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Effects of Natural and Bio-fertilization as a Partial Substitute for Mineral Fertilization on Vegetative Growth and Fruiting of Balady Mandarin Trees

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Abstract:

Balady mandarin trees grown under Qena region during 2012, 2013 and 2014 seasons were investigated to find the best NPK fertilization through 0 to 100% of natural or bio-fertilizers along with a mineral source. The experiment was arranged in a complete randomized block design with five replications, one tree for each, and it consisted of seven treatments. Filter mud cake and calcium super-phosphate, as well as rock phosphate and feldspar were added once in the middle of December. Biostimulants i.e., nitrobien, phosphoren and potassiumage were added in two equal doses in March and May. Potassium sulphate was applied in two equal doses in March and June, where mineral-N fertilizer was added in three equal doses in March, May and July. The obtained results could be summarized as follow:

- Using the recommended N, P and K via two forms or three forms (mineral, natural plus bio) resulted in an obvious promotion on all growth traits and leaf area and its nutrients, as well as shoot carbohydrates and C/N ratio compared to using them as a mineral fertilizer source only.
- Amending the trees with natural or bio-fertilizer singly or a mixture of natural, bio and mineral NPK fertilizers significantly improved the yield and fruit quality. No significant differences were noticed on most studied traits among all different treatments except with the mineral source (the check treatment).
- The improvement in the fruit quality and the reduction in the juice nitrite content were associated with reduction in the mineral NPK source and, at the same time an increase in the mineral or bio-fertilization sources.

It is evident from the foregoing results that using either three fertilization forms or any two fertilization forms produce healthy trees, with the highest yield and the best fruit quality. In addition, it reduces the environmental pollution as well as produces organic farming products.

Keywords: Natural, Bio-fertilization, Balady mandarin, Yield, Fruit quality, Environmental pollution, NPK.

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Introduction:

Citrus trees have an outstanding economical importance among fruit crops in Egypt. The total production of citrus fruits amounts to 3730685 tons representing 38.2% of the total production of fruit trees. Mandarin is ranked the second crop after oranges in Egyptian citrus industry. Balady mandarin of superior quality is the most popular fruit for its nutritive value and easiness to peel. The area that is planted by mandarin is about 101342 feddans representing about 25.61% of the total area that is planted by citrus with a mean annual production of 885365 tons (Egyptian Ministry of Agriculture, 2012). Balady mandarin trees grown under Upper Egypt conditions are facing a major problem concerning a reduction in their total yield. The poor cropping due to the unbalanced nutrition or the malnutrition (Mengel, 1984). The efficiency of fertilization under field conditions and surface irrigated soils rarely exceeds 50% and usually ranges from 30 to 40% (Yagodin, 1990). A partial replacement of mineral fertilizers by using organic and biofertilization is very effective in controlling the release of nutrients from the soil to plants (Wani and Lee, 1995; Kannaiyan, 2002; El-Salhy *et al*., 2010; Ahmed *et al*., 2013). Organic and biofertilizers are known to improve the uptake and utilization of many nutrients by plants due to increase their availability in the soil through improving the structure, moisture, retentions and pH of the soil as well as the biological properties (El-Khayat and Abdel-Rehiem, 2013; Abou-Zeed, Eman *et al.*, 2014). Potassium release from soil minerals during the weathering and dissolution reactions is influenced by the soil pH, temperature, moisture and biological activity as well as the reactive surface area of the mineral particles (Lasage, 1995). So, there are increasing interest and demand for using organic and bio-fertilizers as well as slow releasing-K sources for both conventional and organic especially citrus orchards farming (Aly *et al*., 2011).

Previous studies emphasized the beneficial effects of organic and biofertilization as a partial replacement for mineral fertilization in fruit crop orchards such as improving yield and fruit quality as well as avoiding the environmental pollution (Wassel *et al*., 2000; Attia *et al*., 2002; El-Salhy *et al.*, 2002; Ragab, 2006; El-Salhy *et al*., 2006a&b; Wassel *et al.*, 2007a&b; Abdo, 2008; Mohamed *et al*., 2009; Abdel-Rahman, 2010; Mahmoud, 2012; Abdelaal *et al*., 2013; Faraag, 2013; El-Khayat and Abdel-Rehiem, 2013 and Abou-Zeed, Eman *et al.*, 2014).

So, the present study aims to finding out the best fertilization management for Balady mandarin orchards to promote yield and fruit quality and at the same time avoid the environmental pollution.

Materials and Methods:

The present study was carried out during 2012, 2013 and 2014 seasons on thirty five uniform in vigour 16-years old Balady mandarin trees (*Citrus reticulata*, Blanco). They were budded on sour orange rootstock and grown on a private orchard located at Nagh Hamady district, Qena governorate, where the soil is clay loam and well drained with a water table not less than two meter deep. The soil analysis (Table1) was done according to the procedures of Wilde *et al*. (1985). Tree spacing was 5x5 meters apart and the surface irrigation system was followed.

Table (1): Same properties of the experiment soil and the used filter mud cake (FMC).

Soil				FMC			
Character	**Value**	**Character**	**Value**	**Character**	**Value**	**Character**	**Value**
Sand (%)	28.4	EC (1.25 ext. dS/m)	0.56	Total organic matter (%)	68.7	Mg (%)	0.22
Silt (%)	30.1	O.M. (%)	1.16	pH (1:10)	6.52	Ca (%)	1.09
Clay (%)	41.5	Total N (%)	0.09	EC (1:10 dSm^{-1})	4.72	Fe (mg kg^{-1})	1154
Texture grade	Clay loam	$CaCO_3$ (%)	3.19	Total N (%)	1.98	Mn (mg kg^{-1})	323
pH (1:2.5 suspension)	7.90	Available P (mg kg^{-1})	5.0	P (%)	1.11	Zn (mg kg^{-1})	211
		Available K (mg kg^{-1})	417	K (%)	0.18	Cu (mg kg^{-1})	312

The chosen trees were divided into seven groups. Each group had five trees and received one fertilization regime management of the following treatments:

- Treatment 1 (T_1): 1000 N, 150 P_2O_5 and 500 K_2O g/tree as mineral sources, as a check treatment.
- Treatment 2 (T_2): 50, 0.75 and 5 kg of filter mud cake (FMC), rock phosphate and feldspar/tree, respectively, as natural sources.
- Treatment 3 (T_3): 1000 g nitrobin, 300 g phosphoren, 400 g potassiumage/tree, as a biofertilizers.
- Treatment 4 (T_4): 500, 75, 250 g as N, P and K mineral fertilizers, respectively, plus 25, 0.38 and 2.5 kg of FMC, rock phosphate and feldspar/tree, respectively.
- Treatment 5 (T_5): 500, 75, 250 g as N, P and K mineral fertilizers, respectively, plus 500, 150 and 200 of nitrobin, phosphoren and potassiumage/tree, respectively.
- Treatment 6 (T_6): 25, 0.38 and 2.5 kg of FMC plus 500, 150 and 200 g of nitrobin, phoshoren and potassiumpage/tree, respectively
- Treatment 7 (T_7): 330, 50 and 167 g as N, P and K mineral fertilizers, respectively, plus 16.7, 0.25 and 1.67 kg of FMC, rock phosphate and feldspare, respectively, and 330, 100 and 133 g of nitrobin, phosphoren and potassimage/tree, respectively.

The used mineral fertilizers were ammonium nitrate (33.5% N) and calcium super phosphate (15.5% P_2O_5) and potassium sulpahte (48% K_2O). Filter mud cake (FMC) was added as an organic fertilizer. Its chemical analysis is present in Table (1). The used natural rock phosphate contained 19.3% P_2O_5 and the natural potassium feldspar had 10.1% K_20. They were applied as finely ground products. The bio-fertilizers that were nitrobin (N-fixing bacteria), phosphoren (P-dissolved bacteria) and potassiumage, (bio-K).

Ammonium nitrate fertilizer was divided into three equal doses and applied in March, May and July each season. The natural fertilizers were added once in four digs in the four directions around each tree in the middle of January each season. Calcium superphosphate, or rock phosphate, FMC, and feldspar were mixed and added once in the circle around each tree in the middle of December each season. Potassium sulphate was divided on two equal doses and were applied in March and June each season. Biostimulants, namely; nitrobien, phosphoren and potassiumage, were added in two equal doses around the trunk of the tree and was directly irrigated after covering with soil in March and May. Other horticultural practices were carried out as usual. Treatments were arranged in a randomized complete block design

with five replications for each treatment, one tree for each.

The following parameters were determined to evaluate the effect of different fertilization treatments on growth, nutrient status, yield and fruit quality.

The shoot length, number of leaves/shoot and leaf area were estimated (Ahmed and Morsy, 1999); N, P and K contents of the leaves, as well as N in shoots (Wilde *et al*., 1985) and total carbohydrates in shoots (Smith *et al*., 1956), were determined and then the C/N ratio was calculated. Yield components such as fruit retention percentage, number of fruits/tree and yield/tree (kg) were recorded. A sample of 10 fruits for each replication were randomly taken to estimate the fruit quality. The fruit weight, peel percentage and the chemical fruit quality, such as the total soluble solids, the total acidity (expressed as g citric acid/100 ml juice), the ascorbic acid (mg/100 ml juice) and the sugar content (A.O.A.C., methods, 1985), as well as juice nitrite content, (Rindnour-Lisa *et al*., 2000) were determined. The obtained data were statistically analysed according to Mead *et al*. (1993) using the L.S.D. test to define the significance of the differences among various treatment means.

Results:

1- Vegetative Growth:

The results in Table (2) show that all treatments of fertilization resulted a significant increases in the shoot length and leaf parameters over the mineral fertilization treatment (T_1), during the second and third studied seasons. The highest values of these traits were detected on the trees that received the treatment that contained the three forms (T_7) followed in a descending order by any treatment contained two forms. However, in the first season, the results revealed that all treatments did not significantly affect the shoot length compared to the mineral fertilization source (T_1). The average recorded leaf area values over the studied season. Using T_2, T_3, T_4, T_5, T_6 and T_7 were 8.95, 9.06, 9.02, 9.22, 9.19 and 9.23 cm^2, respectively, compared to 8.41 cm^2 for check treatment (T_1). Hence, the respective corresponding increment percentages due to these treatments were 6.42, 7.73, 7.25, 9.63, 9.27 and 9.75% of the check one.

Table (2): Effect of mineral, organic and bio-fertilizers on vegetative growth of Balady mandarin trees during 2012, 2013 and 2014 seasons.

No.	Shoot length (cm)				No. leaves/shoot				Leaf area cm^2			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	49.51	48.25	50.08	49.28	36.50	35.81	36.18	36.16	8.43	8.27	8.52	8.41
T_2	47.08	51.58	53.17	50.61	40.36	39.48	39.51	39.78	8.93	8.82	9.10	8.95
T_3	47.70	52.88	53.76	51.45	38.31	38.10	39.32	38.58	9.08	8.92	9.18	9.06
T_4	50.81	53.66	54.59	53.02	39.50	38.81	39.25	39.19	9.10	8.86	9.10	9.02
T_5	48.52	51.31	52.80	50.88	39.76	39.06	39.53	39.45	9.23	9.11	9.33	9.22
T_6	48.86	54.18	55.43	52.82	40.28	39.60	39.80	39.89	9.17	9.06	9.35	9.19
T_7	49.53	55.60	56.80	53.98	42.05	41.38	41.60	41.68	9.26	9.08	9.35	9.23
LSD 5%	N.S.	2.86	2.61		1.78	1.80	1.84		0.27	0.31	0.26	

T_1: 100% M (control), T_2: 100% natural, T_3: 100% bio-form, T_4: 50% M + 50% natural, T_5: 50% M + 50% bio., T_6: 50% natural + 50% bio. and T_7: 33% M, 33% natural + 33% bio

M: NPK Mineral fertilizers, Natural: filter mud cake, rock phosphate and feldspar, and Bio: nitrobin, phosphoren and potassiumag.

2- Leaf N, P and K Contents and Shoot C/N Ratio

The results in Tables (3 and 4) indicated that using natural and bio-fertilizers singly or in combination, as well as using the mixture of the three forms (mineral, natural and bio-fertilizers) significantly increased N, P and K contents of the leaves as well as the total carbohydrates, nitrogen % and C/N ratio of the shoots Balady mandarin trees compared to using the NPK mineral fertilizer source (T_1).

The maximum leaf N, P and K contents, as well as, shoot carbohydrates and C/N ratio were observed on the trees that received fertilizers contained as 100% natural ones (T_2). No significant differences were noticed in leaf N, P and K contents and shoot C/N ratio with among using NPK fertilizers either natural, other two forms or three forms. Moreover, for all treatments the increase in the total carbohydrates was more than that of the total nitrogen leading to significant increase in the C/N ratio compared to the check one.

The average estimated shoot C/N ratio value over the studied three seasons was 8.20, 8.16, 8.07, 8.08, 8.12 and 8.16 for T_2, T_3, T_4, T_5, T_6 and T_7, respectively, compared to 7.58 for the check one (T_1). The respective increment percentages due to these treatments were 8.18, 7.65, 6.46, 6.60, 7.12 and 7.65% of the check one. These findings emphasize the fact that the vigor growth and fruiting depend on the carbohydrates that are manufactured in the leaves and reserved amount in tissues as well as the nutritional status of tree that is improved through the natural and/or bio-fertilization.

Table (3): Effect of mineral, organic and bio-fertilizers on leaf N, P and K contents of Balady mandarin trees during 2012, 2013 and 2014 seasons.

No.	N (%)				P (%)				K (%)			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	2.11	2.20	2.23	2.18	0.181	0.184	0.188	0.184	1.35	1.31	1.34	1.33
T_2	2.46	2.57	2.61	2.55	0.276	0.281	0.288	0.282	1.68	1.63	1.67	1.66
T_3	2.28	2.39	2.41	2.36	0.234	0.239	0.243	0.239	1.61	1.57	1.60	1.59
T_4	2.36	2.44	2.46	2.42	0.228	0.232	0.237	0.228	1.49	1.45	1.48	1.47
T_5	2.41	2.50	2.53	2.48	0.208	0.214	0.231	0.218	1.55	1.51	1.52	1.53
T_6	2.43	2.60	2.61	2.55	0.258	0.263	0.268	0.263	1.61	1.58	1.61	1.60
T_7	2.42	2.58	2.63	2.54	0.227	0.233	0.237	0.232	1.60	1.55	1.58	1.58
LSD 5%	0.13	0.16	0.14		0.025	0.028	0.031		0.11	0.10	0.11	

Table (4): Effect of mineral, organic and bio-fertilizers on shoot total carbohydrates, nitrogen and C/N ratio of Balady mandarin trees during 2012, 2013 and 2014 seasons.

No.	Total carbohydrates (%)				N (%)				C/N ratio			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	11.16	10.52	11.42	11.04	1.41	1.46	1.50	1.46	7.91	7.21	7.61	7.58
T_2	13.24	12.73	13.63	13.20	1.55	1.62	1.66	1.61	8.54	7.86	8.21	8.20
T_3	12.66	11.98	12.95	12.53	1.49	1.54	1.58	1.54	8.50	7.72	8.20	8.16
T_4	12.59	11.78	12.73	12.37	1.50	1.54	1.56	1.53	8.39	7.65	8.16	8.07
T_5	12.72	11.98	12.91	12.54	1.51	1.56	1.59	1.55	8.43	7.68	8.12	8.08
T_6	12.97	12.56	13.38	12.97	1.52	1.63	1.65	1.60	8.53	7.71	8.11	8.12
T_7	12.89	12.52	13.46	12.96	1.52	1.61	1.64	1.59	8.48	7.78	8.21	8.16
LSD 5%	1.03	0.96	1.08		0.07	0.09	0.06		0.38	0.34	0.41	

3- Yield and its Components:

Applying the natural (T_2) or bio-fertilizers (T_3) singly or as a mixture of natural, bio- and mineral NPK fertilizers (T_7) to Balady mandarin trees showed an increase in the productivity of trees (Table 5). These fertilization treatments significantly increased the fruit retention percentage and number of fruits per tree compared to the recommended NPK doses that were completely used via mineral sources (T_1). Morover, the yield/tree significantly increased due to these fertilization treatments compared to the check treatment. However, no significant differences were found in yield components with using either (T_3, T_4, T_5, T_6 or T_7) fertilizer treatments, compared to use the natural fertilizer (T_2).

The maximum yield components were 1.57% of fruit retention, 360.5 fruits/tree and 51.9 kg/tree averaged over the three studied seasons and were obtained due to the using N, P and K that were totally from natural sources (T_2). However, the minimum yield components were 1.29% fruit retention, 305.3 fruits/tree and 41.2 kg/tree averaged over the three studied seasons due to using the mineral NPK sources only (T_1). Hence, the increase percentage was 21.70, 18.08 and 25.97% for fruit retention, number of fruits and yield/tree, respectively.

Table (5): Effect of mineral, organic and bio-fertilizers on the yield and its components of Balady mandarin trees during 2012, 2013 and 2014 seasons.

No.	Fruit retention (%)				No. fruits/tree				Yield/tree (kg)			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	1.26	1.18	1.44	1.29	246.6	395.8	273.5	305.3	34.3	52.9	36.5	41.2
T_2	1.62	1.40	1.70	1.57	285.3	470.5	325.8	360.5	44.6	66.0	45.1	51.9
T_3	1.50	1.38	1.67	1.52	276.4	452.4	305.7	344.8	43.2	65.1	43.9	50.7
T_4	1.54	1.40	1.70	1.55	280.2	457.2	328.1	355.2	42.8	66.8	46.2	51.3
T_5	1.38	1.31	1.58	1.42	266.4	424.7	294.4	328.5	39.8	60.1	42.3	47.6
T_6	1.49	1.37	1.65	1.57	210.6	438.2	309.9	339.6	41.8	61.9	43.6	49.1
T_7	1.52	1.35	1.66	1.51	278.9	453.5	305.8	346.1	43.5	65.2	44.5	51.2
LSD 5%	0.08	0.06	0.11		18.22	26.68	19.38		2.38	3.56	2.81	

4- Fruit Quality:

The results in Tables (6, 7 and 8) show that all investigated fertilization regimes (T_2, T_3, T_4, T_5, T_6 and T_7) improved the fruit quality of Balady mandarin in terms of increasing the fruit weight, pulp %, total soluble solids (TSS), TSS/acid ratio and sugar and vitamin C contents and decreasing the titratable acidity and nitrite (NO_2) content compared to the use of N, P and K in mineral sources.

Fertilizing Balady mandarin trees with NPK as three forms (33% mineral, 33% natural and 33% bio-form) resulted in the best results with regard to the fruit quality parameters, since such treatment gave the heaviest fruit and the highest values of total soluble solids as well as sugar and vitamin C contents and the least juice nitrite content. No significant differences in the fruit quality parameter were recorded due to using fertilizers having the three forms, two forms, natural form or bio-form. Unfavourable effects on the fruit quality parameters were observed on the trees

with applying NPK as 100% mineral source. The fruit weight, TSS, total sugar, V.C and nitrite averaged over three seasons were 148.38 g, 12.28%, 9.00, 44.64 mg/g and 1.54 ppm, respectively, due to use the three forms (T_7). On other hand, the least values of these respective parameters were 134.18 g, 11.45%, 8.36%, 38.43 mg/g and 2.91 ppm for the mineral source only (check treatment). Therefore, the increase percentage were 10.58, 7.25, 7.66 and 16.13% for fruit weight, TSS, total sugar and vitamin C contents, respectively. However, the decrease percentage of juice nitrite was (47.08%). Such improvement is very important to citrus organic production.

Table (6): Effect of mineral, organic and bio-fertilizers on fruit weight, fruit pulp % and total soluble solids (TSS%) of Balady mandarin fruits during 2012, 2013 and 2014 seasons.

No.	Fruit weight (g)				Fruit pulp (%)				TSS (%)			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	138.22	131.11	133.20	134.18	71.30	70.68	71.53	71.17	11.23	11.33	11.80	11.45
T_2	153.71	138.70	140.53	144.31	73.38	72.50	73.39	73.09	11.68	12.36	12.52	12.19
T_3	153.35	143.18	143.46	146.66	73.65	72.90	73.67	73.41	11.88	12.28	12.41	12.19
T_4	151.83	140.96	141.60	144.30	72.60	71.89	72.83	72.44	11.76	12.02	12.37	12.05
T_5	150.42	142.00	145.83	145.42	72.75	72.00	72.95	72.57	11.67	11.86	12.65	12.06
T_6	154.62	140.60	141.90	145.71	74.52	73.64	74.55	74.17	11.63	12.14	12.68	12.15
T_7	152.80	148.58	143.76	148.38	74.48	73.15	74.10	74.31	11.90	12.23	12.70	12.28
LSD 5%	8.36	7.28	6.11		1.92	1.68	1.59		0.39	0.48	0.43	

Table (7): Effect of mineral, organic and bio-fertilizers on titratable acidity %, TSS/acid ratio and nitrite contents of Balady mandarin juice during 2012, 2013 and 2014 seasons.

No.	Titratable acidity (%)				TSS/acid ratio				Nitrite (ppm)			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	1.30	1.39	1.35	1.36	8.44	8.15	8.74	8.49	2.92	2.84	2.98	2.91
T_2	1.18	1.23	1.21	1.21	9.89	10.18	10.07	10.05	1.64	1.40	1.68	1.60
T_3	1.16	1.20	1.18	1.18	10.24	10.34	10.33	10.30	1.49	1.43	1.55	1.49
T_4	1.21	1.26	1.25	1.24	9.72	9.82	9.67	9.74	1.93	1.85	1.92	1.90
T_5	1.19	1.23	1.23	1.22	9.81	10.28	9.80	9.96	1.76	1.68	1.83	1.76
T_6	1.15	1.20	1.17	1.17	10.11	10.57	10.38	10.35	1.55	1.56	1.63	1.58
T_7	1.13	1.19	1.15	1.16	10.53	10.67	10.68	10.63	1.53	1.48	1.61	1.54
LSD 5%	0.06	0.05	0.08		0.38	0.51	0.59		0.42	0.37	0.35	

Table (8): Effect of mineral, organic and bio-fertilizers on sugar and vitamin C (V.C.) contents of Balady mandarin fruits during 2012, 2013 and 2014 seasons.

No.	Total sugar (%)				Reducing sugar (%)				V.C. (mg/g)			
	2012	2013	2014	Mean	2012	2013	2014	Mean	2012	2013	2014	Mean
T_1	8.24	8.37	8.46	8.36	3.10	3.36	3.27	3.24	39.35	38.11	37.95	38.44
T_2	8.91	9.03	9.11	9.02	3.38	3.66	3.55	3.53	46.02	44.56	44.38	44.99
T_3	8.88	9.01	9.08	8.99	3.36	3.64	3.53	3.51	44.65	43.29	42.93	43.62
T_4	8.73	8.87	8.93	8.84	3.30	3.59	3.49	3.46	43.81	42.50	42.15	42.82
T_5	8.51	8.65	8.80	8.65	3.28	3.51	3.41	3.40	43.18	41.82	41.48	42.16
T_6	8.58	8.72	8.83	8.71	3.29	3.54	3.46	3.43	45.86	44.53	44.12	44.84
T_7	8.92	9.00	9.09	9.00	3.36	3.63	3.54	3.51	45.80	44.31	43.80	44.64
LSD 5%	0.25	0.26	0.30		0.15	0.14	0.12		2.33	2.56	2.98	

Discussion and Conclusion:

Fertilization is one of the important management tools for increasing crop production. Nitrogen is a necessary element for chlorophyll, protoplasm, protein and nucleic acid synthesis (Nijjar, 1985), so that its application can induce an increase the growth traits due to increasing the cell number and its size. Potassium is a macronutrient that plays a great regulatory role in many physiological and biochemical processes of the plant. It is important in the formation and function of proteins, fats, carbohydrates and chlorophyll as well as maintaining the balance of salts and water in plant cells (Achilea, 1998). Phosphorus is very important in the metabolic processes, i.e. blooming and flower development. It is the main constituent of energy compounds (Attia *et al*., 2002). Major compensation to overcome the low fertility of soils is to use chemical fertilizers that become an expensive item for orchard management and environment pollution. Using organic and bio-fertilizers are considered a promising alternative for chemical fertilizers, as well as, very safe for soil, human, animals and environment (Verna, 1990; El-Salhy *et al*., 2010). Moreover, the organic fertilization has a positive action in increasing the activity of microflora, water holding capacity, soil structure aggregation, soil organic matter, soil humus content and the availability of most nutrients inducing an increasing nutrient supply and improving the efficiency of macro elements as well as its ability to meet some micronutrient requirements (El-Nagar, 1996). Such stimulation on the uptake of nutrients leads to enhance the biosynthesis of organic foods and cell division (Miller *et al*., 1990).

Biofertilizers are microbial inoculants that have an important role on biological, physical and chemical soil properties. There are a number of inoculants that can serve as useful components of integrated plant nutrient supply systems. Such inoculants may help in increasing crop productivity by increasing biological N fixation, availability or uptake of nutrient through solubilization or increasing absorption, stimulation of the plant growth through hormonal action, antibiosis and by decomposition of organic residues (Subba-Rao *et al*., 1993; Wu *et al*., 2005).

So, it could be concluded that the fertilization using either natural or bio sources singly or in combination, or as three fertilization sources is effective in improving the tree vigour expressed as an increase in shoot growth, leaf surface expansion and its nutrient status.

These findings emphasize the vital importance of these fertilization sources in order to overcome the losses of nutrients by leaching, volatilization and mobility of nutrients. These sources, also, improve the soil fertility due to their high residual nutrient values, enhance the solubility of nutrients and increase the activity of microorganisms.

Moreover, natural and biofertilizers improved the nutrient status and the total leaf surface area of the trees which led to enhance pho-

tosynthesis and increase synthesis of carbohydrates and proteins and consequently enhance cell division and enlargement leading to an increase in the fruit weight and size. Also, more available carbohydrates were produced and translocated to the fruit that advance the fruit maturity and improve the fruit chemical attributes. In addition, both organic and biofertilizers as well as all combinations of fertilization forms caused a sharp reduction in the juice nitrite content. This may be because the nitrogen that is in the mineralization-immobilization cycle stays longer and thus is more slowly available. Moreover, use of organic and biofertilizers induced a further reduction in NO_3-N accumulation in the plant compared to the use of mineral nitrogen (El-Sisy, 2000). In addition, these fertilization treatments for the organic farming production are important and necessary.

The beneficial effects of the organic fertilizers on the growth and fruiting of citrus trees were emphasized by Ibraheim *et al*. (1993), Ebrahim and Mohamed (2000), Wang *et al*. (2000), Srivastava *et al*. (2002), El-Salhy *et al*. (2002), Wei *et al*. (2002), Ahmed *et al*. (2007), Abdo (2008), El-Salhy *et al*. (2010), Abdel-Rahman (2010), Aly *et al*. (2011), Mahmoud (2012) and Ahmed *et al*. (2013).

In addition, the pormotive effects of bio-fertilizers were reported by Helail and El-Deeb (1993), Attia *et al*. (2002), Hegab *et al*. (2005), Mostafa (2006), El-Salhy *et al*., (2006a,b), Ahmed *et al*. (2007), Abdo (2008), Ismail-Omayma *et al*. (2011), El-Khayat and Abdel-Rhiem (2013) and Abou-Zeed, Eman *et al.* (2014).

So, the application of natural and bio-sources of fertilizers along with the mineral one is effective for improving growth and fruiting aspects of citrus trees.

Therefore, it could be concluded that using either natural or biofertilization, singly or in combination as well as along with mineral sources improves the tree nutrient status, yield and fruit quality. In addition, it minimizes the environmental pollution which could be occurred by excess of chemical fertilizers. Furthermore, using natural and biofertilization sources improve the soil fertility and reduces the added fertilizer requirements. Thus, the growers are able to produce organic farming products.

References:

A.O.A.C. (1985): Association of Official Agricultural Chemists. Official Methods of Analysis 14th Ed. P. 490-500, Benjamin Franklin Station, Washington, D.C., U.S.A.

Abdelaal, A.H., F.F. Ahmed, S.E.M. El-Masry and A.A. Abdallah (2013): Using potassium sulphur as well as organic and biofertilization for alleviating the adverse effects of salinity on growth and fruiting of Valencia orange trees. Stem Cell. 4 (4): 27-32.

Abdel-Rahman, M.M.A. (2010): Effect of different sources of nitrogen and potassium fertilizers on growth and fruiting of Bal-

ady mandarin trees. Ph.D. Thesis in Pomology, Fac. Agric., Assiut Univ., 57-169.

Abdo, Z.A.A. (2008): Effect of some biofertilization treatments on growth and fruiting of Balady mandarin trees. Ph.D. Thesis Fac. of Agric. Minia Univ.

Abou-Zeed, Eman, A.A.; A.M. El-Salhy; H.A. Abdel-Galil and Ebtsam, F.M. Badawy (2014): Effect of yeast and different phosphorus fertilizer sources on growth and fruiting of Balady mandarin trees. Assiut J. Agric. Sci., 45 (3): 49-64.

Achilea, O. (1998): Citrus and tomato quality is improved by optimized K nutrition. In: Improved crop quality by nutrient management. Anac, D. and P. Martin-prevel (eds). Kluwere Academic Publishers, 19-22.

Ahmed, F.F. and M.H. Morsy (1999): A new method for measuring leaf area in different fruit species. Minia J. Agric. Res. & Dev. 19: 97-105.

Ahmed, F.F., A.E.M. Mansour and E.A. Shaaban (2007): Effect of different sources of mineral N applied with organic and bio fertilizers on fruiting of Washington navel orange trees. Minia J. Agric. Res. and Develop. 27 (9): 30-51.

Ahmed, F.F., A.M.K. Abdelaal and M.H.A. Faraag (2013): Partial replacement of inorganic N fertilizer in Balady mandarin orchards by using organic and biofertilization. Stem. 4 (2): 21-28.

Aly, Q.A., A.M. El-Salhy, H.A. Abdel-Galil and S.M. El-Masry (2011): Effect of different potassium fertilizer sources and antioxidant application on vegetative growth, nutrient status and fruiting of Balady mandarin trees. Assiut J. of Agric. Sci. 42 (Special Issue): 317-331.

Annual Reports and Agricultural Economics Research in A.R.E. (2012).

Attia, K.K.; A.M. El-Salhy and M.M. El-Dsouky (2002): Effect of mineral and bio-fertilization of phosphorus on nutrient status, yield quality of Balady mandarin trees and Roomy Red grapevines. The 3rd Scientific of Agric. Sci., Assiut, 20-22 Oct. (III): 351-369, Egypt.

Ebrahiem, T.A and G.A. Mohamed (2000): Response of Balady mandarin trees growing on sandy soil to application of filter mud and farmyard manure. Assiut J. of Agric. Sci. 31 (5): 55-69.

El-Khayat, H.M. and M.A. Abdel-Rehiem (2013): Improving mandarin productivity and quality by using mineral and biofertilization. Alex. J. Agric. Res. 58 (2): 141-147.

El-Nagar, E.M. (1996): Effect of applying some organic residues to sand and calcareous soils on growth and composition of some plants. M.Sc. Thesis, Fac. of Agric., Mansoura Univ., Egypt.

El-Salhy, A.M., H.A. Abdel-Galil, A.H. Abdel-Aal and M.M. Ab-

del-Rahman (2010): Effect of different nitrogen fertilizer sources on vegetative growth, nutrient status and fruiting of Balady mandarin trees. Assiut J. of Agric. Sci., 41 (Special Issue): 153-160.

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.M. Marzouk and T.A. Ali (2006a): Physiological studies on the effect of active dry yeast application on Balady mandarin trees. 1- Vegetative growth and nutrient status. The 3rd Int. Conf. for Develop. and the Env. In the Arab World, March 21-23, pp. 605-613.

El-Salhy, A.M.; H.M. Marzouk and T.A. Ali (2006b): 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.

El-Sisy, L.M.H. (2000): Assessing the pollution caused by excessive nitrogen fertilization. J. Agric. Sci., Mansoura Univ., 25 (11): 7297-7313.

Farag, M.H.A. (2013): Reducing the amount of chemical fertilization partially by using organic and biofertilization in Balady mandarin orchards. M.Sc. 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: 107-120.

Helail, B.M. and M.D. El-Deeb (1993): Response of Rangpur lime seedling to soil inoculation with mycorrhizal fungi. Egypt. J. Appl. Sci., 8 (8): 485-505.

Ibraheim, T.A.; F.F. Ahmed and K.G. Assy (1993): Behavior of Balady mandarin trees (*Citrus reticulate* L.) growing in sandy soil to different forms and concentrations of potassium foliar sprays. Assiut J. of Agric. Sci. (24).

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 Sciences 5 (11): 1285-1289.

Kannaiyan, S. (2002): Biotechnology of Biofertilizers. Alpha Sci. Inter. Ltd B. O. Bpx 4067 Pang Boorne. 68 U.K. pp. 1-275.

Lasage, A.C. (1995): Fundamental approaches in describing mineral dissolution and precipitation rates. In: White A.F., Brantley, S.L. (eds) Chemical weathering rates of silicate minerals, Reviews in Mineralogy 31, 23-86. Washington : Mineralagical Society of America.

Mahmoud, Kh, M.H. (2012): Reducing inorganic N fertilizer in Balady mandarin orchard through application of extracts of yeast, seaweed and farmyard manure. M.Sc. Thesis, Fac. of Agric., Minia Univ., Egypt.

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.

Mengel, K. (1984): Nutrition and Metabolism of plants. Fisher Verlage Stutgart and New York, 110-115.

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.

Mohamed, A.K.A., M.M.M. Ahmed and M.M. El-Akkad (2009): Is it possible to compensate the annual fertilization in Mandarin orchards by using the biofertilziers? Assiut J. of Agric. Sci., 40 (4): 37-68.

Mostafa, F.M.A. (2006): Improving fruit quality of organically produced fruits of Egyptian lime by applying some bio-fertilizers and gibberellic acid. Assiut J. of Agric. Sci. 37 (2): 83-100.

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

Ragab, M.M. (2006): Response of Balady mandarin trees to drip irrigation and nitrogen fertilization. Ph.D. Thesis, Fac. of Agric., Minia Univ., Egypt.

Rindonour-Lisa, A.; E. Sion-Julia, A.H. Michael, A.W. David, M.M. Sean, R.B. Garry and R.S. Douglas (2000): A spectrophotometer method for the direct detection and quantitation of nitric oxide nitrite and nitrite in cell culture media. Analytical Biochemistry, 281: 223-229.

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

Srivastava, A.K., S. Shyam and R.A. Marathe (2002): Organic citrus soil fertility and plant nutrition with K of sustainable Agric. Food Products Press., Binghamton, USA, 19 (3): 5- 29.

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

Verna, L.N. (1990): Role of biotechnology in supplying plant nutrients in the vineties, Fertilizer News 35: 87-97.

Wang, C.Q., S.L. Wang, J.Y. Zhoiu, Q.Y. Zhou, Z.Y. Deng and W.C. Han (2000): On the citrus requirement on nutritions and the special organic compound fertilizers. South China fruits, 29: 5, 18-22.

Wassel, A.M., F.F. Ahmed and T.A. Ebrahiem (2000): Nitrogen better management for high and quality of Balady mandarin

trees grown in sandy soil. The 2nd Conf. of Agric. Sci., Fac. of Agric., Assiut Univ., Assiut, Oct. 2000, 293-300.

Wassel, A.M., M.A. Mohamed, M.A. Ragab, R.A. Sayed and Y.A. Hussein (2007a): Influence of biofertilization and application of potassium. I- On growth and leaf chemical composition of Balady mandarin trees (Citrus reticulate, Blanco). 1st Inter. Conf. on Desert Cultivation Future (problems & Solution) 27-29 March, Minia Univ. Egypt.

Wassel, A.M., M.A. Mohamed, M.A. Ragab, R.A. Sayed and Y.A. Hussein (2007b): Influence of biofertilization and application of potassium. II- on yield and fruit quality of Balady mandarin trees (*Citrus reticulata*, Blanco). 1st Inter. Conf. on Desert Cultivation Future (problems & Solution) 27- 29 March, Minia Univ. Egypt.

Wani, S.P. and K.K. Lee (1995): Microorganisms as biological inputs for sustainable agriculture. In organic agriculture, theory and practices (ed) P.K. Thampan, Peekay, Tree crops development. Foundation, Gandhi Nagar – Cochin 682-220, pp m: 36-76.

Wei, L.J.; C. Fang; L. Dongbi; W. Yun Fan, Y. Chang Bing and W.Y. Hua (2002): Potassium chloride on growth of citrus tree, yield and quality of fruits. Soil and Fertilizers Beijing, 4: 34.

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.

Wu, S.C., Z.H. Cao, Z.G. Li, K.C. Chcung and M.H. Wong (2005): Effects of biofertilizer containing N-fixer, P and K solubilizers trial. Geoderma 125: 155-166.

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

تأثيرات التسميد الطبيعي والحيوي كبديل جزئي للتسميد المعدني علي النمو الخضري وإثمار أشجار اليوسفي البلدي

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الملخص:

أجريت هذه الدراسة خلال ثلاثة مواسم متتالية ٢٠١٢ ، ٢٠١٣ ، ٢٠١٤ ، بمزرعة خاصة تقع في نجع حمادي – قنا – مصر، وتهدف إلي دراسة تأثير الاستبدال الجزئي للأسمدة المعدنية بالأسمدة الطبيعية والحيوية علي الحالة الغذائية وإثمار أشجار اليوسفي البلدي مقارنة باستخدام الجرعة السمادية للنيتروجين والفوسفور والبوتاسيوم (NPK) بالأسمدة المعدنية فقط. حيث أستخدم الأسمدة الطبيعية (طينة المرشحات، صخر الفوسفات والفلسبار) بينما كانت الحيوية (النتروبين ، الفوسفورين والبوتاسيوماج).

ويمكن تلخيص أهم النتائج كما يلي:

- سبب التسميد بالخليط الثلاثي للأسمدة (المعدني + الطبيعي + الحيوي) زيادة مؤكدة في صفات النمو الخضري ومحتوي الأوراق من العناصر الغذائية (NPK) وكذلك نسبة الكربوهيدرات ونسبة الكربوهيدرات إلي النيتروجين بالأفرع مقارنة باستخدام الأسمدة المعدنية فقط.
- أدي إستخدام الأسمدة الطبيعية أو الحيوية بصورة فردية أو استخدام الخليط الثلاثي والثنائي للأسمدة إلي زيادة مؤكدة في إنتاجية الأشجار مقارنة باستخدام الجرعة السمادية في صورة أسمدة معدنية فقط.
- سبب التسميد بالصورة الثلاثية أو الثنائية تحسن واضح في الصفات الثمرية مع نقص في تركيز النترات بالعصير مقارنة باستخدام الأسمدة المعدنية.
- لا توجد فروق جوهرية في أغلب الصفات تحت الدراسة نتيجة التسميد بأي من الصورة الطبيعية أو الحيوية أو الثنائية أو الثلاثية.

من نتائج هذه الدراسة يمكن التوصية بأفضلية التسميد بالصورة الثلاثية أو أي صورة ثنائية حيث يؤدي ذلك إلي تحسين النمو والحالة الغذائية للأشجار مع إنتاج محصول عال ذو خصائص ثمرية جيدة فضلاً عن تقليل التلوث البيئي الناشئ عن زيادة الأسمدة المعدنية وإمكانية إنتاج ثمار يوسفي عضوياً.