Relation of Spraying Silicon with Fruiting of Keitte Mango Trees Growing Under Upper Egypt Conditions

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Abstract: This study was carried out during 2013 and 2014 seasons for examining the effect of spraying potassium silicate at 0.05 to 0.2 % applied once, twice or thrice on fruiting of Keitte mango trees. Foliar application of potassium silicate once, twice or thrice at 0.05 to 0.2% was accompanied with enhancing all growth characters, leaf pigments, N, P and K in the leaves, initial fruit setting %, fruit retention %, yield and fruit quality rather than non-application. The promotion was materially associated with increasing concentrations and frequencies of potassium silicate. A slight promotion on such parameters was observed with increasing concentrations form 0.1 to 0.2% and frequencies from twice to thrice. Carrying out two sprays of 0.1% potassium silicate at growth start and just after fruit setting was responsible for improving yield and fruit quality of Keitte mango trees grown under Upper Egypt condition.

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1. Introduction

Poor cropping is considered to be a serious and major problem that faces Keitte mango growers in Upper Egypt. There are many factors responsible for lowering yield such as unsuitable environmental conditions and malnutrition. Fruiting in such mango cv is obviously affected by various biotic and abiotic stresses.

Various studies showed that using silicon was beneficial for counteracting the adverse effects of water stress on growth, nutritional status and fruiting of the plants (**Epstein, 1999 and Matichenkov *et al.*, 2000**). It is also shown that silicon increases drought tolerance in plants by maintaining plant water balance, photosynthesis activity, erectness of leaves and structure of xylem vessels under higher transpiration rates. Also, it is responsible for encouraging water transport and root growth under unfavourable conditions and antioxidants defense system (**Neumann and Zur- Nieden, 2011**).

Levitt (1980); Matickenkov *et al.* (2000); Ma and Takahashi (2002); Kanto (2002); Gad El-Kareem (2012); Ahmed *et al.* (2013a) and (2013b); Al- Wasfy (2013) ; El- Khawaga and Mansour (2014) and Ibrahim and Al- Wasfy (2014) mentioned that using silicon in all sources at 0.05 to 0.2% was accompanied with enhancing growth and fruiting of fruit crops.

The goal of this study was examining the effect of various concentration and frequencies of potassium silicate on the yield and fruit quality of Keitte mango trees grown under Upper Egypt conditions.

2. Material and Methods

This study was carried out during 2013 and 2014 seasons on 30 uniform in vigour 11- years old Keitte mango trees onto polyembryonic seedling mango rootstock and grown in sandy soil in a private orchard located at Qena district, Qena Governorate. The selected trees are planted at 5 x 5 meters apart. Drip irrigation system was followed. All the selected trees received the common horticultural practices that already applied in the orchard. Table (1) show the analysis of the tested soil (**Chapman and Pratt, 1975**).

Table (1): Analysis of the testes soil

Constituent	Values
Sand %	80.9
Silt %	10.0
Clay %	9.1
Texture grade	Sandy
pH (1: 2.5 extract)	7.95
EC (1: 2.5 extract ppm) mmhos/ cm^{o}C	960
$CaCO_3$ %	5.1
O.M. %	0.8
Total N %	0.04
Available P (ppm)	1.3
Available K (ppm)	120

This study included the following ten treatments from different concentrations and frequencies of potassium silicate.

1- Control (sprayed with water trees).

2- Spraying potassium silicate at 0.05 % once at growth start (1st week of Mar.).
3- Spraying potassium silicate at 0.05 % twice at growth start (1st week of Mar.) and again just after fruit setting (mid. of Apr).
4- Spraying potassium silicate at 0.05 % thrice at the same previous two dates and at one month later (mid. of May).
5- Spraying potassium silicate at 0.1% once as previously mentioned.
6- Spraying potassium silicate at 0.1% twice as previously mentioned.
7- Spraying potassium silicate at 0.1% thrice as previously mentioned.
8- Spraying potassium silicate at 0.2% once as previously mentioned.
9- Spraying potassium silicate at 0.2% twice as previously mentioned.
10- Spraying potassium silicate at 0.3% thrice as previously mentioned.

Each treatment was replicated three times, one tree per each. potassium silicate (20% Si + 10% K_2O) at the named concentrations and frequencies were mixed with triton B as a wetting agent at 0.05% and all trees were covered completely with silicon solutions. Randomized complete block design (RCBD) was adopted.

During both seasons, the following parameters were measured, Spring shoot length (cm.), number of leaves/ shoot and leaf area(cm^2) (**Ahmed and Morsy, 1999**), chlorophylls a & b and total chlorophylls (mg/ 100 g F.W.) **(Von- Wettstein, 1957 and Hiscox and Isralstam, 1979)** percentages of N, P, K and Mg in the leaves (**Wilde *et al.*, 1985 and Summer, 1985**) percentages of initial fruit setting and fruit retention, yield/ tree, fruit weight(g.) and dimensions (length & width in cm.), fruit firmness (pound/ $inch^2$), percentages of fruit peel, seeds and pulp, edible to non edible portions, T.S.S. %, total acidity % (as g citric acid / 100 ml juice) (**A.O.A.C., 2000**), total, reducing and non reducing sugars (**Lane and Eynon, 1965 and A.O.A.C., 2000**), vitamin C (mg/ 100 ml juice) and total fibre percentage (**A.O.A.C., 2000**).

Statistical analysis was done using new L.S.D. at 5% according to **Mead *et al.*, (1993)**.

3. Results

1- Growth characters:

It is clear that from the obtained data in Table (2) that spraying Keitte mango trees once, twice or thrice with potassium silicate at 0.05 to 0.2% significantly was accompanied with enhancing shoot length, number of leaves/ shoot and leaf area over the check treatment. There was a gradual stimulation on these growth characters with increasing concentrations and frequencies of application. Significant differences on these growth traits were observed among all concentrations and frequencies except between 0.1 and 0.2% as well as between using silicon twice or thrice. Therefore, the recommended treatment from economical point of view was using potassium silicate twice at 0.1%. The untreated trees produced the minimum values.

2-Leaf chemical composition:

Data in Tables (2 &3) clearly reveal that leaf pigments namely chlorophylls a & b and total chlorophylls, N, P, K and Mg in the leaves of Keitte mango trees were significantly increased as a result of using potassium silicate once, twice or thrice at 0.05 to 0.5% comparing to the control treatment. The promotion on these leaf pigments and nutrients was associated with increasing concentrations and frequencies of potassium silicate. Increasing concentrations from 0.1 to 0.2% and frequencies from twice to thrice failed significantly to promote these organic and mineral nutrients. The maximum values were recorded on the trees that received three sprays of potassium silicate at 0.2%. The untreated trees produced the minimum values. These results were true during both seasons.

3- Percentages of initial fruit setting and fruit retention and yield per tree.

It is evident from the data in Table (3) that varying concentrations and frequencies of potassium silicate significantly varied the percentage of initial fruit setting, fruit retention and yield/ tree. Foliar application of potassium silicate once, twice or thrice at 0.05 to 0.2% caused a significant promotion on these parameters comparing with the control treatment. The promotion on fruit setting parameters and yield was associated with increasing concentrations and frequencies of potassium silicate. No significant promotion on fruit setting and yield was observed with increasing concentrations from 0.1 to 0.2% and frequencies form twice to thrice. Therefore, the recommended treatment was application of potassium silicate twice at 0.1%. Under such promised treatment, yield per tree reached 33.3 and 35.0 kg compared with the yield of the control trees that reached 22.2 and 21.9 kg during both seasons, respectively. The percentage of increase on the yield above the control reached 50.0 and 59.8% during 2013 and 2014 seasons, respectively.

4- Fruit quality:

Data in Tables (3 to 5) clearly show that treating Keitte mango trees once, twice or thrice with potassium silicate at 0.05 to 0.2% significantly was very effective in improving fruit quality in terms of increasing weight, length and width of fruit, pulp %, edible to non- edible, total, reducing and non reducing sugars % and vitamin C and decreasing the percentages of seed and peels weights, total acidity % and total fibre % relative to the control treatment. The

promotion on fruit quality was greatly depended on increasing concentrations and frequencies of potassium silicate. Increasing concentrations from 0.1 to 0.2% as well as frequencies from twice to thrice failed significantly to enhance fruit quality. The best results with regard to fruit quality from economical point of view were obtained due to using potassium silicate twice at 0.1%. Unfavourable effects on fruit quality were observed on untreated trees. The present treatments had no effect on fruit firmness. These results were true during both seasons.

Table (2): Effect of different concentrations and frequencies of potassium silicate on growth characters, chlorophylls a& b, total chlorophyll and percentage of N in the leaves of Keitte mango trees during 2013 and 2014 seasons.

Potassium silicate treatments	Shoot length (cm.)		No. of leaves / shoot		Leaf area $(cm)^2$		Chlorophyll a (mg// 100 g F.W.)		Chlorophyll b (mg// 100 g F.W.)		Total chlorophylls (mg// 100 g F.W.)		Leaf N %	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	40.0	39.3	31.0	30.0	74.1	75.0	10.1	10.0	3.2	3.1	13.3	13.1	1.71	1.59
Si at 0.05 % once	41.5	41.9	32.0	33.0	75.9	76.8	11.0	10.9	3.8	3.9	14.8	14.8	1.81	1.80
Si at 0.05 % twice	44.0	44.4	33.0	35.0	77.9	78.8	11.9	11.8	4.4	4.5	16.3	16.3	1.91	1.89
Si at 0.05 % thrice	44.1	44.5	33.0	35.0	78.0	78.9	12.0	11.9	4.5	4.6	16.5	16.5	1.92	1.91
Si at 0.1 % once	47.5	47.9	37.0	38.0	82.0	82.9	15.9	16.0	5.5	5.8	21.4	21.8	2.06	2.05
Si at 0.1 % twice	49.0	49.9	39.0	40.0	86.0	86.9	17.0	17.1	6.5	6.8	23.5	23.9	2.17	2.15
Si at 0.1 % thrice	49.3	50.0	39.0	40.0	86.3	87.0	17.2	17.2	6.6	6.9	13.8	24.1	2.18	2.18
Si at 0.2 % once	47.7	48.0	37.0	38.0	82.2	83.0	15.9	16.0	5.6	6.0	21.5	22.0	2.07	2.06
Si at 0.2 % twice	49.1	49.9	39.0	40.0	86.3	87.0	17.0	17.1	6.6	7.0	23.6	24.1	2.18	2.16
Si at 0.2 % thrice	50.0	50.3	39.0	40.0	86.4	87.3	17.2	17.2	6.7	7.1	23.9	24.3	2.19	2.19
Mew L.S.D. at 5%	1.0	0.9	0.9	1.0	0.8	1.0	0.7	0.7	0.4	0.4	0.6	0.7	0.06	0.05

Si = potassium silicate

Table (3): Effect of different concentrations and frequencies of potassium silicate on the percentages of P, K and Mg, percentages of initial fruit setting and fruit retention, yield / tree and fruit weight of Keitte mango trees during 2013 and 2014 seasons.

Potassium silicate treatments	Leaf P %		Leaf K %		Leaf Mg %		Initial fruit setting %		Fruit retention %		Yield / tree (kg.)		Fruit weight (g.)	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	0.12	0.11	1.31	1.29	0.61	0.62	11.1	10.9	0.88	0.89	22.2	21.9	340.6	341.0
Si at 0.05 % once	0.15	0.14	1.38	1.40	0.66	0.69	11.6	11.7	0.94	0.93	23.9	24.0	352.3	353.4
Si at 0.05 % twice	0.18	0.18	1.46	1.48	0.72	0.75	12.2	12.3	1.00	0.99	26.0	26.3	363.3	364.1
Si at 0.05 % thrice	0.19	0.18	1.48	1.49	0.73	0.75	12.3	12.4	1.01	1.03	26.3	26.5	364.0	365.3
Si at 0.1 % once	0.23	0.24	1.59	1.60	0.81	0.83	13.2	13.5	1.11	1.14	30.3	31.0	381.0	381.9
Si at 0.1 % twice	0.26	0.27	1.71	1.72	0.86	0.88	14.0	14.4	1.21	1.22	33.3	35.0	392.0	392.0
Si at 0.1 % thrice	0.27	0.28	1.72	1.73	0.87	0.89	14.1	14.5	1.22	1.23	33.5	35.3	393.0	392.9
Si at 0.2 % once	0.23	0.24	1.61	1.60	0.82	0.83	13.3	13.5	1.12	1.15	30.5	31.3	382.0	382.0
Si at 0.2 % twice	0.27	0.24	1.71	1.72	0.87	0.88	14.1	14.5	1.22	1.22	33.5	35.5	393.0	392.0
Si at 0.2 % thrice	0.28	0.29	1.72	1.73	0.88	0.90	14.2	14.6	1.23	1.23	33.6	35.6	394.0	393.0
Mew L.S.D. at 5%	0.02	0.02	1.05	1.06	0.04	0.04	0.4	0.4	0.05	0.06	1.0	1.1	9.0	9.2

Si = potassium silicate

Table (4): Effect of different concentrations and frequencies of potassium silicate on some physical characters of the fruits of Keitte mango trees during 2013 and 2014 seasons.

Potassium silicate treatments	Fruit length (cm.)		Fruit width (cm.)		Fruit firmness (1b / inch^2)		Seeds %		Fruit peel %		Pulp %		Edible, none -dibble portions	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	10.1	10.0	7.5	7.4	35.1	36.0	13.1	12.9	18.5	17.5	68.9	69.6	2.22	2.29
Si at 0.05 % once	10.5	10.6	7.9	8.0	35.2	36.1	12.5	12.6	17.0	16.0	70.5	71.4	2.39	2.50
Si at 0.05 % twice	10.9	11.0	8.3	8.4	35.2	36.1	12.0	12.1	16.0	15.0	72.0	72.9	2.57	2.69
Si at 0.05 % thrice	11.0	11.1	8.4	8.5	35.3	36.2	11.9	12.0	15.9	14.8	72.2	73.2	2.60	2.73
Si at 0.1 % once	11.5	11.7	9.0	9.2	35.3	36.2	11.0	11.0	13.2	13.0	75.8	76.0	3.13	3.17
Si at 0.1 % twice	12.2	12.5	9.5	9.8	35.4	36.2	10.5	10.4	12.1	12.0	77.6	77.6	3.46	3.46
Si at 0.1 % thrice	12.3	12.6	9.6	9.9	35.4	36.3	10.4	10.3	12.0	11.9	77.6	77.8	3.46	3.50
Si at 0.2 % once	11.6	11.8	9.1	9.3	35.4	36.3	10.9	10.9	13.1	12.9	76.0	76.2	3.17	3.20
Si at 0.2 % twice	12.3	12.6	9.5	9.9	35.5	36.3	10.4	10.3	12.0	11.9	77.6	77.8	3.46	3.50
Si at 0.2 % thrice	12.4	12.7	9.6	10.0	35.5	36.3	10.3	10.2	11.9	11.8	77.8	78.0	3.50	3.55
Mew L.S.D. at 5%	0.3	0.3	0.3	0.3	NS	NS	0.4	0.4	0.6	0.6	1.4	1.3	0.11	0.13

Si = potassium silicate

Table (5): Effect of different concentrations and frequencies of potassium silicate on the chemical characteristics of the fruits of Keitte mango trees during 2013 and 2014 seasons.

Potassium silicate treatments	T.S.S. %		Total acidity %		Total sugars %		Reducing sugars %		Non-reducing sugars %		V.C. (mg/ 100 g F.W.)		Total fibre %	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	9.4	9.3	0.971	0.960	7.5	7.7	2.7	2.5	4.8	5.2	40.1	40.0	1.14	1.19
Si at 0.05 % once	9.8	10.0	0.950	0.939	7.8	8.0	3.0	2.9	4.8	5.1	42.0	41.9	1.05	1.00
Si at 0.05 % twice	10.5	10.7	0.929	0.910	8.0	8.4	3.3	3.2	4.7	4.2	43.9	44.0	1.00	0.95
Si at 0.05 % thrice	10.6	10.8	0.928	0.909	8.1	8.5	3.3	3.3	4.8	5.2	44.0	44.3	0.99	0.94
Si at 0.1 % once	11.5	11.9	0.879	0.863	8.4	8.6	3.7	3.9	4.7	4.7	46.0	46.3	0.81	0.75
Si at 0.1 % twice	12.0	12.5	0.850	0.830	8.7	9.0	4.0	4.3	4.7	4.7	48.0	49.0	0.71	0.66
Si at 0.1 % thrice	12.1	12.6	0.849	0.829	8.8	9.1	4.1	4.4	4.7	4.7	48.3	49.3	0.69	0.65
Si at 0.2 % once	11.5	12.0	0.877	0.860	8.5	8.7	3.8	4.0	4.7	4.7	46.1	46.4	0.80	0.74
Si at 0.2 % twice	12.1	12.6	0.849	0.829	8.8	9.1	4.1	4.4	4.7	4.7	48.1	49.1	0.70	0.65
Si at 0.2 % thrice	12.2	12.7	0.847	0.827	8.9	9.2	4.2	4.5	4.7	4.7	48.5	49.1	0.68	0.63
Mew L.S.D. at 5%	0.3	0.3	0.018	0.017	0.2	0.2	0.2	0.2	NS	NS	1.0	1.0	0.05	0.5

Si = potassium silicate

4. Discussion:

The previous positive action of silicon on growth and fruiting of Keitte mango trees might be attributed to its essential roles on counteracting the adverse effects of water stress and disorders on growth and fruiting as well as enhancing the tolerance of trees to drought., water transport and root development (**Levitt, 1980, Epstein, 1999; Matichenkov, *et al.*, 2000 and Kanto, 2002**).

These results are in harmony with those obtained by **Gad El – Kareem (2012); Ahmed *et al.*, (2013a) and (2013b); Al – Wasfy (2013), El- Khawaga and Mansour (2014) and Ibrahim and Al- Wasfy (2014)**.

Conclusion

Carrying out two sprays of 0.1% potassium silicate at growth start and again just after fruit setting was responsible for improving yield and fruit quality of Keitte mango trees grown under Upper Egypt conditions.

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