

Impact of Shading and Foliar Spray with Some Nutritive Solutions on Growth, Nutritional Status, Productivity and Fruit Quality of Keitt Mango Trees

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Abstract

Present study was carried out on 7 years old Keitt mango trees budded on Succary rootstock, grown under drip irrigation in sandy soil orchard located at Wady EL-Natroon, EL-Behaira Governorate, Egypt during 2019 and 2020 seasons. Factorial experiment was conducted to investigate specific and interaction effects of tree shading with ceroon net combined with foliar spray of 9 N, P, K, Ca, Mg nutritive solutions on some growth, nutritional status, yield and fruit quality (physical & chemical properties) of Keitt mango cv. Data obtained revealed that, most evaluated parameters responded specifically to both studied factors (shading & foliar nutrition treatments). Hence, all growth parameters, leaf N, P, K%, yield (No. & weight), fruit physical (weight & pulp %) and fruit juice chemical properties (TSS, TSS/Acid ratio, total sugars and v.c) contents were increased by shading application. Moreover, all nutritive solutions improved the abovementioned parameters than control (water spray). However, both T9 (fertifeed Ca, Mg-COOH + fertifeed P, K-COOH) and T5 (Fertifeed phosphy-K COOH) and to great extent T7 (Carpox-K COOH + NH₄NO₃) were the superior. Accordingly, specific effect of each factor (shading & nutritive solutions) reflected certainly on their combinations whereas spraying shaded Keitt mango trees with T9 (fertifeed Ca, Mg-COOH plus fertifeed P, K-COOH) and / or T5 (Fertifeed P-K COOH) nutritive solutions exhibited statistically the greatest beneficial effects on their various evaluated growth, nutritional status, yield and fruit quality parameters.

Key wards: Mango, shading, nutritive solutions, growth, nutritional status, yield and fruit quality.

Introduction

Mangoes (*Mangifera indica* L.) belong to family Anacardaceae, native to South Eastern Asia and considered one of the most important ever green fruits of the tropical and sub-tropical countries. It is one of the most popular and favorite fruits because of its rich and delicious flavor (aroma & taste). It is considered to be the queen of fruits.

Mango trees were introduced to Egypt around 1825 year and ever since, its' cultivation has gradually expanded throughout the country and became one of the main fruits grown in Egypt, which recently ranking third after citrus and grape crops. The total cultivated area in Egypt reached to about 289288 feddans that produced about 1066404 tons (**Ministry of Agriculture and land reclamation, 2017**). The production areas are focused in Ismailia, Sharkia, Behira and Giza Governorates.

The "Keitt" mango is a late-season (October-December), large fruit size with small seed size and fruit lacked color. It quickly gained commercial acceptance for its long shelf life, flavor, productivity and lack of fiber to be more widely planted mango cv. in Egypt. The growth habit of Keitt mango tree is characterized by long, arching branches with poor growth in the subtropics. The trees are vigorous, but do not to reach heights much over 20 feet. It has a low spreading habit that is not as compact as most other mango cultivars, and develops an open canopy with a relative heavy and consistent production (**Tomer et al., 1993**).

Many factors affecting mango cultivation, the

climate elements (sunlight, temperature and humidity) considered as the most important crucial factors for cultivation especially for fruit trees such as mango which have specific environmental requirements.

Exposing mango fruit to high temperature and intense light conditions during growth season may lead to metabolic and physiological disorders which certainly reflected negatively on both yield and fruit quality (**Léchaudel et al., 2013**).

Shading mango trees can be considered as an effective technique to avoid undesirable effects of excess solar under hot climate (**Jutamane and Onnom, 2016**).

Potassium (K) is an essential mineral nutrient element for mango, associated with water usage by the plant, disease tolerance, fruit productivity and sugar content in the fruit pulp juice (**Shinde et al., 2006 and Bally, 2009**).

Foliar spray of nutrients helps in efficient utilization of nutrients to plants directly through leaves within few days we can realize the effect of nutrients spray. **Ranjit et al., (2008)**; **Anees et al., (2011)** and **Nafees (2011)** found that, foliar spray of nutrients on mango trees significantly increase fruit yield, fruit quality and improving leaf mineral contents.

This study aimed to improve productivity, fruit quality and nutritional status of Keitt mango cv. by shading with ceroon net combined with foliar spray with some nutritive solutions.

Materials and Methods

This study was carried out on 7 years old Keitt mango trees budded on Succary mango rootstock, grown under drip irrigation located at Wady EL-Natroun region, EL-Behaira Governorate, Egypt during 2019 and 2020 seasons. It was aimed to investigate foliar spray with some nutritive solutions and shading application. So, a factorial experiment was conducted to study the specific and interaction effects of two factors (shading with ceroon net and eight nutritive solutions + water spray as control). Whereas the evaluated treatments were representative of the eighteen combinations between variables of two factors i.e., 2 variables of 1st factor (shading & no shading) and nine spray solutions of the 2nd factor {T1- tap water spray, T2- (Carpox-K COOH), T3 (potamin – K NH₂), T4 (T2 + H₃PO₄), T5 (Fertifeed phosphy-K COOH only), T6 (T3 + H₃PO₄), T7 (T2 + NH₄NO₃), T8 (calemag Ca Mg NH₂) and T9 (T5 + fertifeed Ca, Mg-COOH)}. Taking into consideration that such N, P, K, Ca, Mg nutritive compounds were varied not only due to their nutrient element / s containing but also to either the commercial source or the chemical form of the nutrient element carrier its self (COOH & NH₂).

Moreover, these nutritive solutions were prepared by adding 1.5 g Carpox-k, 2.0 ml potamin, 0.20 ml of conc. H₃PO₄, 2.0 ml fertifeed P, K, 1.5 g NH₄NO₃, 2.0 ml Calemage and 2.0 ml fertifeed Ca, Mg per each liter of corresponding solutions. Foliar spray of various nutritive solutions even tap water was applied three times yearly i.e., on early Feb., Apr. and Jun. 2019 & 2020 years. The complete randomized block design with three replications was used for arranging the investigated treatments i. e., 18 combinations (2 shading × 9 nutritive solutions).

The specific and interaction effects of two studied factors were evaluated through the response of the following measurements:

1- Vegetative growth:

Number and length of sprouted shoots, No of leaves per each as well as average leaf area and its dry weight were the five evaluated growth parameters.

2- Nutritional status:

Leaf N, P and K content were determined. Total N was determined by micro Kjeldahl according to **Pregl (1945)**, phosphorus was determined using a Spekol spectrophotometer at 882.0 UV according to the method described by **Murphy and Riely (1962)** and K was determined using Flame photometer according to **Chapman and Pratt, (1961)**.

3- **Productivity (yield):** Number and weight (kg) of harvested fruits per tree were recorded.

4- **Fruit quality** (physical & chemical properties):

A- Fruit physical characteristics: The average of fruit weight and pulp % were

determined.

B- Fruit chemical characteristics: Fruit juice TSS%, TSS/Acid ratio, total sugars and vitamin C (ascorbic acid) content were calibrated.

-Statistical Analysis:

Data obtained during both experimental seasons were subjected to analysis of variance and significant differences among means were determined according to (**Snedecor and Cochran, 1977**). In addition, significant differences among means were differentiated according to the Duncan's, multiple test range at 5% level (**Duncan, 1955**) where capital and small letters were used for distinguishing between values of specific and interaction effects, respectively.

Results and Discussion

1- Vegetative growth measurements:

Number and length of spring sprouted shoots /tree, number of leaves per each and the average leaf area, as well as its dry weight were the five investigated growth parameters pertaining their response to specific and interaction effects of two investigated factors (shading with ceroon net & nutritive spray solutions). Data obtained during both 2019 and 2020 experimental seasons are presented in **Tables (1), (2) and (3)**.

A- Specific effect:

With regard to the specific effect of trees shading with ceroon net, data obtained during both 2019 & 2020 seasons displayed that, the five evaluated growth measurements followed typically the same trend. Herein, shading application with ceroon net significantly increased those evaluated parameters as the difference i. e., increase exhibited in a given parameter value by shading was compared with the analogous one of these trees grown without shading.

As for the specific effect of the eight sprayed N, P, K, Ca and Mg nutritive solutions, it could be generally observed that, all or most sprayed solutions increased such evaluated growth parameters than those of the tap water sprayed trees (control). However, the investigated spray nutritive solutions were not equally the same as their effectiveness on stimulating growth parameters were concerned from one hand. It could be safely said that, the 9th, 5th, 7th, 4th and 2nd spray treatments i.e., (Fertifeed phosphy-K + Fertifeed Ca + Mg each in COOH form), (Fertifeed phosphy-K COOH only), (Carpox-K COOH + NH₄NO₃), (Carpox-K COOH + H₃PO₄) and (Carpox-K COOH only), respectively were the most effective spray treatments. Nevertheless, such effective spray solutions could be significantly arranged into the descending order i. e., T9 the superior and/or T5 followed by T7, T4 and T2. However both 9th and 5th spray simulative solutions did not significantly differ during two seasons particularly as their influence on shoot length and

leaf (area & dry weight) was concerned. However, value of shoot number of shoots/tree (2nd season) of the sprayed trees with either 5th or 9th spray solutions were also significantly the same. Meanwhile, three other spray solutions i. e., T3 (potamin –K NH₂), T8 (calemag Ca Mg NH₂) and two great extent T6 (T3 + H₃PO₄) were statistically the inferior as compared to the abovementioned five effective spray treatments. In some cases such three least effective spray treatments did not significantly vary than control (tap water spray), particularly with shoot length and leaf dry weight during both seasons, as well as number of shoots/tree in 2nd season.

B- Interaction effect:

The superiority and inferiority of a given variable of any of the two investigated factors i.e., shading with ceroon net and foliar spray with some nutritive solutions were directly reflected on their possible combinations. It was quite evident that both combinations of spraying the shaded Keitt mango trees with either T9 (fertifeed Ca, Mg-COOH plus fertifeed P, K-COOH) or T5 (Fertifeed phosphy-K COOH only) were statistically the superior. Since, the greatest values of the five evaluated growth parameters i. e., number of shoots / tree, shoot length, No. of leaves per shoot and leaf (area & dry weight) were significantly in closed relationship to such two superior combinations. This trend was true during both 2019 and 2020 experimental seasons with a unique exception noticed in the number of sprouted shoots per tree during 2nd season, whereas such combination representative of spraying shaded

Keitt trees with 7th solution (Carbox-K COOH + NH₄NO₃) exhibited a comparable value of this parameter statistically similar to that of the aforesaid two superior combinations. On the contrary, combination of the nonshaded – water sprayed trees showed generally the least values of the five differential evaluated growth parameters. However, such inferior combination did not significantly vary than other growth depressive combinations, especially those representative of the unshaded trees sprayed with either T3 (potamin –K NH₂) or T8 (calemag Ca Mg - NH₂) solutions whereas both had equally the same effectiveness from one hand and did not significantly differ than the inferior combination (no shaded water sprayed trees) from the other.

In addition, other combinations were in between the aforesaid two extremes. Taking into consideration that same combinations of such intermediate category identically those representative of the shaded Keitt mango trees sprayed with either T2 (Carbox-K COOH) or T4 (Carbox-K + H₃PO₄) tended significantly to exceed other members of such category.

These results go in line with those found by **Abou-Hadid and EL-Beltagy (1992)** and **Medany et al., (2009)** on shading of mango; **Kelani (2012)** and **Taha et al., (2014)** on sprayed mango trees with calcium and potassium.

Table 1. Number of shoots and shoot length (cm.) of Keitt mango trees in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	2019 Season		No. of shoots /tree		2020 Season		Mean*
	No shading	Shading	Mean*	No shading	Shading		
T1- Water spray	24.33 j	32.33 gh	28.33 I	25.00 g	36.33 cde	30.67 E	
T2- Carbox-K (CooH)	31.33 h	38.67 d	35.00 E	34.33 c-f	40.33 bcd	37.33 BCD	
T3- Potamin –K (NH₂)	28.67 i	35.00 f	31.83 G	27.33 fg	38.33 cd	32.83 CDE	
T4- (T2 + H₃PO₄)	32.33 gh	39.67 d	36.00 D	33.33 d-g	42.67 abc	38.00 BC	
T5- Fertifeed (P,KCooH)	41.33 c	48.67 a	45.00 B	35.33 c-f	47.00 ab	44.17 AB	
T6- (T3 + H₃PO₄)	29.00 i	37.33 e	33.17 F	29.67 efg	40.33 bcd	35.00 CDE	
T7- (T2 + NH₄NO₃)	37.00 e	43.33 b	40.17 C	35.78 cde	47.67 ab	41.72 AB	
T8- Calemage (Ca,MgNH₂)	25.00 j	33.33 g	29.17 H	28.67 efg	35.33 c-f	32.00 DE	
T9- Fertifeed Ca, MgCooH + T5	42.00 c	49.67 a	45.83 A	40.00 bcd	51.00 a	45.50 A	
Mean**	32.33 B	39.78 A		32.16 B	42.11 A		
	Shoot length (cm.)						
T1- Water spray	29.33 hi	35.00 fg	32.17 E	30.00 jk	35.33 fg	32.67 E	
T2- Carbox-K (CooH)	30.33 hi	38.17 de	34.25 C	31.00 ij	39.00 e	35.00 DE	
T3- Potamin –K (NH₂)	29.00 i	38.00 de	33.50 CD	29.00 k	39.00 e	34.00 DE	
T4- (T2 + H₃PO₄)	34.67 g	39.57 cd	37.12 B	33.67 gh	40.67 de	37.17 C	
T5- Fertifeed (P,KCooH)	44.33 b	51.10 a	47.72 A	43.67 bc	52.00a	47.83 A	
T6- (T3 + H₃PO₄)	31.00 h	36.67 ef	33.38 C	32.67 hi	37.00 f	34.83 D	
T7- (T2 + NH₄NO₃)	35.33 fg	41.33 c	38.33 B	36.33 f	42.23 cd	39.28 B	
T8- Calemage (Ca,MgNH₂)	29.00 i	35.67 fg	32.33 DE	29.67 jk	36.33 f	33.00 E	
T9- Fertifeed Ca, MgCooH + T5	43.67 b	50.77 a	47.22 A	44.67 b	51.07 a	47.87 A	
Mean**	34.07 B	40.70 A		34.52 B	41.40 A		

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

Table 2. Number of leaves per shoot and leaf area of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	Number of leaves					Mean*
	2019 Season		Mean*	2020 Season		
	No shading	Shading		No shading	Shading	
T1- Water spray	20.67 j	24.33 gh	22.50 G	23.00 l	26.33 hij	24.67 F
T2- Carbox-K (CooH)	25.33 fg	28.00 de	26.67 D	27.00ghi	30.00 c	28.50 C
T3- Potamin –K (NH ₂)	22.67 i	25.67 f	24.17 F	25.33 jk	28.33d-g	26.83 DE
T4- (T2 + H ₃ PO ₄)	26.00 f	28.67 d	27.33 D	27.67f-h	29.67 cd	28.67 C
T5- Fertifeed (P,KCooH)	28.33 de	32.33 b	30.33 B	31.67 b	34.67 a	33.17 A
T6- (T3 + H ₃ PO ₄)	23.33 hi	28.00 de	25.67 E	25.67 ijk	28.67 c-f	27.17 D
T7- (T2 + NH ₄ NO ₃)	27.33 e	30.00 c	28.67 C	29.00cde	32.00 b	30.50 B
T8- Calemage (Ca,MgNH ₂)	22.33 i	23.33 fg	23.83 F	24.67 k	27.33 fgh	26.00 E
T9- Fertifeed Ca, MgCooH + T5	30.00 c	33.67 a	31.83 A	32.33 b	35.67 a	34.00 A
Mean**	25.11 B	28.44 A		27.37 B	30.30 A	
	Leaf area (cm²)					
T1- Water spray	56.94 m	60.67 k	58.95 G	57.23 m	61.37 k	59.30 G
T2- Carbox-K (CooH)	68.07 h	72.75 f	70.41 D	68.53 h	73.00 f	70.76 D
T3- Potamin –K (NH ₂)	58.13 l	62.16 j	60.15 F	58.38 l	62.36 j	60.37 F
T4- (T2 + H ₃ PO ₄)	73.09 ef	76.25 d	74.67 C	72.22 g	76.59 d	74.40 C
T5- Fertifeed (P,KCooH)	77.53 c	81.61 a	79.18 A	77.81 c	82.06 a	79.93 A
T6- (T3 + H ₃ PO ₄)	66.67 i	70.57 g	68.62 E	67.68 i	71.66 g	69.67 E
T7- (T2 + NH ₄ NO ₃)	73.67 e	79.56 b	76.62 B	74.55 e	79.42 b	76.99 B
T8- Calemage (Ca,MgNH ₂)	57.12 m	61.16 k	59.14 G	57.93 l	62.10 j	60.01 F
T9- Fertifeed Ca, MgCooH + T5	77.09 cd	81.28 a	79.57 A	77.86 c	82.00 a	79.93 A
Mean**	67.59 B	71.81 A		68.02 B	72.29 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

Table 3. Leaf dry weight (g) and leaf N (%) content of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	Leaf dry weight (g)					Mean*
	2019 Season		Mean*	2020 Season		
	No shading	Shading		No shading	Shading	
T1- Water spray	0.580 h	0.633 efg	0.607 D	0.580 j	0.647 f-i	0.613 E
T2- Carbox-K (CooH)	0.600 fgh	0.673 de	0.637 D	0.630 g-j	0.693 def	0.662 CD
T3- Potamin –K (NH ₂)	0.590 gh	0.653 e	0.622 D	0.610 hij	0.667 efg	0.638 DE
T4- (T2 + H ₃ PO ₄)	0.643 ef	0.707 cd	0.675 C	0.650 f-i	0.717 de	0.683 C
T5- Fertifeed (P,KCooH)	0.750 bc	0.833 a	0.792 A	0.787 c	0.850 ab	0.818 A
T6- (T3 + H ₃ PO ₄)	0.590 gh	0.667 de	0.628 D	0.607 ij	0.677 efg	0.642 DE
T7- (T2 + NH ₄ NO ₃)	0.710 cd	0.790 ab	0.750 B	0.730 d	0.800 bc	0.765 B
T8- Calemage (Ca,MgNH ₂)	0.580 h	0.643 ef	0.612 D	0.593 j	0.660 fgh	0.627 DE
T9- Fertifeed Ca, MgCooH+ T5	0.767 b	0.840 a	0.803 A	0.790 c	0.867 a	0.828 A
Mean**	0.646 B	0.716 A		0.664 B	0.731 A	
	N %					
T1- Water spray	1.99 m	2.12 jk	2.05 G	2.06 j	2.24 h	2.15 F
T2- Carbox-K (CooH)	2.19 hi	2.53 cd	2.36 D	2.27 gh	2.58 cde	2.42 CD
T3- Potamin –K (NH ₂)	2.03 lm	2.40 gh	2.14 E	2.14 i	2.37 f	2.25 E
T4- (T2 + H ₃ PO ₄)	2.25 g	2.55 c	2.40 C	2.29 gh	2.58 cd	2.43 C
T5- Fertifeed (P,KCooH)	2.44 e	2.72 b	2.58 B	2.49 e	2.74 b	2.61 B
T6- (T3 + H ₃ PO ₄)	2.17 ij	2.49 de	2.33 D	2.25 h	2.51 de	2.38 D
T7- (T2 + NH ₄ NO ₃)	2.54 c	2.84 a	2.69 A	2.62 c	2.87 a	2.74 A
T8- Calemage (Ca,MgNH ₂)	2.08 kl	2.35 f	2.12 E	2.34 fg	2.13 ij	2.24 E
T9- Fertifeed Ca, MgCooH + T5	2.55 c	2.85 a	2.70 A	2.63 c	2.86 a	2.74 A
Mean**	2.25 B	2.52 A		2.34 B	.54 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

2- Nutritional status:

Data obtained regarding the specific and interaction effects of (shading with ceroon net & foliar spray with some N, P, K, Ca, Mg solutions) and their combinations are presented in **Tables (3) and (4)**.

A- Specific effect:

It is quite evident that, leaf three N, P, K % of shaded Keitt mango trees increased significantly than those of the unshaded ones. Regarding the specific effect of nutritive solutions spray on leaf N, P, K %, the response of three nutrient elements was not similar. Hence, leaf N and K% were significantly increased by all the eight nutritive solutions over control (tap water spray). Whereas, both T9 and T7 solutions were the superior followed by T5 (Fertifeed P-K COOH) as the leaf N% was concerned, while, with leaf K% T9 (fertifeed Ca, Mg + fertifeed P, K-COOH) also and T5 (Fertifeed P-K COOH) followed by T7 (Carbox-K COOH + NH₄NO₃) were the most effective. As the leaf P%, differences than control were too slight to reach level of significance especially during 1st 2019 season, while in 2nd 2020 season T9 only increased it significantly than other investigated nutritive solutions.

B- Interaction effect:

Specific effect of each investigated factor reflected on their combinations, so it could be clearly noticed that both leaf N and K% followed approximately the same trend. Since, richest leaf N & K contents were significantly coupled with the three combinations of spraying shaded trees with either T9, T7 or T5 nutritive solutions. However, with leaf N% leaves of spraying shaded trees with T7 (Carbox-K COOH + NH₄NO₃) were significantly richer than analogous ones sprayed with T5 (Fertifeed P-K COOH), while the reverse was true with leaf K%. On the contrary, leaves of both water spray combinations, especially of the nonshaded trees were significantly the poorest in their N, K contents. In addition, other combinations were in between the aforesaid two extremes. On the other hand, leaf P% of various combinations did not significantly differ with a unique exception in 2nd 2020 season only, whereas spraying shaded trees with T9 having significantly the richest leaf P%.

These results are in general agreement with the findings of **Oosthuysen (1996)** and **Abd El -Gawad (2017)** on spray mango trees with some nutrients; **Mustafa et al., (2018)** on shading mango trees.

Table 4. Leaf phosphorus and potassium percentages content of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	P%					
	2019 Season		Mean*	2020 Season		Mean*
	No shading	Shading		No shading	Shading	
T1- Water spray	0.219 a	0.242a	0.231 A	0.226 b	0.242 b	0.234B
T2- Carbox-K (CooH)	0.228 a	0.254 a	0.241 A	0.235 b	0.250 b	0.243 B
T3- Potamin -K (NH ₂)	0.216 a	0.247 a	0.232 A	0.225 b	0.251 b	0.238 B
T4- (T2 + H ₃ PO ₄)	0.234 a	0.253 a	0.243 A	0.238 b	0.253 b	0.246 B
T5- Fertifeed (P,KCooH)	0.238 a	0.254 a	0.246 A	0.245 b	0.261 b	0.253AB
T6- (T3 + H ₃ PO ₄)	0.225 a	0.248 a	0.237 A	0.229 b	0.252 b	0.241 B
T7- (T2 + NH ₄ NO ₃)	0.235 a	0.254 a	0.245 A	0.235 b	0.259 b	0.247 B
T8- Calemage (Ca,MgNH ₂)	0.219 a	0.245 a	0.232 A	0.232 b	0.245 b	0.238 B
T9- Fertifeed Ca, MgCooH + T5	0.240 a	0.263 a	0.251 A	0.223 b	0.373 a	0.305 A
Mean**	0.228 B	0.251 A		0.234 B	0.265 A	
	K%					
T1- Water spray	2.20 hi	2.41 ef	2.30 D	2.17 i	2.38 f	2.28 F
T2- Carbox-K (CooH)	2.26 g	2.49 d	2.36 C	2.28 gh	2.50 c	2.39 CD
T3- Potamin -K (NH ₂)	2.26 g	2.44 de	2.35 C	2.56 gh	2.42 def	2.34 E
T4- (T2 + H ₃ PO ₄)	2.25 gh	2.46 de	2.37 C	2.30 g	2.50 c	2.400 C
T5- Fertifeed (P,KCooH)	2.56 c	2.81 a	2.68 A	2.59 b	2.79 a	2.69 A
T6- (T3 + H ₃ PO ₄)	2.24 gh	2.45 de	2.35 C	2.25 gh	2.46 cd	2.35 DE
T7- (T2 + NH ₄ NO ₃)	2.39 f	2.61 b	2.50 B	2.38 ef	2.58 b	2.48 B
T8- Calemage (Ca,MgNH ₂)	2.18 i	2.43 ef	2.31 D	2.23 h	2.43 de	2.33 E
T9- Fertifeed Ca, MgCooH + T5	2.55 c	2.81 a	2.68 A	2.62 b	2.82 a	2.72 A
Mean**	2.32 B	2.55 A		2.34 B	2.54 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

3. Productivity (yield measurements):

Number and weight (kg) of harvested fruits per an individual tree were two yield parameters evaluated regarding the response of specific and interaction effects of studied factors (shading & nutritive solutions), data obtained are presented in **Table (5)**.

A. Specific effect:

Both yield parameters followed the same trend regarding their response to specific effect of foliar spray nutritive solutions. Hence, both T9 (fertifeed Ca, Mg-COOH + fertifeed P, K-COOH) and T5 (Fertifeed P-K COOH) were statistically the superior, followed by the T7 (Carbox-K COOH + NH₄NO₃). Moreover, all investigated N, P, K, Ca, Mg nutritive solutions increased significantly two yield parameters over the tap water spray (control). However T3 (potamin -K NH₂), T6 (T3 + H₃PO₄) and T8 (calemag Ca, Mg -NH₂) were significantly the least effective. Other nutritive solutions in between.

As for the specific effect of tree shading with ceroon net, differences were too slight and could be safely neglected from the statistical standpoint.

B. Interaction effect:

Table (5) displays obviously that, both combinations of spraying shaded trees of Keitt mango cv. with either T9 (fertifeed Ca, Mg-COOH plus fertifeed P, K-COOH) or T5 (Fertifeed P-K COOH) increased both yield parameters than other combinations. However, such two superior combinations did not significantly differ during two seasons as the number of harvested fruits /tree was concerned, while with the fruits weight combination of the spraying shaded trees with T9 surpassed statistically the analogous one of T5 spray during two seasons. Two combinations of water spray trees (regardless of nutritive solutions spray) were statistically the inferior. In addition, other combinations were in between, however spray shaded trees with T7 (Carbox-K COOH + NH₄NO₃) exceeded statistically other members of such intermediate category.

These results are in general agreement with the findings of **Ataide and Jose (1999)**, **Hafle *et al.*, (2003)** and **Malik & Singh (2006)** on spray mango trees with some nutrients, **Medany *et al.*, (2009)** and **Léchaudel *et al.*, (2013)** on shading mango trees.

Table 5. Yield as number and weight (kg) of fruits per Keitt mango tree in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	Number of harvested fruits/tree					
	2019 Season			2020 Season		
	No shading	Shading	Mean*	No shading	Shading	Mean*
T1- Water spray	18.00 i	17.00 j	17.50 G	19.67 k	18.33 l	19.00 G
T2- Carbox-K (CooH)	20.33 fg	21.33 de	20.83 CD	22.00 g	23.00 f	22.50 D
T3- Potamin -K (NH ₂)	19.33 h	19.67 gh	19.50 E	21.00 hi	21.00 hi	21.00 E
T4- (T2 + H ₃ PO ₄)	21.00 ef	21.67 de	21.33 C	23.33 ef	23.67 ef	23.50 C
T5- Fertifeed (P,KCooH)	24.00 bc	25.33 a	24.67 A	26.33 c	27.33 ab	26.83 A
T6- (T3 + H ₃ PO ₄)	21.00 ef	20.33 fg	20.67 D	20.67 ij	21.67 gh	21.17 E
T7- (T2 + NH ₄ NO ₃)	22.00 d	23.33 c	22.67 B	24.00 e	25.00 d	24.50 B
T8- Calemage (Ca,MgNH ₂)	19.00 h	18.00 i	18.50 F	20.33 ijk	20.00 jk	20.17 F
T9- Fertifeed Ca, MgCooH + T5	24.33 b	26.00 a	25.17 A	26.67 bc	27.67 a	27.17 A
Mean**	21.00 A	21.41 A		22.67 A	23.07 A	
	Weight of harvested fruits (kg) per tree					
T1- Water spray	9.10 l	9.62 k	9.37 G	9.96 k	10.37 jk	10.17 F
T2- Carbox-K (CooH)	11.18 i	12.76 ef	11.94 D	12.01 fg	13.80 d	12.73 C
T3- Potamin -K (NH ₂)	10.21 j	11.46 i	10.88 E	10.93 i	12.10 f	11.79 DE
T4- (T2 + H ₃ PO ₄)	11.65 hi	13.01 e	12.31 CD	12.50 ef	14.07 d	13.42 BC
T5- Fertifeed (P,KCooH)	14.12 d	16.32 b	15.19 A	15.68 b	15.47 b	15.42 A
T6- (T3 + H ₃ PO ₄)	11.38 i	12.00 gh	11.69 D	11.21 hi	12.73 e	11.96 D
T7- (T2 + NH ₄ NO ₃)	12.37 fg	14.13 d	13.22 B	13.97 d	14.80 c	14.03 B
T8- Calemage (Ca,MgNH ₂)	10.31 j	10.50 j	10.22 F	10.70 ij	11.57 gh	11.14 E
T9- Fertifeed Ca, MgCooH + T5	14.67 c	16.97 a	15.79 A	15.51 b	17.70 a	16.59 A
Mean**	11.57 B	12.86 A		12.31 B	13.53 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

4- Fruit quality:

Fruit physical characteristics (average fruit weight & fruit pulp %) and chemical characteristics (fruit juice TSS%, TSS/Acid ratio, total sugars% and vitamin C content) were the investigated fruit qualities. Data obtained during 2019 & 2020 seasons are presented in **Tables (6), (7) and (8)**.

4.1. Fruit physical properties:

Table (6) displays that, both fruit weight and fruit pulp % responded specifically to shading application. However, differences were more pronounced with average fruit weight, whereas fruits of the shaded trees were significantly heavier than those of nonshaded trees. Meanwhile, with pulp % differences between shaded and unshaded trees were too light to be taken into consideration.

Referring the specific effect of nutritive solutions spray, both fruit physical properties followed to great extent the same trend. Hence, T9 and T5 were statistically the most effective, descendly followed by T7 and to some extent T4. However, T3, T6 and T8 were generally the least effective as compared to control (tap water spray). In addition, other combinations were in between.

B. Interaction effect:

Table (6) reveals that, combinations of spraying the shaded trees with either T9, T5 or T7 especially 1st combination having statistically the heaviest fruit weight and the greatest values of fruit pulp %. However, spraying the non-shaded trees with any of the T3, T6 and T8 nutritive solutions yielded fruits with lightest average weight and the least pulp % which in most cases did not significantly vary than the analogous fruits of neither shaded nor sprayed with any of the N, P, K, Ca, Mg nutritive solutions.

4-2. Fruit chemical characteristics:

A. Specific effect:

The fruit juice TSS %, TSS/ Acid ratio, total sugars% and vitamin C content followed a similar trend as shown from **Tables (7) & (8)** pertaining their response to each of both studied factors solely i. e., shading & foliar nutritive solutions. Herein, fruit juice of the shaded Keitt mango trees having significantly higher values of four chemical characteristics as compared to analogous chemical constituents of the nonshaded trees. Nevertheless, the investigated eight nutritive solutions increased significantly TSS%, TSS/Acidity ratio and total sugars % over the tap water spray (control). Meanwhile, T9, T5 and T7 were statistically the most effective, especially with both TSS/Acid ratio and TSS%, while with total sugars % T7 ranked second.

On the other hand with fruit juice V.C. content, most nutritive N, P, K, Ca, Mg solutions did not significantly vary than control (water spray) in spite of T9, T5 and T7 solutions were still the superior either compared to control or other sprayed solutions.

B-interaction effect:

Referring the interaction effect, **Tables (7) and (8)** display that, two combinations of shaded Keitt mango trees sprayed with either T9 or T5 having significantly the richest fruits in their juice TSS%, TSS/Acid ratio, total sugars% and vitamin C content descendly followed by shaded trees sprayed with T7. On the contrary, combination of the non shaded trees sprayed with water was the inferior ascendly followed by those combinations of spraying the unshaded trees with either T3, T6 or T8 from the statistical point of view. In addition, other combinations were in between.

These results are in general agreement with those previously found by **Mthembu (2001) and Fivaz & Lonsdale (2001)** on shading mango trees, **Sherkawy (2006); Taha et al., (2014) and El-Kosary et al., (2019)** on spray mango trees with some nutrients.

Table 6. Fruit weight (g) and fruit pulp percentage of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons

Treatments	Fruit weight (g)					
	2019 Season		Mean*	2020 Season		Mean*
	No shading	Shading		No shading	Shading	
T1- Water spray	505.40 l	565.90 h	535.60 D	506.30 e	564.30 b-e	535.30 C
T2- Carbox-K (CooH)	548.90 i	597.80 d	573.30 BC	540.00b-e	592.40 abc	566.20 B
T3- Potamin -K (NH ₂)	533.00 k	583.00 fg	558.00 CD	535.10 cde	588.40 abc	561.80 B
T4- (T2 + H ₃ PO ₄)	554.30 i	600.00 cd	577.20 BC	545.80 b-e	568.50 ab	557.51 BC
T5- Fertifeed (P,KCooH)	588.00 ef	643.70 b	615.90 AB	548.00 b-e	595.20 abc	571.60 AB
T6- (T3 + H ₃ PO ₄)	541.10 j	590.00 e	565.60 CD	535.50 cde	594.50 abc	565.00 B
T7- (T2 + NH ₄ NO ₃)	562.00 h	605.10 c	583.50 AB	526.00 de	578.80 a-d	547.75 BC
T8-Calemage(Ca,MgNH ₂)	527.70 k	577.30 g	552.50 CD	520.30 de	575.20 bcd	552.40 BC
T9-Fertifeed Ca, MgCooH + T5	602.60 cd	652.60 a	627.60 A	581.40 a-d	639.50 a	610.50 A
Mean**	551.40 B	601.70 A		541.60 B	588.53 A	

Fruit pulp percentage						
T1- Water spray	72.58 n	72.99 mn	72.78 F	71.21 j	72.07 hi	72.14 E
T2- Carbox-K (CooH)	75.29 hi	76.21 ef	75.92 C	72.58 f	74.78 d	74.38 D
T3- Potamin –K (NH ₂)	73.62 kl	74.31 j	73.61 E	72.39 gh	73.11 f	73.25 E
T4- (T2 + H ₃ PO ₄)	75.84 fg	76.49 e	76.71 B	74.15 e	75.33 c	75.24 C
T5- Fertifeed (P,KCooH)	77.68 c	78.23 ab	77.96 A	75.90 b	77.20 a	77.05 B
T6- (T3 + H ₃ PO ₄)	74.93 i	75.58 gh	75.26 D	72.80 fg	74.42 de	71.11 D
T7- (T2 + NH ₄ NO ₃)	76.36 e	77.21 d	76.89 B	74.11 e	75.85 b	75.48 C
T8-Calemage(Ca,MgNH ₂)	73.26 lm	73.96 jk	73.31 EF	71.91 i	72.75 fg	72.83 E
T9-Fertifeed Ca, MgCooH + T5	77.82 bc	78.49 a	78.16 A	77.27 a	77.30 a	77.79 A
Mean**	75.27 A	75.95 A		73.59 A	74.76 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

Table 7. Total soluble solids (TSS) and TSS/Acid ratio of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	2019 Season		TSS % Mean*	2020 Season		Mean*
	No shading	Shading		No shading	Shading	
	T1- Water spray	15.17 h	15.35 g	15.26 D	15.41 h	15.83 g
T2- Carbox-K (CooH)	17.50 de	18.04 c	17.77 B	17.46 de	18.11 c	17.78 B
T3- Potamin –K (NH ₂)	16.98 f	17.39 de	17.19 C	17.06 f	17.44 e	17.25 C
T4- (T2 + H ₃ PO ₄)	17.55 d	18.02 c	17.79 B	17.55 de	18.13 c	17.84 B
T5- Fertifeed (P,KCooH)	18.13 c	18.93 a	18.53 A	18.15 c	18.97 a	18.56 A
T6- (T3 + H ₃ PO ₄)	16.99 f	17.52 de	17.25 C	17.07 f	17.60 d	17.33 C
T7- (T2 + NH ₄ NO ₃)	18.02 c	18.48 b	18.25 A	18.11 c	18.91 a	18.51 A
T8-Calemage (Ca,MgNH ₂)	16.86 f	17.36 e	17.11 C	16.99 f	17.43 e	17.21 C
T9-Fertifeed Ca, MgCooH + T5	18.35 b	18.97 a	18.66 A	18.37 b	18.99 a	18.68 A
Mean**	17.28 B	17.78 A		17.35 B	17.93 A	
TSS/Acid ratio						
T1- Water spray	20.15 n	21.43 m	20.76 F	21.02 k	22.20 j	21.60 G
T2- Carbox-K (CooH)	30.52 f	33.42 d	31.83 C	30.64 e	34.62 b	32.21 C
T3- Potamin –K (NH ₂)	24.03 k	25.97 i	24.95 E	24.49 hi	26.70 g	25.67 E
T4- (T2 + H ₃ PO ₄)	31.17 e	33.59 cd	31.94 C	30.46 e	34.27 b	32.32 C
T5- Fertifeed (P,KCooH)	34.01 bc	37.15 a	35.50 A	33.41 c	37.99 a	35.55 A
T6- (T3 + H ₃ PO ₄)	26.69 h	27.96 g	27.29 D	26.97 g	28.77 f	27.86 D
T7- (T2 + NH ₄ NO ₃)	31.46 e	34.39 b	33.30 B	32.35 d	34.85 b	33.84 B
T8- Calemage (Ca,MgNH ₂)	23.31 l	24.92 j	24.10 E	23.94 i	25.16 h	24.57 F
T9- Fertifeed Ca, MgCooH + T5	34.43 b	37.44 a	35.38 A	34.49 b	37.77 a	36.10 A
Mean**	27.78 B	29.93 A		28.12 B	30.65 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

Table 8. Total sugars% and vitamin C of Keitt mango cv. in response to specific and interaction effects of tree shading with ceroon net and spray with some nutritive solutions during two successive 2019 and 2020 experimental seasons.

Treatments	Total sugars %					
	2019 Season		Mean*	2020 Season		Mean*
	No shading	Shading		No shading	Shading	
T1- Water spray	10.65 e	11.29 de	10.97 F	10.68 k	11.34 j	11.01 D
T2- Carbox-K (CooH)	12.63 b-e	13.43 bc	13.03 CD	12.61 g	13.26 d	12.94 B
T3- Potamin –K (NH₂)	12.63 b-e	13.08 bcd	12.85 D	12.62 g	13.13 e	12.88 B
T4- (T2 + H₃PO₄)	12.79 bcd	13.34 bc	13.07 CD	12.62 g	13.53 b	13.07 B
T5- Fertifeed (P, KCooH)	13.64 bc	14.18 ab	13.91 B	13.24 d	14.20 a	13.72 A
T6- (T3 + H₃PO₄)	12.68 b-e	13.19 bcd	12.94 CD	12.45 h	13.37 c	12.91 D
T7- (T2 + NH₄NO₃)	12.62 b-e	14.00 bc	13.31 C	12.75 f	13.50 b	13.13 B
T8- Calemage (Ca, MgNH₂)	11.96 cde	12.74 bcd	12.35 E	11.92 i	12.80 f	12.36 C
T9- Fertifeed Ca, MgCooH + T5	12.59 b-e	16.16 a	14.37 A	13.60 b	14.23 a	13.91 A
Mean**	12.47 B	13.49 A		12.50 B	13.26 A	
	Vitamin C					
T1- Water spray	34.52 i	37.35 fgh	35.94 D	35.34 hi	39.17 ef	35.27 C
T2- Carbox-K (CooH)	37.16 fgh	40.24 cde	38.70 CD	37.28 fgh	40.35 de	38.81 BC
T3- Potamin –K (NH₂)	35.66 hi	38.33 efg	37.00 D	34.18 i	38.30efg	36.24 C
T4- (T2 + H₃PO₄)	37.97 fgh	40.22 cde	39.09 BCD	37.92efg	40.26 de	39.09 BC
T5- Fertifeed (P, KCooH)	42.14 bcd	43.69 ab	42.92 AB	41.80 cd	45.37 ab	43.58 AB
T6- (T3 + H₃PO₄)	36.29 ghi	38.30 efg	37.30 D	36.32 ghi	38.40 efg	37.36 C
T7- (T2 + NH₄NO₃)	39.66 def	43.00 abc	41.33 ABC	39.28 def	43.20 bc	41.24 AB
T8- Calemage (Ca, MgNH₂)	34.59 i	37.92 fgh	36.26 D	34.35 i	37.95efg	36.15 C
T9- Fertifeed Ca, MgCooH + T5	42.64 abc	45.44 a	44.04 A	42.04 cd	46.19 a	44.11 A
Mean**	37.85 B	40.50 A		37.61 B	41.02 A	

*, ** refer to specific effect of nutritive spray solution and shading application with ceroon net, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at 5% level.

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تأثير التظليل والرش الورقي ببعض المحاليل المغذية على النمو والحالة الغذائية وإنتاجية وجودة ثمار أشجار المانجو كيت محمود السيد عايد- محمد محمد شرف- محمد عبدالوهاب خميس- احمد رزق عطوية- خالد على بكرى قسم البساتين – كلية الزراعة بمشتر- جامعة بنها

أجريت هذه الدراسة على أشجار مانجو كيت عمر سبع سنوات مطعومة على أصل السكرى ونامية بارض رملية تحت نظام الري بالتنقيط بمنطقة وادي النطرون – محافظة البحيرة – مصر خلال عامي 2019 و 2020 لدراسة التأثير النوعي والتفاعلي للعاملين: 1- تظليل الأشجار بشباك السيران شبه المنفذة والرش الورقي بمحاليل بعض المركبات العضوية التجارية لعناصر النيتروجين واللفوسفور والبوتاسيوم والكالسيوم والمغنسيوم التي تختلف في مصادرها التجارية ونوع العنصر او العناصر التي تتضمنها والهيئة الكيميائية التي توجد عليها المادة الحاملة لتلك العناصر (كربوكسيل COOH او امين NH₂) ومحاليل الرش كانت: 1- ماء كمقارنة ، 2- كربوكسى K-COOH ، 3- بوتامين K- NH₂ ، 4- كربوكسى K + H₃PO₄ ، 5- فرتيفيد P,K-COOH ، 6- بوتامين K-NH₂ + H₃PO₄ ، 7- كربوكسى K-COOH + NH₄NO₃ ، 8- كالمياج Ca, Mg-NH₂ ، 9- (فرتيفيد Ca, Mg-COOH + فرتيفيد P,K-COOH) ، وعليه تم تصميم تجربة عاملية لتوزيع 18 معاملة (تراكيب بين 2عامل اول × 9 عامل ثانی) بحيث كررت كل معاملة 3 مرات ومثلت كل مكررة بشجرتين ، وعن اهم النتائج على التغيرات التي حدثت فى القياسات نتيجة التأثير النوعى لكل عامل والتفاعلى بينهما يمكن ان نوجزها كالتالى: تأثرت نسبيا كل او معظم القياسات بكل من العاملين ، فقد تحسنت كل القياسات الخضرية (عدد الافرخ ومتوسط اطوالها وعدد الاوراق لكل منها ومساحة ووزن الورقة) ، كذلك محتوى الاوراق من النيتروجين والبوتاسيوم والمغنسيوم وانتاجية الشجرة سواء عدد او وزن الثمار لكل شجرة وخصائص الثمار الطبيعية (وزن الثمرة ونسبة اللب) والكيميائية (النسبة المثوية للمواد الصلبة الذائبة الكلية و نسبتها الى الحموضة والسكريات الكلية وفيتامين ج) وذلك بتظليل الاشجار بالسيران او الرش ببعض المحاليل المغذية خاصة المعاملة رقم 9 ، 5 ، 7 . وعليه فان اشجار المانجو كيت المظلة بالسيران والتي تم رشها باي من المعاملات 9 او 5 او 7 اعطت تلك المعاملات افضل واعلى القيم للصفات المرغوبة السابق الاشارة اليها ، ويمكن ان نوصى بتظليل المانجو صنف كيت بالسيران شبه المنفذ مع رشها بمحلول المعاملات 9 او 5 او 7 .