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Impact of Seaweed Extract as A Partial Replacement of Mineral N Fertilizers on Fruiting of Taimour Mango Trees

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THIS STUDY was carried out during 2013 and 2014 seasons to examine the effect of foliar application of seaweed extract four times at 1 to 8% as an alternative to mineral N fertilizers on growth, plant pigments, nutrients, namely N,P,K,Mg, Zn, Fe, Mn and Cu in the leaves, yield and fruit quality of 'Taimour' mango trees. mineral N (1000 g N/ tree / year) was added at percentages 0.0 to 100% as inorganic source in the form of amonnium nitrate

Using the 50 to 75% mineral N source plus 1 to 2% seaweed extract gave good results on all the studied parameters comparing with using N as 100% mineral as well as when inorganic N was added at 0.0 or 25%?. Applying only inorganic was superior than not applying mineral N even when foliar application of seaweed extract at 8% was applied. The increasing content of the investigated parameters was significantly related to the reduction of mineral N percentage from 100 to 0.0 % and at the same time to increasing concentrations of seaweed extract from 0.0 to 8%. The results obtained in the present study indicates that four application of seaweed extract at 2% to Taimour mango trees , plus reduction of inorganic N fertilizers by 50% gave the best results regarding yield and fruit quality

Keywords: Mango, Yield, Fruit quality, Nutrition,

Poor yield in mango cv. Taimour grown under Minia Region conditions is considered as a major problem that faces mango growers in such area. Unbalanced malnutrition as well as unsuitable environmental conditions are considered the main causes for decline on the yield. Most studies carried out recently emphasized the beneficial effects of controlling N uptake as well as application of seaweed extract on checking this serious problem. For avoiding the use of chemicals, application of natural products was arisen. (Cabrera *et al*., 2003). Application of seaweed extract as an organic biostimulant is quickly becoming an accepted practice in fruit orchards. It has been used as a soil conditioner and slow release fertilizer for over a century. It derives from *Ascophyllum nedosum* algae and has many important regularly roles in plants such as controlling different disorders as well as improving growth and fruiting due to its higher content of N, P, K, Mg, vitamins B_1, B_2, B_6 and cytokinins (Fornes *et al*., 2002, Khanszada *et al*., 2007 and Khan *et al*., 2009).

The studies carried out by Mouftah (2007), Mohamed *et al*. (2008), Mahmoud (2012) and Abdelaal *et al*. (2012) emphasized the beneficial effects of applying different sources of N on fruit crops rather than using ammonium nitrate alone.

Spraying seaweed extract to different fruit crops has been. found to improve yield and fruit quality by many researchers Gobara (2004), Hegab and Shaarawy (2005), Ebeid – Sanaa (2007), Ahmed *et al*. (2008), Abd El-Motty- Elham *et al*. (2010), El-Sayed- Esraa (2010), Mohamed and El- Sherawy (2013) and Gamal (2013).

The target of this study was examining the effect of partially replacing mineral N by spraying seaweed extract on yield of Taimour mango trees.

Material and Methods

This study was conducted during 2013 and 2014 seasons on 15 uniform in vigour 12-years old Taimour mango trees grafted onto polyembryonic mango seedling rootstocks in a private orchard located at Minia district, Minia Governorate, Upper Egypt. The texture of the soil was clay. The analysis of the soil where the trees are planted was carried out according to the procedures outlined by Wilde *et al*. (1985) and indicates a clay texture (Table 1)

TABLE 1. Analysis of the soil

Constituent	Values
Sand %	4.2
Silt %	12.0
Clay %	83.8
Texture	Clay
O.M. %	2.1
pH (1: 2.5 extract)	7.63
EC (1: 2.5 extract) mmhos/ 1 cm 25°C	0.81
$CaCO_3$%	1.52
Total N %	0.10
Available P (olson method , ppm)	5.2
Available K (ammonium acetate, ppm)	420

The trees are planted at 7x7 meters apart with water provided through surface irrigation. The trees were subjected to the standard horticultural practices for mango cultivation except those dealing with the application of N at different sources as well as seaweed extract.

This study included the following five treatments:

- Application of the N (1000 g N/ tree / year) via 100% inorganic N (2985.1 g ammonium nitrate / tree / year).
- Application of the N via 75 % inorganic (2238.8 g ammonium nitrate / tree / year) + spraying seaweed extract at 1%
- Application of the N via 50 % inorganic (1492.5 g ammonium nitrate / tree / year) + spraying seaweed extract at 2 %

- Application of the N via 25 % inorganic (746.3 g ammonium nitrate / tree / year) + spraying seaweed extract at 4 %
- Application of the N via 0.0 % inorganic N + spraying seaweed extract at 8 %

Each treatment was replicated three times, one tree for each. Ammonium nitrate fertilizer (33.5 % N) as a source of mineral N was divided into three equal batches applied at March, April and May during both seasons. Seaweed extract (Table 2) was sprayed four times at the last week of Feb. and at 21 days intervals. Triton B as a wetting agent was added at 0.05 % to all seaweed extract solutions and spraying was done till runoff. Randomized complete block design was followed.

TABLE 2. Chemical analysis of seaweed extract (Algae 600 seaweed)

Constituents	Values
Organic matter %	45
Total N %	0.6
P %	6
K %	20
Amino acids	4
Mg	0.06
Ca	1.0
Fe	0.3
S %	1.0
Cu (ppm)	30
Appearance	Brownish powder

Twenty leaves from Spring growing cycle were chosen on the medium of four labeled branches (four shoots for each direction) for measuring the leaf area according to Ahmed and Morsy (1999**)**. In these fresh leaves, chlorophylls a & b and total chlorophylls (mg / 100 g F.W.) were recorded according to the technique by Von- Wettstein (1957). Following the procedure recommended by Summer (1985) twenty six months mature leaves from non- fruiting shoots in the Spring growth cycle (were taken (1^{st} week of Sept.) for determination of N, P, K, Mg and Ca (as %) and Zn, Fe, Mn and Cu (as ppm), Fruit retention %, number of fruits / tree, yield per tree (kg.), fruit weight (g.), T.S.S. %, total acidity (as citric acid/ 100 ml juice), total and reducing sugars % , crude fibre % was also determined following the official methods of analysis (A.O.A., 2000) **.**Nitrate and nitrite concentrations were also measured (ppm) in the fruit juice following the procedures set by Ridnour- Lisa, *et al*. (2000).

Statistical analysis was done according to Mead *et al*., (1993) and treatments were compared using new L.S.D. at 5%.

Results and Discussion

Effect of using seaweed extract as a partial replacement of inorganic N fertilizer on leaf area.

Data in Table 3 clearly show that supplying the trees with N as 50 to 75% inorganic plus spraying the trees four times with seaweed extract at 2% significantly stimulated the leaf area relative to using inorganic N at percentages lower than 50% over with the application of seaweed extract at 4% to 8% or when inorganic N was added at 100% of the inorganic N. Using N as 100% inorganic significantly was followed by enhancing the leaf area rather than using N as 0.0 to 25% inorganic plus spraying seaweed extract at 4 to 8%. The maximum leaf area was recorded on the trees that received N as 50% inorganic N plus carrying out four sprays of seaweed extract at 2%. The trees sprayed with seaweed extract four times at 4% without inorganic N fertilization gave the minimum values. These results were true during both seasons.

Effect of using seaweed extract as a partial replacement of inorganic N fertilizer on leaf chemical composition.

Data in Tables 3 & 4 clearly show that plant pigments namely chlorophylls a & b , total chlorophylls and mineral elements like N, P, K, Mg, Ca, Zn, Fe , Mn and Cu in the leaves were significantly improved in response to fertilizing the trees with N as 0.0 to 75% inorganic plus spraying the trees four times with seaweed extract at 1 to 8 % relative to using N via inorganic N alone. The increases in concentrations of these parameters were significantly associated with reducing inorganic N percentages from 100 to 0.0 % and at the same time increasing percentages of seaweed extract from 0.0 to 8%. The maximum values were recorded on the trees that received four sprays of seaweed extract at 8 % only. The trees received N as 100 % inorganic N gave the lowest values. These results were true during both seasons.

Effect of using seaweed extract as a partial replacement of inorganic N fertilizer on fruit retention and yield.

It is clear from the data in Table that using N as 50 to 75% in organic as well as spraying seaweed extract at 1 to 2 % significantly improved fruit retention as well as yield expressed in number of fruits / tree and weight (kg.) relative to the application of N as 100% inorganic or when N was added as 0.0 to 25% inorganic N even with the application of seaweed extract at 4 to 8%. A significant decline on the fruit retention % and yield was observed when inorganic N percentage was lowered to 0.0 to 25% inorganic under the application of seaweed extract at 4 to 8%. Using N as 100% inorganic was significantly superior than using it as 0.0 to 25% inorganic even with the application of seaweed extract at 4 to 8%. The best results with regard to yield were obtained with using N as 50% inorganic + spraying seaweed extract four times at 2%. Under such promised treatment, yield per tree reached 38.6 and 39.6 kg compared with the yield of the trees received N as 100% inorganic that reached 27.5 and 28.2 kg during both seasons, respectively. The percentage of increase in yield due to using the previous treatment over the check treatment reached 40.4 during both seasons.

TABLE 3. Effect of replacing partially mineral N fertilization by using seaweed extract on the leaf area, plant pigments as well as percentages of N,P,K and Mg in the leaves of Taimour mango trees during 2013and 2014 seasons.

Treatment	Leaf area $(cm)^2$		chlorophyll a (mg/ 100 g F.W.)		Chlorophyll b (Mg/100 g F.W.)		Total chlorophylls (Mg/100 g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014
N as 100 % M.N.	80.0	81.2	8.1	8.3	3.3	3.4	11.4	11.7
N as 75% MN + 1 % seaweed	84.0	85.7	8.7	9.0	3.5	3.7	12.2	12.7
N as 50 % MN + 2 % seaweed	87.0	88.9	9.5	10.0	4.0	4.0	13.5	14.0
N as 25 % MN + 4 % seaweed	77.6	78.0	10.0	11.2	4.3	4.4	14.3	15.6
N as 0.0 % MN + 8 % seaweed	75.3	76.0	11.9	11.9	4.6	4.7	16.5	16.6
New L.S.D. at 5%	1.0	1.0	0.3	0.3	0.2	0.2	0.4	0.4
Treatment	**Leaf N %**		**Leaf P %**		**Leaf K %**		**Leaf Mg %**	
	2013	2014	2013	2014	2013	2014	2013	2014
N as 100 % M.N.	1.61	1.64	0.18	0.17	1.33	1.32	0.51	0.52
N as 75% MN + 1 % seaweed	1.71	1.76	0.22	0.21	1.40	1.40	0.55	0.56
N as 50 % MN + 2 % seaweed	1.80	1.86	0.26	0.25	1.47	1.46	0.60	0.61
N as 25 % MN + 4 % seaweed	1.88	1.92	0.30	0.29	1.55	1.52	0.65	0.66
N as 0.0 % MN + 8 % seaweed	1.95	2.01	0.35	0.33	1.62	1.63	0.71	0.71
New L.S.D. at 5%	0.06	0.07	0.03	0.03	0.05	0.04	0.03	0.03

M.N. = Mineral N

TABLE 4. Effect of replacing partially mineral N fertilization by using seaweed extract on the leaf content of Ca(as %) , Zn, Fe and Mn and Cu (as ppm) , fruit retention (as %) and yield per tree of Taimour mango trees during 2013and 2014 seasons.

Treatment	Leaf Ca %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
	2013	2014	2013	2014	2013	2014	2013	2014
N as 100 % M.N.	2.33	2.22	49.5	50.0	52.5	53.0	52.9	54.0
N as 75% MN + 1 % seaweed	2.41	2.50	54.0	55.0	55.5	56.0	55.0	57.0
N as 50 % MN + 2 % seaweed	2.51	2.61	58.0	59.0	59.0	60.0	58.0	60.0
N as 25 % MN + 4 % seaweed	2.64	2.74	62.3	64.0	62.0	64.0	61.0	62.5
N as 0.0 % MN + 8 % seaweed	2.81	2.91	66.0	67.3	65.6	67.0	64.3	65.0
New L.S.D. at 5%	0.07	0.07	2.5	2.3	2.2	2.1	1.9	2.0
Treatment	**Leaf Cu (ppm)**		**Fruit retention %**		**No. of fruits / tree**		**Yield/tree (kg.)**	
	2013	2014	2013	2014	2013	2014	2013	2014
N as 100 % M.N.	1.22	1.17	0.76	0.75	130.0	133.0	27.5	28.2
N as 75% MN + 1 % seaweed	1.26	1.22	0.84	0.86	145.0	148.0	32.9	33.7
N as 50 % MN + 2 % seaweed	1.31	1.27	0.94	0.97	160.0	163.0	38.6	39.6
N as 25 % MN + 4 % seaweed	1.36	1.33	0.71	0.69	120.0	123.0	31.4	32.5
N as 0.0 % MN + 8 % seaweed	1.41	1.40	0.66	0.62	110.0	112.0	30.5	31.5
New L.S.D. at 5%	0.03	0.04	0.04	0.04	8.0	7.0	0.8	0.8

M.N. = Mineral N

Effect of using seaweed extract as a partial replacement of inorganic N fertilizer on fruit quality

Data in Table 5 clearly show that supplying the trees with N as 0.0 to 75% inorganic plus seaweed extract at 1 to 8% significantly improved fruit quality in terms of increasing fruit weight, T.S.S. %, total and reducing sugars % and decreasing total acidity %, crude fibre %, nitrate and nitrite in the juice relative to using N, completely via inorganic N alone. The promotion on fruit quality was significantly associated with reducing percentages of inorganic N from 100 to 0.0% and at the same time increasing concentrations of seaweed extract from 0.0 to 8%. The best results with regard to fruit quality were observed with using four sprays of seaweed extract at 8% with the neglection of using inorganic N. Unfavourable effects on fruit quality were observed on the trees that fertilized with N completely via inorganic N. These results were true during both seasons.

The higher own content of seaweed extract from essential nutrients namely N, P, K, Mg, Ca, Fe and Cu as well as amino acids (see table 3), as well as vitamins B, antioxidants, organic acids and fats, as well as its benefits as a soil conditions and natural fungicides for controlling different disorders indicated by other researchers , (Ito and Hori, 1989, Fornes *et al*., 2005 , Khanszada *et al*.,

2007 and Khan *et al*., 2009) could explain its positive action on growth and fruiting of Taimour mango trees.

TABLE 5. Effect of replacing partially mineral N fertilization by using seaweed extract on some physical and chemical characteristics of the fruits of Taimour mango trees during 2013and 2014 seasons.

Treatment	Fruit weight (g.)		T.S.S. %		Total acidity %		Total sugars %	
	2013	2014	2013	2014	2013	2014	2013	2014
N as 100 % M.N.	211.9	212.3	14.2	14.0	0.303	0.299	11.1	10.8
N as 75% MN + 1 % seaweed	227.0	228.0	14.5	14.5	0.281	0.261	11.4	11.3
N as 50 % MN + 2 % seaweed	241.0	243.0	14.7	14.9	0.260	0.226	11.7	11.7
N as 25 % MN + 4 % seaweed	262.0	264.0	15.0	15.3	0.240	0.201	12.0	12.0
N as 0.0 % MN + 8 % seaweed	277.0	281.0	15.3	15.7	0.201	0.183	12.3	12.3
New L.S.D. at 5%	11.0	11.2	0.2	0.2	0.020	0.022	0.2	0.2
Treatment	**Reducing sugars %**		**Crude fibre %**		**Nitrite (ppm)**		**Nitrate (ppm)**	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
N as 100 % M.N.	3.1	3.0	1.00	0.92	3.00	3.00	7.11	6.97
N as 75% MN + 1 % seaweed	3.3	3.3	0.84	0.80	2.11	2.11	5.00	4.97
N as 50 % MN + 2 % seaweed	3.6	3.6	0.71	0.66	1.92	1.88	4.11	3.91
N as 25 % MN + 4 % seaweed	4.0	3.9	0.60	0.50	1.41	1.31	3.19	3.00
N as 0.0 % MN + 8 % seaweed	4.2	4.3	0.41	0.32	1.00	0.97	2.00	1.99
New L.S.D. at 5%	0.2	0.2	0.09	0.10	0.04	0.03	0.04	0.04

M.N. = Mineral N

These results are in harmony with those obtained by Gobara (2004), Hegab and Sharawy (2005), Ebeid- Sanaa (2007), Ahmed *et al*. (2008), El- Sayed-Esraa (2010) and Gama (2013). The results of Mouftah (2007), Mohamed *et al*. (2008), Mahmoud (2012) and Abdelaal *et al*. (2012) emphasized the possibility of using seaweed extract as a partial replacement of inorganic N fertilizer.

Conclusion

Under the condition of this experiment it was found that in order to improve yield and quality of Taimour mango trees it is suggested to fertilize the trees with N (1000 g / tree / year) via 50% inorganic plus spraying the trees four times with seaweed extract at 2%.

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تأثير مستخلص الأعشاب البحرية كبديل جزئى للأسمدة النتروجينية المعدنية علي الاثمار في أشجار المانجو التيمور

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أجريت هذه الدراسة خلال موسمى ٢٠١٣/ ٢٠١٤ لاختبار تأثير الرش الورقى لمستخلص الأعشاب البحرية أربعة مرات بتركيز ١ الى ٨ ٪ كبديل جزئى للاسمدة النتروجينية المعدنية على النمو، الصبغات النباتية ، العناصر الغذائية وهى النتروجين، والفوسفور والبوتاسيوم والماغنسيوم والزنك والحديد والمنجنيز والنحاس فى الأوراق وكمية المحصول وخصائص الجودة لأشجار المانجو التيمور، ولقد تم استخدام الكمية الموصى بها من النتروجين (١٠٠٠ جرام للشجرة / العام) بنسبة مئوية من صفر الى ١٠٠٪ للأشجار نتروجين معدنى.

أدى إستخدام الكمية الموصى بها من النتروجين خلال ٥٠ الى ٧٥٪ سماد نتروجينى معدنى جنبا الى جنب مع رش مستخلص الأعشاب البحرية بتركيز ١ إلى ٢٪ إلى إعطاء نتائج جيدة على جميع المقاييس تحت الدراسة وذلك بالمقارنة بإستخدام النتروجين فى الصورة المعدنية فقط أو عندما يستخدم النتروجين فى الصورة المعدنية بنسبة صفر الى ٢٥٪ ولقد تفوق إستخدام النتروجين فى الصورة المعدنية فقط عن عدم التسميد المعدنى حتى مع الرش الورقى لمستخلص الأعشاب البرية بتركيز ٨٪ وكان التحسن فى الصفات تحت الدراسة مرتبطا بتقليل النسبة المستخدمة من النتروجين المعدنى من ١٠٠ الى صفر ٪ وفى نفس الوقت زيادة التركيز المستخدم من مستخلص الاعشاب البحرية من صفر الى ٨٪ وكانت هناك تأثيرات غير مرغوبة على هذه الصفات عند تقليل النسبة المستخدمة من السماد النتروجينى المعدنى من ٥٠ الى صفر ٪

توضح نتائج هذه الدراسة أن رش أشجار المانجو التيمور أربعة مرات بمستخلص الاعشاب البحرية بتركيز ٢٪ مع تسميد الاشجار بالنتروجين المعدنى بنسبة ٥٠٪ يعطى أفضل النتائج بخصوص كمية المحصول وخصائص الجودة للثمار.