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Partial Replacement of Nitrogen Fertilization by Humic Acid and Seaweed Extracts in Balady Mandarin Orchards

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Abstract

This study was carried out in the experimental orchard, Faculty of Agriculture, Assiut University, Egypt, to investigate the possibility of replacing nitrogen fertilization of Balady mandarin orchards by humic acid or seaweed extract during 2014, 2015 and 2016 seasons.

The experiment was arranged in a randomized complete block design with three replications per treatment, one tree each. Mineral nitrogen fertilization was splitted into three equal batches and added in March, May and August, while liquid nitrogen as organic form was added once in March. Seaweed extract spraying and humic acid as soil dressing were applied three times on mid of March, June and August.

The obtained results could be summarized as follow:

Using recommended nitrogen dose (RND) via liquid organic-N, as well as a combination of inorganic or organic plus humic acid or seaweed significantly increased the growth traits as well as N, P, K and total chlorophyll of leaves compared to the use of RND via mineral-N (check treatment).

The maximum values of these traits were recorded on trees that fertilized with the triple form (33% mineral and 33 g humic acid plus 33% seaweed). No significant differences due to fertilize via triple form using either organic or mineral form, as well as via double form using either humic acid or seaweed extract.

Fertilization via either double or triple forms could achieve a beneficial improvement to the nutrient status and C/N ratio of trees since it increased the yield/tree compared to the use of RND via mineral-N only.

Using double or triple forms improved the fruit quality in terms of increasing fruit weight, pulp percentage, total soluble solids, sugar and vitamin C contents and decreasing the total acidity compared to the use of RND via mineral-N source only. The best fruit quality was recorded due to triple forms.

It is evident from the foregoing results that replacing 25 to 66% of nitrogen fertilization by humic acid or/and seaweed extract improved the tree nutrient status, yield and fruit quality. In addition, it minimized the production costs and environmental pollution which could be occurred by excess of chemical fertilizers. Theremore, the growers are able to produce organic farming products.

Keywords: *Fertilization, Humic acid, Seaweed, Balady mandarin, Nutrient status, Yield, Fruiting.*

Introduction

Citrus is the most important world crop after grapes. It is one of the most cash crops in more than 140 countries occupying a special priority in the international trade. In addition, citrus is the most important fruit crop in Egypt and its cultivation had increased dramatically during the past ten years. The cultivated areas by citrus orchards were 395730 feddans and produced 3730685 ton fruits. Mandarin trees occupied 101342 feddans and producing 885365 tons, according to the annual statistics of Ministry of Agriculture in 2015.

Mandarin (*Citrus reticulate*, Blanco) is one of the most important citrus fruit in many countries including Egypt. The major mandarin production in Egypt is confined to local Balady cultivars which belongs to common Mediterranean mandarin group.

Fertilization is one of the most important tools in increasing crop yield, especially with nitrogen. Nitrogen fertilization effects depend upon the nutrient status of the cultivated soil, as well as the applied amount, sources and methods of N applications (Yagodin, 1990). Nitrogen fertilizer under field condition and surface irrigation soils usually ranged between 30 and 40% (Sahrawat, 1979).

It is well known that citrus needs large amounts of fertilizers especially nitrogen. So, the major problems facing growers are the high cost of excessive manufactured fertilizers needs for plants. Besides, these chemical fertilizers are considered as air, soil and water polluting agents during their production and utilization.

So, biological fertilization plays an important role in increasing the yield and fruit quality as well as, it has corrective techniques for avoiding the diverse hazards induced by chemical application (Subba Rao *et al*., 1993). Bio-fertilizers are mainly consisted of beneficial microorganisms that can release nutrients from rock and plant residues in the soil and make them available for economical crop (El-Haddad *et al*., 1993; Kannaiyan, 2002 and El-Salhy *et al*, 2010).

Using organic fertilizers in citrus orchard means producing clean fruit and juice without using chemicals and reducing to the lower extent the application of mineral fertilizers. Using organic fertilizers covers all forms of organic soil amendments and it depends on using recycle animal manure and farm residues to produce a composite for enhancing the biological cycles, improving soil fertility and avoiding all forms of pollution that may result from conventional agriculture techniques (Miller *et al*., 1990; Yagodin, 1990; Obreza and Ozores, 2000 and El-Salhy *et al*., 2010).

Humic acid is a bio-stimulant, which acts as a growth booster by inflicting positive effects on soil and plant characteristics. It is a complex mixture of aromatic organic acid with diverse functional groups bearing sulphur, nitrogen, phosphorus, carbon, hydrogen and oxygen in varying percentages and metal ions (Zhang and Ervin, 2004).

Humic acid produces dominant effects on plants by stimulating enzyme activity, membrane permeability, photosynthesis (Muscolo *et al*., 2007), respiration (Nardi *et al*., 2002). Maintaining transpiration rate, increasing protein and vitamin contents and yield of dry matter (Liu *et al*., 1998).

Seaweed extracts have long been recognized as excellent natural fertilizers and sources of organic matter. The benefits of using seaweed extract over time when an application program is followed over number of seasons. They had higher amounts of C, N, P, S, K, Mg, Ca, Fe, Mn, Zn, Cu and Mo (Tung *et al*., 2003 and Fornes *et al*., 2005).

Applying humic acid, organic and bio-fertilizer may be useful in minimizing the amount of mineral fertilization (Abd El-Monem *et al*., 2008).

Producing organic or healthy citrus fruits was not achieved without using bio-fertilizers. They may help in improving crop productivity by increasing the biological N fixation, the availability and uptake of nutrients and stimulation of natural hormones. Hence, the use of organic and bio-fertilizers had often been reposed as an ideal method to improve citrus trees production (Subba Rao *et al*., 1993; Boutrous *et al*., 1995; Hegab *et al*., 1997; Ebrahim *et al*., 2000; El-Salhy *et al*., 2002; Kannaiyan, 2002; El-Salhy *et al*., 2006; Ahmed *et al*., 2008; Abdo, 2008 and El-Salhy *et al*., 2010).

So, the goal of this study was examining the possibility of replacing mineral-N fertilizers partially by using humic acid and seaweed to improve the growth and fruiting of Balady mandarin trees.

Materials and Methods

The present study was carried out during the three successive seasons of 2014, 2015 and 2016 on 45 years old Balady mandarin trees (*Citrus reticulata,* Blanco) budded on sour orange root stock and planted at 5x5 m apart. They were grown on the Experimental Orchard of the Faculty of Agriculture, Assiut University, Egypt, where the soil has a clay texture (Table 1) and irrigated via surface irrigation and it is well drained.

Table 1. Analysis of the soil of the experimental site before starting the study.

Characters	Value	Character	Value
Sand (%)	21.15	Total N (%)	0.14
Silt (%)	31.55	Available P (ppm)	8.25
Clay (%)	48.30	Available K (ppm)	332.15
Texture	Clay	DTPA-extractable	
pH (1:2.5)	8.19	Fe (ppm)	22.70
E.C (1:2.5) (dS/m)	2.26	Mn (ppm)	18.31
Organic matter (%)	1.38	Zn (ppm)	4.6
$CaCO_3$ (%)	3.66	Cu (ppm)	3.18

Twenty four healthy trees with no visual nutrient deficiency symptoms and were as uniform as possible were chosen and assigned for carrying out this experiment. The chosen trees were divided into eight groups. Each group received one fertilization regime management as the following.

1. Application of the recommended dose of N (1000g N/tree) completely via inorganic N sources (2985 g ammonium nitrate (33.5% N/tree).

2. Application of 75% the recommended dose of N through inorganic N sources (2239 g ammonium

nitrate/tree) and humic acid (25 g/tree).

3. Application of 75% the recommended dose of N through inorganic N sources (2239 g ammonium nitrate) and spraying seaweed extract at 25 g/5Lwater/tree.

4. Application of the recommended dose of N (1000 g N/tree) completely via organic N sources (liquid organic 3L/tree).

5. Application of 75% the recommended dose of N through organic N sources (liquid organic ammonium 2.25 L) and humic acid (25 g/tree).

6. Application of 75% the recommended dose of N through organic N sources (liquid organic 2.25 L) and spraying seaweed extract at 25 g/5L/tree.

7. Application of 33% the recommended dose of N through inorganic N sources (985 g ammonium nitrate), plus humic acid 33 g) and spraying seaweed extract at 33 g/5L/ tree.

8. Application of 33% the recommended dose of N through organic N sources (liquid organic 1 L), plus humic acid (33 g) and spraying seaweed extract at 33 g/5L/tree.

Liquid N fertilizer was added once at spring growth cycle started at the first week of March. Ammonium nitrate (33.5% N) as a fast release N fertilizer as splitted into three equal batches and added on the first week of March, May and August.

Seaweed extract spraying was applied three times on mid of March, June and August. Humic acid was adding as soil dressing at the same times of seaweed.

The experiment was set in a randomized complete block design with three replications per treatment, one tree each.

The following parameters were measured during the three growth seasons.

Vegetative growth, leaf chlorophyll and nutrient status:

Four main branches which were nearly uniform in growth, diameter and foliage density and distribution around the periphery from each tree were chosen and labeled in February. In the autumn growth cycle, the following vegetative characters were measured:

Shoot length (cm), leaf number/shoot, leaf area (cm^2) were estimated by bicking and weighing 30 full mature leaves/tree and weighing 60 sections (2 sections of 1 cm^2/leaf) were recorded, then the average leaf area (cm^2) was calculated as leaves weight (g) x 2/sections weight (g), leaf chlorophyll content was recorded by using chlorophyll meter (Minolta, SPAD 502 plus). Using ten leaves/replicate from the fourth terminal expended leaf of the shoot.

N, P and K in leaves and total carbohydrates and nitrogen shoots:

Samples of fifty mature leaves were randomly selected from the non fruiting shoots of the spring flush in mid September to determine N, P and K in leaves. Nitrogen was determined in shoots using the digestion with a mixture of sulfuric acid and hydrogen peroxides, according to standard methods outline by (Champan and part, 1975 and Wilde *et al*., 1985). Another part of each ground dried shoot sample was used to determine the total carbohydrates according to Smith *et al*. (1956).

Yield and its components:

At harvesting time, during the last week of December, the number of fruit per tree was counted and then, the yield per tree was calculated.

Fruit Quality:

Samples of 10 fruits were randomly taken from each tree to estimate the fruit quality. The fruit weight and the chemical fruit quality such as total soluble solids %, total acidity %, ascorbic acid and sugar contents % were determined according to A.O.A.C. methods (1995). The obtained data were statistically analyzed according to Gomez and Gomez (1984) and Mead *et al*. (1993) the new L.S.D. test was used to define the significance of the differences between the various treatment means.

Results

1- Vegetative growth:

Data in Tables (2 & 3) showed the effect of organic nitrogen fertilization as well as seaweed extract and humic acid treatments on shoot length, leaf number/shoot, leaf area and total chlorophyll percentage of Balady mandarin trees during 2014, 2015 and 2016 seasons. It is obvious from the data that the results took similar trend during the three studied seasons.

Using the recommended nitrogen dose (RND) via liquid organic-N (T_4) as well as a combination of inorganic plus humic acid (T_2) or seaweed (T_3) significantly increased the shoot growth and leaf traits compared to the use of RND via mineral-N (check treatment T_1).

The maximum value of shoot length and leaf traits were obtained due to the fertilization with 33 g humic acid + 33 g seaweed + 33% of RND via mineral-N (T_7). No significant differences due to fertilization via triple form whether using mineral (T_7) or organic (T_8) sources, as well as, via double form using humic acid (T_2 & T_5) or seaweed extract (T_3 & T_6).

The highest value of shoot length was 52.39 cm, leaf area was 9.46 cm^2 and chlorophyll percentage was 68.25% (as an av. of the three studied seasons) due to fertilization via triple form (T_7). On the other hand, the corresponding least values were 42.10 cm, 7.50 cm^2 and 55.9% (as an av. of the three studied seasons) were detected on trees that fertilized with the recommended dose of nitrogen (RND) via mineral (T_1).

Hence, the increment percentage attained 24.44, 26.13 & 22.09% (as an av. of the three studied seasons) for shoot length, leaf area and chlorophyll percentage due to fertilizate via triple form (33% mineral plus 33% humic acid and 33% seaweed extract, T_7) compared to check treatment (100% inorganic, T_1), respectively.

2- Percentage of N, P and K in leaves, as well as, total carbohydrates, nitrogen and C/N ratio of shoots:

Data presented in Tables (4 & 5) showed the effect of different nitrogen fertilization treatments on leaf content of N, P and K as well as shoot contents of carbohydrates, nitrogen and C/N ratio of Balady mandarin trees during 2014, 2015 and 2016 seasons. Data in the above mentioned tables revealed that the percentage of N, P and K in leaves varied significantly according to the different studied applications. It is obvious from the data that results took similar trend during the three studied seasons.

Fertilization via either organic only (T_4), or double form, mineral-N plus humic acid (T_2), mineral-N plus seaweed (T_3), organic plus humic acid (T_5), organic plus seaweed (T_6), as well as triple form, mineral-N plus humic acid and seaweed (T_7) or organic-N plus humic acid and seaweed (T_8) significantly increased the N, P and K contents of leaves as well as total carbohydrates, nitrogen and C/N ratio of shoot compared to the use of mineral-N only (T_1).

Table 2. Effect of different nitrogen fertilizer sources on shoot length (cm) and laterals number/shoot of Balady mandarin trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	Shoot length (cm)				Laterals number/shoot			
	2014	2015	2016	Mean	2014	2015	2016	Mean
100% RND, mineral T_1	40.05	36.05	50.20	42.10	5.33	6.33	8.00	6.56
75% RND, min and 25 H.A. T_2	48.11	44.38	55.11	49.20	7.00	7.33	9.00	7.78
75% RND, min and 25 SW T_3	46.36	44.34	55.81	48.84	6.00	8.00	9.00	7.67
100% RND, organic T_4	43.90	41.50	53.93	46.44	8.00	6.67	9.00	7.89
75% RND org and 25 H.A. T_5	44.24	43.95	54.58	47.59	8.00	8.00	10.00	8.67
75% RND org and 25 S.W T_6	42.16	39.25	55.27	45.56	7.00	7.67	9.33	8.00
33% min., 33% H.A and 33% S.W T_7	49.82	49.64	57.71	52.39	9.00	10.00	11.00	10.00
33% org., 33% H.A. and 33% S.W.T_8	49.99	46.67	56.12	50.93	9.00	9.00	10.00	9.33
New LSD 5%	2.25	2.08	2.71		0.78	1.08	1.22	

Table 3. Effect of different nitrogen fertilizer sources on number of leaves, leaf area (cm^2) and chlorophyll content of Balady mandarin trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	Number of leaves				Leaf area (cm^2)				Chlorophyll SPAD vule			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	28.00	22.41	33.11	27.84	7.46	7.52	7.52	7.50	49.27	53.68	64.75	55.90
T_2	40.67	27.00	43.18	36.95	7.77	9.15	8.25	8.39	52.29	56.77	70.26	59.77
T_3	38.00	27.22	42.0	35.74	7.59	9.18	8.52	8.43	56.54	62.43	71.67	63.55
T_4	35.53	25.08	37.20	32.60	7.65	8.87	8.22	8.25	51.66	60.27	69.36	60.43
T_5	38.96	29.03	39.61	35.87	8.20	8.59	8.59	8.46	51.73	6431	69.34	61.79
T_6	38.85	26.52	38.30	34.56	7.84	9.41	8.41	8.55	55.84	60.70	71.77	62.77
T_7	40.03	29.88	44.15	38.02	9.32	9.74	9.33	9.46	64.63	66.44	73.68	68.25
T_8	42.50	28.38	42.51	37.80	8.50	9.65	9.06	9.07	61.36	64.75	73.60	66.57
New LSD 5%	1.99	2.29	2.58		0.31	0.38	0.43		1.96	2.31	1.86	

Table 4. Effect of different nitrogen fertilizer sources on contents of N, P and K% in leaves of Balady mandarin trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	N %				P %				K %			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	2.18	2.15	2.45	2.26	0.172	0.190	0.183	0.182	1.14	1.10	1.09	1.11
T_2	2.50	2.22	2.57	2.43	0.230	0.255	0.246	0.244	1.39	1.26	1.44	1.36
T_3	2.32	2.28	2.60	2.40	0.238	0.262	0.254	0.251	1.55	1.30	1.23	1.36
T_4	2.32	2.26	2.57	2.38	0.223	0.248	0.239	0.237	1.34	1.35	1.23	1.31
T_5	2.41	2.37	2.57	2.45	0.260	0.285	0.263	0.269	1.32	1.56	1.40	1.43
T_6	2.35	2.57	2.61	2.51	0.248	0.258	0.248	0.251	1.47	1.39	1.26	1.37
T_7	2.59	2.83	2.77	2.73	0.261	0.283	0.273	0.272	1.60	1.61	1.55	1.59
T_8	2.56	2.87	2.68	2.70	0.242	0.276	0.261	0.260	1.52	1.62	1.54	1.56
New LSD 5%	0.09	0.10	0.11		0.025	0.018	0.016		0.05	0.04	0.05	

Table 5. Effect of different nitrogen fertilizer sources on shoot total carbohydrates %, shoot total nitrogen % and C/N ratio of Balady mandarin trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	Shoot total carbohydrates %				Shoot total nitrogen %				C/N ratio			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	11.67	9.49	13.10	11.42	1.47	1.57	1.68	1.57	7.94	6.04	7.38	7.26
T_2	16.43	13.10	19.15	16.23	1.70	1.63	1.84	1.66	9.66	8.04	10.41	9.37
T_3	17.80	13.30	16.78	16.48	1.63	1.64	1.85	1.69	10.94	8.11	9.09	9.38
T_4	15.41	15.25	16.68	15.78	1.64	1.69	1.85	1.72	9.41	9.02	9.03	8.34
T_5	15.30	16.03	18.85	16.73	1.71	1.74	1.89	1.78	8.95	9.21	9.97	9.38
T_6	16.41	17.12	16.70	16.75	1.77	1.93	1.86	1.87	9.26	8.87	8.96	9.03
T_7	21.65	20.86	23.15	21.88	1.84	1.99	1.97	1.99	11.79	10.48	11.77	11.50
T_8	18.64	20.41	21.78	20.28	1.77	1.98	1.93	1.94	10.51	10.34	11.27	10.71
New LSD 5%	1.77	1.96	1.93		0.06	0.05	0.08		0.78	0.89	0.85	

The maximum values of N, P, K% and C/N ratio were 2.73, 0.272, 1.59 and 11.50% (as an av. of the three studied seasons) due to triple form (mineral-N plus humic acid and seaweed, T_7, respectively

No significant differences were seen between fertilization via triple form due to either the use of the mineral-N or organic as well as, due to the use of double form, whatever, humic acid or seaweed extract.

Contrarly, the last corresponding values were 2.26, 0.182, 1.11 and 7.26 due to fertilize via mineral-N only (T_1). Hence, the corresponding increment percentage attained 20.80, 49.45, 43.24 & 58.40 (as an av. of the three studied seasons) due to the triple form compared to the use of mineral-N only (T_1), respectively.

From the above mentioned results, it could be noticed that using combination of humic acid and seaweed is very effective in vigour and nutrient status of trees compared to the using of mineral nitrogen only.

Therefore, it could be concluded that fertilization by a combined two or three sources of nitrogen would achieve a beneficial improvement of the vigour and nutritional status of trees.

3- Yield and its components:

As a general overlook to the results in Table (6) it could be observed that the number of fruit/tree and yield were significantly increased by using a combination of mineral-N plus either humic acid (T_2) or seaweed (T_3) organic nitrogen alone (T_4) or in combination with humic (T_5), seaweed (T_6) as well as triple form (T_7 & T_8) compared to the use of RND via mineral-N source alone (check treatment, T_1).

The maximum value of number of fruit/tree was 307.53 fruit and the yield was 49.25 kg/tree (as an av. of the three studied seasons) due to the use of RND via triple form (T_7). Whereas, the minimum value of the yield/tree was 29.83 kg/tree due to RND via mineral-N only (T_1).

Hence the increment of yield /tree due to T_7 attained 65.10% (as an av. of the three studied seasons) compared to check treatments (T_1).

Also the yield/tree due to fertilization via mineral-N combined with humic acid (T_2) was 41.90, combined with seaweed (T_3) was 42.49 kg (as an av. of the three studied seasons). Moreover, the yield/tree was 42.74 & 44.34 kg/tree (as an av. of the three studied seasons) due to organic plus humic acid (T_5) and organic plus seaweed (T_6), respectively. Hence the increment percentage of yield/tree attained 40.46, 42.44, 43.28 & 48.64% (as an av. of the three studied seasons) due to T_2, T_3, T_5 and T_6 compared to T_1, respectively.

There are no significant differences between fertilization via any form of double forms. As well as no significant differences between fertilization via triple form whether using mineral-N or organic.

It is clear that the use of double form or triple form (mineral plus organic and bio) have beneficial effects on C/N ratio and yield. In addition, such fertilization treatments reduce the cost of production and environmental pollution problems.

4- Fruit properties:

Data illustrated in Tables (7 & 8) showed the effect of different sources of organic and bio-fertilization on fruit weight, % pulp weight, total soluble solids, sugar and V.C content as well as total acidity of Balady mandarin fruits during 2014, 2015 and 2016 seasons. In general, the obtained results took similar trend during the three studied seasons.

Data revealed that, fertilization with organic, double form or triple form improved the fruit quality in terms of increasing the fruit weight, pulp percentage, total soluble solids (TSS), sugar and vitamin C contents and decreasing the total acidity compared to the use of the recommended dose of nitrogen (RND) via mineral-N source.

The high values of fruit weight were 151.43, 156.38 & 163.27 g and TSS were 11.34, 11.63 & 12.13% and V.C. were 64.13, 66.08, 69.86 mg/100 g (as an av. of the three studied seasons) due to T_2, T_5 and T_7, respectively. Whereas, the least value of fruit weight was 141.26 g, TSS was 10.81% and vitamin C was 59.79 mg/100g (as an av. of the three studied seasons) due to check treatment (T_1), respectively.

Hence, the increment percentages of the fruit weight were 7.20, 10.70 & 15.13% and of TSS were 4.90, 7.58 & 12.21% and of vitamin C were 7.26, 10.52 & 16.84% (as an av. of the three studied seasons) due to T_2, T_5 and T_7 compared to T_1, respectively.

Table 6. Effect of different nitrogen fertilizer sources on fruit number/tree and yield/tree (kg) of Balady mandarin trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	Number of fruit/tree				Yield/tree (kg)			
	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	236.38	131.18	285.25	217.60	28.85	19.53	41.12	29.83
T_2	284.33	191.48	369.31	281.71	37.50	30.91	57.30	41.90
T_3	265.26	189.21	374.14	276.20	36.18	31.53	59.76	42.49
T_4	296.38	196.60	376.18	289.72	39.65	32.18	60.31	44.05
T_5	273.95	190.16	360.85	274.99	36.68	31.89	59.65	42.74
T_6	311.18	203.11	352.36	288.88	42.50	33.80	56.71	44.34
T_7	321.79	211.15	398.65	307.53	46.36	37.00	64.39	49.25
T_8	311.63	206.53	383.16	300.44	45.51	35.58	62.68	47.92
New LSD 5%	15.08	11.32	18.34		2.11	1.68	1.83	

Table 7. Effect of different nitrogen fertilizer sources on fruit weight (g) and pulp weight (%) of Balady mandarin fruits trees during 2014, 2015 and 2016 seasons.

Char. / Treat.	Fruit weight (g)				Pulp weight %			
	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	125.48	152.80	145.50	141.26	62.72	80.17	67.27	70.05
T_2	132.87	163.31	158.11	151.43	70.02	85.14	71.33	75.50
T_3	136.87	168.60	160.25	155.24	69.22	85.09	70.37	74.89
T_4	134.03	165.67	162.18	153.96	67.80	83.55	69.80	73.72
T_5	135.15	170.18	163.80	156.38	69.17	84.82	71.70	75.23
T_6	137.57	168.11	164.20	155.63	69.83	84.88	70.43	75.05
T_7	146.71	176.30	166.81	163.27	70.69	85.23	72.51	76.14
T_8	146.50	172.80	164.50	161.27	67.65	85.11	70.97	74.58
New LSD 5%	6.55	5.94	6.59		1.71	1.88	1.66	

Table 8. Effect of different nitrogen fertilizer sources on total soluble solids %, acidity % and V.C. (mg/100g/juice) of Balady mandarin juice during 2014, 2015 and 2016 seasons.

Char. / Treat.	T.S.S. (%)				Acidity (%)				V.C. (mg/100 g juice)			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	9.87	10.80	11.77	10.81	1.46	1.42	1.48	1.45	52.80	67.36	59.22	59.79
T_2	10.33	11.50	12.20	11.34	1.30	1.21	1.40	1.30	56.00	78.40	58.00	64.13
T_3	10.80	11.50	12.00	11.43	1.32	1.37	1.37	1.35	56.88	78.40	59.76	65.01
T_4	10.45	11.09	12.15	11.23	1.34	1.37	1.39	1.37	55.31	69.98	62.70	62.66
T_5	10.80	11.56	12.53	11.63	1.36	1.24	1.36	1.32	57.12	78.40	62.72	66.08
T_6	11.00	11.50	12.17	11.56	1.27	1.30	1.41	1.33	56.00	77.87	63.21	65.69
T_7	11.20	12.33	12.86	12.13	1.22	1.16	1.35	1.24	60.46	82.56	66.57	69.86
T_8	11.10	12.20	12.70	12.00	1.12	1.13	1.33	1.19	60.00	81.30	66.20	69.17
New LSD 5%	0.33	0.28	0.31		0.13	0.10	0.12		1.77	1.84	1.99	

Table 9. Effect of different nitrogen fertilizer sources on total sugar (%) and reducing sugar (%) of Balady mandarin juice during 2014, 2015 and 2016 seasons.

Char. / Treat.	Total sugar (%)				Reduce sugar (%)			
	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	6.87	8.38	7.67	7.64	2.24	3.03	3.40	2.89
T_2	7.50	9.08	8.44	8.34	2.55	3.38	3.90	3.28
T_3	7.20	9.05	8.32	8.19	2.48	3.21	3.60	3.10
T_4	7.50	8.99	8.14	8.21	2.55	3.26	3.86	3.22
T_5	7.73	9.10	8.79	8.54	2.48	3.52	3.91	3.30
T_6	7.24	8.97	8.10	8.10	2.44	3.22	3.83	3.16
T_7	7.68	9.22	8.66	8.52	2.61	3.46	3.97	3.35
T_8	7.76	9.37	8.82	8.65	2.64	3.53	4.03	3.40
New LSD 5%	0.27	0.36	0.33		0.11	0.10	0.13	

Contrarly, using organic nitrogen, double form or triple form (mineral, humic acid and seaweed extract) gave the least values of total acidity compared to fertilize by mineral source.

The low values of total acidity were 1.40, 1.42 & 1.30% (as an av. of the three studied seasons) due to T_2, T_5 & T_8 compared the highest one (1.65%) due to the use of mineral source only (T_1). Hence, the decrement percentage of total acidity attained 15.15, 13.94 & 21.21% (as an av. of the three studied seasons) due to T_2, T_5 and T_8 compared to T_1, respectively.

There are no significant differences seen due to fertilization via any double form, as well as using any triple fertilization whether mineral-N or organic. Moreover, using the triple form gave higher improvement than using the double form. hence, the money-wise evaluation of the application of these N sources is in fvaour of triple fertilization form. Such fertilization program is very important for the production of mandarin fruits, since the increase of the fruit weight and size and improving the fruit quality induce an increase in the marketable yield.

Discussion and Conclusion

Nitrogen fertilization is one of the important tools in increasing crop yield. Nitrogen plays a key role in the nutrition of fruit trees. It is a necessary element for chlorophyll, protoplasm and nucleic acids (Nijjar, 1985). So, that its application can result in an increase in the cell number and size with an increase in the number and area of leaves.

The organic fertilizers improves soil physical properties by increasing nutrient and water holding capacity, total pore space, aggregate stability, erosion resistance, temperature insulation and decreasing apparent soil density. Application of organic fertilizers improves the chemical properties by increasing cation exchange capacity and soil nutrient content (Shiralipour *et al*., 1992).

Humic acid is a complex mixture of aromatic organic acids, with diverse functional groups bearing sulphur, N, P, C, H and O, in varying percentages and metal ions and improves the availability of nutrients to plants (Zhang *et al*., 2010). It encourages the conversion elements like N, P, Fe. Cu, Mg and Pb into available forms to plants (Adam *et al*., 1999).

Humic acid produces dormant effects on plant by stimulating enzyme activity, membrane permeability photosynthesis, Muscolo *et al*. (2007), increasing protein and vitamin content (El-Mohamedy and Ahmed, 2009) and yield of dry matter (Liu *et al*., 1998).

The results of Sharaf *et al*. (2011), Abbas *et al*. (2012), Abdel Hamied-Sheven (2014) and Al-Hayani *et al*. (2016) confirmed the beneficial effect of using humic acid on growth, nutritional status, yield and fruit quality on different orange and mandarin trees.

The great benefits of bio-fertilizers on growth and fruiting were attributed to their positive action on enhancing microflora activity, soil fertility, N fixation and availability of all nutrients (Kannaiyan, 2002).

The promoting effect of seaweed extract on growth, nutritional status of the trees, yield and fruit quality might be attributed to its higher own content from natural hormones namely IAA, GA_3 and cytokinins that are responsible for stimulating all growth characters. Also, it plays an important role in enhancing the biosynthesis of most foods and plant pigments and it is also responsible for enhancing the resistance of trees (Kulk, 1995 and Fornes *et al*., 2005).

The promoting effect of seaweed extract on growth, nutritional status, yield and fruit quality was supported by the results of (Lugtenberg *et al*., 1991; Dahama, 1999; Irizar-Garza *et al*., 2003; Hegab *et al*., 2005; Gamal, 2006; Hassan Hoda, 2008; Ahmed *et al*., 2008; Ismail Omyma *et al*., 2011 and Abdel-Al *et al*., 2012).

Conclusion:

Therefore, it could be concluded that using humic acid and seaweed extract as organic and bio-fertilizer sources improve the tree nutrient status, yield and fruit quality leading to an increase of the packable yield. In addition, it minimizes the production costs and environmental pollution which could be occurred by excess of chemical fertilizers. Furthermore, using organic and bio-fertilizers improve the soil fertility and reduce the added fertilization requirements. Thus, the growers are able to produce organic farming products.

References

Abbas, T.; S. Ahmed; M. Ashraf; M.A. Shahid; M. Yasin; R.M. Balal; M.A. Pervez and S. Abbas. 2012. Effect of humic and application at different growth stages of Kinnow mandarin (*Citrus reticulate* Blanco) on the basis of physio-bio-chemical and reproductive responses. Academic J. of Biotechnology, 1 (1): 14-20.

Abdel Hamied-Sheren, A. 2014. Response of Valencia orange to some natural and synthetic soil conditioners under North Sinai (Egypt) conditions. Inter. J. of Advanced Res. 2 (11): 802-810.

Abdel-Aal, A.M.K.; F.F. Ahmed and K.M. Hassan. 2012. Partial replacement of chemical N fertilizer in Balady mandarin orchard though application of extracts of yeast, seaweed and farmyard manure. Minia J. Agric. Res. & Develop. 50 (1): 129-148.

Abdel-Monem-Eman, A.A.; M.M.S. Saleh and E.A.M. Mostafa. 2008. Miniizing the quantity of mineral nitrogen fertilizers on grapevine by using humic acid, organic and bio-fertilizers. Research J. of Agric. and Biological Sci. 4 (1): 46-50.

Abdo, Z.A.A. 2008. Effect of some bio-fertilization treatments on growth and fruiting of Balady mandarin trees. Ph.D. Thesis, Fac. of Agric. Minia Univ., Egypt.

Adam, M.S. 1999. Promotive effect of *Cyanobacteria Nostoc* Muscorum on the growth of some crop plants. Acta Microbiologioolinica, 48 (2): 163-171.

Ahmed, F.F.; A.A. Gobara; E.E. Abo El-Komsan and A.F. Gamal. 2008. Groth and fruiting of Washington Navel orange trees as affected by some antioxidant and algae extract treatments. Inter. Conf. for Environ. Studies Menufia Univ. pp. 200-220.

Al-Hayani, M.A.; A.M. Altamimi and Alhathal Nisreenm. 2016. Effect of humic acid spray on Cleopatra mandarin seedlings. Basrah J. Agric. Sci. 29 (2): 461-474.

Association of Official Agricultural Chemists 1995. Official Methods of Analysis 14th ed. (A.O.A.C.) Benjamin Franklin Station, Washington D.C., U.S.A., p 490-510.

Boutrous, B.N.; M.S. El-Shamaa; S. El-Barki and R.N. Saad. 1995. Field application of vescular var mycorrhizal fungi and element sulphur to reduce calcareous soil problem for lime orchard. Egypt. J. Appl. Sci. 10 (1): 153-164.

Champan, H.D. and P.F. Pratt. 1975. Methods of analysis for soils, plants and water, univ. of California. Division of Agric. Sci., 172-173.

Dahama, A.K. 1999. Organic farming for sustainable agriculture agro Botani, Daryagum, New Delhi, India p. 258.

Ebrahiem, T.A.; F.F. Ahmed and E.A. Abo El-Komsan. 2000. Response of Balady mandarin trees grown on sandy soil to spraying active dry yeast and some macronutrients. Assiut J. Agric. Sci. 31 (5).

El-Haddad, M.E.; Y.Z. Ishac and M.L. Mostafa 1993. The role of bio-fertilizers in reducing agricultural costs, decreasing environment pollution and raising crop yield, Arab Unite. J. Agric. Sci. Ain Shams Univ. Cairo, 1 (1): 147-195. Egypt.

El-Mohamedy, R.S.R. and M.A. Ahmed. 2009. Effect of bio-fertilizers and humic acid on control of dry root-rot disease and improvement yield and quality of mandarin. Research J. Agric. Biol. Sci. 5 (2): 127-139.

El-Salhy, A.M., M. El-Dsouky and K.K. Attia 2002. Effect of organic and inorganic nitrogen fertilization on nutrient status, yield and fruit quality of Balady mandarin trees. The 3rd Conf. of Agric. Sci., Fac. of Agric., Assiut Univ., Assiut, Oct. 2003, 303-315.

El-Salhy, A.M.; H.A. Abdel-Galil; A.H. Abdaal and M.M. Ali. 2010. Effect of different nitrogen fertilizer sources on vegetative growth, nutrient status and fruiting of Balady mandarin trees. Assiut J. Agric. Sci. 41 (4): 153-170.

El-Salhy, A.M.; H.M. Marzouk and T.A. Ali. 2006. Physiological studies on the effect of active dry yeast application on Balady mandarin trees. II- Yield and fruit quality. The 3rd Int. Conf. for Develop. And the Env. in the Arab World, March 21-23, pp. 615-622.

Fornes, F.; M. Sanchez Perales and J.L. Guardiola 2005. Effect of a seaweed extract on citrus fruit maturation Is Hs Acta Hort. 379. Inter. Symp. on quality of Fruit and Vegetable. Influence of Pre and Post harvest factors and Technology.

Gamal, A.F. 2006. Response of Washington Navel orange trees to some antioxidants and bio-fertilization treatments. M.Sc. Thesis, Fac. of Agric., Minia Univ., Egypt.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agriculture Researches (2nd ed.) Published by John Wiley and Sons, New York, U.S.A. p. 10-20.

Hassan-Hoda, M.I. 2008. Effect of algae extract on productivity of Balady orange trees. M.Sc. Thesis, Fac. of Agric., Minia Univ., Egypt.

Hegab, M.Y.; A.M.A. Sharawy and S.A.G. El-Saida. 2005. Effect of algae extract and mono-potassium phosphate on growth and fruiting of Balady orange trees. Bull. Fac. Agric., Cairo Univ., 56: 107-210.

Hegab, M.Y.; F.F. Ahmed and A.H. Ali 1997. Influence of spraying active dry yeast on growth and productivity of Valencia orange trees (*Citrus sinensis*). Proc. of the 1st Sci. Conf. of Agric. Sci. Fac. Agric., Assiut Univ., Dec. 13-14 Vol. 1: 73-85.

Irizar Garza, M.B.; V.P. Vargas; G.D. Garza; C.V. Tuty; M.I. Rojas; C.A. Trujillo; S.R. Garcia; M.D. Aguirre; G.J.C. Martinez; M.S. Alvarado; C.O. Grageda; G.J. Valero and M.J.F. Aguirre 2003. Use of bio fertilizers in agricultural crops in the central region of Mexico. Agricultural Tecnica in Mexico Institute Nacional de Investigaciones Forestales, Agricolas pecuarias (INIFAP), Mexico City Mexico, 29 (2): 213-225.

Ismail-Omayma, M.; O.F. Dakhly and M.N. Ismail. 2011. Influence of some bacteria strains and algae as bio-fertilizers on growth of Bitter orange seedlings. Australian J. of Basic and Applied Sci. 5 (11): 1285-1289.

Kannaiyan, S. 2002. Biotechnology of bio-fertilizers. Alpha Sci. Inter Ltd. P.O. Box 4067 Pang Bourne R. 68. M.K. pp: 1-275.

Kullk, M.M. 1995. The potential cyanobacteria (blue green algae) for using and algae in biological control of plant pathogenic. Bacteria and Fungi European J. of Plant Pathology, 101 (6): 585-599.

Liu, C.; R.J. Copper and D.C. Bowman. 1998. Humic acid application effects photosynthesis root development and nutrient content of creeping bent grass. Hort. Sci. 33: 1023-1025.

Lugtenberg, B.J.J.; L.A. De. Weger; J.W. Bennett and L.A. Deweger 1991. Microbial stimulation of plant growth and protection from disease. Current Opinion in Biotechnology, 2 (3): 457-464.

Mead, R., R.N. Gurnow and A.M. Harted 1993. Statistical Methods in Agriculture and Experimental Biology (2nd ed.). Chapman and Hall, London. p. 10- 44.

Miller, E.W., D.L. Donahue and J.U. Miller 1990. Soils "An Introduction to soils and plant Growth" (5th ed.). Prentice Hall, International Inc. Engleword Cliffs, New Jersy, pp 303- 339.

Muscolo, A.; M. Sidari and E. Attina. 2007. Biological activity of humic substances is related to their chemical structure. Soil Sci. Soc. Amer. J. 71: 75-85.

Nardi, S.; D. Pizzeghello; A. Muscolo and A. Vianello. 2002. Physiological effects of humic substances in plant growth. Soil Biol. Biochem, Exeter 34: 1527-1537.

Nijjar, G.S. 1985. Nutrition of fruit trees. Mrs. Usha Raj Kumar for Kalyanin publishers, New Delhi, p. 10-52.

Obreza, T.A. and H.M. Ozores 2000. Management of organic amendments in Florida citrus production system. Fifty Ninth Annual Meeting of the soil crop science, Socity of Florida Sarasota, Florida, U.S.A. 22-24 Sep. 1999, Soil and Crop Sci., Soci. Of Florida, 59: 22-27.

Sahrawat, K.L. 1979. Nitrogen losses in rice soils. Fert. News. 24: 38-48.

Sharaf, M.M.; Kh.A. Bakry and S.F. Gioushy. 2011. The influence of some bio and organic nutritive addend on growth, productivity, fruit quality and nutritional status of Washington navel orange trees. Egypt. J. of Appl. Sci. 26 (9): 253-263.

Shiralipour, A.; D. MeConnell and W. Smith. 1992. Physical and chemical properties of soils as affected by municipal solid waste compost application. Biomass and Bioenergy, 3: 261-266.

Smith, F.; M.A. Gilles; J.K. Homilton and P.A. Godes 1956. Colorimetric methods for determination of sugar and related substances. Chem. 28: 350-356.

Subba-Rao, N.S., G.S. Venkateraman and S. Kannaiyan 1993. Biological nitrogen fixation. Indian Council. Agric. Res. New Delhi, p. 112.

Tung, Y.H.O.; A. Quigg; Z.V. Finkel; A.J. Milligan; K. Wyman; P.G. Falkowski and F.M.M. Morel 2003. The elemental composition of some marine phytoplankton. J. of Phycology, 39 (1): 10-20.

Wilde, S.A., B.B. Gorey, J.G. Layer and J.K. Voigt 1985. Soils and Plant Analysis for tree culture. Published by Mohan primlani, Oxford and IBH publishing Co., New Delhi, p. 1- 142.

Yagodin, B. A. 1990. Agriculture Chemistry. Mir publishers Moscow p. 278-281.

Zhang, J.J.; L.B. Wang and C.L. Li 2010. Hamus characteristic after maize residues degradation in soil amended with different copper concentrations. Plant Soil Environ, 56: 120-124.

Zhang, X. and E.H. Ervin. 2004. Cytokinin-containing seaweed and humic acid extracts associated with creeping bentgrass leaf cytokining and drought resistance. Crop Sci. 44: 1737-1745.

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الاستبدال الجزئي للتسميد النيتروجيني بحمض الهيوميك ومستخلص الطحالب البحرية في بساتين اليوسفي البلدي

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الملخص

أجريت هذه الدراسة خلال ثلاثة مواسم متتالية ٢٠١٤ و ٢٠١٥ و ٢٠١٦ بمزرعة كلية الزراعة جامعة أسيوط – مصر– لدراسة إمكانية استبدال التسميد النيتروجيني بكل من حمض الهيوميك أو مستخلص الطحالب البحرية فردياً أو معاً. وقد صممت التجربة بنظام القطاعات العشوائية الكاملة وتحتوي علي ثمانية معاملات وكررت كل معاملة ثلاثة مرات لكل مكررة شجرة.

وقد أظهرت النتائج ما يلي:

- أدي استخدام التسميد العضوي أو التسميد بالصورة الثنائية (معدني أو عضوي بالإضافة إلي حمض الهيوميك أو الطحالب البحرية) زيادة مؤكدة في صفات النمو الخضري ومحتوي الأوراق من الكلوروفيل وكل من النيتروجين والفوسفور والبوتاسيوم مقارنة بالتسميد النيتروجيني المعدني فقط،
- سبب استبدال ٢٥ أو ٦٦% من الأسمدة المعدنية بحمض الهيوميك أو مستخلص الطحالب البحرية تحسناً واضح للحالة الغذائية ومستوي المواد الكربوهيدراتية للنيتروجين بالأفرع وبالتالي زيادة المحصول وتحسين صفات الثمار مقارنة بالتسميد الفردي للنيتروجين المعدني.
- سجلت أفضل النتائج باستبدال ٦٦% من النيتروجين المعدني بحمض الهيوميك ومستخلص الطحالب البحرية.

من نتائج هذه الدراسة يمكن التوصية بأهمية استبدال ٢٥-٦٦% من النيتروجين المعدني بحمض الهيوميك ومستخلص الطحالب – حيث يؤدي ذلك إلي تحسين النمو والحالة الغذائية للأشجار مع إنتاج محصول عال ذو خصائص ثمرية جيدة فضلاً عن تقليل تكاليف التسميد والتلوث البيئي الناشئ عن زيادة الأسمدة المعدنية مع إمكانية إنتاج ثمار يوسفي عضوية.