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Effect of Spraying Sucrose and Some Nutrient Elements on Fagri Kalan Mango Trees

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Abstract: This experiment was carried out during 2003 and 2004 seasons on adulet Fagri kalan mango trees grown in sandy soil under drip irrigation system in a private farm at El-Sadat district, Minufiya governorate, Egypt to study the effect of spraying trees with sucrose at 10% alone or in combination either with potassium citrate at (0.15, 0.3 %) or with boric acid at (0.25, 0.5 %) once at full bloom stage on friut set, friut drop, fruit retention, yield, tree yield, fruit quality and leaf mineral content. Results showed that spraying Fagri Kalan mango trees once at full bloom with sucrose at 10% combined with potassium citrate at 0.3% was very effective in improving fruit set, fruit retention, yield as number of fruits or weight (kg)/tree and increased fruit length in (cm) fruit width in (cm) and fruit weight in (gm), pulp/fruit percentage and enhanced total soluble soilds (TSS). Moreover, it reduced fruit drop and weight of peel and seed in (gm) comparing with the control. However, spraying sucrose at 10% with potassium citrate at 0.3 % or with boric acid at 0.25 % improved nitrogen, potassium and boron contents in the leaves. Presence of boric acid at both concentrations with sucrose at 10% increased leaf boron content. On the other hand, all treatments had no effect on leaf phosphours percentage.

Key words: Mango, sucrose, potassuim, boron, sandy soil, fruit drop, yield, fruit quality, leaf mineral content

INTRODUCTION

The mango is one of the most important fruits in the tropics and subtropics.In Egypt, mango is considered the most popular fruit and occupies the third place in acreage after citrus and grapes.The area under mango orchards reached (122582 feddan), producing about 318791 tons of fruits annually (Ministry of Agric, statistics, 2004). It is well known that many problems face and affect mango productivity i.e. poor fruit set and high fruit drop percentage at different fruit growth stages especially in the new reclaimed lands. Such trees grow under sandy soil conditions are poorly yielded with low fruit quality due to lacking their mineral constituents. Sucrose has a positive effect on fruit setting, yield and fruit quality[1].

However, various trials were done to minimize the percentage of fruit drop, increase tree yield and improve fruit quality by spraying trees with some macro and micronutrients as foliar application to reach such goal. Potassium and boron as a macro and a micronutrient play an important regulatory role in many physiological and biochemical processes of plant. Many investigators found a great response to potassium and boron applications on fruit setting, fruiting and total yield[2,3,4].

Work done in South Africa[5] indicates that major nutrients should not be stinted particularly potassium during fruit growth applied as a foliar spray of KNO_3 at a dosage of 2-4% depending on the cultivar[4] to compensate for the translocation of this element to the growing fruits.

Some micronutrients are only or chiefly required at specific times such as boron during the on set of flowering when foliar application is reported to be of benefit to subsequent fruit set[6,7,8].

Therefore this experiment was carried out to increase fruit set, productivity and improving fruit quality of Fagri Kalan mango trees grown under sandy soil conditions at El–Sadat district, using sucrose spray alone or in combination either with potassium citrate or with boric acid.

MATERIALS AND METHODS

This study was carried out during two successive seasons (2003 and 2004) on 12 years old Fagri Kalan mango trees grafted onto seedling rootstock and planted at 5 meters apart in sandy soil under drip irrigation system in a privet farm at El–Sadat district, (70 Km North Cairo from the Desert Road) Minufiya government. The texture of the soil is sandy; the physical and chemical properties

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Table 1: chemical and physical properties of soil at the trial location

Mechanical Analysis				pH	E.C dsm^{-1}	$CaCO_3$ %	Cations					Anions			
Sand %	Silt %	Clay %	Texture				N %	P %	K %	Ca meg/L	Mg meg/L	CO_3	HCO_3 meg/L	Cl	SO_4
90	5	5	Sandy soil	8.20	1.50	5.50	traces	0.44	0.57	2.65	2.40	---	3.85	53	55.65

of the experimental soil are presented in Table (1).

The selected trees were uniform in vigor as possible. Fertilization program and other agricultural practices were the same for all trees. The complete randomized block design was used, while each of the following treatments was replicated three times using one tree/plot.

1- Control (sprayed with water only).
2- Sucrose sprayed at 10%.
3- Sucrose sprayed at 10% + Potassium citrate at 0.15%.
4- Sucrose sprayed at 10% + Potassium citrate at 0.3%.
5- Sucrose sprayed at 10% + boric acid at 0.25%.
6- Sucrose sprayed at 10% + boric acid at 0.5%.

Therefore, the experiment included six treatments; each treatment was replicated three times on one tree per each. All trees were sprayed once at full bloom (10/4/2003 and 12/4/2004) until the run off point. Triton B at 0.1 % as a wetting a gent was used.

In July of each season leaf samples were taken, washed with tap water then with distilled water, dried at 70°C until constant weight, ground and finally digested. The digested solution was used to determine N, P, K percentage and B as ppm in leaves which estimated by standard procedure according to Wilde[9].

The following parameters were measured for both seasons:

1- Fruit set/panicle was recorded.
2- Fruit drop % was calculated using the following equation:

$$\text{Fruit drop \%} = \frac{\text{Fruit set - Fruit retention}}{\text{Fruit set}} \times 100$$

3- Fruit retention/panicle was recorded at mature stage (a week before harvest) in both seasons.
4- Number of fruits per tree were recorded at harvest time (end of September) for all treatments in both seasons, then the tree yield in (kg) was recorded.
5- Fruit quality:- A sample of 10 ripe fruit from the total fruits of each tree was taken at the harvest time to be used for determining the physical and chemical properties i.e. fruit weight (gm) fruit length (cm) fruit width (cm), pulp/fruit percentage, peel weight (gm), seed weight (gm). Total soluble solids TSS% was measured by using a hand refractometer and acidity % as citric acid content using fresh juice with titration against 0.1 Na OH.

The data were subjected to analysis of variance and Duncan's multiple range test was used to differentiate means[10].

RESULTS AND DISCUSSIONS

1- Fruit set: Data in Table (2) clearly showed that all treatments significantly increased fruit set number/panicle compared with control trees in both seasons. Spraying sucrose at 10% combined with potassium citrate at 0.15 % in the first seasons gave the highest value of fruit set (11.27), followed in a decreasing order by spraying sucrose 10% + potassium citrate 0.3% (8.80), while in the second season spraying sucrose 10% + potassium citrate at 0.3 % gave the highest value of fruit set (11.47), followed by sucrose 10% + boric acid at 0.5 % (10.93) and sucrose 10% + Potassium citrate 0.15 % (10.77). Generally spraying sucrose combined with potassium citrate or boric acid enhanced fruit set while untreated trees gave the lowest fruit set in the two studied seasons (5.90–6.47), respectively.

2- Fruit drop percentage: Table (2) Showed that fruit drop percentage was significantly affected by different treatments in the two seasons. Spraying sucrose at 10% combined with potassium citrate at 0.3% gave the lowest value of fruit drop percentage. This was true in the two studied seasons. On the other hand, the untreated trees gave the highest fruit drop percentage in the two seasons (84.3 – 90.7), respectively. This finding means that spraying Fagri Kalan mango trees with sucrose 10% + potassium citrate 0.3% had a beneficial effect on reducing fruit drop percentage.

3- Fruit retention: As showing in Table (2) obtained results indicated that control trees exhibited the lowest fruit retention per panicle in the two studied seasons. On the contrary, the trees treated with sucrose 10% + potassium citrate 0.3% gave the higher numbers of fruit retention at mature stage in both seasons (2.27 – 2.08), respectively. In addition, foliar application of sucrose 10% + potassium citrate 0.15 % or sucrose 10% + boric acid 0.5 % in the two seasons had also a beneficial effect in this

Table 2: Effect of sucrose, potassium citrate and boric acid sprays on fruit set, fruit drop, fruit retention and yield as number and weight of fruits / tree of Fagri Kalan mango trees in 2003 - 2004, seasons.

Treatments	Fruit set/panicle		Fruit drop %		Fruit retention/ panicle		No . of fruits/tree		Yield (kg)/tree	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Control	5.90c	6.47d	84.30a	90.70a	0.93c	0.57e	23.70d	18.0d	9.02e	7.13e
Sucrose 10 %	6.10c	7.57c	82.50a	88.70a	1.07c	0.86d	30.0c	23.30c	12.24d	9.90d
Sucrose 10 % + Potassium citrate 0.15%	11.27a	10.77ab	81.80ab	83.40b	2.05a	1.79bc	37.0ab	42.70b	16.87b	20.0c
Sucrose 10 %+ bpotassium citrate 0.3 %	8.80b	11.47a	74.20c	81.90b	2.27a	2.08a	40.0a	55.0a	19.00a	32.35a
Sucrose 10 % + bboric acid 0.25 %	8.37b	10.13b	79.20abc	83.40b	1.47b	1.68c	34.0b	43.30b	14.72c	19.74c
Sucrose 10 % + boric acid 0.5 %	8.50b	10.93ab	76.80bc	82.90b	1.97a	1.87b	37.30ab	50.0a	17.05b	26.83b
Significance at 5 % level	s	s	s	s	s	s	s	s	s	s

Means having the same letter(s) within a column are not significantly different at 5 % level

concern as compared with the control or with spraying trees by sucrose 10% alone.

From the above results, it could be concluded that the presence of potassium citrate or boric acid in sucrose spraying solution had a beneficial effect on increasing fruit set, fruit retention and decreasing fruit drop. This may be due to the improving effect of such treatments on nutritional status of the trees specially potassium and boron, which reflected on increasing fruit set and fruit retention. In this respect, Qin[11] and Hassan[12] reported that it seems that the improvement in fruit set % could be explained as a result to increase pollen grains germination and pollen tube elongation due to boron treatments. The pervious results are agreed with those obtained by [2,3,4,13] who reported that spraying mango trees with potassium increased fruit set, fruit retention and reduced fruit drop.

4- Number of fruits/tree: Table (2) exhibited the effect of spraying Fagri Kalan mango trees with various treatments on number of fruits per tree. It is clear that yield as number of fruits per tree was significantly increased by all treatments compared with the control. The control trees had (23.70), (18.0) fruits/tree in the 1st and 2nd seasons, respectively. On the other hand, spraying trees with sucrose 10% + potassium citrate 0.3 % reached the maximum number of fruits / tree (40.0 – 55.0) in the first and second seasons, respectively. Meanwhile spraying sucrose 10% + boric acid 0.5% recorded (37.3 and 50.0 fruits/tree) in the two seasons, respectively. On the other hand, the other treatments gave intermediate values in yields as number of fruits/tree.

5- Yield as (Kg)/tree: Regarding yield as (kg)/tree, it could be noticed from Table (2) that all treatments significantly increased yield (kg)/tree than the control in both seasons. Spraying trees with sucrose 10% + potassium citrate 0.3% produced the highest yield weight (19.0 and 32.35 (kg)/tree) followed in a decreasing order by spraying trees with sucrose 10% + boric acid 0.5% (17.05 and 26.83 (kg)/tree) in the first and second seasons, respectively. On the other hand, the control trees exhibited the lowest yield weight (9.02 and 7.13 kg/tree) in the first and second seasons, respectively. In addition, the other treatments recorded intermediate values in the yield as kg/tree.

From the pervious results, it is clear that yield as number of fruits/tree or as weight (kg/tree) was increased and reached the maximum by spraying trees with sucrose 10% + potassium citrate 0.3%, followed in a decreasing order by spraying with sucrose 10% + boric acid 0.5%. The increment in yield either as number of fruits or weight (kg)/tree may explained by the positive effect of spraying sucrose, especially when combined with potassium or boron on fruit set, fruit retention, average fruit weight (gm) and reducing fruit drop. The obtained results may confirm the previous work done by[4,14,15,16] Who reported that yield of mango and orange were increased by potassium application and yield of olive was increased by boron application.

6- Fruit quality:

a) Physical properties: Results in Table (3) cleared that most treatments significantly increased fruit length (cm), fruit width (cm), fruit weight (gm) and pulp/fruit % than the control in the two seasons. In this respect, highest values in these parameters were recorded from trees sprayed with sucrose 10% + potassium citrate 0.3 % followed in decreasing order by those sprayed with

Table 3: Effect of sucrose, potassium citrate and boric acid sprays on some physical and chemical fruit properties of Fagri Kalan mango trees in 2003 - 2004, seasons.

Treatments	Fruit length (cm)		Fruit width (cm)		Fruit weight (gm)		Peel weight (gm)		Seed weight (gm)		Pulp/fruit %		T.S.S. (%)		Acidity (%)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Control	11.8d	12.3e	5.77d	6.27d	379d	396e	64.0a	76.3a	45.7a	49.7	71.06d	68.18d	17.40d	18.33e	0.26	0.27
Sucrose 10 %	12.4c	12.7d	6.17c	6.83c	407cd	424d	62.3a	72.3b	45.3a	49.0	73.56cd	71.39d	19.53c	19.67d	0.29	0.28
Sucrose 10 % + Potassium citrate 0.15%	13.3b	13.5c	6.40bc	7.17a	455ab	468c	57.7b	65.7c	43.7ab	48.3	77.71ab	75.64c	19.60bc	20.13c	0.30	0.30
Sucrose 10 % + potassium citrate 0.3 %	13.8a	14.1a	6.80a	7.33a	475a	588a	52.7c	60.0d	39.7c	46.0	80.55a	81.97a	19.93b	22.0a	0.32	0.32
Sucrose 10 % + boric acid 0.25 %	13.2b	13.5c	6.30bc	6.93bc	433bc	456c	57.0b	65.3c	43.3ab	48.7	76.84bc	75.0c	19.80bc	20.73b	0.30	0.31
Sucrose 10 % + boric acid 0.5 %	13.4b	13.8b	6.50b	7.13ab	457ab	538b	55.7b	62.0d	41.7bc	46.7	78.69ab	79.80b	20.87a	22.07a	0.33	0.35
Significance at 5 % level	s	s	s	s	s	s	s	s	s	Ns	s	s	s	s	NS	NS

Means having the same letter(s) within a column are not significantly different at 5 % level

sucrose 10% + boric acid 0.5%. Moreover, both treatments tended to decrease fruit peel and seed weight (gm) comparing with all other treatments including the control. However, the differences in peel weight were significant in both seasons, while the significance in seed weight was only detected in the first one.

b) Chemical properties: Results presented in Table (3) indicated that total soluble solids TSS in Fagri Kalan fruits were significantly increased by treatments compared with the control in the two seasons. However, TSS tended to be increased gradually through increasing the concentration of potassium or boron in the spraying solution. In this respect, sucrose 10 % + boric acid 0.5% gave the higher values in the two seasons, followed in a decreasing order by sucrose 10% + potassium citrate 0.3%.

Concerning acidity in the fruits, no differences between treatments in the two seasons of the study were noticed. However, acidity percentage ranged between (0.26 – 0.33 %) in the first season and (0.27 – 0.35%) in the second season.

The previous results revealed that spraying sucrose 10% + potassium citrate 0.3% or sucrose 10% + boric acid 0.5% improved physical and chemical properties of Fagri Kalan mango fruit comparing with the other treatments. These results are in harmony with those obtained by[17,4,13,11,14,15] who reported that average fruit weight, fruit size, peel thickness, juice weight, juice % and TSS were improved by potassium or boron application.

7- leaf mineral content: Data in table (4) show the effect of spraying sucrose at 10% solely or in combination with potassium citrate at (0.15 % - 0.3 %) or boric acid at (0.25 % - 0.5%) on N, P, K and B contents in the leaves of Fagri Kalan mango trees. In general, nitrogen, phosphorus, potassium and boron percentages in the leaves in most treatments including the control were within the optimum level in the two seasons[18].

Nitrogen: Results in Table (4) showed that nitrogen content in the leaves was significantly affected by treatments in both studied seasons. However, a particular trend in leaf N content was noticed, that spraying sucrose 10% + potassium citrate either at the low concentration (0.15%) or the high one (0.3%) tended to increase N% in the leaves than in those sprayed with sucrose 10% alone. Similarly, but to a higher extent trees sprayed with sucrose 10% + boric acid only at the low concentration (0.25%) increased N% in the leaves and recorded the higher values of leaf N content (1.17 & 1.14) in the first and second seasons, respectively. In this respect, boron application induced a high stimulation effect on leaf N%[19]. Moreover, results cleared that increasing the concentration of potassium citrate in sucrose 10% spraying solution had a beneficial effect on N content in the leaves while, increasing boric acid concentration (0.5%) in sucrose 10% spraying solution significantly decreased N content in the leaves and than the optimum level.

Phosphorus: Data presented in table (4) showed that there were no significant differences among the treatments on phosphors percentage in the leaves of mango cv. Fagri Kalan in both studied seasons.

Table 4: Effect of sucrose, potassium citrate and boric acid sprays on leaf mineral content in Fagri Kalan mango trees in 2003 - 2004, seasons.

Treatments	N %		P %		K %		B ppm	
	2003	2004	2003	2004	2003	2004	2003	2004
Control	1.070ab	0.980ab	0.070	0.080	0.51	0.540cd	42.0d	31.2d
Sucrose 10 %	0.953b	0.963b	0.077	0.083	0.54	0.490d	42.3d	33.1d
Sucrose 10 % +Potassium citrate 0.15%	1.010ab	1.063ab	0.067	0.080	0.61	0.607bc	43.8d	35.2d
Sucrose 10 %+ potassium citrate 0.3 %	1.137a	1.113ab	0.073	0.080	0.70	0.773a	55.6c	48.4c
Sucrose 10 % + boric acid 0.25 %	1.177a	1.140a	0.070	0.075	0.66	0.700ab	82.2b	78.6ab
Sucrose 10 % + boric acid 0.5 %	0.753c	0.803c	0.080	0.100	0.59	0.600bc	98.1a	86.9a
Significance at 5 % level	s	s	Ns	Ns	Ns	s	s	s
Optimum level according to Bhargava and Chadha (1988)	1-1.5 %		0.06 -0.18 %		0.3 – 1.2 %		25 – 100 PPm	

Means having the same letter(s) within a column are not significantly different at 5 % level

However phosphorus content ranged between (0.067–0.080 %) in the first season and (0.075 – 0.100 %) in the second one. Phosphorus percent in the leaves was around the optimum level (0.06 – 0.18 %)[18] .

Potassium: In Table (4), concerning the leaf K % in the first season, results indicated that different spray treatments slightly and insignificantly increased K % in leaves than the control (0.51%). This may be due to the encouragement of K absorption from soil rather than utilization in plant tissues.

In the second season, it is clear that most treatments significantly raised leaf potassium content than the control. In this respect, spraying trees with sucrose at 10% + potassium citrate at 0.3 % gave the highest value of potassium content in the leaves (0.773 %), followed in decreasing order by sucrose at 10% + boric acid at 0.25 % (0.700 %).

Boron: It is obvious from table (4) that boron content in the leaves was significantly affected by treatments especially when trees sprayed with sucrose at 10% and boric acid at any concentration.

Higher values of boron in the leaves were obtained when trees sprayed with sucrose at 10% + boric acid at 0.5 % followed by sucrose at 10% + boric acid at 0.25 %, while the lowest value was obtained with control. Similar results were obtained in the second season.

Results in Table (4) cleared that the presence of potassium citrate or boric acid especially at the high concentration in sucrose 10% spraying solution increased the respective element in the leaves compared with sucrose 10% spraying solely or with the control.

From the abovementioned results it could be mentioned that spraying sucrose at 10% with potassium citrate at 0.3 % or boric acid at 0.25 % improved nitrogen, potassium and boron content in the leaves. These results are in agreement with those reported by [19,14,20,16].

It could be concluded that spraying Fagri Kalan mango trees grown under sandy soil conditions once at full bloom with (sucrose at 10% +potassium citrate at 0.3%) was the promising treatment, since it improved fruit set, fruit retention, yield as number of fruits or weight (kg)/tree. Also it increased length, width of fruit, fruit weight, pulp % and total soluble solids. Moreover, it reduced fruit drop and weight of both peel and seed of fruits comparing with the control, and finally, it enhanced nitrogen, potassium and boron content in the leaves.

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