Response of Zaghloul Date Palms to Spraying Boron, Silicon and Glutathione

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Abstract: During 2011 and 2012 seasons, Zaghloul date palms received four sprays of single and combined application of boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 %. This study focused on the effects of these treatments on leaf area, total chlorophylls, different nutrients in the leaves, yield and fruit quality. Single or combined applications of boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 % was very effective in enhancing leaf area, total chlorophylls, yield and quality in relative to the check treatment. The promotion was associated with using B, Si and Glutathione, in descending order. Combined applications were preferable than using each one alone in this respects. The best results with regard to yield and fruit quality of Zaghloul date palms were obtained due to spraying a mixture of boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 % four times.

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1. Introduction

Date palm (*Phoenix dactylifera* L.) is considered to be one of the important fruit species grown in Egypt. Zaghloul is considered the best soft type date palm.

Nowadays, many efforts had been established for finding out the best horticultural practices that are responsible for enhancing yield and fruit quality of the prime soft date palm cv. Zaghloul growing under Minia region conditions. Using boron, silicon and Glutathione are considered the best treatment for solving the problem of yield decline and inferior fruit quality of such date palm cv. Increasing the tolerance of Zaghloul date palm to all stress conditions namely unsuitable environmental conditions, drought and salinity is considered important in this respect.

Glutathione as antioxidant is the most important non- protein thiol present in the plants. It is essential in sulfur metabolism and very important in producing tolerance to all stress plants. It regulates sulfur uptake and produces antioxidant defense system for avoiding the great damage and hazards that caused by reactive oxygen species. It is responsible for enhancing the biosynthesis of organic foods and cell division **(Levitt, 1980; Rennenberg, 1982 and Meister and Anderson, 1983).**

Boron is considered an essential micro nutrient plays an important role in increasing pollen grains germination and pollen tube elongation, consequently, fruit set % and finally the yield. It is responsible for stimulating cell division, biosynthesis and translocation of sugars water uptake, tolerance of fruit crops to different disorders, nutrient uptake and the biosynthesis of IAA **(Nijjar, 1985).**

The beneficial effect of silicon in increasing the tolerance of plants to drought and salinity is attributed to its effect on stimulating the antioxidant defense system in plants **(Epstein, 1999 and Epstein and Bloom, 2003).**

Boron was found to enhance growth and fruiting of fruit crops **(Osman, 1999; Abd El- Migeed *et al*., 2002; Saleh and Abd El- Monem- Eman, 2003; Abd- Allah, 2006 and Ebeid- Sanaa, 2007).**

Using silicon was very effective in enhancing growth and fruiting of different fruit crops **(Matichenkov *et al*., 2000;Kanto, 2002; Ma and Takahashi, 2002; Neumann and Zur- Nieden, 2011; Gad El- Kareem, 2012 and Al- Wasfy, 2013).**

Spraying Glutathione proved to be very beneficial in enhancing growth and fruiting of different fruit crops **(Levitt, 1980; Rennenberg, 1982; Meister and Anderson, 1983; Dekok and Stulen, 1993; Jorge *et al*., 1993; Foyer *et al*., 1997; Noctor and Foyer, 1998; Tausz and Grill, 2000; Kocsy *et al*., 2001; Mullineaux and Rausch, 2005 and Abdelaal *et al*., 2012).**

The merit of this study was elucidating the effect of single and combined applications of boric acid, potassium silicate and Glutathione on fruiting of Zaghloul date palms.

2. Materials and Methods

This study was carried out during 2011 and 2012 seasons in a private orchard situated at Maghagha district, Minia Governorate on 24 palms 20- years old Zaghloul date palms. Soil texture is silty clay and the palms are planted at 7 × 7 meters apart. The selected palms were irrigated through surface system. Pruning

was carried out to maintain leaf bunch ratio at 8: 1 (according to **Sayed, 2002)**. Number of female spathes per each palm was adjusted to ten spathes. Artificial pollination was achieved by inserting five male strands into the female bunch using known high activating pollen source throughout 2 – 3 days after female spathe creaking followed by bagging **(Omar, 2007)**. Each selected palm received the common horticultural practices that are already applied in the orchard except those dealing with using royal jelly, silicon and vitamins B.

This study included the following eight treatments:

1. Control (untreated palms).
2. Spraying boric acid at 0.05 % (0.5 g l^{-1}).
3. Spraying potassium silicate at 0.1 % (0.5 g l^{-1}).
4. Spraying Glutathione at 0.1 % (0.5 g l^{-1}).
5. Spraying boric acid at 0.05 % + potassium silicate at 0.1 %.
6. Spraying boric acid at 0.05 % + Glutathione at 0.1 %.
7. Spraying potassium silicate at 0.1 % + Glutathione at 0.1 %.
8. Spraying all the prementioned.

Each treatment was replicated three times, one palm per each. Randomized complete block design was followed. Boric acid (17 % B), potassium silicate (25 % Si + 10 % K_2O) and Glutathione were sprayed four times during each season at growth start (1st week of Mar), just after fruit setting (1st week of Apr.) and at one month intervals (1st week of May and June). Triton B as a wetting agent was used with all solutions at 0.05 % and the spray was done till runoff (5 L/ palm). The control palms received tap water mixed with Triton B at 0.5 %.

During both seasons, the following parameters were carried out:-

1- Leaf area (m^2) (**Ahmed and Morsy, 1999)**.
2- Total chlorophylls (a + b) as (mg/ g^{-1} F.W) **(Moran, 1999 and Wettstein, 1957).**
3- Percentages of N, P, K and Mg in the dried leaves according to **Chapman and Pratt (1965).**
4- Leaf content of Si (mg/ g^{-1}) in the dried leaves according to the procedures that outlined in **Elliot and Snyder (1991).**
5- Bunch weight (kg.).
6- Yield/ palm (kg.) at the first week of September.
7- Some physical and chemical characteristics of the fruits namely fruit weight (g.) and dimensions (length and width, cm.) as well as percentages of pulp and seeds, pulp/ seed, total soluble solids %, total and non- reducing sugars % **(A.O.A.C., 1995)**, total acidity % (as g malic acid/ 100 g pulp) according to **A.O.A.C., (1995)**; fibre crude % and total soluble tannins % were determined **(A.O.A.C., 1995).**

All the obtained data were tabulated and subjected to the proper statistical analysis using new L.S.D at 5 % according to **Mead *et al*., (1993).**

3. Results

Leaf area

It is clear from the data in Table (1) that single and combined applications of boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 % significantly stimulated the leaf area in relative to the check treatment. The stimulation was significantly associated with using Glutathione, potassium silicate and boric acid, in ascending order. Combined applications of these materials were preferable than using each alone in this respect. Application of boric acid, potassium silicate and Glutathione together gave the maximum values. The minimum values were recorded on untreated palms. These results were true during both seasons.

Total chlorophylls:

It is clear from the data in Table (1) that total chlorophylls was significantly improved in response to spraying boric acid, potassium silicate and Glutathione either applied singly or in all possible combinations rather than non- application. Significant differences were detected among all treatments on such character. In ascending order, using Glutathione, potassium silicate and boric acid resulted in the greatest values of total chlorophylls. Triple and double applications was significantly favourable than single ones in this connection. The maximum values were recorded on the palms that treated four times will all materials together. The control treatment produced the lowest values. Similar trend was noticed during both seasons.

Leaf content of N, P, K, Mg and Si:

Data in Table (1) clearly reveal that single and combined applications of boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 % significantly was very effective in enhancing N, P, K, Mg and Si in the leaves rather than non- application. The best material was boric acid followed by potassium silicate and Glutathione occupied the last position in this respect. Significant differences were observed on these nutrients among all treatments. Using the three materials together gave the maximum values. Control treatment produced the minimum values. Similar trend was observed during both seasons.

Yield and bunch weight:

Data in Tables (1 & 2) obviously reveal that yield and bunch weight were positively affected by single and combined application of boric acid, potassium silicate and Glutathione compared to non-application. The promotion was attributed to using boric acid, potassium silicate and Glutathione, in descending order. Combined applications were favourable than using each material alone in this respect. The maximum yield (216 and 224 kg) was presented on the palms that received four sprays of a mixture containing the three materials together. The minimum values (156.0 and 157.6 kg) were recorded on the control treatment during both seasons. These results were true during both seasons.

Physical and chemical characteristics of the fruits

It is worth to mention that single and combined applications of boric acid, potassium silicate and Glutathione was significantly very effective in improving quality of the fruits in terms of increasing fruit weight and dimensions (length & width), percentage of pulp, pulp/ seed, T.S.S as well as total and reducing sugars and reducing total acidity %, total soluble tannins % and total crude fibre % in relative to the check treatment. The present treatments had no significant effect on non- reducing sugar. The promotion on both physical and chemical characteristics of the fruits was correlated to using boric acid, potassium silicate and Glutathione, in descending order. A significant promotion on fruit quality was observed due to using combined applications of these materials rather than application of each material alone. The best results with regard to fruit quality were obtained with using the three materials together. Untreated palms produced unfavourable effects on quality of the fruits. These results were true during both seasons.

Table (2): Effect of single and combined applications of boric acid, Glutathione and potassium silicate on leaf area, total chlorophylls, percentages of N, P, K and Mg, Si content in the leaves and bunch weight of Zaghloul date palms during 2011 and 2012 seasons.

Treatment	Leaf area (m^2)		Total chlorophylls (mg/ g^{-1} F.W)		Leaf N %		Leaf P %		Leaf K %		Leaf Mg %		Leaf Si (mg/ g^{-1})		Bunch weight (g.)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Control	1.94	2.01	10.25	10.28	1.71	1.82	0.10	0.12	1.33	1.40	0.51	0.52	4.11	4.22	19.5	19.7
Boric acid at 0.05 %	2.10	2.16	11.80	11.71	1.93	2.04	0.24	0.25	1.41	1.50	0.63	0.63	4.30	4.41	23.0	23.9
Potassium silicate at 0.1 %	2.05	2.11	11.55	11.40	1.86	1.97	0.19	0.20	1.45	1.52	0.59	0.60	4.21	4.32	22.0	22.8
Glutathione at 0.1 %	1.99	2.06	11.00	11.05	1.78	1.89	0.15	0.17	1.39	1.46	0.55	0.56	4.16	4.27	21.0	22.0
Boric acid + potassium silicate	2.36	2.42	12.75	12.80	2.20	2.31	0.33	0.35	1.64	1.71	0.87	0.90	5.31	5.42	25.5	26.4
Boric acid + Glutathione	2.30	2.37	12.50	12.30	2.12	2.23	0.30	0.32	1.56	1.63	0.80	0.83	5.20	5.31	25.0	26.0
Potassium silicate +	2.18	2.25	12.22	11.99	2.02	2.13	0.27	0.30	1.50	1.57	0.71	0.75	4.90	5.01	24.0	25.0

Glutathione																
All	3.41	2.52	13.41	13.11	2.30	2.41	0.36	0.41	1.71	1.77	0.90	0.95	6.00	6.19	27.0	28.0
New L.S.D at 5 %	**0.04**	**0.05**	10.25	10.28	**0.05**	**0.06**	**0.03**	**0.04**	**0.04**	**0.05**	**0.04**	**0.03**	**0.09**	**0.08**	**0.9**	**1.0**

Table (3): Effect of single and combined applications of boric acid, Glutathione and potassium silicate on some physical and chemical characteristics of the fruits of Zaghloul date palms during 2011 and 2012 seasons.

Treatment	Yield/ palm (kg.)		Fruit weight (g.)		Fruit length (cm)		Fruit width (cm)		Pulp %		Seeds %		Pulp / seed	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
Control	156.0	157.6	21.0	20.9	5.41	5.51	2.69	2.70	78.5	79.0	21.5	21.0	3.7	3.8
Boric acid at 0.05 %	184.0	191.2	24.1	24.2	5.73	5.84	2.84	2.85	82.5	83.0	17.5	17.0	4.7	4.9
Potassium silicate at 0.1 %	176.0	182.4	23.1	23.2	5.61	5.71	2.79	2.80	81.1	81.4	18.9	18.6	4.3	4.4
Glutathione at 0.1 %	168.0	176.0	22.0	22.2	5.50	5.60	2.74	2.75	80.0	80.2	20.0	19.8	4.0	4.1
Boric acid + potassium silicate	204.0	211.2	27.5	28.0	5.91	6.03	3.00	3.02	86.5	87.0	13.5	13.0	6.4	6.7
Boric acid + Glutathione	200.0	208.0	26.3	26.5	5.81	5.92	2.95	2.97	85.3	86.0	14.7	14.0	5.8	6.1
Potassium silicate + Glutathione	192.0	200.0	25.1	25.2	5.74	5.84	2.90	2.91	84.0	84.5	16.0	15.5	5.3	5.5
All	216.0	224.0	29.0	29.6	6.05	6.17	3.11	3.15	90.5	91.0	9.5	9.0	9.5	10.1
New L.S.D at 5 %	**6.3**	**7.5**	**1.0**	**1.1**	**0.07**	**0.06**	**0.04**	**0.04**	**1.1**	**1.2**	**0.4**	**0.5**	**0.8**	**0.7**

4. Discussion

The present promoting effect of boron could be explained on the light of its positive action on cell division, biosynthesis and movement of sugars, pollen germination, uptake of water and nutrients and increasing the tolerance of plants to different disorders **(Nijjar, 1985).** The beneficial effects of both silicon and Glutathione on enhancing the tolerance of plants to all stresses due to increasing antioxidant defense systems as well as their important role in the biosynthesis of organic foods **(Levitt, 1980; Epstein, 1999 and Epstein and Bloom, 2003)** could explain the present results.

The results of **Ebeid- Sanaa (2007)** on B; **Abd El-aal *et al.*, (2012)** on Glutathione and **Gad El-Kareem (2012)** on Si emphasized the present results.

Table (4): Effect of single and combined applications of boric acid, Glutathione and potassium silicate on some chemical characteristics of the fruits of Zaghloul date palms during 2011 and 2012 seasons.

Treatment	T.S.S %		Total sugars %		Reducing sugars %		Non-reducing sugars %		Total acidity %		Total soluble Tannins %		Total crude fibre %	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
Control	26.0	26.7	20.0	20.9	13.3	13.5	6.7	7.4	0.451	0.444	0.69	0.64	0.84	0.86

Boric acid at 0.05 %	28.1	28.8	22.0	22.8	14.8	15.0	7.2	7.8	0.364	0.357	0.57	0.51	0.59	0.60
Potassium silicate at 0.1 %	27.4	28.1	21.3	22.2	14.1	14.3	7.2	7.9	0.390	0.383	0.63	0.58	0.66	0.67
Glutathione at 0.1 %	26.6	27.4	20.6	21.5	13.7	14.0	6.9	7.5	0.420	.0.413	0.66	0.61	0.72	0.73
Boric acid + potassium silicate	30.3	31.0	24.0	24.9	16.7	17.0	7.3	7.9	0.274	0.267	0.35	0.30	0.36	0.37
Boric acid + Glutathione	29.5	30.2	23.3	24.2	16.1	16.5	7.2	7.7	0.300	0.291	0.38	0.33	0.40	0.41
Potassium silicate + Glutathione	28.7	29.4	22.7	23.6	15.5	15.8	7.2	7.8	0.325	0.318	0.49	0.39	0.44	0.46
All	31.9	32.3	24.8	25.9	17.2	17.5	7.6	8.4	0.255	0.248	0.31	0.28	0.31	0.33
New L.S.D at 5 %	**0.6**	**0.7**	**0.5**	**0.4**	**0.3**	**0.4**	**NS**	**NS**	**0.021**	**0.024**	**0.02**	**0.02**	**0.04**	**0.05**

Conclusion

Treating Zaghloul date palms four times with a mixture containing boric acid at 0.05 %, potassium silicate at 0.1 % and Glutathione at 0.1 % gave good results with regard to yield and fruit quality.

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