Effect of Silicon and Chitosan on Fruit Setting, Yield and Fruit Quality of Zebda Mango Trees Grown Under Minia Region Conditions

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Abstract: This study was carried out during 2016 and 2017 seasons to examine the effect of using silicon via two sources (potassium or calcium silicate) at 0.05 to 0.2% twice or thrice and chitosan at 0.1% (thrice) on fruit setting, yield and fruit quality of Zebda mango trees. Treating the trees with silicon via potassium and calcium forms at 0.05 to 0.2% twice or thrice and / or chitosan at 0.1% (thrice) was very effective in enhancing initial fruit setting %, yield and fruit quality characteristics relative to the control treatment. Total acidity and total crude fiber % tended to reduce with the present treatments. Silicon in the form of potassium silicate materially was more effective than using the other silicon form namely calcium silicate. Using silicon was measurably effective than using chitosan in this respect. The best results with regard to fruit setting, yield and fruit quality was attributed to using potassium silicate and chitosan at 0.1 for each together three times (at growth start, just after fruit setting and 21 days later) with a mixture of potassium silicate and chitosan together each at 0.1%.
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1. Introduction

The promotion on growth and tree nutritional status due to the great tolerance of the trees to biotic and abiotic stresses surely reflected on improving flowering, fruit setting, yield and fruit quality in various fruit crops **(Sauvas *et al*, 2002 Lux *et al*, 2003, Gang *et al*, 2003, Hattori *et al*, 2003, Ma, 2004, Taher *et al*, 2006, Eweis *et al*, 2006, Chien and Chou, 2006, Liu *et al*, 2007 and Shao *et al*, 2013)**

Using silicon **(EL – Khawaga and Mansour, 2014, Ibrahim and EL – Wasfy, 2014, Mohamed, 2015, Mohamed *et al*, 2015, Wassel *etal* 2015, Akl *etal* 2015, Mohamed 2016, and Rizk, 2017)** chitosan **(Gornik *etal*, 2008, Meng *etal*, 2010, El-Miniawy *et al.*, 2013; Hadwiger, 2013, Xing *etal*, 2015, Hassain and Iqbal, 2016, Tayel *et al*, 2016 and Khafagy, 2018)** had a announced promotion on flowering, fruit setting, yield and fruit quality in different horticultural crops.

The target of this experiment was examining the effect of single and combined applications of silicon and chitosan on fruit setting, yield and fruit quality of Zebda mango trees grown under Minia region conditions.

2, Materials and Methods

This investigation was conducted during the two consecutive seasons of 2016 and 2017 on sixty 11-years old Zebda mango trees onto Succary mango rootstock. The trees are grown in a private mango orchard located at Mallawy district, Minia Governorate. The uniform in vigour trees of Zebda mango (60 trees) were planted at 7 x 7 meter apart. The soil texture of the tested orchard is silty clay with a water table depth not less than two meters. Surface irrigation system was followed using Nile water.

The results of orchard soil analysis (according to Wilde et al., 1985) are shown in Table (1)

Table (1): Mechanical, physical and chemical analysis of the tested orchard soil.

Particle size distribution:	
Sand %	6.1
Silt %	56.7
Clay	37.2
Texture	Silty clay
pH (1:2.5 extract)	7.35
EC (1: 2.5 extract) (mmhos/Icm/25°C)	0.81
O.M. %	2.39
CaCO3 %	1.45
Total N %	0.18
Available P (ppm, Olsen)	4.1
Available K (ppm/ ammonium acetate)	491.3
Available Mg (ppm)	115.0
Available S (ppm)	7.11
Available EDTA extractable micronutrients (ppm)	
Zn	1.49
Fe	12.11
Mn	9.39

The selected trees received a basal recommended fertilizer including the application of 20 m3 farmyard manure (0.35 %N. 0.45 % P_2O_5, and 1.2 % K_2O) added in early December, 200 kg/ fed/ mono calcium superphosphate (15.5 % P_2O_5) added in mid January, 450 kg/ fed ammonium sulphate (20.6% N) added in three equal dressings in February, April and July and 200 kg/ fed potassium sulphate (48 % K_2O) added in two equal dressings applied in mid February and April, in addition to the regular agricultural and horticultural practices which were followed in the orchard including micronutrient application, pruning, hoeing, irrigation with Nile water as well as pathogens, insects and weed control.

This experiment included the following twenty treatments from spraying different sources, concentrations and frequencies of application of silicon and Chitosan:

1) Control (treated with water trees).
2) Spraying potassium silicate at 0.05% twice (growth start and just after fruit setting).
3) Spraying potassium silicate at 0.05% thrice (growth start and just after fruit setting and 21 days later).
4) Spraying potassium silicate at 0.1% twice (growth start and just after fruit setting).
5) Spraying potassium silicate at 0.1% thrice (growth start and just after fruit setting and 21 days later).
6) Spraying potassium silicate at 0.2% twice (growth start and just after fruit setting).
7) Spraying potassium silicate at 0.2 % thrice (growth start and just after fruit setting and 21 days later).
8) Spraying calcium silicate at 0.05% twice (growth start and just after fruit setting).
9) Spraying calcium silicate at 0.05% thrice (growth start and just after fruit setting and 21 days later).
10) Spraying calcium silicate at 0.1% twice (growth start and just after fruit setting).
11) Spraying calcium silicate at 0.1% thrice (growth start and just after fruit setting and 21 days later).
12) Spraying calcium silicate at 0.2% twice (growth start and just after fruit setting).
13) Spraying calcium silicate at 0.2% thrice (growth start and just after fruit setting and 21 days later).
14) Chitosan at 0.1%
15) Spraying potassium silicate at 0.05% + Chitosan at 0.1%
16) Spraying potassium silicate at 0.1% +Chitosan at 0.1%
17) Spraying potassium silicate at 0.2% + Chitosan at 0.1%
18) Spraying calcium silicate at 0.05% +Chitosan at 0.1%
19) Spraying calcium silicate at 0.1% +Chitosan at 0.1%
20) Spraying calcium silicate at 0.2% +Chitosan at 0.1%

Therefore, the experiment evolved twenty treatments. Each treatment was replicated three times, one tree per each. When silicon in both forms was applied in combined with chitosan both were applied three times at growth, just after fruit setting and 21 days later. Spraying was done till runoff (about 25 L solution). The untreated trees sprayed with water containing Triton B.

This study was statistically analyzed using Randomized complete block design (RCBD) in which the experiment included twenty treatments and each treatment was replicated three times, one tree per each.

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

1- The percentage of initial fruit setting, number of fruits/tree and yield (tree/kg).

2- Physical characteristics of the fruits namely weight (g), height, diameters and thickness of fruit (cm), flesh fruit (%), edible to edible non portions of fruits **(Lane and Eynon, 1965)**.

3- Chemical characteristics of the fruits namely percentages of T.S.S., total acidity as (g citric acid/100 ml juice), reducing, non-reducing and total sugars, and total crude fibre as well as vitamin C. **(Lane and Eynon, 1965 and A.O.A.C, 2000).**

4- All the obtained data during the course of this study in the two successive seasons, 2016 and 2017 were tabulated and statistically analyzed. The difference between various treatments means were compared using new L.S.D. parameter at 5% (according to **Mead *et al*., 1993)**

3. Results and Discussion

1- Percentage of initial fruit setting.

Single and combined applications of chitosan at 0.1 % and/or silicon at different sources, concentrations and frequencies as shown in Table (2) had significant promotion on the percentage of initial fruit setting relative to the control. Initial fruit setting was significantly improved due to using silicon and / or chitosan relative to the control. The promotion on initial fruit setting was in proportional to the increase in concentrations of silicon regardless the source of application from 0.05 to 0.2% and frequencies of application from twice to thrice. Increasing concentrations of silicon forms from 0.1 to 0.1 % and frequencies of application from twice to thrice failed to show significant stimulation on the percentage of initial fruit setting. Using silicon via K

form was superior than using the other source namely Ca silicate. Application of silicon in both forms significantly was responsible for enhancing the percentage of initial fruit setting compared to using chitosan at 0.1 %. The maximum values of initial fruit setting were recorded on the trees that received K – silicate at 0.2% plus chitosan at 0.1 % during both seasons. The untreated trees produced the maximum values during 2016 & 2017 seasons. These results were true during both seasons.

The positive action of both silicon and chitosan on flowering aspects surely reflected on promoting initial fruit setting.

2- The yield:

Single and combined applications of chitosan at 0.1 % and/or silicon at different sources, concentrations and frequencies as shown in Table (2) had significant promotion on the yield expressed in number of fruits/tree and yield per weight relative to the control. The yield expressed in number of fruits/tree and yield per weight was significantly improved due to using silicon and / or chitosan relative to the control. The promotion on yield expressed in number of fruits/tree and yield per weight was in proportional to the increase in concentrations of silicon regardless the source of application from 0.05 to 0.2% and frequencies of application from twice to thrice. Increasing concentrations of silicon forms from 0.1 to 0.1 % and frequencies of application from twice to thrice failed to show significant stimulation on the yield expressed in number of fruits/tree and yield per weight setting. Using silicon via K form was superior than using the other source namely Ca silicate. Application of silicon in both forms significantly was responsible for enhancing the yield expressed in number of fruits/tree and yield per weight compared to using chitosan at 0.1 %. The maximum values of yield expressed in number of fruits/tree (720.0 & 724 fruit) and yield per weight (257.8 & 261.4 kg) were recorded on the trees that received K – silicate at 0.2% plus chitosan at 0.1 % during both seasons, respectively. But from economical point of view it is suggested to use potassium silicate twice at 0.1 % plus chitosan at 0.1 % (since no measurable differences were recorded among the higher to concentration namely (0.1 & 0.2 %) and frequencies of application (once and thrice). Under such promised treatment yield per tree reached 257 & 260 Kg. compared with 93.3 & 92.6 produced by untreated trees during both seasons, respectively. The percentage of increase on the yield due to using the previous promised treatment over the control treatment reached 175 & 181.4 % during both seasons, respectively. These results were similar during both seasons.

3- Some physical and chemical characteristics of the fruit:

It is evident from the obtained data in Tables (3 to 6) that treating the trees with silicon and / or chitosan was significantly favourable in enhancing fruit quality in terms of increasing weight, height, diameter and thickness of fruit, edible to non-edible portion of fruits, T.S.S%, total, reducing, and non-reducing sugars% and vitamin C and decreasing total acidity% and total fiber % relative to the control. The promotion on fruit quality was in proportional to the increase in silicon concentrations in both forms. Increasing concentrations from 0.1 to 2% and frequencies of application from twice to thrice had no significant promotion on fruit quality. Using silicon in K or Ca forms at 0.05% to 0.2% was significantly favourable than using chitosan at 0.1 %in this respect. Using chitosan was significantly preferable than the control treatment in this connection.

Using silicon with chitosan was significantly favourable than using each alone in enhancing fruit quality. The best results with regard to fruit quality were obtained due to treating the trees with silicon in potassium form at 0.1% besides chitosan at 0.1% from economical point of view. Unfavorable effects on fruit quality were recorded on untreated trees. These results were true during both seasons. The promoting effect of silicon and chitosan on pigments and Mg surely reflected on enhancing photosynthesis and sugars and advancing maturity.

Discussion

The promoting effect of silicon on fruit quality characteristics of Zebda mango trees might be attributed to its positive action on enhancing the tolerance of the trees to biotic and abiotic stresses, balancing plant water uptake, enhancing photosynthesis, root development, water transport and reducing transpiration rate through forming silicon cuticle double layers on leaf epidermal tissues and various disorders, in addition to the promoting effect of silicon and chitosan on enhancing pigments and Mg which reflecting on increasing photosynthesis and sugars and advancing maturity **(Sauvas *et al*,2002, Lux *et al*,2003 Gany *et al*,2003, Hattori *et al*, 2003, Ma,2004 and Tahir *et al*, 2006)**

The results of **EL-Khawaga and Mansour (2014), Ibrahim and AL- Wasfy (2014), Mohamed (2015), Mohamed *etal* (2015), Wassel *etal* (2015), Akl *etal* (2015), Mohamed (2016) and Rizk (2017)** supported the present results regarding the effect of silicon on stimulating fruit quality characteristics of Zebda Mango trees.

The favourable effects of chitosan on growth characteristics, nutritional states, pigments and

uptake of N, P, K, Mg, Ca, Zn, Fe and Mn of Zebda mango trees which were responsible for enhancing quality were supported by the previous findings that obtained by **Eweis *etal* (2006), Chien and Chou, (2006), Liu *etal* (2007) and Chao *etal* (2015).**

These results regarding the effect of chitosan on advancing fruit quality are in harmony with those obtained by **Gornik *et al* (2008), Meng *et al* (2010), Hadwiger (2013) EL- Miniawy *et al* (2013), Xing *et al* (2015), Hosssain and Iqbal (2016), Tayel *et al* (2016) and Khafagy (2018).**

Table (2): Effect of chitosan and different sources, concentration and frequencies of silicon application on the percentage of initial fruit setting, number of fruits/tree and yield of Zebda Mango trees during 2016 and 2017 seasons

Treatment	Initial fruit setting %		No. of fruits / tree		Yield / tree (kg)	
	2016	2017	2016	2017	2016	2017
Control	32.2	32.0	300	296	93.3	92.6
K.silicate at 0.05 % twice	37.0	36.8	489	328.0	160.4	108.2
K.silicate at 0.05 % thrice	37.3	37.1	489	492	160.9	162.9
K.silicate at 0.1 % twice	39.0	38.8	664	498	221.8	167.3
K.silicate at 0.1 % thrice	39.1	38.9	664	664	222.4	223.8
K.silicate at 0.2 % twice	39.0	38.8	664	664	222.4	223.8
K.silicate at 0.2 % thrice	39.2	39.0	664	664	222.4	223.8
Ca.silicate at 0.05% twice	34.5	34.3	312	312	99.5	100.2
Ca.silicate at 0.05% thrice	35.0	34.8	312	312	99.8	100.5
Ca.silicate at 0.1% twice	35.7	35.5	468	480	151.5	156.5
Ca.silicate at 0.1% thrice	35.8	35.6	477	480	154.5	156.5
Ca.silicate at 0.2% twice	35.7	35.5	477	480	154.5	156.5
Ca.silicate at 0.2% thrice	35.8	35.6	477	480	154.5	156.5
Chitosan at 0.1%	33.4	33.2	306	308	96.4	97.6
K.silicate at 0.05 % + Chitosan	45.2	45.0	704	708	248.5	251.3
K.silicate at 0.1 % + Chitosan	46.4	46.2	720	724	257.0	260.6
K.silicate at 0.2 % + Chitosan	46.5	46.3	720	724	257.8	261.4
Ca.silicate at 0.05% + Chitosan	41.9	41.7	680	684	231.2	233.9
Ca.silicate at 0.1% + Chitosan	44.0	43.8	692	696	238.7	242.2
Ca.silicate at 0.2% + Chitosan	44.1	43.9	692	696	239.4	242.9
New L.S.D at 5%	1.0	1.1	3.0	3.0	0.6	0.7

Table (3): Effect of chitosan and different sources, concentration and frequencies of silicon application on some physical characteristic of the fruits of Zebda Mango trees during 2016 and 2017 seasons.

Treatment	fruit weight (g)		fruit height (cm)		Fruit diameter (cm)	
	2016	2017	2016	2017	2016	2017
Control	311.0	313.0	11.7	11.6	6.7	6.3
K.silicate at 0.05 % twice	328.0	330.0	12.9	13.0	7.8	7.4
K.silicate at 0.05 % thrice	329.0	331.0	13.0	12.9	7.9	7.5
K.silicate at 0.1 % twice	334.0	336.0	13.2	13.1	8.0	7.6
K.silicate at 0.1 % thrice	335.0	337.0	13.3	13.2	8.1	7.7
K.silicate at 0.2 % twice	335.0	337.0	13.2	13.1	8.1	7.7
K.silicate at 0.2 % thrice	335.0	337.0	13.3	13.2	8.1	7.7
Ca.silicate at 0.05% twice	319.0	321.0	12.3	12.2	7.2	6.8
Ca.silicate at 0.05% thrice	320.0	322.0	12.4	12.2	7.3	6.9
Ca.silicate at 0.1% twice	324.0	326.0	12.6	12.5	7.5	7.1
Ca.silicate at 0.1% thrice	324.0	326.0	12.6	12.5	7.5	7.1
Ca.silicate at 0.2% twice	324.0	326.0	12.6	12.5	7.5	7.1
Ca.silicate at 0.2% thrice	324.0	326.0	12.6	12.5	7.5	7.1
Chitosan at 0.1%	315.0	317.0	12.0	11.9	7.0	6.6
K.silicate at 0.05 % + Chitosan	353.0	355.0	14.1	14.0	9.0	8.6
K.silicate at 0.1 % + Chitosan	357.0	360.0	14.4	14.3	9.3	8.9
K.silicate at 0.2 % + Chitosan	358.0	361.0	14.5	14.4	9.4	9.0
Ca.silicate at 0.05% + Chitosan	340.0	342.0	13.6	13.5	8.4	8.0
Ca.silicate at 0.1% + Chitosan	345.0	348.0	13.8	13.7	8.6	8.2
Ca.silicate at 0.2% + Chitosan	346.0	349.0	13.9	13.8	8.7	8.3
New L.S.D at 5%	4.0	3.9	0.2	0.3	0.2	0.2

Table (4): Effect of chitosan and different sources, concentration and frequencies of silicon application on some physical and chemical characteristic of the fruits of Zebda Mango trees during 2016 and 2017 seasons.

Treatment	Fruit thickness (cm)		Flesh fruit %		Edible to non edible portions		T.S.S %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	5.4	5.3	69.1	70.0	2.21	2.19	15.5	15.6
K.silicate at 0.05 % twice	7.0	6.9	65.5	66.4	2.64	2.62	16.5	16.6
K.silicate at 0.05 % thrice	7.1	7.0	65.6	66.6	2.65	2.63	16.6	16.7
K.silicate at 0.1 % twice	7.4	7.3	66.0	67.0	2.75	2.73	16.8	16.9
K.silicate at 0.1 % thrice	7.5	7.4	66.1	67.1	2.76	2.74	16.9	17.0
K.silicate at 0.2 % twice	7.4	7.3	66.0	67.0	2.75	2.73	17.0	17.1
K.silicate at 0.2 % thrice	7.5	7.4	66.1	67.1	2.76	2.74	17.0	17.1
Ca.silicate at 0.05% twice	6.0	5.9	64.0	65.0	2.41	2.39	15.9	16.0
Ca.silicate at 0.05% thrice	6.2	6.1	64.1	65.1	2.42	2.40	16.0	16.1
Ca.silicate at 0.1% twice	6.5	6.4	64.5	65.5	2.52	2.50	16.2	16.3
Ca.silicate at 0.1% thrice	6.6	6.5	64.6	65.6	2.53	2.51	16.3	16.4
Ca.silicate at 0.2% twice	6.6	6.5	64.5	65.5	2.52	2.50	16.2	16.3
Ca.silicate at 0.2% thrice	6.7	6.6	64.7	65.7	2.53	2.51	16.3	16.4
Chitosan at 0.1%	5.7	5.6	63.5	64.5	2.31	2.29	15.7	15.7
K.silicate at 0.05 % + Chitosan	8.2	8.1	68.1	69.1	3.02	3.00	17.9	18.0
K.silicate at 0.1 % + Chitosan	8.5	8.4	69.0	70.0	3.12	3.10	18.1	18.2
K.silicate at 0.2 % + Chitosan	8.6	8.5	69.1	70.1	3.13	3.11	18.2	18.3
Ca.silicate at 0.05% + Chitosan	7.7	7.6	67.0	68.0	2.86	2.84	17.2	17.3
Ca.silicate at 0.1% + Chitosan	8.0	7.9	67.6	68.6	2.96	2.94	17.5	17.6
Ca.silicate at 0.2% + Chitosan	8.1	8.0	67.7	68.7	2.97	2.95	17.6	17.7
New L.S.D at 5%	0.2	0.2	0.3	0.3	0.09	0.08	0.2	0.2

Table (5): Effect of chitosan and different sources, concentration and frequencies of silicon application on some chemical characteristics of the fruits of Zebda Mango trees during 2016 and 2017 seasons.

Treatment	Total acidity %		Total sugars %		Reducing sugars %	
	2016	2017	2016	2017	2016	2017
Control	0.415	0.413	12.7	12.6	3.3	3.3
K.silicate at 0.05 % twice	0.340	0.338	14.0	13.9	4.4	4.4
K.silicate at 0.05 % thrice	0.338	0.336	14.1	14.0	4.5	4.5
K.silicate at 0.1 % twice	0.320	0.318	14.4	14.3	4.7	4.6
K.silicate at 0.1 % thrice	0.319	0.317	14.5	14.4	4.8	4.6
K.silicate at 0.2 % twice	0.319	0.317	14.4	14.3	4.7	4.7
K.silicate at 0.2 % thrice	0.318	0.316	14.5	14.4	4.8	4.8
Ca.silicate at 0.05% twice	0.379	0.347	13.3	13.2	3.7	3.7
Ca.silicate at 0.05% thrice	0.378	0.376	13.4	13.3	3.8	3.8
Ca.silicate at 0.1% twice	0.360	0.358	13.6	13.5	4.0	4.0
Ca.silicate at 0.1% thrice	0.359	0.357	13.6	13.5	4.1	4.1
Ca.silicate at 0.2% twice	0.359	0.357	13.7	13.6	4.0	4.0
Ca.silicate at 0.2% thrice	0.358	0.356	13.7	13.6	4.1	4.1
Chitosan at 0.1%	0.399	0.397	13.0	12.9	3.5	3.5
K.silicate at 0.05 % + Chitosan	0.259	0.257	15.3	15.2	6.0	5.9
K.silicate at 0.1 % + Chitosan	0.239	0.237	15.6	15.5	6.2	6.1
K.silicate at 0.2 % + Chitosan	0.236	0.234	15.7	15.6	6.3	6.2
Ca.silicate at 0.05% + Chitosan	0.300	0.298	14.7	14.6	5.2	5.1
Ca.silicate at 0.1% + Chitosan	0.280	0.278	14.9	14.8	5.5	5.5
Ca.silicate at 0.2% + Chitosan	0.279	0.277	15.0	14.9	5.6	5.6
New L.S.D at 5%	0.016	0.014	0.3	0.2	0.2	0.2

Table (6): Effect of chitosan and different sources, concentration and frequencies of silicon application on some chemical characteristic of the fruits of Zebda Mango trees during 2016 and 2017 seasons.

Treatment	Non reducing sugars %		Vitamin C (mg / 100 ml jucie)		Total crude fiber %	
	2016	2017	2016	2017	2016	2017
Control	9.4	9.3	46.3	47.0	0.28	0.29
K.silicate at 0.05 % twice	9.6	9.5	51.1	51.8	0.16	0.17
K.silicate at 0.05 % thrice	9.6	9.5	51.2	51.9	0.15	0.16
K.silicate at 0.1 % twice	9.7	9.7	52.3	53.0	0.13	0.14
K.silicate at 0.1 % thrice	9.7	9.8	53.4	54.1	0.12	0.13
K.silicate at 0.2 % twice	9.7	9.6	52.3	53.0	0.13	0.13
K.silicate at 0.2 % thrice	9.7	9.6	53.4	54.1	0.12	0.13
Ca.silicate at 0.05% twice	9.6	9.5	48.5	49.2	0.24	0.25
Ca.silicate at 0.05% thrice	9.6	9.5	48.6	49.3	0.23	0.24
Ca.silicate at 0.1% twice	9.6	9.5	49.7	50.5	0.20	0.21
Ca.silicate at 0.1% thrice	9.5	9.4	50.0	50.7	0.19	0.20
Ca.silicate at 0.2% twice	9.7	9.6	49.8	50.5	0.20	0.21
Ca.silicate at 0.2% thrice	9.6	9.5	50.1	50.8	0.19	0.20
Chitosan at 0.1%	9.5	9.4	74.4	48.0	0.26	0.26
K.silicate at 0.05 % + Chitosan	9.3	9.3	57.3	58.0	0.07	0.07
K.silicate at 0.1 % + Chitosan	9.4	9.4	58.4	59.1	0.05	0.05
K.silicate at 0.2 % + Chitosan	9.4	9.4	59.0	59.7	0.05	0.05
Ca.silicate at 0.05% + Chitosan	9.2	9.5	55.0	55.7	0.11	0.11
Ca.silicate at 0.1% + Chitosan	9.4	9.3	56.0	56.8	0.09	0.09
Ca.silicate at 0.2% + Chitosan	9.9	9.3	56.1	57.0	0.09	0.09
New L.S.D at 5%	NS	NS	0.9	0.8	0.2	0.2

Conclusion

The best results with regard to fruit setting, yield and fruit quality of Zebda Mango trees grown under Minia region conditions were attributed to spraying potassium silicate and chitosan together each at 0.1 % three times at growth start just, after fruit setting and 21 days later.

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