Response of Keitte Mango Trees to Spray Boron Prepared by Nanotechnology Technique

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Abstract: This study was performed during 2016 and 2017 seasons to examine the effect of nano versus normal boron on growth and fruiting of Keitte mango trees onto Succary mango rootstock and grown under Upper Egypt conditions. Treating Keitte mango trees three times with nano boron at 5 to 20 ppm or normal boron at 50 to 200 ppm considerably improved all growth aspects, photosynthetic pigments, N, P, K, Mg, B, Zn, Fe and Mn, initial fruit setting, fruit retention, number of fruits/ tree, yield per tree and per fed. as well as physical and chemical characteristics of the fruits relative to the control. Using boron via nanotechnology was superior than using boron through normal methods in this respect. The best results with regard to yield and fruit haracteristics of Keitte mango trees were obtained by treating the trees three times with nano boron at 10 ppm.

Keywords: Nanotechnology- traditional method, boron, growth, yield fruit characteristics Keitte mangoes

1. Introduction

Boron is responsible for enhancing cell division, pollen germination, sugar biosynthesis and translocation, IAA building, water uptake, movement of natural hormone, and the tolerance of fruit trees to disorders (**Nijjar, 1985; Yagodin, 1990 and Mengel *et al.,* 2010**).

Nanotechnology is a promising field of interdisciplinary research. It opens up a wide array of opportunities in various fields like medicine, pharmaceuticals, electronics and agriculture. The potential uses and benefits of nanotechnology are enormous. The current global population is nearly 7 billion with 50 % living in Asia. A large proportion of those living in developing countries face daily food shortages as a result of environmental impacts or political instability, while in the developed world there is surplus of food. For developing countries, the drive is to develop drought and pest resistant crops, which also maximize yield. The potential of nanotechnology to revolutionize the health care, textile, materials, information and communication technology, and energy sectors has been well publicized. The application of nanotechnology to agriculture and food industries is also getting attention nowadays. Investments in agriculture and food nanotechnologies carry increasing weight because their potential benefits range from improved food quality and safety to reduced agricultural inputs and improved processing and nutrition (**Rai *et al.,* 2012).** While most investment is made primarily in developed countries, research advancements provide glimpses of potential applications in agricultural, food, and water safety that could have significant impacts on rural populations in developing countries. This study is concentrated on modern strategies and potential of nano-materials in sustainable agriculture management as modern approaches of nanotechnology. (**Prasad *et al.,* 2014**).

Previous studies showed that using boron via nano technology (**Refaai, 2014; Roshdy and Refaai, 2016; Mohamed *et al.,* 2017; Abdalla, 2018 and El- Sayed – Esraa, 2018 and Wassel *et al.,* 2017**) and normal boron (**Abdallah, 2006; Mahfouz, 2007; El- Sayed – Esraa, 2010; Mohamed and Mohamed, 2013 and Hassan-Huda, 2014**).

The target of this study was elucidating the effect of using nano versus normal boron on fruiting of Keitte mango trees grown under Upper Egypt conditions.

2. Materials and Methods

This study was carried out during the two consecutive seasons of 2016 and 2017 on twenty – one 16 years old Keitte mango trees budded onto Succary mango rootstock. The selected Keitte mango trees (21 trees) are grown in a private mango orchard located at Kalabsha city, Naser El- Noba district, Aswan governorate. The uniform in vigour trees are planted at 3x3 meters apart (460 trees / fed). The texture of the sol is sandy with a water table depth not less than two meters. Drip irrigation system was followed leaving four dippers per each tree and each dipper drains four liters water in one hour.

The scope of this study was examining the effect of spraying nano versus normal boron on

growth and fruiting of Keitte mango trees grown under Upper Egypt conditions.

The twenty one of Keitte mango trees received a basal recommended fertilizers including the application of 5 tons F.Y.M., 400 kg ammonium nitrate (33.5 % N), 300 kg mon calcium supherphosphate (15.5 P_2O_5), 300 kg potassium sulphate (48 % K_2O) and 10 kg magnesium sulphate (9.6 % Mg) per feddan nitrogen fertilizer was weekly via fertigation. Phosphours fertilizers was added at ten equal batches, the first was added via soil and the other nine batches were applied after berry setting via drip irrigation potassium fertilizer was added at ten equal batches added via fertigation one before first bloom and the other nine batches were applied after berry setting via drip irrigation. Farmyard manure was added once via soil after winter pruning. Three sprays of micronutrients (Zn, Fe, Mn and Cu) via chelated form at 0.05% were used at growth start, just after berry setting and at one month later. Magnesium sulphate was added via fertigation at five equal batches before first bloom and the other four batches were added after berry setting. Other horticultural practices included hoeing and pest control management were carried out as usual.

Physical and chemical properties of the experimental soil at 0.0 – 90 cm depth are presented in Table (1) according to the procedures of **Black *et al* (1965) and Carter (1993)**.

Table (1): Analysis of the tested soil:

Constituents	Values
Particle size distribution	
Sand %	78.5
Silt %	11.5
Sand %	10.0
Texture	Sandy
pH (1: 2.5 extract)	8.0
EC (1: 2.5 extract) mmhos/ 1 cm 25°cm	1.11
Organic matter %	11.0
Total CaCO$_3$ %	2.2
Total N %	0.015
P ppm (Oslen)	3.3
K ppm (ammonium acetate)	85.0
Available micronutrients (EDTA, ppm):	
Fe	0.8
Zn	0.9
Mn	0.7
Cu	0.6

This study included the following seven treatments from concentrations of nano and normal boron in addition to the control:

1- Control (sprayed with water trees).

2- Spraying boron in the form of boric acid (17 % B) at 50 ppm (0.295 g boric acid/ L water).

3- Spraying boron in the form of boric acid (17 % B) at 100 ppm (0.59 g boric acid/ L water).

4- Spraying boron in the form of boric acid (17 % B) at 200 ppm (1.18 g boric acid/ L water).

5- Spraying boron via nano boron at 5 ppm (5 mg nano boron/ L water).

6- Spraying boron via nano boron at 10 ppm (10 mg nano boron / L water).

7- Spraying boron via nano boron at 20 ppm (20 mg nano boron / L water).

Each treatment was replicated three time, one tree per each. Spraying of boron either applied via nano or normal method was done three times, the first spray at growth start (last week of Feb.), the second just after fruit setting (last week of Apr.) and the third at one month later (last week of May). Triton B as a wetting agent was added to all spraying solution of boron at 0.05% and spraying was done till runoff.

Randomized complete block design (RCBD) was adopted. each the experiment included 7 treatment. Each treatment was replicated three times one tree per each.

Generally, the following measurements were recorded during the two seasons of this study.

1 Vegetative growth characteristics in the spring growth cycles:

The four growth characteristics in the Spring growth cycle namely shoot length (cm), shoot thickness (cm) and number pf leaves/ shoot and leaf area were measured in the four labeled branches around each side of the trees (in the first week of May). Twenty mature leaves in the non- fourting shoots (**Summer, 1985**) were taken for measuring the length and width of leaf. Leaf area was measured using the following equation as reported by **Ahmed and Morsy (1999).**

LA = 0.70 (L x W) – 1.06

Where LA = leaf area (cm^2)

L- Maximum length of leaf (cm)

W= Maximum width of leaf (cm)

2- Measurements of Plant pigments

Samples of ten mature and fresh leaves per each replicate in the middle of the selected shoots were taken. The leaves were cut into small pieces, homogenated and extracted by 25% acetone in the presence of a little amount of Na_2CO_3 and silical quartz then filtered through central glass funnel G4. The optical density of the filtrate was determined using Carl-Zeis spectrophotometer at the wave length of 662, 644 and 440 nm to determine chlorophylls (a and b) and carotenoids, respectively, Content of each pigments was calculated by using the following equations (**Von –Wettstein 1957**).

Chl. A= (9.784 x E 662) – (0.99 x E 644) mg/L

Chl. B= (21.426 x E 644) – (4.65 x E 622) =

mg/L

Total carotenoids = (4.965 x E 440 − 0.268 (chlorophyll a + chlorophyll b).

E= Optical density at a given wave length.

The chlorophylls a and b as well as total carotenoids were calculated as mg/g fresh weight of leaves. Also total chlorophylls was estimated (mg/ 1008 FW (**Fadle an Seri El Deen,1978**).

3. Measurements of leaf content of N, P, K, Mg, Zn, Fe, Mn and B

The same previous leaves taken for measuring leaf area were well washed with running tap water followed twice by distilled water, dried in oven at 70° C for 24 hours and ground in stainless steel mill. Wet digestion was done by using concentrated sulphoric acid for overnight (**Black *et al.,* 1965**). Digestron was boiled and cooked with using H_2O_2 till colourless. (**Evenhuis and Deward, 1980**). In the digestion, the leaf content of N, P, K, Mg, Zn, Fe and Mn were determined as follows on dry weight basis (**Cottenie *et al.,* 1982**).

1-Nitrogen % was determined by the modified micro kjeldahl method as described by **Peach and Tracey (1968).**

2-Phosphorus IN was determined by using spekol Specterophotometer (**Carter, 1993**).

3-Potassium % was determined by using Flame photometer according to the procedure reported by **Chapman and Pratt (1965)**.

4-Magnesium % was determined by using verses methods by (**Carter, 1993**).

5-Micronutrients namely Zn, Fe and Mn (in ppm) were measured using atomic absorption spectrophotometer Perkin Elmer model 5000 according to (**Chapman and Pratt, 1965**).

6- Boron was determined using not water method (**A.O.A.C., 200**).

4. Measurements of percentages of initial fruit setting and fruit retention:

Percentage of initial fruit setting was calculated by dividing the total number of settled fruits just after fruit setting by total number of flowers per each panicle and multiplying the product x 100. Fruit retention % was estimated by dividing number of fruits just before harvesting by total number of flowers per panicle and multiplying the produce x 100.

5. Measurements of yield as well as physical and chemical properties of the fruits:

5.1. Yield:

Harvesting was achieved during the regular commercial harvesting time under Aswan Governorate conditions (middle of August) in both seasons when the flesh of fruits become yellowish. The yield expressed in weight per tree (kilogram) and per feddan (tons) as recorded.

5.2. Physical an chemical t properties of the fruits:

Twenty fruits were taken randomly from the yield of each tree, then transferred to the laboratory for determining the following physical and chemical properties of the fruits.

5.2.1. Physical properties of the fruits:

1-Averages fruit weight (g)

2-Averages fruit dimensions (in cm) (length, width and thickness) by vernier caliper).

3-Percentage of flesh, peel and seed of the fruits.

4-Ratio of edible to non-edible portions by dividing pulp weight (edible) by weights of peel and seed (non-edible).

5.2.2. Chemical properties of the fruits:

The studied chemical characteristics of the fruits included:

5.2.2.1. Total soluble solids (TSS%):

The flesh of fruit was well minced with an electric blender and the paste was squeezed and the total soluble solids were determined by using handy refractometer (according to **A.O.A.C., 2000**).

5.2.2.2. Sugars content:

The percentages of the total and reducing sugars were determined according to method that outlined by **Lan and Eynon, 1965**) (according to **A.O.A.C., 2000**). Non reducing sugars was calculated.

5.2.2.3. Total acidity:

Twenty five grams of flesh was blended with 100ml distilled water by an electric blender, the extract was filtrated and twenty ml. of it was titrated against 0.1 N sodium hydroxide using phenolophthalene as an indicator according to the (**A.O.A.C., 2000**). Acidity was determined as g citricacid / 100 g pulp.

5.2.2.4. Vitamin C:

The pulp content of vitamin C (mg. Ascorbic acid/ 100 g pulp) was determined by titration with 2, 6 dichlorophenol indophenol according to (**A.O.A.C., 2000**). Total crude fibre %. It was determined using method that outlined in **A.O.A.C. (2000)**.

6. Statistical analysis:

Thereafter, the obtained data during the two seasons were collected, tabulated and subjected to the proper statistical analysis of variance method reported by **Gomez and Gomez (1984) and Mead *et al.,* (1993)**. The differences between treatment means were differentiated using new L.S.D. at 5% parameter.

3. Results
1-Some vegetative growth aspects

It is clear from the obtained data (in Table 2) that treating Keitte mango trees three times with nano boron at 5 to 20 ppm and normal boron at 50 to 200 ppm significantly was responsible for stimulating length and thickness of shoot, leaf area and number of leaves/ shoot relative to the control. There was a gradual promotion on these growth aspects with increasing concentrations of nano and normal boron. Significant differences were observed on these growth aspects between all concentrations except between the higher two concentrations of nano and normal boron. Treating the trees with nano boron at 5 to 20 ppm was significantly superior in enhancing these growth traits than using normal boron. The maximum values of shoot length (47.3 & 48.3 cm) and thickness (0.46 & 0.43 cm), leaf area (77.3 & 78.7) and number of leaves shoot (50.0 & 51.0 leaf) were recorded on the vines that treated with boron via nano technology at 20 ppm. The lowest values were recorded on the untreated trees. These results were true during both seasons.

Table (2): Effect of spraying normal and nano boron on some vegetative growth aspects of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Shoot length (cm)		Shoot thickness (cm)		Leaf area $(cm)^2$		Number of leaves / shoot	
	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	41.2	41.9	0.22	0.19	71.2	70.9	38.0	36.0
Normal boron at 50 ppm	42.6	43.0	0.28	0.26	72.3	72.6	41.0	41.0
Normal boron at 100 ppm	43.7	44.7	0.33	0.31	74.0	74.3	44.0	43.0
Normal boron at 200 ppm	44.0	45.0	0.34	0.32	74.3	74.4	45.0	44.0
Nano boron at 5 ppm	45.7	46.3	0.40	0.37	76.0	76.9	47.0	46.0
Nano boron at 10 ppm	47.0	48.0	0.45	0.42	77.0	78.6	49.0	49.0
Nano boron at 20 ppm	47.3	48.3	0.46	0.43	77.3	78.7	50.0	51.0
New L.S.D. at 5%	1.0	0.9	0.05	0.04	0.9	1.2	2.0	2.0

2- The leaf chemical components

It is obvious from the obtained data (in Table 3 & 4) that treating the trees with nano boron at 5 to 20 ppm or normal boron at 50 to 200 ppm three times significantly enhanced all chemical components namely chlroophylsl a, b, total chlroophylls, total carotenoids, N, P, K, Mg, B, Zn, Fe and Mn relative to the control. The promotion on these chemical aspects was significantly associated with increasing concentration of nano boron from 5 to 10 ppm and normal boron from 50 to 100 ppm. Increasing concentrations of nano boron from 10 to 20 ppm and normal boron from 100 to 200 ppm failed to show significant measurable promotion on these chemical components. Using boron through nano biotechnology was significantly superior in enhancing these chemical components than using boron via normal method. The maximum chlorophylls a (6.7 & 7.0 mg/ g F.W.), b (2.9 & 2.8 mg/ g F.W.), total chlorophylls (9.6 & 9.8 mg/ g F.W.), total carotenoids (2.5 & 2.5 mg/ g F.W.), N (1.92 & 1.91 %), P (0.216 & 0.223 %), K (1.65 & 0.62 %), Mg (0.78 & 0.81 %), B (5.7 & 5.4 %), Zn (58.0 & 58.0 ppm), Mn (61.1 & 61.3 ppm) and Fe (66.6 & 68.6 ppm) were recorded on the trees that sprayed three times with nano boron at 20 ppm. The untreated trees produced the lowest values. These results were true during 2016 and 2017 seasons.

Table (3): Effect of spraying normal and nano boron on photosynthetic pigments and percentages of N and P in the leaves of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Chlorophyll a (mg/ g F.W.)		Chlorophyll b (mg/ g F.W.)		Total chlorophylls (mg/ g F.W.)		Total carotenoids (mg/ g F.W.)		Leaf N %		Leaf P %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	4.2	3.8	1.1	0.9	5.3	4.7	0.9	0.8	1.58	1.56	0.164	0.159
Normal boron at 50 ppm	4.9	5.0	1.4	1.2	6.3	6.2	1.2	1.2	1.66	1.64	0.174	0.171
Normal boron at 100 ppm	5.5	5.6	1.8	1.7	7.3	7.3	1.5	1.6	1.72	1.69	0.190	0.188
Normal boron at 200 ppm	5.6	5.7	1.9	1.8	7.5	7.5	1.6	1.7	1.74	1.70	0.191	0.190
Nano boron at 5 ppm	6.1	6.4	2.4	2.4	8.5	8.8	2.0	2.1	1.82	1.81	0.202	0.209
Nano boron at 10 ppm	6.6	6.9	2.8	2.7	9.4	9.6	2.4	2.4	1.91	1.90	0.215	0.222
Nano boron at 20 ppm	6.7	7.0	2.9	2.8	9.6	9.8	2.5	2.5	1.92	1.91	0.216	0.223
New L.S.D. at 5%	0.4	0.3	0.3	0.2	0.4	0.3	0.2	0.3	0.05	0.04	0.010	0.009

3- The percentages of initial fruit setting and fruit retention

It is evident from the obtained data (in Table 5) that percentages of initial fruit setting and fruit retention were significantly improved in response to treating the trees with nano boron at 5 to 20 pm or normal boron at 50 to 200 ppm. There was a gradual promotion on such two parameters with increasing concentrations of nano boron from 5 to 20 ppm and normal boron from 50 to 200 ppm. No significant promotion on the percentages of initial fruit setting and fruit retention was observed among the higher two concentrations of nano and normal boron. Therefore, from economical point of view, it is suggested to use the medium concentration of nano and normal boron namely 10 and 100 ppm, respectively. The maximum values of initial fruit setting (13.2 & 13.3%) and fruit retention (0.960 & 0.93 %) were recorded on the trees that received nano boron at 20 ppm during both seasons, respectively. The untreated trees produced the minimum values. These results were tree during both seasons.

4- The yield per tree and per feddan

It is clear from the obtained data (in Tale 5) that yield expressed in number of fruits/ tree and weight per tree and feddan was significantly improved due to treating the trees three times with nano boron at 5 to 20 ppm or normal boron at 50 to 200 ppm three times over the control. All parameters were gradually increased by increasing concentrations of nano and normal boron. Increasing concentrations of nano boron from 10 to 20 ppm had no significant promotion on the yield. Yield was unsignifcantly increased with increasingly normal boron concentrations from 100 to 200 ppm. Using boron via nanotechnology at 5 to 20 ppm was significantly superior than using boron via traditional methods in improving the yield. The highest yield from economical point of view was recorded when the trees received three sprays of nano boron at 10 ppm. Yield / fed. under such promised treatment reached 13.8 and 14.8 tons, while in the untreated trees reached 7.2 & 7.1 tons during both seasons, respectively. The percentage of increment on the yield due to application of nano boron at 10 ppm over the control treatment reached 91.7 and 100.8 % during 2016 and 2017 seasons, respectively. Using normal boron at 200 ppm gave yield 10.6 & 11.0 tons during 2016 & 2017 seasons, respectively. The percentage of increment on the yield / fed. of the previous treatment over the application of nano boron at 10 ppm reached 30.2 and 34.5% during both seasons, respectively. These results were true during both seasons.

5- Fruit characteristics

It is noticed from the obtained data (in Tables 6 & 7 & 8) that treating the trees three times with nano boron at 5 to 20 ppm or normal boron at 50 to 200 ppm was significantly very effective in improving fruit characteristics in terms of increasing weight, diameter, height and thickness of fruit, flesh %, the ratio between edible to none dibble portions of the fruits, T.S.S., total and reducing sugars %, vitamin C and reducing percentages of peel and seeds weight, total acidity and total crude fibre relative to the control. The promotion on fruit quality was associated with increasing concentrations of nano and normal boron. Using boron via nano was significantly superior than using boron via normal in enhancing fruit quality. No significant promotion on fruit characteristics was observed among 10 and 20 ppm nano boron and 100 and 200 ppm normal boron. The best results with regard to fruit characteristics were observed on the trees that received boron via nano technology at 10 ppm from economical point of view. Unfavourable effects on fruit characteristics are observed on untreated trees. Percentages of non reducing sugars was unaffected. These results were true during both seasons.

Table (4): Effect of spraying normal and nano boron on the percentages of K and Mg as well as leaf content of B, Zn, Mn and Fe (as ppm) of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Leaf K %		Leaf Mg %		Leaf B (ppm)		Leaf Zn (ppm)		Leaf Mn (ppm)		Leaf Fe (ppm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	1.31	1.27	0.57	0.59	4.1	3.9	50.1	48.7	52.9	51.8	55.1	56.0
Normal boron at 50 ppm	1.36	1.34	0.61	0.64	4.4	4.2	51.9	50.9	55.0	53.9	58.9	59.0
Normal boron at 100 ppm	1.42	1.39	0.66	0.68	4.8	4.5	54.0	53.8	56.9	56.0	61.4	61.9
Normal boron at 200 ppm	1.44	1.40	0.67	0.69	4.9	4.6	54.6	54.0	57.0	56.3	61.6	62.0
Nano boron at 5 ppm	1.52	1.51	0.73	0.74	5.3	5.0	56.0	55.7	59.0	58.8	64.1	65.0
Nano boron at 10 ppm	1.62	1.61	0.77	0.80	5.6	5.3	58.3	57.9	60.9	61.0	66.2	67.9
Nano boron at 20 ppm	1.65	1.62	0.78	0.81	5.7	5.4	58.6	58.0	61.1	61.3	66.6	68.0
New L.S.D. at 5%	0.04	0.03	0.03	0.03	0.2	0.2	1.2	1.4	1.6	1.7	1.9	2.1

Table (5): Effect of spraying normal and nano boron on the percentages of initial fruit setting and fruit retention and yield per tree and per feddan of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Initial fruit setting %		Fruit retention %		Number of fruits / tree		Yield/ tree (kg.)		Yield (fed.) (tons)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	8.1	7.9	0.69	0.67	45.0	44.0	15.7	15.5	7.2	7.1
Normal boron at 50 ppm	9.4	9.6	0.74	0.73	53.0	55.0	19.1	19.8	8.8	9.1
Normal boron at 100 ppm	10.6	10.8	0.79	0.79	61.0	63.0	22.7	23.4	10.4	10.8
Normal boron at 200 ppm	10.7	10.9	0.80	0.80	62.0	64.0	23.1	23.9	10.6	11.0
Nano boron at 5 ppm	12.0	12.3	0.85	0.86	70.0	75.0	26.7	28.6	12.3	13.2
Nano boron at 10 ppm	13.1	13.2	0.89	0.92	76.0	82.0	29.9	32.1	13.8	14.8
Nano boron at 20 ppm	13.2	13.3	0.90	0.93	77.0	83.0	30.3	32.6	13.9	15.0
New L.S.D. at 5%	1.0	1.1	0.04	0.05	6.0	7.0	2.0	2.6	1.2	1.4

Table (6): Effect of spraying normal and nano boron on some physical characteristics of the fruits of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Av. Fruit weight (g.)		Av. Fruit height (cm.)		Av. Fruit diameter (cm.)		Av. Fruit thickness (cm.)		Peel weight %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	349.2	351.2	13.8	13.7	9.6	9.5	8.5	8.4	11.1	10.9
Normal boron at 50 ppm	361.0	360.9	14.1	14.0	9.9	9.8	8.8	8.7	10.5	10.2
Normal boron at 100 ppm	371.5	371.9	14.4	14.3	10.2	10.1	9.0	8.9	10.0	9.5
Normal boron at 200 ppm	372.0	372.7	14.5	14.3	10.3	10.2	9.1	9.0	9.9	9.4
Nano boron at 5 ppm	381.0	380.9	14.8	14.6	10.5	10.5	9.4	9.2	9.4	8.7
Nano boron at 10 ppm	393.0	391.9	15.1	14.9	10.9	10.8	9.6	9.5	8.7	8.0
Nano boron at 20 ppm	394.0	392.3	15.1	15.0	11.0	10.9	9.7	9.6	8.6	7.9
New L.S.D. at 5%	8.1	7.7	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.6

Table (7): Effect of spraying normal and nano boron on some physical and chemical characteristics of the fruits of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Seed weight %		Flesh weight %		Edible to non edible portions		T.S.S. %		Total sugars %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	10.1	10.4	78.8	78.7	3.7	3.7	10.0	9.9	7.4	7.0
Normal boron at 50 ppm	9.0	9.4	80.5	80.4	4.1	4.1	10.5	10.6	7.7	7.4
Normal boron at 100 ppm	8.0	8.4	82.0	82.1	4.6	4.6	11.0	11.1	8.1	7.8
Normal boron at 200 ppm	7.8	8.2	82.3	82.4	4.6	4.6	11.1	11.2	8.2	7.9
Nano boron at 5 ppm	6.8	7.1	83.8	84.2	5.2	5.3	11.6	11.6	8.5	8.6
Nano boron at 10 ppm	5.8	6.1	85.5	85.9	5.9	6.1	12.0	12.1	8.8	8.9
Nano boron at 20 ppm	5.6	6.0	85.8	86.1	6.0	6.2	12.1	12.2	8.9	9.0
New L.S.D. at 5%	0.9	0.8	1.1	1.2	0.4	0.4	0.4	0.4	0.2	0.3

Table (8): Effect of spraying normal and nano boron on some chemical characteristics of the fruits of Keitte mango trees during 2016 and 2017 seasons.

Treatments	Reducing sugars %		Non- reducing sugars %		Total acidity %		Vitamin C (mg/ 100 ml juice)		Total crude fibre %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control (0.0 ppm)	3.0	2.9	4.4	4.1	0.919	0.916	41.5	40.7	1.09	1.11
Normal boron at 50 ppm	3.3	3.4	4.4	4.0	0.900	0.890	42.7	41.9	1.00	1.02
Normal boron at 100 ppm	3.5	3.7	4.6	4.1	0.880	0.870	44.0	44.0	0.90	0.89
Normal boron at 200 ppm	3.6	3.8	4.6	4.1	0.879	0.868	44.3	44.6	0.88	0.87
Nano boron at 5 ppm	4.0	4.2	4.5	4.4	0.859	0.850	46.0	45.9	0.77	0.75
Nano boron at 10 ppm	4.3	4.5	4.5	4.4	0.831	0.829	48.0	47.8	0.65	0.63
Nano boron at 20 ppm	4.4	4.5	4.5	4.5	0.829	0.824	48.3	48.0	0.64	0.62
New L.S.D. at 5%	0.2	0.2	NS	NS	0.012	0.011	1.1	0.9	0.08	0.06

4. Discussion

The beneficial effects of using nano boron on growth and fruiting of Keitte mangoes might be attributed to its positive action on synchronizing the release of boron and preventing undesirable nutrient losses to soil, water and air via direct internalization by crops and avoiding the interaction of nutrients with soil, microorganisms of water and air as well as increasing their efficiency and reducing soil toxic. The potential negative effects associated with over dosage and frequency of application. They mainly delay the release of the nutrients and extend the fertilizer effect period (**Rai, 2012 and Prasad *et al.,* 2014**). The important regulatory effect of boron in activating metabolism enzymes, biosynthesis and translocation of sugars, building of IAA, cell division and enlargement, water absorption and nutrient transport give another explanation (**Nijjar, 1985 and Mengel *et al.,*2001**) These results regarding the effect of using boron via nano technology on promoting growth, yield and fruit quality of Keitte mangos are in agreement with those obtained by **Abdallah (2006); Refaai (2014); Roshdy and Refaai (2016), Mohamed *et al.,* (2017) and Abdalla (2018).** These results concerning the promoting effect of using boron via on fruiting methods are in harmony with those obtained on **El-Sayed-Esraa (2010)** on Ewaise mangoes; **Hassan-Huda (2014)** on Valencia oranges; **Mohamed and Mohamed (2013)** on Sewy data palms; **Ahmed *et al.,* (2014)** on El-Saidy date palms and **Sayed- Ola (2014)** on El-Saidy date palms.

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