RESPONSE OF KEITTE MANGO TREES TO SPRAYING GLUTATHIONE AND BORIC ACID

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ABSTRACT

During 2015 and 2016 seasons Keitte mango trees grown under Aswan climatic conditions were treated with glutathione and/or boric acid each at 0.025 to 0.1%. The merit was examining the effect of these treatments on growth, nutritional status, yield and quality of the fruits. The trees received three sprays on March, April and May.

Treating the trees three times with glutathione and/or boric acid each at 0.025 to 0.1% materially was accompanied with stimulating the leaf area, total chlorophylls, N, P, K, fruit retention%, yield as well as physical and chemical characteristics of the fruits relative to the control treatment. The promotion was related to the increase in concentrations. Combined applications were superior than using each material alone. Using boric acid was superior than glutathione in this respect.

Treating Keitte mango trees three times with a mixture of glutathione and boric acid each at 0.05% was necessary for producing higher yield and better fruit quality.

Keywords: Keitte mango, glutathione, boric acid, yield, fruit quality

INTRODUCTION

Yield decline of Keitte mango trees grown under sandy soil conditions is considered serious problem facing mango growers under Aswan region conditions. Previous studies emphasized the beneficial effects of using glutathione and boric acid on production of fruit crops.

Boron is very vital in promoting cell division, biosynthesis and translocation of sugars, leaf pigments, water and nutrient uptake, root development and the tolerance of fruit crops to biotic stress. The great importance of boron is appeared in enhancing fertilization of flowers and berry setting (**Epstein and Bloom, 2003**).

One sequence of the aerobic life from is the continuous formation of reactive oxygen species (ROS), a process enhanced by abiotic stress. ROS levels need to be controlled and various antioxidants have evoloved for this purpose. Glutathione (GSH) is involved in both the direct and the indirect control of ROS concentrations (**Szala *et al*., 2008**).

Glutathione ($C_{10}H_{17}$, N_3O_6S) is an important antioxidant in plants. It is capable of preventing damage to important cellular components caused by reactive oxygen species. It is a tripeptide comprised of three amino acids, cysteine, glutanic acid and glycine.

Glutathione is the most important non-protein thiol present in plants. It is essential in sulfur metabolism and defense against most stresses. It is important pool of reduced sulfur and it regulates sulfur uptake at root level. Reduced glutathione, the major water soluble antioxidant in photosynethetic and non-photothyentic tissues, reacting directly or indirectly with reactive oxygen species, contribute to maintain the integrity of cell structure and the proper functions of various metabolic pathways. In addition to its effects on expression of defense gene glutathione may also be involved in redox control of cell division and enhanced growth of plants (**Mullineaux and Rausch, 2005**).

Application of boron (**Abd El-Hameed, 2012; Ibrahim *et al*., 2014; Mohamed *et al*., 2015; Mohamed, 2016; Mahmoud, 2016 and Habasy-Randa *et al*., 2016**) and glutathione (**Gad El-Kareem, 2012; Abdelaal *et al*., 2012; Ahmed *et al*., 2012**; **Ahmed *et al*., 2013; El-Khawaga and Mansour, 2014; and Akl *et al*., 2017**) was very effective in enhancing growth, nutritional status of the trees, yield and fruit quality in different fruit crops species.

The target of this study was elucidating the effect of single and combined applications of boric acid and glutathione on fruiting of Keitte mango trees grown under sandy soil.

MATERIALS AND METHODS

This study was carried out during 2015 and 2016 seasons on thirty uniform in vigour 10-years old Keitte mango trees onto seedling rootstock and grown in sandy soil in a private orchard located at Kom Omboo district, Aswan Governorate. The selected trees are planted at 5 X 5 meters apart. Drip irrigation system was followed. The selected trees received the common horticultural practices that already applied in the orchard.

Table (1) shows the analysis of the tested soil (Wilde *et al*., 1985).

Constitute	Values
Sand %	84.9
Silt %	10.1
Clay %	6.0
Texture	Sandy
pH (1:2.5 extract)	8.0
E.C (1:2.5 extract, ppm)	550
$CaCO_3$%	4.1
O.M %	0.7
Total N %	0.03
Available P (ppm)	1.1
Available K (ppm)	90.0

This study included the following ten treatments:
1- Control
2- Spraying glutathione at 0.025%
3- Spraying glutathione at 0.05%
4- Spraying glutathione at 0.1%
5- Spraying boric acid at 0.025%
6- Spraying boric acid at 0.05%
7- Spraying boric acid at 0.1%
8- Spraying both at 0.025%
9- Spraying both at 0.05%
10 Spraying both at 0.1%

Each treatment was replicated three times, one tree per each. Both glutathione and boric acid were sprayed three times at the first week of Mar., Apr. and May using Triton B as a wetting agent at 0.05%and spraying was done till runoff.

Randomized complete block design (RCBD) was followed. The untreated trees sprayed with water containing Triton B.

During both seasons, the following measurements were recorded:

1- Leaf area in the Spring growth cycle (**Ahmed and Morsy, 1999**).

2- Leaf pigments namely chlorophyll a and b (as mg/100g F.W) for measuring total chlorophylls (**Von-Wettstein, 1957**).

3- Percentages of N, P and K in the non leaves of non-fruiting shoots on dry weight basis (**Summer, 1985 and Cottenie *et al.*, 1982**).

4- Percentage of fruit retention and yield per tree (kg).

5- Physical and chemical characteristics of the fruits namely fruit weight (g) and fruit firmness (Ib/inch^2), edible to non-edible portions. T.S.S.%, total acidity% (as g cetric/100ml juice), total and reducing sugars, (**Lane and Eynon, 1965**) (**A.O.A.C., 2000**).

Vitamin C (mg/100 ml juice) and total fibre % (**A.O.A.C.,** 2000).

Statistical analysis was done and the treatment means were compared using New L.S.D. at 5% (**Mead *et al.*, 1993**).

RESULTS AND DISCUSSION

1. Leaf area and its content of total chlorophylls, N, P and K:

It is clear from the data in Table (2) that treating Keitte mango trees three times with glutathione and/or boric acid each at 0.025 to 0.1% significantly stimulated the leaf area as well as total chlorophylls, N, P and K in the leaves relative to the control treatment. The promotion was associated with increasing concentrations. Using boric acid was significantly superior than using glutathione. Combined applications were significantly favourable than using each alone in this respect. No significant promotion on these parameters were observed with increasing concentrations from 0.05 to 0.1% from each material. The maximum values were recorded on the trees that

received both at 0.1%. Untreated trees produced the lowest values. These results were true during both seasons.

Table (2): Effect of spraying Glutathione and/or boric acid on the leaf area, total chlorophylls, N, P, K, fruit retention%, yield and fruit weight of Keitte mango trees during 2015 and 2016 seasons.

Treatments	Leaf area $(cm)^2$		Total chlorophylls (mg/100g F.W)		Leaf N %		Leaf P %		Leaf K %		Fruit retention%		Yield/tree (kg)		Fruit weight(g.)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	74.7	76.0	12.9	12.6	1.64	1.59	0.111	0.109	1.19	1.16	0.69	0.70	19.9	20.0	341.0	350.0
Glutathione at 0.025%	77.0	78.9	14.0	13.9	1.73	1.74	0.117	0.115	1.27	1.25	0.74	0.74	23.0	22.9	355.0	367.0
Glutathione at 0.05%	80.0	81.9	15.0	14.8	1.81	1.82	0.125	0.117	1.36	1.33	0.79	0.78	26.9	27.0	371.0	380.0
Glutathione at 0.01%	80.4	82.0	15.3	14.9	1.82	1.83	0.126	0.118	1.37	1.34	0.80	0.79	27.1	27.2	373.0	381.0
Boric acid at 0.025%	82.9	85.0	16.6	16.5	1.94	2.00	0.132	0.129	1.44	1.42	0.86	0.84	29.3	29.0	400.0	397.0
Boric acid at 0.05%	86.0	88.0	17.7	17.5	2.04	2.08	0.141	0.138	1.51	1.49	0.92	0.88	32.3	32.2	420.0	419.0
Boric acid at 0.01%	86.3	88.4	18.0	17.6	2.05	2.09	0.142	0.139	1.52	1.50	0.93	0.89	32.6	32.4	421.0	420.0
Both at 0.025%	88.0	90.0	18.9	18.7	2.15	2.25	0.159	0.157	1.59	1.55	0.96	0.94	36.0	36.1	450.0	449.9
Both at 0.05%	89.9	91.7	20.0	19.9	2.26	2.34	0.170	0.170	1.65	1.61	0.99	0.98	38.0	38.4	481.0	475.0
Both at 0.01%	90.0	92.0	20.2	20.1	2.27	2.35	0.171	0.171	1.66	1.63	1.00	0.99	38.1	38.5	485.0	476.0
New L.S.D at 5%	**1.4**	**1.6**	**0.7**	**0.9**	**0.06**	**0.08**	**0.003**	**0.004**	**0.06**	**0.04**	**0.03**	**0.04**	**1.9**	**2.1**	**11.1**	**10.7**

2. Percentage of fruit retention and yield/tree:

Data in table (2) clearly show that subjecting the trees to single and combined applications of glutathione and boric acid each at 0.025 to 0.1% significantly improved both fruit retention % and yield/tree compared to the control treatment. There was a gradual promotion on fruit retention and yield with increasing concentrations of glutathione and boric acid. Increasing concentrations of glutathione and boric acid each from 0.05 to 0.1% failed to show significant promotion on such two parameters. Combined applications were significantly preferable than using each alone in this respect. From economical point of view, it is recommended to use a mixture of glutathione and boric acid at 0.05%. Under such promised treatment yield reached 38.0 & 38.4 kg during both seasons, respectively. The untreated tree produced 19.9 and 20.0 kg during 2015 & 2016 seasons, respectively. The percentage of increment on the yield due to using the previous promised treatment over the control treatment reached 91.0 & 92.0 % during both seasons, respectively. These results were true during both seasons.

3. Physical and chemical characteristics of the fruits:

It is obvious from the data in Tables (2 & 3) that quality of the fruits was significantly improved due to treating the trees with glutathione and boric acid each 0.025 to 0.1% either alone or in combinations over the control. This promotion was appeared in terms of increasing fruit weight, edible to non-edible portions, T.S.S.%, total and reducing sugars and vitamin C and

decreasing total acidity% and total fibre%. The promotion on fruit quality was associated with increasing concentrations. Using boric Acid was significantly preferable than using glutathione. Combined applications were significantly superior than using each material alone in this respect. The best results were obtained due to using both materials together at 0.05% (since no considerable stimulation was observed among 0.05 and 0.1%). Untreated trees produced unfavourable promotion on these characteristics. Fruit firmness was unaffected by the present treatments. These results were true during both seasons.

Table (3): Effect of spraying Glutathione and/or boric acid on some physical and chemical characteristics of the fruit of Keitte mango trees during 2015 and 2016 seasons.

Treatments	Fruit firmness (pound/ Ib/inch2)		Edible to non-edible portions of fruit		T.S.S.%		Total acidity %		Total sugars %		Reducing sugars %		Vtamin C content (mg/100ml juice)		Total fibre %	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	34.1	34.2	2.1	2.2	9.4	9.5	0.889	0.879	7.1	6.9	3.0	2.9	39.9	41.0	1.11	1.20
Glutathione at 0.025%	34.3	34.4	2.6	2.7	9.7	10.0	0.870	0.860	7.4	7.4	3.3	3.3	41.9	43.0	1.04	1.13
Glutathione at 0.05%	34.4	34.5	3.0	3.1	10.1	10.4	0.850	0.840	7.7	7.8	3.6	3.5	44.0	45.5	0.97	1.04
Glutathione at 0.01%	34.5	34.5	3.1	3.2	10.2	10.5	0.849	0.839	7.8	7.9	3.7	3.6	44.3	46.0	0.96	1.03
Boric acid at 0.025%	34.6	34.5	3.6	3.7	10.6	11.0	0.820	0.822	8.1	8.2	4.0	4.1	46.9	48.0	0.92	0.97
Boric acid at 0.05%	34.7	34.6	4.0	4.1	11.0	11.5	0.791	0.781	8.4	8.6	4.3	4.4	49.0	49.9	0.87	0.92
Boric acid at 0.01%	34.7	34.7	4.1	4.2	11.1	11.6	0.790	0.780	8.5	8.7	4.4	4.5	49.3	50.0	0.86	0.91
Both at 0.025%	34.8	34.8	4.4	4.6	11.4	12.0	0.760	0.759	8.8	9.0	4.7	4.9	51.0	52.5	0.80	0.79
Both at 0.05%	35.0	34.9	4.7	5.0	12.0	12.5	0.741	0.730	9.1	9.3	5.0	5.2	52.9	54.0	0.74	0.70
Both at 0.01%	35.5	34.9	4.8	5.1	12.1	12.6	0.740	0.729	9.2	9.4	5.1	5.3	53.0	54.3	0.72	0.69
New L.S.D at 5%	**NS**	**NS**	**0.3**	**0.4**	**0.3**	**0.3**	**0.012**	**0.012**	**0.2**	**0.3**	**0.2**	**0.2**	**1.1**	**1.4**	**0.05**	**0.07**

DISCUSSION

Boron is responsible for enhancing growth, nutritional status of the trees, yield and fruit quality through its essential roles in enhancing cell division, biosynthesis of sugars and pigments, translocation of sugars enhancing fertilization of flowers, preventing the absorption of flowers, water and nutrient uptake, encouraging root development and enhancing the tolerance of plant to different disorders (**Epstein and Bloom, 2003**).

One sequence of the aerobic life form is the continuous formation of reactive oxygen species (ROS), a process enhanced by abiotic stresses. ROS levels need to be controlled for this purpose. Glutathione (GSH) is involved in both the direct and the indirect control of ROS concentrations (**Szala *et al.*, 2008**).

Glutathione is the most important non-protein thiol present in plants. It is essential in sulfur metabolism and defense against most stresses. It is important pool of reduced sulfur and it regulates sulfur uptake at root level.

Reduced glutathione, the major water soluble antioxidant in photosynethetic and non-photothyentic tissues, reacting directly or indirectly with reactive oxygen species, contribute to maintain the integrity of cell structure and the proper functions of various metabolic pathways. In addition to its effects on expression of defense gene glutathione may also be involved in redox control of cell division and enhanced growth of plants (**Mullineaux and Rausch, 2005**).

The promoting effect of boron on growth, yield and fruit quality of Keitte mango trees was emphasized by the results of **Ibrahim *et al*., (2014); Mohamed *et al*., (2015); Mohamed, (2016); Mahmoud, (2016) and Habasy-Randa *et al*., (2016)**.

The results of **Gad El-Kareem, (2012); Abdelaal *et al*., (2012); Ahmed *et al*., (2012)**; **Ahmed *et al*., (2013); El-Khawaga and Mansour, (2014); and Akl *et al*., (2017**) supported the present results regarding the effect of glutathione on growth and fruiting of Keitte mango trees.

CONCLUSION

Carrying out three sprays on March, April and May of a mixture containing glutathione and boric acid each at 0.05% was necessary for improving yield and fruit quality of Keitte mango trees grown under Aswan climatic conditions.

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الملخص العربى

استجابة أشجار المانجو الكيت لرش الجلوتاثيون وحامض البوريك

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تم خلال موسمى ٢٠١٥، ٢٠١٦ رش أشجار المانجو الكيت النامية تحت الظروف المناخية لمنطقة أسوان بالجلوتاثيون وحامض البوريك بالصورة الفردية والمشتركة بتركيز ما بين ٠.٠٢٥ إلي ٠.١% وكان الهدف اختبار تأثير هذه المعاملات علي النمو والحالة الغذائية وكمية المحصول وخصائص الجودة للثمار ولقد تم رش الأشجار ثلاث مرات فى مارس وأبريل ومايو.

أدى الاستخدام الفردى والمشترك للجلوتاثيون وحامض البوريك بتركيز ما بين ٠.٠٢٥ إلي ٠.١ % إلي حدوث تحسن واضح فى مساحة الورقة والكلوروفيل الكلى فى الورقة والنيتروجين والفوسفور والبوتاسيوم والنسبة المئوية للثمار المتبقية علي الشجرة وكمية المحصول والخصائص الطبيعية والكيميائية للثمار وذلك بالمقارنة بمعاملة الكونترول وكان التحسن متوافقا مع الزيادة فى التركيز المستخدم من هاتين المادتين كذلك كان الاستخدام المشترك أفضل من الاستخدام الفردى ولقد تفوق استخدام حامض البوريك عن رش الجلوتاثيون فى هذا الصدد.

إن معاملة أشجار المانجو الكيت ثلاث مرات بمخلوط يتكون من الجلوتاثيون وحامض البوريك بتركيز ٠.٠٥% لكل منهما يكون ضروريا لاعطاء كمية محصول مرتفعة وخصائص جودة عالية للثمار.

الكلمات الدالة: المانجو الكيت – الجلوتاثيون – حامض البوريك – كمية المحصول – خصائص الجودة للثمار