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RESPONSE OF TAIMOUR MANGO TREES TO APPLICATION OF THE ANTIOXIDANT GLUTATHIONE

A M. K. Abd El Aal[(1)], A. A. B. Masoud[(2)] and A. Y. Mohamed[(3)]

[(1)] Hort. Dept., Fac. of Agric. Minia Univ. Egypt.
[(2)] Hort. Dept., Fac. of Agric. Assiut Univ. Egypt.
[(3)] Tropical Fruits Research Dept. Hort. Res. Instit. ARC, Giza, Egypt.

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ABSTRACT: *During 2010 and 2011 seasons, Taimour mango trees received two, three or four sprays of Glutathione at 0.05, 0.1 and 0.2 % beside the control treatment.*

Results reveal that using Glutathione twice, thrice or four times at 0.05 to 0.1 % considerably was accompanied with stimulating the leaf area, leaf content of N, P, K and Mg, fruit retention %, yield/ tree, weight and thickness of fruit, edible to non- edible portions of fruit, pulp %, T.S.S %, total and reducing sugars and fruit vitamin C content and decreasing total acidity % in relative to the check treatment. The promotion was associated with increasing concentrations and frequencies of Glutathione. Negligible effect was detected on these parameters with increasing concentration from 0.1 to 0.2 % and frequencies from thrice to four times of Glutathione.

The best results with regard to yield and fruit quality of Taimour mango trees were obtained with spraying Glutathione thrice at 0.1 %.

Key words : *Mango, antioxidant, glutathione, yield, fruit quality .*

INTRODUCTION

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 photosynthetic and non- photosynthetic 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 genes, glutathione may also be involved in redox control of cell division and enhanced growth of plants (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 and Mullineaux and Rausch, 2005).

Yield decline is the major problem faces Taimour mango trees grown in sandy soil due to unsuitable environmental conditions.

The aim of the present work is to evaluate the influence of the antioxidant glutathione on fruiting of Taimour mango trees grown in sandy soils.

MATERIALS AND METHODS

This study was carried out during the two consecutive seasons of 2010 and 2011 seasons on thirty uniform in vigour 18- years old Taimour mango trees onto Balady mango seedling rootstock in a private orchard located at West Matay, Minia Governorate. The soil of the orchard is sandy, well drained and with water table depth not less than two meters. The chosen trees are planted at 5 × 5 meters apart. Drip irrigation system was followed. The selected trees were subjected to normal horticultural practices that are usually followed in the orchard except those concerning with the application of Glutathione or any antioxidants.

The present experiment included the following ten treatments from concentrations and frequencies of glutathione:-

1- Control (which the trees were sprayed with water).
2- Spraying glutathione at 0.05 % twice at spring growth cycle start (last week of

Feb.) and again just after fruit setting (mid. of April).

3- Spraying glutathione at 0.1 % twice as previously mentioned.
4- Spraying glutathione at 0.2 % twice as previously mentioned.
5- Spraying glutathione at 0.05 % thrice at spring growth cycle start, just after fruit setting and at one month later (mid. of May).
6- Spraying glutathione at 0.1 % thrice as previously mentioned.
7- Spraying glutathione at 0.2 % thrice as previously mentioned.
8- Spraying glutathione at 0.05 % four times at spring growth cycle start, just after fruit setting and at one month intervals (mid. of May and June).
9- Spraying glutathione at 0.1 % four times as previously mentioned.
10- Spraying glutathione at 0.2% four times as previously mentioned.

Each treatment was replicated three times, one tree per each. Triton B as a wetting agent at 0.05 % was added to all glutathione solutions before spray. Spraying was done till runoff (30 L/ tree). The control treatment was sprayed with water containing Triton B.

The experiment was set up in a completely randomized block design. Each treatment was replicated three times, one tree per each.

Twenty leaves from Spring growth cycle were chosen on four labeled branches (four shoots for each direction) for measuring the leaf area according to equation given by Ahmed and Morsy (1999). Leaf area (cm^2) = 0.70 (leaf length x leaf width) – 1.06.

Twenty mature leaves from non- fruiting shoots in the Spring growth cycle Summer (1985) were taken for the determination of N, P, K and Mg. Leaves were dried at 70 ° C and digested using H_2SO_4 and H_2O_2 (Chapman and Pratt, 1965). In the digestion, percentages of N, P, K and Mg were determined according to the procedures that outlined by Chapman and Pratt (1965).

Percentage of fruit retention was estimated by dividing the number of fruits retained on each tree just before harvesting by total number of flowers and multiplying the product by 100.

Harvesting was made at the second week of July in the two seasons. Yield expressed in weight (kg.) per tree was recorded. Ten fruits from each tree were taken for determination of the following physical and chemical characteristics. These include, fruit weight (g.) and thickness (cm.), percentage of pulp, edible to non edible portions of the fruit, percentage of total soluble solids, percentage of total acidity (as g citric acid/ 100 ml juice) (according to A.O.A.C., 1995), percentages of total and reducing sugars were determined by Lane and Eynon volumetric method outlined in A.O.A.C. (1995) and ascorbic acid content in the juice (as mg/ 100 ml juice) by titration against 2 , 6 dichloro phenol endophenol (A.O.A.C., 1995).

All the obtained data were tabulated and statistically analyzed using New L.S.D. parameter for made all comparisons among different treatment means according to Mead *et al*., (1993).

RESULTS AND DISCUSSION

1- Effect of different concentrations and frequencies of Glutathione on the leaf area and its contents of N, P, K and Mg.

Data in Tables (1& 2) clearly show that spraying of Glutathione twice, thrice or four times at 0.05 to 0.2 % significantly was accompanied with stimulating the leaf area and its content of N, P, K and Mg in relative to the Check treatment. Significant differences on these parameters were observed among all concentrations and frequencies of Glutathione except among the higher two concentrations (0.1 and 0.2) and frequencies (thrice and four times). There was a gradual and significant promotion on the leaf area and these nutrients with increasing concentrations and frequencies of Glutathione. The maximum values were recorded on the trees that received four sprays of Glutathione at 0.2 %.

The untreated trees had the lowest values. These results were true during 2010 and 2011 seasons.

The beneficial effect of Glutathione on enhancing cell division as well as increasing the tolerance of plants to different stresses could result in enhancing growth and nutritional status of the tree (Dekok and Stulen, 1993; Foyer *et al*., 1997 and Tausz and Grill, 2000).

These results are in agreement with those obtained by Meister and Anderson (1983) and Jorge *et al*., (1993).

Table (1): Effect of different concentrations and frequencies of Glutathione on leaf area (cm^2) and percentages of N, P and K in the leaves of Taimour mango trees during 2010 and 2011 seasons.

Treatment	Leaf area (cm^2)		Leaf N %	
	2010	2011	2010	2011
Control	60.5	61.2	1.71	1.82
Glutathione at 0.05 % twice.	61.8	62.5	1.80	1.86
Glutathione at 0.1 % twice.	63.0	63.7	1.89	1.95
Glutathione at 0.2 % twice.	63.2	64.0	1.90	1.96
Glutathione at 0.05 % thrice.	64.0	64.8	1.97	2.03
Glutathione at 0.1 % thrice.	69.0	69.9	2.05	2.10
Glutathione at 0.2 % thrice.	69.5	70.0	2.07	2.11
Glutathione at 0.05 % four times.	64.2	65.0	1.98	2.04
Glutathione at 0.1 % four times.	69.3	70.0	2.06	2.11
Glutathione at 0.2 % four times.	69.8	70.4	2.08	2.12
New L.S.D at 5 %	1.0	0.9	0.05	0.06
Character	Leaf P %		Leaf K %	
Control	0.18	0.19	1.41	1.43
Glutathione at 0.05 % twice.	0.21	0.22	1.47	1.48
Glutathione at 0.1 % twice.	0.24	0.25	1.55	1.54
Glutathione at 0.2 % twice.	0.25	0.26	1.56	1.55
Glutathione at 0.05 % thrice.	0.28	0.29	1.64	1.60
Glutathione at 0.1 % thrice.	0.33	0.36	1.71	1.66
Glutathione at 0.2 % thrice.	0.34	0.36	1.72	1.67
Glutathione at 0.05 % four times.	0.29	0.30	1.65	1.61
Glutathione at 0.1 % four times.	0.33	0.37	1.72	1.67
Glutathione at 0.2 % four times.	0.34	0.37	1.73	1.68
New L.S.D at 5 %	0.02	0.03	0.04	0.04

Table (2): Effect of different concentrations and frequencies of Glutathione on the percentage of Mg in the leaves, fruit retention %, yield per tree (kg.) and fruit weight (g.) of Taimour mango trees during 2010 and 2011 seasons.

Treatment	Leaf Mg %		Fruit retention %	
	2010	2011	2010	2011
Control	0.41	0.44	0.55	0.58
Glutathione at 0.05 % twice.	0.46	0.50	0.64	0.66
Glutathione at 0.1 % twice.	0.50	0.55	0.70	0.72
Glutathione at 0.2 % twice.	0.51	0.56	0.71	0.73
Glutathione at 0.05 % thrice.	0.55	0.61	0.78	0.80
Glutathione at 0.1 % thrice.	0.60	0.65	0.85	0.87
Glutathione at 0.2 % thrice.	0.61	0.66	0.86	0.88
Glutathione at 0.05 % four times.	0.56	0.62	0.79	0.81
Glutathione at 0.1 % four times.	0.61	0.65	0.86	0.88
Glutathione at 0.2 % four times.	0.62	0.66	0.87	0.89
New L.S.D at 5 %	0.03	0.03	0.06	0.06
Character	Yield/ tree (kg.)		Fruit weight (g.)	
Control	57.0	55.0	199.5	200.0
Glutathione at 0.05 % twice.	61.0	61.8	208.9	209.4
Glutathione at 0.1 % twice.	67.0	68.0	218.0	218.6
Glutathione at 0.2 % twice.	67.5	68.5	219.0	219.7
Glutathione at 0.05 % thrice.	71.0	72.0	228.0	229.0
Glutathione at 0.1 % thrice.	75.0	75.5	237.0	238.3
Glutathione at 0.2 % thrice.	75.5	75.9	237.0	238.5
Glutathione at 0.05 % four times.	71.5	72.5	228.5	230.0
Glutathione at 0.1 % four times.	75.5	76.0	237.6	239.0
Glutathione at 0.2 % four times.	76.0	76.0	238.0	239.0
New L.S.D at 5 %	3.0	3.1	7.7	8.0

2- Effect of different concentrations and frequencies of Glutathione on fruit retention % and Yield per tree:

It is evident from the data in Table (2) that carrying out two, three or four sprays of Glutathione at 0.05 to 0.2 % significantly improved fruit retention % and yield/ tree rather than unspraying. The promotion was associated with increasing concentrations from 0.0 to 0.2 % and frequencies from twice to four times. Meaningless promotion on fruit retention % and yield were observed with increasing concentrations of Glutathione from 0.1 to 0.2 and frequencies from thrice to four times. From economical point of view, spraying Taimour mango trees thrice with Glutathione at 0.1 % gave the best results with regard to yield. Under such promised treatment, yield reached 75 and 75.5 kg per

tree during 2010 and 2011 seasons, respectively. The untreated trees produced 57 and 55 kg per tree during both seasons. The percentage of increase on the yield due to application of the previous promised treatment reached 31.6 and 37.3 % over the check treatment during both seasons. Similar results were announced during the two seasons.

The promoting effect of Glutathione on growth and nutritional status in favour of producing more fruits (fruit retention) could explain the present results.

These results are in agreement with those obtained by Meister and Anderson (1983) and Jorge *et al*., (1993).

3- Effect of different concentrations and frequencies of Glutathione on some physical and chemical characteristics of the fruits:

It is noticed from the data in Tables (2, 3 & 4) that foliar application of Glutathione twice, thrice or four times at 0.05 to 0.2 % significantly improved fruit quality in terms of increasing fruit weight, fruit thickness, pulp %, edible to non- edible portions, total soluble solids %, total and reducing sugars and vitamin C content and decreasing total acidity % comparing with the check treatment. The promotion on fruit quality was associated with increasing concentrations and frequencies of Glutathione. Increasing concentrations from 0.1 to 0.2 % as well as frequencies from thrice to four times had negligible promotion on quality of the fruits. The best results were obtained with using Glutathione at 0.1 % thrice. Unfavourable effects were recorded on untreated trees. These results were true during both seasons.

Table (3): Effect of different concentrations and frequencies of Glutathione on some physical and chemical characteristics of the fruits of Taimour mango trees during 2010 and 2011 seasons.

Treatment	Fruit thickness (cm.)		Pulp %	
	2010	2011	2010	2011
Control	5.0	5.1	69.1	69.2
Glutathione at 0.05 % twice.	5.4	5.5	70.2	70.7
Glutathione at 0.1 % twice.	5.9	5.9	71.9	72.4
Glutathione at 0.2 % twice.	6.0	6.1	72.0	72.4
Glutathione at 0.05 % thrice.	6.5	6.4	73.1	73.5
Glutathione at 0.1 % thrice.	7.1	6.8	74.9	75.1
Glutathione at 0.2 % thrice.	7.1	6.9	75.0	75.1
Glutathione at 0.05 % four times.	6.5	6.5	73.1	73.5
Glutathione at 0.1 % four times.	7.2	6.9	75.0	75.1
Glutathione at 0.2 % four times.	7.2	6.9	75.2	75.2
New L.S.D at 5 %	0.3	0.3	1.0	1.1
Character	Edible/ non- edible portions		T.S.S %	
Control	1.9	1.9	15.0	15.0
Glutathione at 0.05 % twice.	2.2	2.2	15.3	15.3
Glutathione at 0.1 % twice.	2.6	2.7	15.6	15.7
Glutathione at 0.2 % twice.	2.6	2.8	15.6	15.8
Glutathione at 0.05 % thrice.	2.9	3.2	16.0	16.1
Glutathione at 0.1 % thrice.	3.2	3.6	16.4	16.6
Glutathione at 0.2 % thrice.	3.2	3.6	16.5	16.6
Glutathione at 0.05 % four times.	2.9	3.2	16.0	16.1
Glutathione at 0.1 % four times.	3.2	3.6	16.5	16.6
Glutathione at 0.2 % four times.	3.2	3.6	16.6	16.6
New L.S.D at 5 %	0.3	0.3	0.3	0.3

Table (4): Effect of different concentrations and frequencies of Glutathione on some chemical characteristics of the fruits of Taimour mango trees during 2010 and 2011 seasons.

Treatment	Total sugars %		Reducing sugars %	
	2010	2011	2010	2011
Control	11.5	11.8	2.9	3.1
Glutathione at 0.05 % twice.	12.0	12.3	3.2	3.4
Glutathione at 0.1 % twice.	12.4	12.8	3.5	3.8
Glutathione at 0.2 % twice.	12.5	12.9	3.5	3.8
Glutathione at 0.05 % thrice.	12.9	13.4	3.7	4.2
Glutathione at 0.1 % thrice.	13.5	13.9	3.9	4.6
Glutathione at 0.2 % thrice.	13.5	14.0	4.0	4.6
Glutathione at 0.05 % four times.	13.0	13.5	3.7	4.3
Glutathione at 0.1 % four times.	13.5	14.0	4.0	4.7
Glutathione at 0.2 % four times.	13.5	14.0	4.0	4.7
New L.S.D at 5 %	0.4	0.4	0.3	0.3
Character	Total acidity %		Ascorbic acid (mg/ 100 ml juice)	
Control	0.450	0.466	32.3	33.3
Glutathione at 0.05 % twice.	0.420	0.444	33.6	34.0
Glutathione at 0.1 % twice.	0.399	0.420	35.0	35.5
Glutathione at 0.2 % twice.	0.397	0.417	35.3	35.6
Glutathione at 0.05 % thrice.	0.371	0.390	37.0	37.7
Glutathione at 0.1 % thrice.	0.350	0.360	39.0	40.0
Glutathione at 0.2 % thrice.	0.347	0.357	39.5	40.5
Glutathione at 0.05 % four times.	0.370	0.388	37.3	38.0
Glutathione at 0.1 % four times.	0.349	0.357	39.4	40.3
Glutathione at 0.2 % four times.	0.346	0.355	40.0	40.6
New L.S.D at 5 %	0.18	0.19	0.9	0.9

The promoting effect of Glutathione on enhancing plant pigments, cell division and the biosynthesis of carbohydrates could result in advancing maturity (Meister and Anderson, 1983).

These results are in agreement with those obtained by Meister and Anderson (1983) and Jorge *et al*., (1993).

As a conclusion, treating Taimour mango trees three times (growth start, just after fruit setting and one month later) with glutathione at 0.1 % is suggested to be beneficial for improving the yield quantitively and qualitatively.

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"استجابة أشجار المانجو التيمور لإستخدام مضاد الأكسدة الجلوتاثيون"

أحمد محمد كمال عبد العال[١] ، علاء عبد الجابر بدوي مسعود[٢] ، أحمد يس محمد[٣]

[١] قسم البساتين – كلية الزراعة – جامعة المنيا – مصر.

[٢] قسم البساتين – كلية الزراعة – جامعة أسيوط – مصر.

[٣] قسم الفاكهة الإستوائية – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر.

الملخص العربي

خلال موسمي ٢٠١٠ ، ٢٠١١ تم رش أشجار المانجو التيمور مرتين، ثلاثة أو أربعة مرات بالجلوتاثيون بتركيز ٠.٠٥ ، ٠.١ ، ٠.٢ % بالإضافة إلي معاملة الكونترول

أشارت نتائج الدراسة إلي أن استخدام الجلوتاثيون مرتين وثلاثة أو أربعة مرات بتركيز ما بين ٠.٠٥ إلي ٠.٢ % يكون مصحوبا بتحسن ملحوظ في مساحة الورقة ومحتوي الورقة من عناصر النيتروجين والبوتاسيوم والفوسفور والماغنيسيوم والنسبة المئوية للثمار الباقية علي الشجرة وكمية المحصول للشجرة ، وزن وسمك الثمرة والنسبة ما بين الجزء الصالح للأكل والغير صالح، النسبة المئوية للب والنسبة المئوية للمواد الصلبة الذائبة الكلية والنسبة المئوية للسكريات الكلية والمختزلة ومحتوي الثمرة من فيتامين ج ونقص النسبة المئوية للحموضة الكلية وذلك مقارنة بمعاملة الكونترول. وكان التحسن مرتبطا بزيادة تركيزات وعدد مرات رش الجلوتاثيون وكان التأثير طفيفا علي هذه المقاييس عند زيادة التركيز المستخدم من ٠.١ إلي ٠.٢ % وعدد مرات الرش من ثلاثة إلي اربعة من الجلوتاثيون.

أمكن الحصول علي أفضل النتائج بخصوص كمية المحصول وخصائص الجودة للثمار في أشجار المانجو التيمور عند رش الجلوتاثيون ثلاثة مرات بتركيز ٠.١ %.