Productive Capacity of Manfalouty Pomegranate Trees in Relation to Spraying of Silicon and Vitamins B

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Abstract: During 2013 and 2014 seasons, Manfalouty pomegranate trees grown under Assiut environmental conditions subjected to spraying potassium silicate at 0.05 to 0.2% and / or vitamins B at 25 to 100ppm three times. The merit of this study was elucidating the impact of using single or combined application of silicon and vitamins B on growth , nutritional status of the trees, fruit splitting % and fruiting of such pomegranate cv. Single and combined applications of potassium silicate at 0.05 to 0.2% and vitamins B at 25 to 100 ppm considerably improved all growth characters, plant pigments, nutrients in the leaves, yield and fruit quality. Percentage of fruit splitting was remarkably declined in response to these treatments. Increasing concentrations from 0.1 to 0.2% of potassium silicate and from 50 to 100 ppm vitamins B had meaningless effect on such parameters. For reducing fruit splitting and improving yield and fruit quality of Manfalouty pomegranate trees, it is suggested to use a mixture of potassium silicate at 0.1 and vitamins B (B_1 + B_2 + B_6 + B_{12}) at 50 ppm three times at growth start, just after fruit setting and at one month later.

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1. Introduction

Fruit splitting and poor yield of Manfalouty pomegranate trees grown under Assiut environmental conditions are considered the main problems facing pomegranate growers. Using non traditional horticultural practices such as application of silicon and vitamins nowadays for controlling such two drawbacks were arised. Using silicon is beneficial in increasing the tolerance of plants to all stresses as well as enhancing photosynthesis and leaf water potential (**Epstein, 1999**). Application of vitamins B is responsible for improving the tolerance of plants to all stresses, photosynthesis, cell division and plant pigments b (**Samiullah, 1988**).

Previous studies showed that application of silicon was very effective in promoting growth and fruiting of fruit crops (**Gad El- Kareem, 2012; Ahmed *et al.,* 2013; Abdelaal and Oraby- Mona, 2013; Al-Wasfy, 2014; El- Khawaga and Mansour, 2014; Ibrahim and Al-Wasfy, 2014 and Gad El Kareem *et al.,* 2014**).

The results of **Ahmed *et al.,* (2010); Ahmed *et al.,* (2011); El- Kady- Hanaa, (2011); Ahmed *et al.,* (2012a), (2012b) and (2012c); Ibrahim- Rehab (2012); Abdelaal (2012); Mekawy (2012); Abdelaal *et al.,* (2013); Abdelaal and Aly (2013); Abdelaal *et al.,* (2014); Gad El- Kareem and Abada (2014); Abd El- Latief (2014); Al-Wasfy (2013) and Hassan (2014)** emphasized the beneficial effects of using vitamins B on growth and fruiting of various fruit crops.

The target of this study was examining the effect of spraying potassium silicate and/ or vitamins B on growth and fruiting of Manfalouty pomegranate trees grown under Assiut environmental conditions.

2. Material and Methods

Table (1): Analysis of the tested soil at the trial location

constituent	Values
Sand %	5.71
Silt %	11.22
Clay %	83.07
Texture	Clay
pH (1: 2.5 extract)	7.69
EC (1 :2.5 extract) (mmhos/cm/25^{o}C)	0.69
O.M. %	2.62
$CaCO_3$%	1.41
Total N %	0.09
Available P (Olsen method , ppm)	4.4
Available K (ammonium acetate , ppm)	449.5

This study was carried out during 2013 and 2014 seasons on forty-eight uniform in vigour 12 years- old Manfalouty pomegranate trees (*Punica granatum* L.) grown in a private orchard situated at Megrease village, Sedfa district, Assiut Governorate. The trees are planted at 4x4 meters apart. Surface irrigation system using Nile water was adopted. The texture of the tested soil is clay. Analysis of the experimental soil was done according to the procedures that outlined by **Wilde *et al.,* (1985)** and the data are shown in Table (1).

This experiment included two factors (A & B). The first factor (A) consisted from four concentrations of potassium silicate namely a_1) 0.0 % , a_2) 0.05 , a_3) 0.1 % and a_4) 0.2% . The second factor (B) comprised from four concentrations of vitamins B (B_1+ B_2+ B_6 + B_{12}) namely b_1) 0.00 ppm, , b_2) 25 ppm , b_3) 50 ppm and b4) 100 ppm. Therefore, this experiment included sixteen treatments. Each treatment was replicated three times, one tree per each. Potassium silicate (25% Si + 10% K_2O) and vitamins B were sprayed three times at growth start just after fruit setting and at one month later.

This experiment was arranged in a randomized complete block design (RCBD) where the four concentrations of potassium silicate and the four concentrations of vitamin B occupied the main and sub plots respectively.

During both seasons, the following parameters were measured, number of main shoots/ tree , main shoot length (cm), number of leaves/ shoot,. Leaf area (cm^2) (**Ahmed and Morsy, 1999**); chlorophylls a & b (**Von – Wettstein, 1957**) and total chlorophylls (mg/ 100 g F.W.) ; percentages of N, P, K, Mg and Ca in the dried leaves (**Chapman and Pratt, 1965; Summer, 1985 and Wilde *et al.*, 1985**), number of flowers per main shoot, percentages of initial fruit setting and fruit retention, number of fruits/ tree, gross and marketable yields (kg) / tree, fruit splitting %, fruit weight (g.) and dimensions (height and diameter, in cm), fruit peel weight % and fruit peel thickness (cm.), grains % , juice %, pomace %, edible to non edible portions, T.S.S. %, total , reducing and non reducing sugars % **(A.O.A.C., 2000)** , total soluble tannins %, (**Balbaa, 1982**) total acidity % as citric acid and, total anthocyanins in the fruit peel and juice (mg/ 100 g F.W.) (**Fulcki and Francis, 1968**).

Statistical analysis was done according to **Mead *et al.*, (1993)** New L.S.D. test at 5% was used to compare the differences between different treatment means.

3. Results and Discussion

1- Some vegetative growth characters:

Table (2): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the number of new shoots / tree average shoot length and number of leaves/ shoot of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Number of new shoots / tree**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	80.0	83.0	85.6	86.0	**83.7**	80.9	83.2	86.3	86.4	**84.2**
a_2 0.05 %	83.5	87.0	90.0	90.6	**87.8**	84.6	87.9	91.9	92.0	**89.1**
a_3 0.1 %	86.0	88.9	91.9	92.0	**89.7**	88.0	91.0	94.3	95.0	**92.1**
a_4 0.2 %	86.6	89.0	92.0	92.3	**90.0**	88.6	91.6	94.6	95.3	**92.5**
Mean (B)	**84.0**	**87.0**	**89.9**	**90.2**		**85.5**	**88.4**	**91.8**	**92.2**	
New L.S.D. 5%	A 2.5	B 2.4	AB 4.8			A 2.2	B 2.1	AB 4.2		
Character	**Average shoot length (cm.)**									
a_1 0.0 %	61.7	64.7	68.0	68.3	**65.7**	62.6	65.6	69.3	70.0	**66.9**
a_2 0.05 %	65.7	68.9	72.3	72.6	**69.9**	66.6	69.8	73.2	73.3	**70.7**
a_3 0.1 %	69.8	72.9	76.0	76.3	**73.8**	70.5	71.0	74.3	75.0	**72.7**
a_4 0.2 %	70.0	73.0	76.0	76.0	**73.8**	71.0	71.3	75.0	75.6	**73.2**
Mean (B)	**66.8**	**69.9**	**73.1**	**73.3**		**67.7**	**69.4**	**73.0**	**73.2**	
New L.S.D. 5%	A 2.0	B 2.1		AB 4.2		A 1.9	B 2.0		AB 4.0	
Character	**Number of leaves / shoot**									
a_1 0.0 %	47.0	51.0	55.0	55.6	**52.2**	46.0	49.6	53.0	53.6	**50.6**
a_2 0.05 %	49.7	53.6	56.7	57.0	**54.3**	51.0	55.0	59.0	59.7	**56.2**
a_3 0.1 %	52.3	56.6	60.0	60.7	**57.4**	55.0	59.0	63.6	64.0	**60.4**
a_4 0.2 %	53.0	57.0	60.6	61.0	**57.9**	55.6	59.3	64.0	64.6	**60.9**
Mean (B)	**50.5**	**54.5**	**58.1**	**58.6**		**51.9**	**55.7**	**59.9**	**60.4**	
New L.S.D. 5%	A 1.9	B 1.8	AB 3.6			A 2.0	B 2.0	AB 4.0		

Table (3): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the leaf area as well as chlorophyll a & b in the leaves of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Leaf area (cm)^2**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	6.11	6.81	7.55	7.60	**7.02**	6.41	7.11	7.91	7.95	**7.35**
a_2 0.05 %	6.61	7.41	8.11	8.13	**7.57**	6.91	7.41	7.92	7.95	**7.55**
a_3 0.1 %	6.83	7.71	8.43	8.45	**7.86**	7.14	7.50	8.31	8.33	**7.82**
a_4 0.2 %	6.88	7.74	8.45	8.60	**7.92**	7.16	7.52	8.35	8.36	**7.85**
Mean (B)	**6.61**	**7.42**	**8.14**	**8.20**		**6.91**	**7.38**	**8.12**	**8.15**	
New L.S.D. 5%	A 0.22	B 0.23	AB 0.46			A 0.23	B 0.23	AB 0.46		
Character	**Chlorophyll a (mg / 100 g F.W.)**									
a_1 0.0 %	11.11	11.31	11.55	11.60	**11.39**	11.00	11.20	11.50	11.55	**11.31**
a_2 0.0 %	11.41	11.64	11.90	11.92	**11.72**	11.50	11.80	12.10	12.12	**11.88**
a_3 0.1 %	11.79	12.10	12.40	12.41	**12.18**	12.00	12.25	12.55	12.60	**12.35**
a_4 0.2 %	11.81	12.11	12.41	12.34	**12.19**	12.03	12.27	12.59	12.60	**12.37**
Mean (B)	**11.53**	**11.79**	**12.10**	**12.03**		**11.63**	**11.88**	**12.19**	**12.22**	
New L.S.D. 5%	A 0.14	B 0.15	AB 0.30			A 0.15	B 0.16		AB 0.32	
Character	**Chlorophyll b (mg / 100 g F.W.)**									
a_1 0.0 %	4.11	4.31	4.55	4.60	**4.39**	3.97	4.20	4.45	4.46	**4.27**
a_2 0.05 %	4.33	4.60	4.81	4.83	**4.64**	4.30	4.50	4.71	4.73	**4.56**
a_3 0.1 %	4.60	4.85	5.10	5.12	**4.92**	4.61	4.83	4.99	4.00	**4.61**
a_4 0.2 %	4.62	4.86	5.11	5.13	**4.93**	4.62	4.84	5.00	4.02	**4.62**
Mean (B)	**4.42**	**4.66**	**4.89**	**4.92**		**4.38**	**4.59**	**4.79**	**4.30**	
New L.S.D. 5%	A 0.11	B 0.11	AB 0.22			A 0.10	B 0.10	AB 0.20		

It is clear from the data in Tables (2 & 3) that the four vegetative growth characters namely number of main shoots / tree, main shoot length , number of leaves/ shoot and leaf area were positively affected by spraying potassium silicate at 0.05 to 0.2% and / or vitamins B (B_1 + B_2 + B_6 + B_{12}) at 25 to 100 ppm compared with the control treatment. The stimulation was associated with increasing concentrations of each material. A slight effect was attributed to increasing concentrations of potassium silicate from 0.1 to 0.2 % and vitamin B from 50 to 100 ppm. The highest values were recorded on the trees that received three sprays of a mixture of potassium silicate at 0.2% plus vitamins B at 100 ppm. The lowest values were recorded on untreated trees. These results were true in both seasons.

2- Leaf chemical composition:

It is clear from the data in Tables (3 & 4 & 5) that leaf content of plant pigments namely chlorophylls a & b and total chlorophylls as well as nutrients namely N, P, K, Mg and Ca were greatly improved due to spraying potassium silicate at 0.05 to 0.2% and/ or vitamins B at 25 to 100 ppm relative to the check treatment. The stimulation was related to the increase in concentrations of each material without clear differences between the higher two concentrations of each material. The highest values of plant pigments and nutrients were recorded on the trees that treated three times with a mixture of potassium silicate at 0.2 % plus vitamins B at 100 ppm . Leaf contents of these nutrients were minimized in the untreated trees. These results were true in both seasons.

3- Flowering and fruit setting:

It is clear from the data in Table (6) that spraying potassium silicate at 0.05 to 0.2% and/ or vitamins B each at 25 to 100 ppm significantly was accompanied with enhancing number of flowers / shoot as well as percentages of initial fruit setting and fruit retention in relative to the control treatment. The increase was in proportional to the increase in concentrations of each material. A slight promotion on these parameters was observed among the higher two concentrations of each material. Using both materials at the higher concentration gave the maximum values. The lowest values were obtained on the untreated vines. These results were true in both seasons.

4- Fruit splitting percentage:

It is clear from the data in Table (7) that a remarkable and significant reduction on the percentage of fruit splitting was observed due to spraying potassium silicate at 0.05 to 0.2% and / or vitamins B at 25 to 100 ppm comparing with the control treatment. There was a gradual reduction on such unfavourable phenomenon with increasing concentrations of each material. No significant reduction was observed among

the higher two concentration of each material. The lowest values were recorded on the trees that received such two materials together at the higher concentration. The untreated trees produced the maximum values. These results were true in both seasons.

5- Yields/ tree:

It is clear from the data in Tables (7 & 8) that gross and marketable yields as well as number of fruits / tree were remarkably improved in response to foliar application of potassium silicate and/ or vitamins B rather than non- application. The promotion was considerably associated with increasing concentrations of each material. A slight promotion on these parameters was observed between using 0.1 and 0.2 % potassium silicate and 50 and 100 ppm vitamins B. Therefore, from economical point of view it is advised to use potassium silicate at 0.1 % and vitamins B at 50 ppm three times for promoting both yields and number of fruits per tree. There was a remarkable reduction on gross and marketable yield and number of fruits / tree in untreated trees. These results were true in both seasons.

6- Some physical and chemical characteristics of the fruits:

It is clear from the data in Tables (8 to 13) that treating the trees with potassium silicate at 0.05 to 0.2 % and/ or vitamins B at 25 to 100 ppm was very effective in improving fruit quality in terms of increasing fruit weight and dimensions (height and diameter), juice %, grain %, edible to non edible portions, T.S.S., total and reducing sugars % and total anthocyanins in the fruit peel and juice and decreasing fruit peel weight and thickness, total acidity % and total soluble tannins rather than the control treatment. The present treatments had no significant effect on pomace % on the promotion on fruit quality was reasonably correlated with increasing concentrations of each material without substantial promotion among the higher two concentrations of each material. Therefore, the recommendation was the application of potassium silicate at 0.1% and vitamins B at 50 ppm for promoting fruit quality. Unfavourable effects on fruit quality were observed on untreated trees. The present treatments had no considerable effects on non reducing sugars %. These results were true in both seasons.

Table (4): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the total chlorophylls and percentages of N and P in the leaves of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Total Chlorophylls (mg / 100 g F.W.)**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	B_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	15.22	15.62	16.10	16.20	**15.79**	14.97	15.40	15.95	16.01	**15.58**
a_2 0.05 %	15.74	16.24	16.71	16.75	**16.36**	15.80	16.30	16.81	16.85	**16.44**
a_3 0.1 %	16.39	16.45	17.50	17.53	**17.09**	16.61	17.08	17.54	17.60	**17.21**
a_4 0.2 %	16.43	16.97	17.52	17.56	**17.12**	16.65	17.11	17.59	17.62	**17.24**
Mean (B)	**15.95**	**16.45**	**16.96**	**17.01**		**16.01**	**16.47**	**16.97**	**17.02**	
New L.S.D. 5%	A 0.41	B 0.39	AB 0.78			A 0.37	B 0.38	AB 0.76		
Character	**Leaf N %**									
a_1 0.0 %	1.62	1.68	1.74	1.75	**6.79**	1.57	1.65	1.74	1.75	**1.68**
a_2 0.05 %	1.73	1.80	1.87	1.88	**1.82**	1.67	1.75	1.84	1.85	**1.78**
a_3 0.1 %	1.86	1.92	1.99	2.00	**1.94**	1.79	1.86	1.94	1.95	**1.86**
a_4 0.2 %	1.87	1.93	1.99	2.02	**1.95**	1.80	1.88	1.95	1.95	**1.90**
Mean (B)	**1.77**	**1.83**	**1.90**	**1.91**		**1.71**	**1.79**	**1.87**	**1.88**	
New L.S.D. 5%	A 0.06	B 0.07	AB 0.14			A 0.05	B 0.06	AB 0.12		
Character	**Leaf P %**									
a_1 0.0 %	0.19	0.23	0.26	0.27	**0.24**	0.21	0.24	0.27	0.28	**0.25**
a_2 0.05 %	0.23	0.26	0.30	0.31	**0.28**	0.24	0.29	0.34	0.35	**0.31**
a_3 0.1 %	0.26	0.31	0.34	0.34	**0.31**	0.28	0.32	0.36	0.36	**0.33**
a_4 0.2 %	0.27	0.31	0.35	0.35	**0.30**	0.29	0.32	0.35	0.36	**0.33**
Mean (B)	**0.24**	**0.17**	**0.31**	**0.32**		**0.26**	**0.29**	**0.33**	**0.34**	
New L.S.D. 5%	A 0.03	B 0.03	AB 0.06			A 0.02	B 0.03	AB 0.06		

Table (5): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the percentages of K, Mg and Ca in the leaves of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Leaf K %**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					014				
a_1 0.0 %	1.19	1.24	1.27	1.28	**1.25**	1.13	1.19	1.25	1.26	**1.52**
a_2 0.05 %	1.26	1.31	1.35	1.36	**1.32**	1.20	1.26	1.32	1.32	**1.28**
a_3 0.1 %	1.31	1.36	1.41	1.42	**1.38**	1.25	1.33	1.41	1.41	**1.35**
a_4 0.2 %	1.32	1.37	1.42	1.43	**1.39**	1.26	1.34	1.42	1.42	**1.36**
Mean (B)	**1.27**	**1.32**	**1.36**	**1.37**		**1.21**	**1.28**	**1.35**	**1.35**	
New L.S.D. 5%	A 0.04	B 0.05	AB 0.10			A 0.05	B 0.05	AB 0.10		
Character	**Leaf Mg %**									
a_1 0.0 %	0.47	0.53	0.60	0.61	**0.55**	0.52	0.57	0.65	0.66	
a_2 0.05 %	0.52	0.59	0.66	0.67	**0.61**	0.58	0.64	0.70	0.72	
a_3 0.1 %	0.57	0.63	0.70	0.72	**0.66**	0.66	0.73	0.80	0.81	
a_4 0.2 %	0.58	0.64	0.72	0.73	**0.66**	0.67	0.74	0.81	0.82	
Mean (B)	**0.54**	**0.60**	**0.67**	**0.68**		**0.61**	**0.67**	**0.74**	**0.75**	
New L.S.D. 5%	A 0.03	B 0.04	AB 0.08			A 0.04	B 0.04	AB 0.08		
Character	**Leaf Ca %**									
a_1 0.0 %	2.29	2.39	2.50	2.52	**2.43**	2.33	2.43	2.53	2.55	**2.46**
a_2 0.05 %	2.40	2.51	2.62	2.64	**2.54**	2.44	2.55	2.66	2.68	**2.58**
a_3 0.1 %	2.49	2.60	2.71	2.71	**2.63**	2.55	2.67	2.77	2.79	**2.70**
a_4 0.2 %	2.50	2.61	2.72	2.72	**2.64**	1.56	2.68	2.78	2.80	**2.50**
Mean (B)	**2.42**	**2.66**	**2.64**	**2.65**		**2.22**	**2.58**	**2.63**	**2.71**	
New L.S.D. 5%	A 0.07	B 0.07	AB 0.14			A 0.07	B 0.08	AB 0.16		

Table (6): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the number of flowers per shoot as well as percentages of initial fruit setting and fruit retention of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**No. of flowers / shoot**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	1.0	3.0	4.0	4.0	**3.0**	2.0	3.0	4.0	4.0	**3.3**
a_2 0.05 %	2.0	4.0	4.0	4.0	**3.5**	3.0	4.0	4.0	4.0	**3.8**
a_3 0.1 %	3.0	4.0	4.0	4.0	**3.8**	4.0	4.0	4.0	4.0	**4.0**
a_4 0.2 %	3.0	4.0	4.0	4.0	**3.8**	4.0	4.0	4.0	4.0	**4.0**
Mean (B)	**3.0**	**3.8**	**4.0**	**4.0**		**3.3**	**3.8**	**4.0**	**4.0**	
New L.S.D. 5%	A 1.0	B 1.0	AB 2.0			A 1.0	B 1.0	AB 2.0		
Character	**Initial fruit setting %**									
a_1 0.0 %	49.4	50.5	51.6	52.0	**50.9**	51.1	52.9	54.0	54.1	**5.3**
a_2 0.05 %	51.5	52.9	54.5	54.7	**53.4**	52.5	54.5	56.0	56.1	**54.8**
a_3 0.1 %	53.7	55.5	58.0	58.1	**56.3**	54.0	56.9	58.9	59.0	**57.2**
a_4 0.2 %	54.0	55.5	58.1	58.3	**56.5**	54.1	57.0	59.0	59.1	**57.5**
Mean (B)	**52.2**	**53.6**	**55.6**	**55.8**		**52.9**	**55.3**	**57.0**	**57.1**	
New L.S.D. 5%	A 0.9	B 0.8	AB 1.6			A 0.8	B 0.8	AB 1.6		
Character	**Fruit retention %**									
a_1 0.0 %	26.0	27.9	30.0	30.3	**28.6**	27.3	30.0	32.0	32.3	**30.4**
a_2 0.05 %	28.0	31.0	34.0	34.3	**31.8**	29.9	33.0	36.5	36.9	**34.1**
a_3 0.1 %	30.0	33.3	36.9	37.0	**34.3**	32.0	36.0	39.3	39.6	**36.7**
a_4 0.2 %	30.3	33.4	36.9	37.1	**34.4**	32.3	36.1	39.6	40.0	**37.0**
Mean (B)	**28.6**	**31.4**	**34.5**	**34.7**		**30.4**	**33.8**	**36.9**	**37.2**	
New L.S.D. 5%	A 1.1	B 1.1	AB 2.2			A 1.3	B 1.4	AB 2.8		

Table (7): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on number of fruits / tree, fruit splitting % and gross yield / tree (kg.) of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Number of fruits / tree**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	36.0	70.0	103.0	104.0	**78.3**	49.0	75.0	111.0	112.0	**86.8**
a_2 0.05 %	47.0	107.0	122.0	123.0	**99.8**	76.0	116.0	134.0	135.0	**115.3**
a_3 0.1 %	77.0	119.0	136.0	137.0	**117.3**	113.0	151.0	189.0	190.0	**150.8**
a_4 0.2 %	78.0	120.0	137.0	138.0	**118.3**	114.0	152.0	190.0	191.0	**161.8**
Mean (B)	**59.5**	**104.0**	**124.5**	**125.5**		**88.0**	**123.5**	**132.5**	**157.0**	
New L.S.D. 5%	A 3.0	B 3.0	AB 6.0			A 4.0	B 3.9	AB 7.8		
Character	**Fruit splitting %**									
a_1 0.0 %	15.6	13.0	10.0	9.9	**12.13**	16.0	12.7	9.6	9.5	**12.0**
a_2 0.05 %	11.0	9.9	9.0	8.8	**9.68**	10.6	9.5	8.6	8.5	**9.3**
a_3 0.1 %	4.1	3.0	2.2	2.1	**2.85**	3.9	3.0	2.0	1.9	**2.7**
a_4 0.2 %	3.9	2.9	2.1	2.0	**2.73**	3.8	2.9	2.0	1.8	**2.6**
Mean (B)	**8.7**	**7.2**	**5.8**	**5.7**		**8.6**	**7.0**	**5.6**	**5.4**	
New L.S.D. 5%	A 1.1	B 1.1	AB 2.2			A 1.0	B 1.1	AB 2.2		
Character	**Gross yield / tree (kg.)**									
a_1 0.0 %	12.6	25.0	37.7	38.2	**28.4**	17.2	26.9	40.8	41.3	**31.6**
a_2 0.05 %	17.0	39.7	46.6	47.1	**37.6**	27.6	43.2	51.5	52.0	**43.6**
a_3 0.1 %	30.0	47.5	55.8	56.3	**47.4**	44.2	60.6	77.7	78.3	**65.2**
a_4 0.2 %	30.4	47.9	56.3	56.7	**47.8**	44.6	61.0	78.3	78.7	**65.7**
Mean (B)	**22.5**	**40.0**	**49.1**	**49.5**		**33.40**	**47.93**	**24.83**	**62.58**	
New L.S.D. 5%	A 2.2	B 2.0	AB 4.0			A 2.5	B 2.5	AB 5.0		

Table (8): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on marketable yield per tree (kg.) as well fruit weight and height of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Marketable yield / tree (kg.)**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	10.6	21.8	33.9	34.4	**25.2**	14.4	23.5	36.9	37.4	**28.1**
a_2 0.05 %	15.1	38.8	42.4	43.0	**34.8**	24.7	39.1	47.1	47.6	**39.6**
a_3 0.1 %	28.8	46.1	54.6	55.1	**46.2**	42.5	58.8	76.1	76.8	**63.5**
a_4 0.2 %	29.2	46.5	55.1	55.6	**46.6**	42.9	59.2	76.7	77.3	**64.2**
Mean (B)	**20.93**	**38.30**	**46.50**	**47.0**		**31.1**	**45.2**	**59.2**	**59.8**	
New L.S.D. 5%	A 2.2	B 2.1	AB 4.2			A 2.0	B 1.9	AB 3.8		
Character	**Fruit weight (g.)**									
a_1 0.0 %	351.0	357.0	366.0	367.0	**360.3**	350.0	358.0	368.0	369.0	**361.3**
a_2 0.05 %	361.0	371.0	382.0	383.0	**374.3**	363.0	372.7	384.0	385.0	**376.2**
a_3 0.1 %	389.0	399.0	410.0	411.0	**402.3**	391.0	401.0	411.0	412.0	**403.8**
a_4 0.2 %	340.0	399.0	411.0	411.0	**402.8**	391.0	401.0	412.0	412.0	**404.0**
Mean (B)	**372.8**	**381.5**	**392.3**	**391.5**		**373.8**	**383.2**	**393.8**	**394.5**	
New L.S.D. 5%	A 9.0	B 9.0	AB 18.0			A 10.0	B 10.0	AB 20.2		
Character	**Fruit height (cm.)**									
a_1 0.0 %	7.91	8.01	8.12	8.13	**8.04**	7.89	8.11	8.25	8.26	**8.13**
a_2 0.05 %	8.11	8.50	8.90	8.99	**8.63**	8.22	8.61	8.99	9.02	**8.71**
a_3 0.1 %	8.26	8.71	9.00	9.03	**8.75**	8.41	8.91	8.99	9.04	**8.84**
a_4 0.2 %	8.27	8.72	**9.01**	9.04	**8.76**	8.42	8.94	9.00	9.05	**8.85**
Mean (B)	**8.14**	**8.49**	**8.76**	**8.80**		**8.24**	**8.64**	**8.81**	**8.84**	
New L.S.D. 5%	A 0.09	B 0.08	AB 0.16			A 0.10	B 0.10	AB 0.20		

Table (9): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on fruit diameter and fruit peel weight and thickness (cm) of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Fruit diameter (cm.)**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	8.11	8.23	8.36	8.37	**8.27**	8.09	8.25	8.50	8.52	**8.27**
a_2 0.05 %	8.25	8.66	8.99	9.05	**8.74**	8.50	8.81	9.11	9.12	**8.89**
a_3 0.1 %	8.55	9.00	9.30	9.32	**9.04**	8.71	9.11	9.25	9.27	**9.09**
a_4 0.2 %	8.57	9.01	9.31	9.33	**9.06**	8.72	9.12	9.26	9.28	**9.09**
Mean (B)	**8.37**	**8.73**	**8.99**	**9.02**		**8.51**	**8.82**	**9.03**	**9.04**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	0.08	0.09	0.18			0.09	0.09	0.18		
Character	**Fruit peel weight %**									
a_1 0.0 %	41.5	39.0	37.5	37.3	**38.8**	43.0	39.5	37.0	36.9	**40.4**
a_2 0.05 %	37.3	35.0	33.0	33.0	**34.6**	37.0	34.8	32.7	32.5	**34.3**
a_3 0.1 %	35.0	33.5	32.0	31.8	**33.0**	34.0	33.0	31.5	31.3	**32.5**
a_4 0.2 %	34.9	33.5	31.9	31.8	**33.0**	33.9	32.9	31.3	31.2	**32.3**
Mean (B)	**37.2**	**35.3**	**33.6**	**33.3**		**38.2**	**35.1**	**33.1**	**33.0**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	1.0	1.0	2.0			1.0	1.1	2.2		
Character	**Fruit peel thickness (cm.)**									
a_1 0.0 %	0.82	0.77	0.72	0.71	**0.76**	0.84	0.76	0.71	0.69	**0.75**
a_2 0.05 %	0.75	0.71	0.66	0.65	**0.69**	0.76	0.70	0.64	0.63	**0.68**
a_3 0.1 %	0.69	0.63	0.60	0.60	**0.63**	0.70	0.62	0.59	0.59	**0.63**
a_4 0.2 %	0.67	0.62	0.60	0.59	**0.62**	0.69	0.61	0.59	0.59	**0.60**
Mean (B)	**0.73**	**0.68**	**0.65**	**0.64**		**0.75**	**0.67**	**0.63**	**0.63**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	0.04	0.03	0.05			0.04	0.03	0.06		

Table (10): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the percentages of grain weight , juice and pomace of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Grain weight %**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	58.5	61.0	62.5	62.7	**61.2**	57.0	60.5	63.0	63.1	**60.9**
a_2 0.05 %	62.7	65.0	67.0	67.0	**65.4**	63.0	65.2	67.3	67.5	**65.8**
a_3 0.1 %	65.0	66.5	68.0	68.2	**66.9**	66.0	67.0	68.5	68.7	**67.6**
a_4 0.2 %	65.1	66.5	68.1	68.2	**67.0**	66.1	67.1	68.7	68.8	**67.6**
Mean (B)	**62.8**	**64.8**	**66.4**	**66.4**		**64.0**	**65.0**	**66.9**	**67.0**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	0.9	0.9	1.8			1.0	1.0	2.0		
Character	**Juice %**									
a_1 0.0 %	38.0	40.0	41.9	42.0	**40.5**	37.7	40.7	42.0	42.0	**40.6**
a_2 0.05 %	40.9	42.9	45.0	45.3	**43.5**	41.0	43.0	45.0	45.0	**43.5**
a_3 0.1 %	43.3	45.6	47.0	47.0	**45.7**	43.5	45.9	46.9	47.0	**45.8**
a_4 0.2 %	43.4	42.7	47.1	47.1	**45.8**	43.6	46.0	47.0	47.0	**43.7**
Mean (B)	**41.4**	**43.6**	**45.3**	**45.4**		**41.5**	**43.9**	**45.2**	**45.3**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	1.2	1.2	2.4			1.0	1.1	2.2		
Character	**Fruit pomace %**									
a_1 0.0 %	20.5	21.0	20.6	20.7	**20.7**	19.3	19.8	21.0	21.1	**20.3**
a_2 0.05 %	21.8	22.1	22.0	21.7	**21.9**	22.0	22.2	22.3	22.5	**22.3**
a_3 0.1 %	51.7	20.9	21.0	21.0	**21.2**	22.5	21.1	21.6	21.7	**21.7**
a_4 0.2 %	51.7	20.8	21.0	21.1	**21.2**	22.5	21.1	21.7	21.8	**21.8**
Mean (B)	**21.4**	**21.2**	**21.2**	**21.1**		**21.6**	**21.0**	**21.7**	**21.7**	
New L.S.D. 5%	A	B	AB			A	B	AB		
	NS	NS	Ns			NS	NS	NS		

Table (11): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on edible / non edible portions and percentages of T.S.S. and total sugars in the fruits of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Edible / non edible portions**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	1.42	1.56	1.67	1.68	**1.58**	1.33	1.53	1.70	1.71	**1.57**
a_2 0.05 %	1.68	1.86	2.03	2.03	**1.90**	1.70	1.87	2.06	2.08	**1.93**
a_3 0.1 %	1.86	1.99	2.13	2.14	**2.03**	1.94	2.03	2.17	2.17	**2.03**
a_4 0.2 %	1.87	1.99	2.13	2.14	**2.03**	1.95	2.04	2.19	2.21	**2.10**
Mean (B)	**1.71**	**1.85**	**1.99**	**2.00**		**1.73**	**1.87**	**2.03**	**2.04**	
New L.S.D. 5%	A 0.05	B 0.06	AB 0.12			A 0.05	B 0.05	AB 0.10		
Character	**T.S.S. %**									
a_1 0.0 %	14.2	14.8	15.5	15.6	**15.0**	14.0	14.9	15.5	15.6	**15.0**
a_2 0.05 %	15.2	15.8	16.3	16.4	**15.9**	14.6	15.1	15.6	15.7	**15.3**
a_3 0.1 %	15.9	16.4	16.5	16.5	**16.3**	16.0	16.5	16.6	16.6	**16.4**
a_4 0.2 %	16.0	16.5	16.5	16.5	**16.4**	16.1	16.6	16.6	16.6	**16.5**
Mean (B)	**15.3**	**15.8**	**16.2**	**16.3**		**15.2**	**15.8**	**16.1**	**16.1**	
New L.S.D. 5%	A 0.03	B 0.03	AB 0.06			A 0.03	B 0.03	AB 0.06		
Character	**Total sugars %**									
a_1 0.0 %	11.5	12.1	12.7	12.8	**12.3**	11.8	12.3	13.0	13.2	**12.6**
a_2 0.05 %	12.3	12.9	13.5	13.6	**13.1**	12.6	13.1	13.5	13.6	**13.2**
a_3 0.1 %	13.0	13.5	14.0	14.1	**13.7**	13.3	13.8	14.2	14.2	**13.9**
a_4 0.2 %	13.1	13.6	**14.1**	14.2	**13.8**	13.4	13.9	14.4	14.5	**14.1**
Mean (B)	**12.5**	**13.0**	**13.6**	**13.7**		**12.8**	**13.3**	**13.8**	**13.9**	
New L.S.D. 5%	A 0.04	B 0.03	AB 0.06			A 0.03	B 0.03	AB 0.06		

Table (12): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the percentages of reducing and non reducing sugars and total soluble tannins in the fruits of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Reducing sugars %**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	10.5	10.9	11.4	11.5	**11.1**	10.6	11.1	11.8	11.9	**11.4**
a_2 0.05 %	11.2	11.7	12.3	12.4	**11.6**	11.2	11.9	12.5	12.5	**12.0**
a_3 0.1 %	11.9	12.5	13.0	13.1	**12.6**	11.9	12.5	13.0	13.1	**12.6**
a_4 0.2 %	12.0	12.6	13.0	13.1	**12.7**	12.0	12.6	13.0	13.1	**12.7**
Mean (B)	**11.4**	**11.9**	**12.4**	**12.5**		**11.4**	**12.0**	**12.6**	**12.7**	
New L.S.D. 5%	A 0.2	B 0.2	AB 0.4			A 0.3	B 0.3	AB 0.6		
Character	**Non- reducing sugars %**									
a_1 0.0 %	1.0	1.2	1.3	1.3	**1.2**	1.2	1.2	1.2	1.3	**1.2**
a_2 0.05 %	1.1	1.2	1.2	1.2	**1.2**	1.4	1.2	1.0	1.1	**1.2**
a_3 0.1 %	1.1	1.0	1.0	1.0	**1.0**	1.4	1.3	1.2	1.1	**1.3**
a_4 0.2 %	1.1	1.0	1.1	1.1	**1.1**	1.4	1.3	1.4	1.4	**1.4**
Mean (B)	**1.1**	**1.1**	**1.2**	**1.2**		**1.4**	**1.3**	**1.2**	**1.2**	
New L.S.D. 5%	A NS	B NS	AB NS			A NS	B NS	AB NS		
Character	**Total soluble tannins %**									
a_1 0.0 %	1.33	1.27	1.18	1.16	**1.24**	1.49	1.20	1.15	1.14	**1.25**
a_2 0.05 %	1.19	1.11	1.03	1.02	**1.09**	1.20	1.09	1.00	0.99	**1.07**
a_3 0.1 %	1.05	0.99	0.91	0.90	**0.96**	1.04	0.96	0.90	0.90	**0.95**
a_4 0.2 %	1.04	0.98	0.90	0.90	**0.96**	1.03	0.95	0.89	0.88	**0.94**
Mean (B)	**1.15**	**1.09**	**1.01**	**1.01**		**1.19**	**1.05**	**0.99**	**0.98**	
New L.S.D. 5%	A 0.05	B 0.05	AB 0.10			A 0.04	B 0.05	AB 0.10		

Table (13): Effect of different concentrations of potassium silicate and vitamins B complex and their combinations on the percentages pf total acidity and total anthocyanins in the peel and juice of Manfalouty pomegranate trees during 2013 & 2014 seasons.

Characters	**Total acidity %**									
Concentrations of potassium silicate (A)	Concentrations of vitamins B complex (B) ppm									
	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)	b_1 0.0	b_2 25	b_3 50	b_4 100	Mean (A)
	2013					2014				
a_1 0.0 %	1.520	1.480	1.441	1.437	**1.470**	1.500	1.460	1.421	1.420	**1.450**
a_2 0.05 %	1.450	1.410	1.380	1.379	**1.405**	1.430	1.391	1.360	1.359	**1.385**
a_3 0.1 %	1.402	1.371	1.340	1.339	**1.363**	1.380	1.351	1.311	1.310	**1.338**
a_4 0.2 %	1.399	1.370	1.338	1.337	**1.361**	1.379	1.350	1.310	1.309	**1.337**
Mean (B)	**1.443**	**1.408**	**1.375**	**1.373**		**1.422**	**1.388**	**1.351**	**1.350**	
New L.S.D. 5%	A 0.031	B 0.033	AB 0.066			A 0.025	B 0.022	AB 0.044		
Character	**Total anthocyanins (mg/ 100 g F.W.) in the peels**									
a_1 0.0 %	46.3	48.9	51.3	51.6	**49.5**	47.3	50.9	53.6	54.0	**51.5**
a_2 0.05 %	50.0	52.2	55.0	55.3	**53.1**	52.9	55.0	58.0	58.3	**56.1**
a_3 0.1 %	54.0	56.5	59.0	59.3	**57.2**	57.0	59.9	61.9	62.0	**60.2**
a_4 0.2 %	54.3	56.8	59.3	59.5	**57.5**	57.3	60.0	62.0	62.0	**60.3**
Mean (B)	**51.2**	**53.6**	**56.2**	**56.4**		**53.6**	**56.5**	**58.9**	**59.1**	
New L.S.D. 5%	A 1.6	B 1.4	AB 2.8			A 1.5	B 1.5	AB 3.0		
Character	**Total anthocyanins (mg/ 100 g F.W.) in the juice**									
a_1 0.0 %	33.3	36.0	38.5	39.0	**36.7**	34.0	37.0	39.0	39.3	**37.3**
a_2 0.05 %	37.0	39.5	42.0	42.3	**40.2**	38.0	41.5	43.0	43.6	**41.5**
a_3 0.1 %	41.0	43.9	46.0	46.3	**44.3**	42.3	45.0	48.0	48.3	**45.9**
a_4 0.2 %	41.3	44.0	46.1	46.4	**44.5**	42.5	45.3	8.2	48.5	**46.1**
Mean (B)	**38.2**	**40.9**	**43.2**	**43.5**		**39.2**	**42.2**	**44.6**	**44.9**	
New L.S.D. 5%	A 1.5	B 1.5	AB 3.0			A 1.6	B 1.6	AB 3.2		

4. Discussion

The positive action of vitamins on fruiting of Manfalouty pomegranate might be attributed to their essential role on protecting the plant cells from senescence and disorders as well as enhancing cell division, the biosynthesis of natural hormones such as IAA and ethylene, nutrient and water uptake, photosynthesis, building of plant pigments and proteins, amino acids and plant metabolism. These important functions of vitamins were surely reflected on enhancing growth and vine nutritional status in favour of enhancing yield and fruit quality. (**Samiulla *et al.*, 1988**).

These results are in harmony with those obtained by **Ahmed *et al.*, (2010); El- Kady- Hanaa (2011); Ahmed *et al.*, (2011); Mekawy (2012); Ibrahim-Rehab(2012); Ahmed *et al.*, (2012b), Abdelaal (2012) Ahmed *et al.*, (2012a); Abdelaal and Aly (2013); Abd El- Latief (2014); Abdelaal *et al.*, (2014) and Al- Wasfy (2014).**

The promoting effect of silicon on fruiting of Manfalouty pomegranates might be attributed to its effect in enhancing the tolerance of plants to all stresses as well as the biosyntehsis of organic fruits (**Epstein, 1999**).

These results are in concordance with those obtained by **Gad El- Kareem, 2012; Ahmed *et al.*, 2013; Abdelaal and Oraby- Mona, 2013; Al-Wasfy, 2014; El- Khawaga and Mansour, 2014; Ibrahim and Al-Wasfy, 2014 and Gad El Kareem *et al.*, 2014**)

Conclusion:

For reducing fruit splitting and improving yield and fruit quality of Manfalouty pomegranate trees, it is suggested to use a mixture of potassium silicate at 0.1 and vitamins B (B_1 + B_2 + B_6 + B_{12}) at 50 ppm three times at growth start, just after fruit setting and at one month later.

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