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IMPROVING PRODUCTIVITY OF "FAGRI KALAN" MANGO TREES GROWN UNDER SANDY SOIL CONDITIONS USING POTASSIUM, BORON AND SUCROSE AS FOLIAR SPRAY [53]

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ABSTRACT

This study aimed to improve mineral status, fruit set, yield and fruit characteristics of Fagri Kalan mango trees grown under sandy soil conditions at El-Sadat district, Minufiya governorate, Egypt. Trees were sprayed during 2001 and 2002 seasons with potassium citrate at 0.3% solely or in combination either with boric acid at (0.25 & 0.5%) or sucrose at (5 & 10%) once at full bloom stage. Spraying potassium + sucrose enhanced nitrogen and potassium contents in the leaves. Meanwhile, spraying potassium + boric acid increased nitrogen, potassium and boron levels in such leaves. On other hand, such treatments had no effect on phosphorus percentage. The results revealed that spraying trees with potassium citrate at 0.3% combined with boric acid at 0.5% was the promising treatment, since it enhanced nitrogen, potassium and boron content in the leaves and raised fruit set, fruit retention and reduced fruit drop, also increased yield as weight and number of fruits/tree. This treatment improved physical and chemical properties of fruits comparing with the other treatments including the control.

Key words: Mango, Sandy soil, Foliar spray

INTRODUCTION

It is well known that most of new reclaimed lands in Egypt is sandy soil, which planted with fruit trees such as mango. Many commercial mango cultivars suffered from high fruit drop, which reaching about 99% loss of fruitless. Such trees grown under sandy soil conditions are poorly yielded with low fruit quality due to lacking their mineral constituents.

Potassium and boron as a macro and micronutrients 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, **Nunez & Davenport (1986), Sharma *et al* (1990)** and **Oosthuyes (1993)** on mango, **Dabas & Jindal (1987)** on grapevines, **El-Saida (1996)** and **Abd El-Migeed (1996)** on orange, **Osman (1999), Hassan (2000)** and **Abd El-Migeed *et al* (2002)** on olive.

Furthermore, sucrose has a positive effect on fruit setting, yield and fruit quality, **Jaswant & Sharma (1994),**

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Jaswant *et al* (1994) and Mostafa *et al* (2001) on pear trees.

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

MATERIAL AND METHODS

This study was carried out during two successive seasons (2001 and 2002) on 10 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, Minufiya governorate. The selected trees were uniform in vigor as possible. Fertilizing 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- Potassium citrate sprayed at 0.3%.
3- Potassium citrate sprayed at 0.3% + boric acid at 0.25%.
4- Potassium citrate sprayed at 0.3% + boric acid at 0.5%.
5- Potassium citrate sprayed at 0.3% + sucrose at 5%.
6- Potassium citrate sprayed at 0.3% + sucrose at 10%.

All trees were sprayed once at full bloom (9/4/2001 and 8/4/2002) until the run off point.

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 *et al* (1985).

Fruit set/panicle was recorded on 30/4/2001 and 24/4/2002.

Fruit drop % was calculated using the following equation:-

$$\textit{Fruit drop \%} = \frac{\textit{fruit set} - \textit{fruit drop}}{\textit{Fruit set}} \times 100$$

Fruit retention/panicle was recorded at mature stage (a week before harvest) in both seasons.

Yield weight (kg) and number of fruits/tree were recorded at harvest time (end of September) for all treatments in both seasons.

Fruit physical properties were determined including length and diameter of fruit in (cm), weight of fruit, peel, seed and flesh in (gm) for each treatment.

Fruit chemical properties were measured as total soluble solids % (T.S.S) by using a hand refractometer and acidity % as citric acid content using fresh juice with titration against 0.1 NaOH.

The data were subjected to analysis of variance and Duncan's multiple range test was used to differentiate means (Duncan, 1955).

RESULTS AND DISCUSSION

Mineral contents in the leaves

Data presented in Table (1) show the effect of spraying potassium citrate solely or in combination with boric acid or sucrose on N, P, K and B contents in the leaves of Fagri Kalan mango trees.

Table 1. Leaf mineral content in Fagri Kalan mango leaves as affected by potassium, boron and sucrose sprays in 2001- 2002 seasons

Treatments	N (%)		P (%)		K (%)		B (ppm)	
	2001	2002	2001	2002	2001	2002	2001	2002
Control	b 1.062	b 1.080	0.07	0.08	c 0.51	c 0.53	d 42.0	d 31.2
Potassium citrate 0.3%	b 1.081	b 1.092	0.09	0.09	bc 0.64	bc 0.66	d 47.4	cd 38.4
Potassium citrate 0.3%+ boric acid 0.25%	ab 1.172	ab 1.180	0.08	0.07	bc 0.60	bc 0.65	b 82.2	ab 78.6
Potassium citrate 0.3%+ boric acid 0.5%	ab 1.292	ab 1.228	0.06	0.07	b 0.65	ab 0.70	a 97.2	a 87.0
Potassium citrate 0.3%+ sucrose 5%	ab 1.287	ab 1.176	0.08	0.08	a 0.81	a 0.82	d 43.2	d 34.2
Potassium citrate 0.3%+ sucrose10%	a 1.364	a 1.335	0.07	0.08	ab 0.70	ab 0.77	c 54.6	c 47.4
Significance at 5% level	S.	S.	N.S.	N.S.	S.	S.	S.	S.
Optimum level according to Bhargava and Shadha (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

1- Nitrogen

Nitrogen content in the leaves was significantly affected by treatments in both studied seasons. In general, presence of sucrose or boric acid at any concentration in the same solution with potassium citrate significantly improved nitrogen content in the leaves. The highest value was obtained when trees sprayed with sucrose at 10%, while there was no difference between sucrose and boric acid treatments. This was true in the two seasons of this study. In this respect, **Barker and Mills (1980)** explained the increment of N value due to the effect of carbohydrate (sucrose) supply on absorption and utilization of ammonium nitrogen. On the other hand, **Osman (1999)** reported that boron applications induced a high stimulative effect on leaf N %.

2- Phosphorus

There were no significant differences among the treatments on phosphorus percentage in the leaves of mango cv. Fagri Kalan in both studied seasons. However, phosphorus content ranged between (0.06 – 0.09%) in the first season and (0.08 – 0.09%) in the second one.

3- Potassium

Potassium content in the leaves was significantly affected by different treatments in both seasons. It is clear that all treatments significantly raised potassium content than the control. In this respect, spraying trees with sucrose at 5% + potassium citrate gave the highest value of potassium content in the leaves. The differences through the other treatments lacked significance. This was true in the first and second season of the study.

4- Boron

Boron content in the leaves was significantly affected by treatments specially when trees sprayed with boric acid at any concentration.

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

From the abovementioned results, it could be concluded that spraying potassium citrate at 0.3% alone raised potassium content in the leaves. Meanwhile, the presence boric acid at any concentration increased nitrogen, potassium and boron content specially when sprayed at 0.5%. On the other hand, the presence sucrose at any concentration in the same solution with potassium citrate improved nitrogen and potassium content in the leaves. These results are in agreement with those reported by **Abd El-Migeed *et al* (2000)** on Hamlin orange, **Mostafa *et al* (2001)** on LeConte pear and **Osman (1999) and Abd El-Migeed *et al* (2002)** on olive trees.

Fruit set

Table (2) shows that all treatments significantly increased fruit set number/panicle compared with control trees in both seasons of the study. Generally, spraying potassium citrate enhanced fruit set number. In this respect, potassium citrate combined with boric acid at 0.5% gave the highest value of fruit set, while untreated trees gave the lowest number. This was true in the two studied seasons.

Fruit drop percentage

In Table (2) results revealed that fruit drop percentage was significantly affected by different treatments in the two seasons. In the first season, spraying potassium citrate alone or combined with boric acid or sucrose significantly reduced fruit drop percentage than the control. However, the lowest value of fruit drop was obtained when trees were sprayed with sucrose at 10%. Similar trend was obtained in the second season.

Fruit retention

Data in Table (2) indicated that number of fruit retained/panicle until the harvest date was significantly affected by treatments in both studied seasons. It is clear that trees treated with boric acid specially at 0.5% + potassium citrate gave the higher numbers of fruit retention at mature stage in both seasons compared with the other treatments.

Table 2. Fruit set, fruit drop, fruit retention and yield as number and weight of fruits/ tree of Fagri Kalan mango as affected by potassium, boron and sucrose sprays in 2001- 2002 seasons

Treatments	Fruit set /panicle		Fruit drop (%)		Fruit retention /panicle		No. of fruits /tree		Yield (kg) /tree	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Control	d 5.90	e 6.47	a 84.3	a 90.73	d 0.93	d 0.57	d 23.70	d 18.0	f 9.02	d 7.13
Potassium citrate 0.3%	a 10.43	c 9.93	b 79.13	b 85.5	bc 2.17	c 1.43	bc 39.3	c 42.0	d 15.81	c 18.52
Potassium citrate 0.3%+ boric acid 0.25%	ab 10.27	b 11.37	b 76.93	b 84.96	ab 2.37	b 1.70	b 40.0	b 48.67	c 17.55	b 21.89
Potassium citrate 0.3%+ boric acid 0.5%	a 10.53	a 12.70	b 76.30	bc 82.93	a 2.50	a 2.17	a 51.3	a 57.3	a 25.28	a 34.44
Potassium citrate 0.3%+ sucrose 5%	c 7.77	d 8.00	b 75.20	bc 84.16	c 1.90	c 1.27	c 36.0	c 40.0	e 14.97	c 17.87
Potassium citrate 0.3%+ sucrose10%	bc 8.80	b 11.47	b 74.17	c 81.93	bc 2.13	a 2.07	b 40.0	a 55.0	b 18.99	a 32.35
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

From the above results, it could be concluded that the presence of potassium citrate and boric acid together in the same solution had a positive effect on increasing fruit set, fruit retention and decreasing fruit drop. This may 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 (1996) and Hassan (2000)** 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 previous results are agreed with those obtained by **Nunez & Davenport (1986), Sharma *et al* (1990), Oosthuyes (1993) and (1996)** who reported that spraying mango trees with potassium increased fruit set, fruit retention and reduced fruit drop.

Yield

It is clear from Table (2) that yield as number of fruits and weight (kg) per tree were significantly increased by all treatments compared with the control. However, number of fruits/tree was improved and reached the maximum (51.3 and 57.3 fruits/tree) in the first and second season, respectively, when trees sprayed with potassium citrate combined with boric acid at 0.5%. Meanwhile, control recorded (23.7 and 18.0 fruits/tree) in both seasons, respectively.

As for yield as kg/tree, the same treatment recorded the highest yield weight (25.28 and 34.44 kg/tree) in the first and second seasons, respectively. The lowest yield weight was obtained with the untreated trees, since it recorded 9.02 and 7.13 kg/tree in the first and second season, respectively.

From the previous results, it is clear that yield as weight or number of fruits/tree was increased and reached the maximum by spraying trees with potassium citrate combined with boric acid specially at 0.5%. This may due to increase fruit set; fruit retention, average fruit weight and reducing fruit drop as a result to potassium and boron applications.

These results are in line with those obtained by **Oosthuyes (1993)** on mango, **Abd El-Migeed *et al* (2000)** and **Saleh *et al* (2001)** on orange and **Abd El-Migeed *et al* (2002)** on olive. who reported that yield of mango and orange were increased by potassium application and yield of olive was increased by boron application.

Fruit characteristics

Table (3) shows the effect of different treatments on Physical and chemical properties of Fagri Kalan mango fruits.

a- Physical properties

Results indicated that length and width of fruits, also fruit and flesh weight of Fagri Kalan mango were significantly increased and recorded higher values when trees sprayed with potassium citrate + boric acid at 0.5% followed in the decreasing order by other treatments. Meanwhile, untreated trees recorded the lower values for these parameters. This was true in both studied seasons. On the contrary, this treatment reduced peel and seed weight than the other treatments in both seasons. However, the differences for peel weight were significant in

Table 3. Physical and chemical properties of Fagri Kalan mango fruits as affected by potassium, boron and sucrose sprays in 2001-2002 seasons

Treatment	Fruit length (cm)		Fruits width (cm)		Fruit weight (gm)		Peel weight (gm)		Seed weight (gm)		Flesh weight (gm)		T.S.S. (%)		Acidity (%)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Control	e 11.80	d 12.30	e 5.77	e 6.27	d 379	c 396	a 64.0	a 76.3	a 45.7	49.7	d 270	c 270	d 17.4	e 18.3	0.26	0.27
Potassium citrate 0.3%	d 12.33	d 12.53	d 6.50	d 6.73	cd 403	b 440	b 60.3	b 65.7	a 44.3	48.0	cd 298	b 326	cd 17.5	d 19.1	0.26	0.28
Potassium citrate 0.3% + boric acid 0.25%	c 12.80	c 13.50	bc 6.70	b 7.23	bc 439	b 450	c 55.7	cd 61.3	a 43.3	47.0	bc 340	b 341	bc 18.0	c 20.6	0.27	0.30
Potassium citrate 0.3% + boric acid 0.5%	a 14.07	a 14.57	a 7.17	a 7.57	a 494	a 601	e 47.7	c 57.7	b 37.7	46.0	a 409	a 498	a 19.7	b 21.3	0.28	0.31
Potassium citrate 0.3% + sucrose 5%	cd 12.53	c 13.63	c 6.63	c 7.10	cd 416	b 446	b 59.3	c 63.0	a 44.7	47.7	cd 312	b 336	b 18.5	bc 20.8	0.27	0.28
Potassium citrate 0.3% + sucrose 10%	b 13.77	b 14.10	b 6.80	b 7.33	ab 475	a 588	d 52.7	d 60.0	b 39.7	46.3	ab 381	a 481	a 19.9	a 22.0	0.29	0.32
Significance at 5% level	S.	S.	S.	S.	S.	S.	S.	S.	S.	N.S	S.	S.	S.	S.	N.S	N.S

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

both seasons, while the significance was found only in the first season for seed weight.

b- Chemical properties

Total soluble solids percentage in Fagri Kalan fruits was significantly affected by treatments. This parameter was gradually increased through different treatments than the control. In this respect, potassium citrate + 10% sucrose gave the higher values (19.9 and 22.0%) in the first and second season, respectively.

Concerning acidity in the fruits, there were no differences between treatments in the two seasons of the study. However, acidity percentage ranged between (0.26 – 0.29%) in the first season and (0.27 – 0.31%) in the second season.

The previous results revealed that spraying potassium citrate + boric acid improved physical and chemical properties of Fagri Kalan mango fruit comparing with the other treatments. These results are in harmony with those obtained by **Bhuyan and Irabagon (1992), Oosthuyes (1993)** and (1996) on mango, **Qin (1996), Abd El-Migeed *et al*** (2000) and **Saleh *et al*** (2001) on orange who reported that average fruit weight, fruit size, peel thickness, juice weight, juice % and TSS were improved by potassium or boron application.

From the abovementioned results, it could be concluded that spraying Fagri Kalan trees once at full bloom with potassium citrate at 0.3% combined with boric acid at 0.5% was the promising treatment, since it increased nitrogen, potassium and boron content in the leaves and improved fruit set, fruit retention, yield as number of fruits or weight/tree. Also it increased length, width of fruit, flesh and fruit weight and enhanced total soluble solids. On the contrary, it reduced fruit drop and weight of peel and seed comparing with the other treatments including the control.

REFERENCES

Abd EL-Migeed, M.M. (1996). ***Effect of Some Macro and Micro Nutrients on Mineral Content, Productivity and Fruit Quality of Navel Orange Trees.*** **pp 26-89.** Ph.D.Thesis in Pomology, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Abd-El-Migeed, M.M.M.; E.A.M. Mostafa and M.M.S. Saleh (2000). Effect of some macro nutrients sprays on mineral status, yield and fruit quality of Hamlin orange trees grown under Rafah conditions. ***J. Agric. Sci. Mansoura Univ., 25 (1): 403-411, Egypt.***

Abd EL-Migeed, M.M.M.; M.M.S. Saleh; E.A.M. Mostafa and M.S. Abou -Raya (2002): Influence of soil and foliar applications of boron on growth, fruit set, mineral status, yield and fruit quality of Picual olive trees. ***Egypt. J. Appl. Sci.; 17(1): 261-272.***

Barker, A.V. and H.A. Mills, (1980). Ammonium and nitrate nutrition of horticultural crops. p. 395-423 *In* Janick,J., (ed.) ***Horticulture Review, Vol. 2: 142-163 and 395-423.*** AVI Publishing Company, INC., Westport, Connecticut.

Bhargava, B.S. and K.L. Shadha (1988). Leaf nutrient guide for fruit and crops. Fertilizer news. (Cited from Ritz, R.E. (1997): The mango, botany, production and uses. ***Univ. Florida, Homested, Florida, U.S.A. pp. 175- 201.***

Bhuyan, M.A.J. and J.A. Irabagon (1992). Effect of fertilizer, potassium nitrate sprays and irrigation on the physic-chemical compostion of mango

(*mangifera indica L.*) fruit cv. Carabao. ***South Indian Hort. 40(1): 9 - 15.***

Dabas, A.S. and P.C. Jindal (1987). Effect of boron and magnesium sprays on bud formation, berry set and drop of grapes. ***J. Agric. Res. 19: 40-44. (Hort. Abst., 57: 280).***

Duncan, D.B. (1955). Multiple range and multiple "F" tests. ***Biometrics, 11: 1-42.***

El- Saida, S.A.G. (1996). ***Physiological Studies on Nutrition in Citrus.*** **pp 62-157.** Ph.D. Thesis, Fac. Agric., Menofiya Univ., Egypt.

Hassan, S.A. (2000). ***Morphological and Physiological Studies on Flowering, Pollination and Fruiting of Picual Olive Trees.*** **pp 111.** Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt

Jaswant, S. and K.K. Sharma (1994). Effect of chemicals on fruit set in "Le conte" interspecific hybrid of common pear *(Pyrus communis)* and sand pear (*P. pyrifolia*). ***Indian J. Agric. Sci., 64, (10): 711-712.***

Jaswant, S.; K.K. Sharma; S.S. Mann., R. Singh and G.P.S. Grewal. (1994). Effect of different chemicals on yield and fruit quality of "Le conte" pear. ***Acta. Hort. No. 367: 210-213.***

Mostafa E.A.M.; M.M.S. Saleh and M.M.M. Abd El-Migeed (2001). Improving LeConte pear trees productivity by spraying GA_3 and sucrose. Arab Univ. ***J. Agric. Sci., Ain Shams Univ., Cairo, Egypt. 9(1): 373- 385.***

Nunez, R. and T.L. Davenport (1986). Abscission of mango fruitlets as influenced by enhanced ethylene biosynthesis. ***Plant Physiol. 82: 891-894.***

Oosthuyes, S.A. (1993). Effect of spraying application of KNo_3, urea and growth regulators on the yield of Tommy Atkins mango. ***South African Mango Growers Association (Yearbook), 13: 58-62.***

Oosthuyes, S.A. (1996). Effect of KNo_3 spray to flowering mango trees on fruit retention, fruit size, tree yield and fruit quality. ***South African Mango Growers Association (Yearbook), 16: 27-31.***

Osman, L.H. (1999). Response of Picual olive trees to soil fertilization with Borax and Magnesium sulphate. Minufiya, ***J. Agric. Res., 24(1): 277-287, Egypt.***

Qin, X. (1996). Foliar spray of B, Zn and Mg and their effects on fruit production and quality of Jincheng orange *(citrus sinensis)*. ***Journal of Southwest Agricultural Univ. 18(1): 40- 45.***

Saleh, M.M.S.; E.A.M. Mostafa and M.M.M. Abd El-Migeed (2001). Response of some orange cultivars to different rates of potassium fertilization under sandy soil conditions. ***Annals Agric. Sci., Ain Shams Univ., Cairo, Egypt. 46(2): 861-873.***

Sharma, T.R.; P.K. Nair and M.K. Nema (1990). Effect of foliar spray of urea, KNo_3 and NAA on fruiting behavior of mango cv. Langra. ***Orriza J. Hort., 18: 1-2, 42-47.***

Wilde, S.A.; R.B. Corey; J.G. Lyer and G.K. Voigt, (1985). ***Soil and Plant Analysis for Tree Culture. pp. 1-142.*** Published by Mohan Primlani, oxford, IBH, Publishing Co., New Delhi.

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تحسين إنتاجية أشجار المانجو " فجرى كلان " النامية تحت ظروف الأراضي الرملية باستخدام الرش الورقي للبوتاسيوم والبورون والسكروز

[٥٣]

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تهدف هذه الدراسة إلى تحسين عقد الثمار والمحصول وكذلك صفات الجودة لثمار أشجار المانجو صنف فجرى كلان النامية في تربة رملية بمدينة السادات - محافظة المنوفية.

رشت الأشجار خلال موسمي ٢٠٠١-٢٠٠٢ بسترات البوتاسيوم بتركيز ٠,٣% بصورة منفردة أو في مخاليط مع حامض البوريك بتركيز (٠,٢٥ & ٠,٥%) أو مع السكروز بتركيز (٥ & ١٠ %) وكانت المعاملة مرة واحدة عند اكتمال الإزهار.

وقد أدت معاملة البوتاسيوم مع السكر إلى زيادة محتوى الأوراق من النيتروجين والبوتاسيوم. بينما أدت معاملة البوتاسيوم مع البورون إلى زيادة محتوى الأوراق من النيتروجين والبوتاسيوم و البورون ولم يتأثر الفوسفور معنويا بالمعاملات.

وقد أشارت النتائج إلى أن رش الأشجار بسترات البوتاسيوم ٠,٣% مع حامض البوريك بتركيز ٠,٥% تعتبر هي المعاملة المثلى. حيث أن هذه المعاملة قد أدت إلى رفع محتوى الأوراق من عناصر النيتروجين والبوتاسيوم والبورون كذلك حسنت من عقد الثمار وقللت من تساقطها وأدت إلى زيادة محصول الأشجار وزنا وعددا.

كما أدت هذه المعاملة إلى تحسين الصفات الطبيعية والكيماوية للثمار وقد تفوقت على باقي المعاملات بما فيها أشجار المقارنة .

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