

EFFECT OF SPRAYING SILICON AND SEAWEED EXTRACT ON GROWTH AND FRUITING OF GRANDNAINE BANANA

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Abstract

During 2011/2012 and 2012 /2013 seasons Grandnaine banana plants received four sprays of potassium silicate and /or seaweed extract each at 0.05 to 0.1%. Growth, flowering, yield as well as physical and chemical characteristics of the fruits in response to silicon and seaweed extract treatments were investigated . Single and combined applications of potassium silicate and seaweed extract each at 0.05 to 0.1 % were very effective in stimulating all growth characters, flowering time, bunch weight as well as physical and chemical characteristics of the fruits in relation to the control treatment. A superior effect was attributed to using seaweed extract rather than potassium silicate. Supplying Grandnaine banana plants four times (on the middle of April, May, June and July) with a mixture containing potassium silicate and seaweed extract each at 0.05 % gave the best results with regard to growth, earliest shooting, yield and fruit quality .

INTRODUCTION

Yield decline is suggested to be a major problem that faces Grandnaine banana cv. grown under middle Egypt conditions. The main reasons for poor cropping are the malnutrition as well as unfavourable environmental conditions.

Recent studies suggest that silicon is beneficial in protecting the plants from all stresses through stimulating the expression of natural defense reaction and the production of phenolic compounds which act as antioxidants (Neumann and Zur-Nieden, 2001, Ma et al, 2001 and Qin and Tian, 2009). Seaweed extract had higher amounts of essential nutrients, amino acids, antioxidants, organic acids, vitamins, natural hormones and phenolic compounds (Kulk, 1995, Strick et al, 1997 and Soliman *et.al.*, 2000).

Silicon application was essential for stimulating growth and fruiting of different fruit crops (Abd El-Hameed, 2012 , Abd El-Aal and Oraby-Mona, 2013 , Ahmed *et. al.*, 2013 and Al-Wasfy, 2013) .

Previous studies revealed that using seaweed extract was very important in improving growth and production of fruit crops (El- Sawy, 2005 , Merwad, 2011, Mahmoud, 2012 and Oraby, 2013) .

The target of this study was elucidating the impact of silicon and seaweed extract singly or in combinations on growth, flowering, yield as well as physical and chemical characteristics of fruits of Grandnaine bananas.

MATERIALS AND METHODS

This study was carried out during 2011/2012 and 2012/2013 seasons on the third and fourth ratoons of Grandnaine banana (the suckers were chosen on the first week of July in both seasons) in a private orchard situated at Kafr Gomaa village, Beni Suef Governorate. Mechanical, physical and chemical analysis of the tested soil are shown in Table (1) (according to Wilde *et. al.*, 1985).

Table 1. Analysis of the tested soil .

Characters	values
Particle size distribution:-	
Sand%	9.0
Silt%	61.0
Clay%	30.0
Texture	Silty clay
PH(1 : 2.5 extract)	7.81
EC(1 : 2.5 extract) mmhos /1cm / 2°C	0.74
O.M %	2.0
CaCO ₃ %	1.08
Total N %	0.10
P (ppm, Olesn method)	4.5
K (ppm, ammonium acetate)	418
EDTA extractable micronutrients (ppm)	
Zn	2.2
Fe	2.7
Mn	2.4

The hools which are cultivated at a spacing of 3.5x3.5 (m.). Surface irrigation system using Nile water was followed. All horticultural practices that already applied in the orchard were done as usual .

This investigation included the following seven treatments :-

- 1) Control (water spryed plants).
- 2) Spraying the plants with Potassium silicate at 0.05 % (0.5 g./ L.).
- 3) Spraying the plants with Potassium silicate at 0.1% (1.0 g./ L.).
- 4) Spraying the plants with Seaweed extract at 0.05% (0.5 g./ L.).
- 5) Spraying the plants with Seaweed extract at 0.1% (1.0 g./ L.).
- 6) Spraying the plants with Potassium silicate + Seaweed extract each at 0.05 % .
- 7) Spraying the plants with Potassium silicate + Seaweed extract each at 0.1 % .

Each treatments was replicated three times (3 hools per each). Potassium silicat (25% Si & 10 % K₂O) and Seaweed extract (Table (2) according to James, 1994) were sprayed four times at the middle of April , May, June and July.

Table 2. Analysis of seaweed extract (according to James,B.1994).

Component	values
Proteins %	6 – 8
Aliginic acid %	10 - 20
Mannitol %	4 - 7
Total N %	1- 1.5
P %	0.02 - 0.09
K %	1 -1.2
Ca %	0.2 - 1.5
S %	3 – 9
Mg %	0.5 - 0.9
Micronutrients(ppm)	
Cu	1- 6
Fe	50 - 200
Mn	5 -12
Zn	10 -100
B	20 -100
Mo	1-5
Natural hormones%	
Cytokinins	0.02
I AA	0.03
ABA	0.01

Triton B as a wetting agent at 0.05 % was added to all solutions of silicon and seaweed extract .The experiment was setup in a randomized complete blocks design with three replicates (3 hools per each).

The following parameters were studied :

1) Vegetative growth and Flowering:

Data on the Vegetative growth and Flowering included: Height(m.) and girth(cm.) of pseudostem , leaf area using the third full sized leaf(from the top) was calculated in (m²) according to (Murry,1960) (leaf area = length x width x 0.8),number of green leaves at bunch shooting and period to bunch shooting(in days) were recorded.

2) Bunch parameters and yield :

The bunches were harvested at bunch maturation stage when the fingers reached the full mature stage during both seasons. Bunch weight(kg.),number of hands per bunch,number of fingers per hand and average hand weight (kg.) were estimated.

3) physical and chemical fruit quality :

Included the following measurements :finger weight(g.),length and diameter of fingers(cm.)as well as percenteges of pulp and fruit peels,T.s.s%, totala cidity % (as g. malic acid / 100 g. pulp) and total sugars (A.O.A.C.,2000) were determined .

The obtained data were tabulated and statistically analyzed that according to Mead *et. al.*, (1993)using new L.S.D.test at 5% for comparing among various treatments means.

RESULTS AND DISCUSSION

1) Effect of spraying silicon and seaweed extract on some Vegetative growth characters and time of Flowering:

It is clear from the data in Table (3) that single and combined application of Potassium silicate and seaweed extract each at 0.05 to 0.1% significantly was responsible for stimulating the four growth characters namely height and girth of pseudostem,leaf area and number of green leaves at bunch shooting of Grandnaine banana plants in relative to the check treatment.The promotion was associated with increasing concentrations of silicon and seaweed extract. Unsignificant promotion on such four growth characters was observed among the two concentrations(0.05 %and 0.1%)of silicon and seaweed extract.Using the two materials together was significantly preferable than using each substance alone in this respect. The maximum values of pseudostem height (3.66 and 3.73 m.), pseudostem girth(94.9 and 95.8 cm.) , leaf area (2.13 and 2.19 m²)and number of green leaves at bunch shooting(13.6 and 14.3) were observed on the plants that received four sprays of a mixture containing potassium silicate and seaweed extract each at 0.1% while the untreated plants produced the minimum values. Time of flowering was significantly advanced with using Potassium silicate and seaweed extract either singly or in combination at 0.05 to 0.1% relatively to the check treatment. The promotion was associated with increasing concentrations of each compound.

Table 3. Effect of spraying potassium silicate and seaweed extract on some Vegetative growth characters and period to bunch shooting(days) of Grandnaine banana during 2011/2012 and 2012/2013 seasons.

Treatment	pseudostem height (m.)		Pseudostem girth (cm.)		Leaf area (m ²)		No. of green leaves at bunch shooting		period to bunch shooting(days)	
	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013
Control (untreated plants)	2.71	2.68	79.3	80.0	1.62	1.71	11.5	12.5	430.0	433.0
Spraying potassium silicate at 0.05 %	2.88	2.99	82.8	83.7	1.71	1.80	12.1	13.0	422.0	424.0
Spraying potassium silicate at 0.1 %	2.89	3.00	83.3	84.0	1.73	1.81	12.2	13.1	420.0	421.0
Spraying seaweed extract at 0.05 %	3.10	3.22	85.9	87.0	1.89	2.01	12.9	13.7	415.0	412.0
Spraying seaweed extract at 0.1 %	3.15	3.25	86.1	87.7	1.92	2.04	13.0	13.8	413.0	411.0
Spraying both materials at 0.05 %	3.62	3.71	94.1	95.0	2.11	2.18	13.5	14.2	408.0	404.0
Spraying both materials at 0.1 %	3.66	3.73	94.9	95.8	2.13	2.19	13.6	14.3	405.0	402.0
New L.S.D. at 5%	0.14	0.17	1.9	2.1	0.05	0.06	0.5	0.4	3.95	3.56

The previous positive action of Silicon on growth characters might be attributed to its important roles in protecting plants against (drought,cold,diseases and fungal attack), alleviating abiotic stress(heavy metals toxicity and salinity)and improving root development, uptake of water and nutrients and plant pigments (Ma *et. al.*, 2001, Datnoff *et. al.*, 2007 and Qin and Tian,2009).These findings regarding the effect of Silicon on stimulating growth characters are in harmony with those obtained by Abd El-Hameed (2012) and Ahmed *et al.* (2013).

The stimulating effect of seaweed extract on growth characters might be attributed to its essential action on enhancing cell division because it contains higher amounts of nutrients namely(N,P,K,Mg,Ca,S,Cu,Fe,Mn,B and Mo), natural hormones

like cytokinins, IA A and GA₃, amino acids, vitamins and antioxidants (James, 1994 & Soliman *et al.*, 2000) these constituents play an important role in protecting plant cells from damage and all stresses around plants and improving cell division and the biosynthesis of organic foods (Kulk, 1995 and Strick *et al.*, 1997). These results with regard to the effect of seaweed extract on growth characters are in agreement with those obtained by (El-Sawy, 2005, and Oraby, 2013).

The advancing effect of silicon and seaweed extract on flowering time might be attributed to their essential role in balancing the ratio between carbohydrates and nitrogen in favour of flowering (Soliman *et al.*, 2000 and Neumann and Zur-Nieden, 2001).

2) Effect of spraying silicon and seaweed extract on bunch parameters and yield:

It is evident from the data in Table (4) that single and combined applications of Potassium silicate and seaweed extract each at 0.05 to 0.1% significantly were accompanied with improving bunch and hand weights, and had no significant effect on number of hands per bunch and number of fingers per hand in relative to the check treatment. The beneficial effects of silicon and seaweed extract on growth and nutritional status of the plants surely reflected on improving bunch and hand weights. The increase on the bunch and hand weights did not correlate with the increase in both number of hands and fingers, since such two characters are genetically affected and were associated with the type, clone or variety, while the increase on the bunch and hand weights correlate with the increase in fingers weight. There was a gradual promotion on bunch and hand weights with increasing concentrations of silicon and seaweed extract. Using seaweed extract was significantly superior than using silicon in improving bunch weight. Increasing concentrations of each substance from 0.05 to 0.1% failed significantly to promote the yield per plant (bunch and hand weights), therefore, the recommended concentration of such two compounds was 0.05%. Combined application was superior than using each compound alone.

Table 4. Effect of spraying potassium silicate and seaweed extract on bunch parameters and yield of Grandnaine banana during 2011/2012&2012/2013 seasons.

Treatment	bunc weight(kg.)		No.of hands / bunch		No.of fingers / hand		Av. hand weight(kg.)	
	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013
Control (untreated plants)	22.1	22.2	12.0	12.0	19.0	19.0	1.67	1.71
Spraying potassium silicate at 0.05 %	24.4	24.8	12.2	12.0	19.3	19.0	1.75	1.78
Spraying potassium silicate at 0.1 %	25.0	25.5	12.3	12.0	19.3	20.0	1.78	1.80
Spraying seaweed extract at 0.05 %	27.3	27.9	12.3	12.0	20.0	20.0	1.85	1.91
Spraying seaweed extract at 0.1 %	28.0	28.3	12.6	12.0	20.0	20.0	1.87	1.92
Spraying both materials at 0.05 %	29.3	29.7	13.0	13.0	20.0	20.0	1.96	2.05
Spraying both materials at 0.1 %	29.6	29.8	13.0	13.0	20.0	20.0	1.99	2.11
New L.S.D. at 5%	1.1	1.2	N.S.	N.S.	N.S.	N.S.	0.07	0.08

The best results with regard to yield were obtained due to spraying the plants four times with a mixture of potassium silicate and seaweed extract each at 0.05% . Under such promised treatment bunch weight reached (29.3 kg. & 29.7kg.) during both seasons, respectively. The percentage of increase on the yield due to using the superior treatment over the control treatment (22.1kg.&22.2kg.) reached (32.6% & 33.8 %) during both seasons, respectively. Similar results were announced during both seasons.

The promoting effects of silicon on the yield and its attributes are concordance with the results of Abd El-Hameed, (2012), Abd El-Aal and Oraby-Mona, (2013), Ahmed *et. al.*, (2013) and Al-Wasfy, (2013).

The improving effects of seaweed extract on the yield and its attributes are in agreement with those obtained by El-Sawy, (2005), Merwad, (2011), Mahmoud, (2012) and Oraby (2013).

3) Effect of spraying silicon and seaweed extract on some physical and chemical characteristics of the fruits :

It is obvious from the data in Tables (5 & 6) that spraying potassium silicate and /or seaweed extract each at 0.05 to 0.1% significantly was very effective in improving fruit quality in terms of increasing weight, length and diameter of finger, pulp %, T.s.s % and total sugars % and reducing both fruit peel% and total acidity% over the control treatment. The promotion on fruit quality was associated with increasing concentrations of each compound. Using seaweed extract was significantly favourable than using silicon in this connection. Using both materials together surpassed the application of each material alone in this respect. Negligible promotion on fruit quality was observed with increasing concentration from 0.05 to 0.1%. Therefore, the best concentration in this respect was 0.05%. Using potassium silicate in combined with seaweed extract each at 0.05 % four times gave the best results with regard to fruit quality. Unfavourable effects on fruit quality were observed on the untreated plants. These results were true during 2011/2012 and 2012/2013 seasons.

The beneficial effects of silicon on protecting the plants from unfavourable effects of environment during maturity surely reflected on improving fruit quality (Ma *et. al.*, 2001). The promoting effect of Silicon on fruit quality was emphasized by the results of Ahmed *et. al.* (2013) and Al-Wasfy(2013).

The high own content of seaweed extract from nutrients especially(Mg)as well as amino acids and vitamins surely reflected on enhancing the biosynthesis of plant pigments and total carbohydrates consequently advancing Fruit maturity (Soliman *et. al.*, 2000).

Table 5. Effect of spraying potassium silicate and seaweed extract on some physical characteristics of the fruits of Grandnaine banana during 2011/2012 and 2012/2013 seasons.

Treatment	Finger weight(g.)		Finger length(cm.)		Finger diameter(cm.)		Pulp %		Fruit peel %	
	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013
Control (untreated plants)	80.0	81.5	19.0	19.1	9.0	9.2	60.7	61.0	39.3	39.0
Spraying potassium silicate at 0.05 %	84.0	87.0	20.0	20.3	9.3	9.6	63.0	63.3	37.0	36.7
Spraying potassium silicate at 0.1 %	84.6	88.0	20.3	20.7	9.4	9.7	63.3	63.6	36.7	36.4
Spraying seaweed extract at 0.05 %	88.9	92.0	21.9	22.2	9.7	9.9	66.0	66.3	34.0	33.7
Spraying seaweed extract at 0.1 %	89.3	92.7	22.0	22.3	9.8	10.0	66.2	66.5	33.8	33.5
Spraying both materials at 0.05 %	97.0	98.9	23.9	24.1	9.9	10.7	70.0	70.2	30.0	29.8
Spraying both materials at 0.1 %	98.0	99.0	24.1	24.3	10.0	10.8	70.7	70.3	29.3	29.7
New L.S.D. at 5%	2.0	1.9	0.6	0.4	0.2	0.2	1.9	1.7	0.5	0.5

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Table 6. Effect of spraying potassium silicate and seaweed extract on some chemical characteristics of the fruits of Grandnaine banana during 2011/2012 and 2012/2013 seasons.

Treatment	T.S.S %		Total acidity %		Total sugars %	
	2011/2012	2012/2013	2011/2012	2012/2013	2011/2012	2012/2013
Control (untreated plants)	16.2	16.0	0.141	0.150	14.8	15.1
Spraying potassium silicate at 0.05 %	16.9	17.2	0.118	0.130	15.3	15.5
Spraying potassium silicate at 0.1 %	17.0	17.3	0.116	0.128	15.4	15.6
Spraying seaweed extract at 0.05 %	18.0	18.6	0.099	0.114	16.0	16.0
Spraying seaweed extract at 0.1 %	18.2	18.7	0.097	0.109	16.1	16.1
Spraying both materials at 0.05 %	19.2	19.5	0.080	0.095	16.8	17.0
Spraying both materials at 0.1 %	19.3	19.6	0.079	0.093	16.9	17.1
New L.S.D. at 5%	0.4	0.5	0.015	0.016	0.3	0.3

The present results with regard to the effect of seaweed extract on fruit quality are in accordance with those obtained by Merwad, (2011), Mahmoud, (2012) and Oraby, (2013).

CONCLUSION

The best results with regard to yield as well as physical and chemical characteristics of the fruits of Grandnaine banana plants were obtained owing to using four sprays (on the middle of April, May, June and July) of a mixture containing Potassium silicate and Seaweed extract each at 0.05% .

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تأثير الرش بالسليكون ومستخلص الأعشاب البحرية على النمو والإثمار في الموز الجرانديان

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خلال موسمي ٢٠١١/ ٢٠١٢ ، ٢٠١٢ / ٢٠١٣ تم رش نباتات الموز الجرانديان اربعة مرات بسليكات البوتاسيوم ومستخلص الاعشاب البحرية بالصوره الفرديه او المشتركه كل بتركيز ما بين ٠,٠٥ الى ٠,١% تم دراسته درجة استجابته النمو والتزهير وكميه المحصول وكذلك الخصائص الطبيعيه والكيميائيه للثمار لمعاملات السليكون ومستخلص الاعشاب البحرية. كان الاستخدام الفردي والمشارك لسليكات البوتاسيوم ومستخلص الاعشاب البحرية بتركيز ما بين ٠,٠٥ الى ٠,١% فعالا جدا في تحسين صفات النمو الخضري وميعاد التزهير ووزن السوياطه وكذلك الخصائص الطبيعيه والكيميائيه للثمار وذلك بالمقارنه بمعامله الكنترول وكان هناك تاثير فائق واضح جدا عند استخدام مستخلص الاعشاب البحرية وذلك مقارنه باستخدام سليكات البوتاسيوم. ان رش نباتات الموز الجرانديان اربعة مرات (فى منتصف ابريل، مايو، يونيو، يوليو) بمخلوط يتكون من سليكات البوتاسيوم ومستخلص الاعشاب البحرية بتركيز ٠,٠٥% لكل منهما اعطى افضل النتائج بخصوص النمو والتزهير المبكر وكميه المحصول وخصائص الجوده للثمار.