident increase in skin color (Hue angle values) appeared a noticeable increase of the intensity of color. The highest hue parameters values (115.3 and 116.2) during the 1st and 2nd season, respectively were found in Keitt mango fruits treated with green miracle at (3 cm / L).

Interaction effect:

Concerning to the interaction effect of CaCO₃, green miracle and number of times spray on color measurements (L, C and h) of Keitt mango fruits. Data presented in (Fig.2-7) revealed that all the treatments increased the values of skin color measurements over control (water sprayed). The increase was significant with comparing control to all treatments except with the values of chroma parameters, where differences didn't reach level of significant. Such trend was true during both seasons of study. Anyhow, it could be noticed obviously that the highest lightness values were statistically coupled with CaCO₃ at 3% + twice spray during 2015 & 2016 experimental seasons. On the contrary, the least lightness values of Keitt mango fruits was markedly in significant relationship to control. Such trend was true during two experimental seasons. On the other hand, h° values responded to any investigated treatment. Consequently, green miracle at 3cm/L. + twice spray exhibited statistically the greatest values of (h°) during both 2015 & 2016 experimental seasons. In addition, other combinations were in between the foresaid two extremes.

However, the previous benefits of anti-sunburn compounds were cited by (Adam *et al.*, 1984; Leopold and Kriedermann, 1985; Seagle *et al.*, 1995; Reiley and Shry, 1997; Bose *et al.*, 2001; Roberts *et al.*, 2002; Skirvin, 2004; Radha and Mathew, 2007 and Peter, 2008).

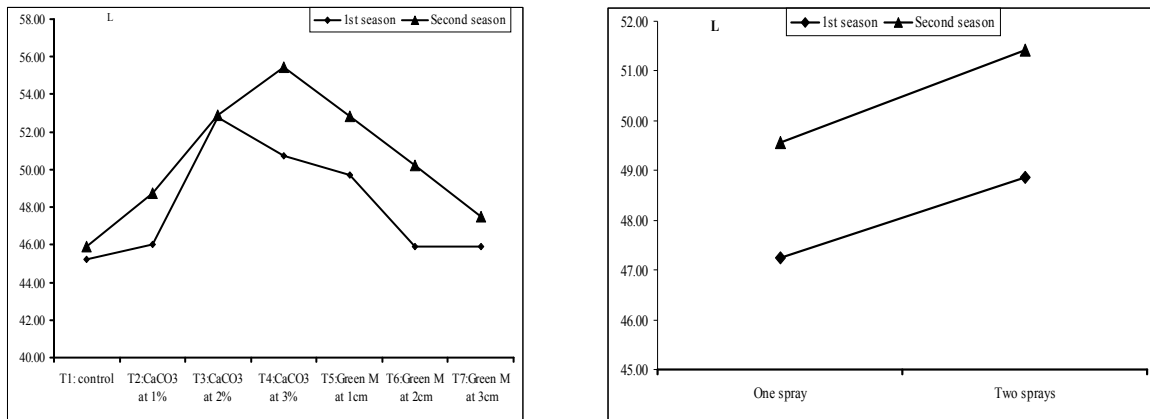


Fig. 2: Effect of Specific effect of treatments and number of times spray (once or twice) on lightness parameter (L) of Keitt mango fruits during two experimental seasons 2015&2016.

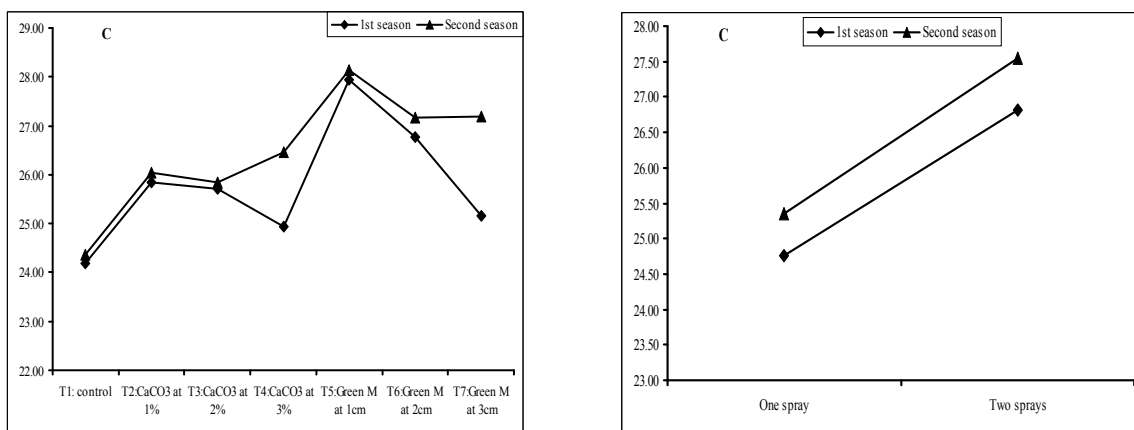


Fig 3: Effect of Specific effect of treatments and number of times spray (once or twice) on Chroma parameter (C) of Keitt mango fruits during two experimental seasons 2015&2016.

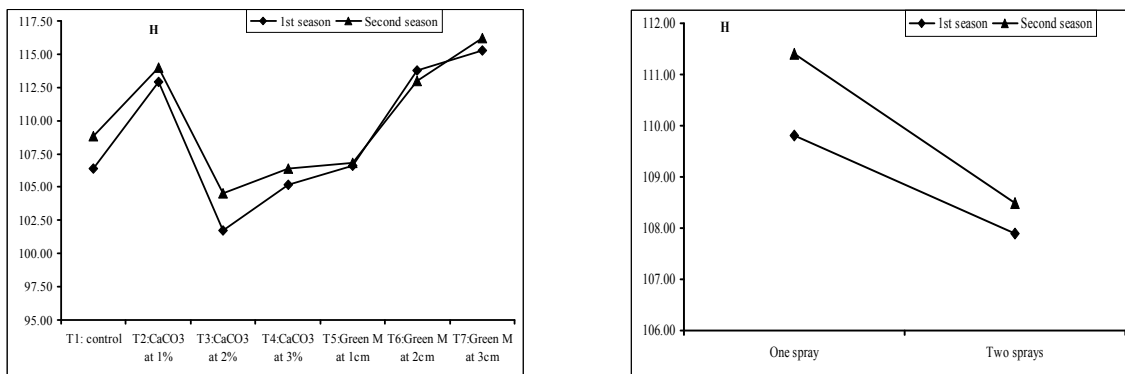


Fig. 4: Effect of Specific effect of treatments and number of times spray (once or twice) on Hue angle parameter (H) of Keitt mango fruits during two experimental seasons 2015&2016.

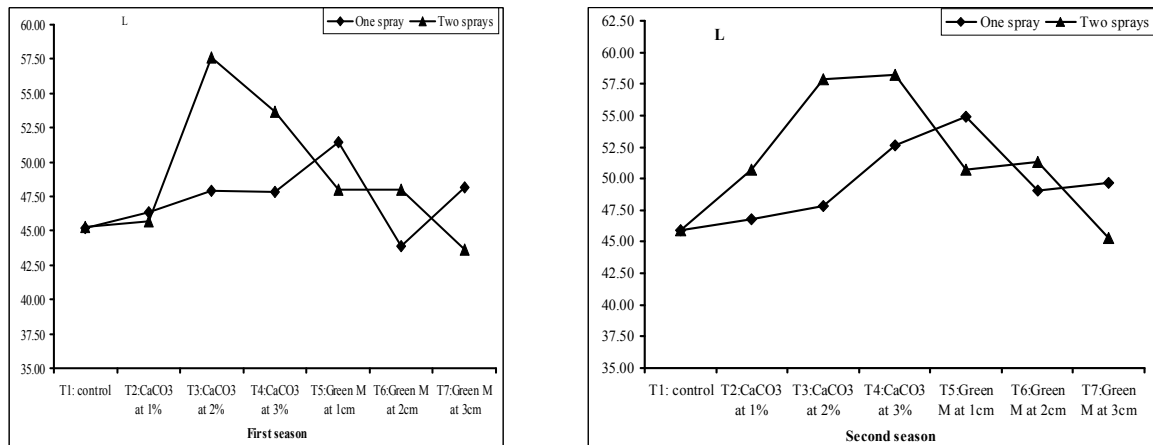


Fig. 5: Effect of interaction between treatments and number of times spray (once or twice) on lightness parameter (L) of Keitt mango fruits during two experimental seasons 2015&2016.

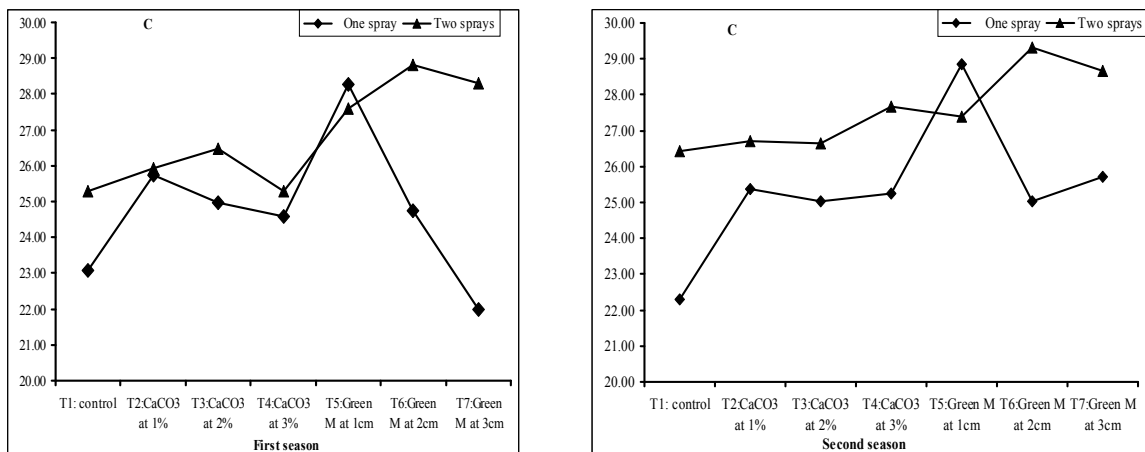


Fig. 6: Effect of interaction between treatments and number of times spray (once or twice) on Chroma parameter (C) of Keitt mango fruits during two experimental seasons 2015&2016.

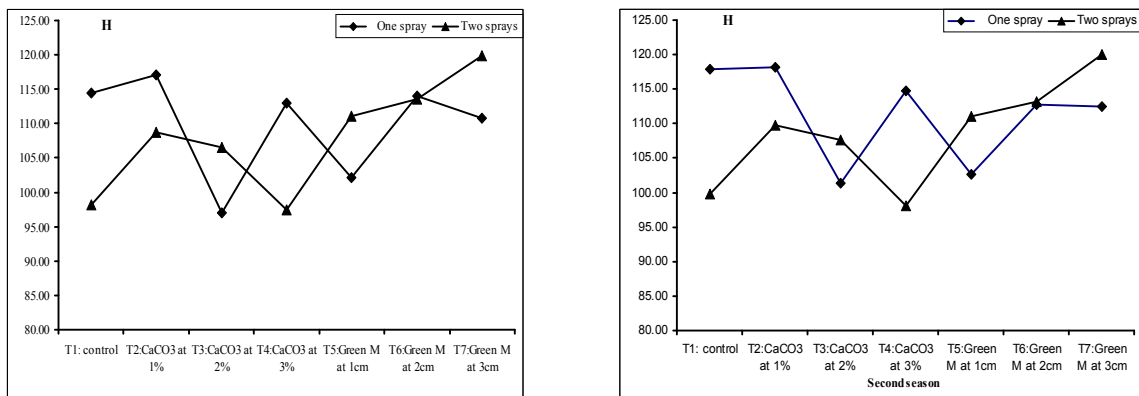


Fig. 7: Effect of interaction between treatments and number of times spray (once or twice) on Hue angle parameter (H) of Keitt mango fruits during two experimental seasons 2015&2016.

Conclusion

It can be recommended from the results of the present study that using of green miracle at 3 cm/L. twice sprayed at mid of June and mid of July was the best on preventing sunburn injury and improved productively and quality of Keitt mango fruits.

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