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THE BENEFICIAL EFFECTS OF FERTILIZERS BY USING NATURAL AND BIO-FERTILIZERS ON VEGETATIVE GROWTH AND FRUITING OF BALADY MANDARIN

A. M. Fathallah, A. E. Hasan, A. A. Kasem and Basma S. A. Salama
Department of Horticulture, Faculty of Agriculture, Menoufia University

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ABSTRACT: This study included was conducted during 2017 and 2018 seasons on 21-year- old Balady mandarin trees (*Citrus reticulata*) budded on sour orange rootstock grown, to investigate the possibility of reducing the amount of mineral fertilizers by using organic and biofertilizers of Balady Mandarin trees. Trees planted at 5x5 meters, grown in clay loam with and irrigated by flood irrigation system. Seven fertilization treatments were applied as follows: 100% mineral NPK fertilizers (control), 100% organic fertilizers (enrichment compost with two natural rocks, rock phosphate and feldspar), 100% biofertilizers (nitrobien, phosphorien and potassiumag), 50% mineral fertilizers + 50% organic fertilizers, 50% mineral fertilizers + 50% biofertilizers, 50% organic fertilizers + 50% biofertilizers and 33.3% mineral fertilizers + 33.3% organic fertilizers + 33.3% biofertilizers. The results indicated that there is a possibility of using organic and biofertilizers as a partial substitute of mineral fertilizers. As this study confirmed the application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) was the best management system for ensuring the best vegetative growth traits, achieving the highest yield with its components, improving the physical and chemical characteristics of fruits and increasing leaf mineral content of Balady Mandarin trees.

Key words: Balady mandarin, mineral fertilizers, organic fertilizers, compost, natural rocks, biofertilizers, yield, fruits.

INTRODUCTION

Citrus is backbone of fruit crop cultivation in Egypt. It takes the first rank in Egypt and it is suggested to be one of the most important cash crops all over the world. During the last few years, citrus area has increased due to increasing demands of local consumption and exports, which is expected to boom in the future.

Citrus has high nutritional values because of its own higher amounts of sugars, minerals, vitamins, organic acid and antioxidants, and it used in various technological purposes such as canning, making juice, jams and other preserves (Chandler, 1987).

Citrus is most important fruit crop in Egypt, as far as its acreage, production and exportation potentialities are concerned. The economic value puts citrus fruit on the top of all other important fruit crops in Egypt. The fruiting acreage of citrus occupies 479656 feddans from the total fruit crops area, which is estimated to be 1385409 feddans. This area of citrus produced 4323030 metric ton fruits. Out of the fruiting citrus area, there are 108134 feddans grown into Balady mandarins cultivars producing 977885 metric ton fruits according to the latest statistics from Ministry of Agriculture (2018).

Fertilization is one of the most important cultural practices carried out during the growing season. One of the most important problems facing grape growers concerning the use of mineral NPK fertilizers is the high cost of the

manufactured fertilizers needed for agriculture. Besides, the excess of mineral fertilizers causes a major pollution of ground water, which it reflects on accumulation of harmful residual substances in the fruits (Montasser *et al.,* 2003).

The continuous application of natural materials is promising in the long term, along with the aforementioned dangers of mineral fertilization is a major problem facing citrus growers. Therefore, a great attention was realized to fulfill the nutrient requirements of fruit trees from organic sources as enriched compost with natural rocks and bio fertilizers as an alternative to chemical fertilizers (El-Haddad *et al.,* 1993).

Organic fertilization is another option for supplying macro and micro nutrients necessary for plant growth (El-Haggar *et al.,* 2004). In addition, the organic materials improve soil structure, aeration, and retention of moisture and reduce soil pH, encourage the natural soil processes, which have long-term effects on soil fertility, hence improve the crop productivity (Singh, 2012).

Biofertilizers are commonly called microbial inoculants which are capable of mobilizing important nutritional elements in the soil from non-usable to usable form by the crop plants through their biological processes. During the last decade, biofertilizers have been extensively used as an eco-friendly approach to minimize the use of chemical fertilizers, improve soil fertility status and for the enhancement of crop production by their biological activity in the rhizosphere (Ram Rao *et al.,* 2007).

Application of organic and bio-fertilizers were considered an important tools to enhance the yield and fruit quality of citrus through increases the organic matter in the soil and also enhances soil physical and chemical properties and biological activities (Shiralipour *et al.,* 1992).

The importance of application of natural rocks (rock phosphate, feldspar and mixed mineral ore) may be attributed to their release of macro elements which make converting them in soluble forms. Utilization of these rocks as natural fertilizer has been received significant interest in the recent years since it is natural, inexpensive and available fertilizer (Mohamed, 2008).

The main target of this investigation is to study the effect of mineral, organic fertilizers and biofertilizers as well as their combinations on tree growth, leaf mineral content, yield and fruit quality of Balady Mandarin trees.

MATERIALS AND METHODS

This investigation was conducted during 2017 and 2018 seasons on 21-year- old Balady mandarin trees (*Citrus reticulata*) budded on sour orange rootstock grown in orchard of the Horticultural Experiment Station, Faculty of Agriculture, Shebin El-kom, Menoufia Governorate. Trees planted at 5x5 meters, grown in clay loam with and irrigated by flood irrigation system. The experimental trees were healthy, similar in growth vigor and received the same horticultural practices.

Soil samples initial were collected from the experimental field of farm area at 0–30 cm soil depth and were analyzed to determine some physical and chemical properties as presented in (Table 1) according to the procedures that outlined by Piper (1950) and Peach and Tracey (1968).

Sixty three fruitful Balady Mandarin uniform trees were selected, each three trees acted as a replicate and each three replicates represented as one of the following treatments.

Table 1. Physical and chemical analysis of the tested soil

Depth of soil sample (cm)	E.C mmhos/cm2	PH	N^+	K^+	Mg^{++}	Cl^-	SO_4^+	HCO_3^-
			mg/100 g soil					
0 – 30	0.59	6.4	0.27	0.030	0.31	0.17	0.85	0.36
30 – 60	0.55	6.5	0.30	0.012	0.31	0.13	0.70	0.41

Seven treatments were applied as follows:

1) **100% Mineral fertilizer (control)**
2) **100% Organic fertilizer**
3) **100% Bio-fertilizer**
4) **50% Mineral fertilizer + 50% Organic fertilizer**
5) **50% Mineral fertilizer + 50% Bio-fertilizer**
6) **50% Organic fertilizer + 50% Bio-fertilizer**
7) **33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer**

Mineral NPK fertilizers (control)

- **3Kg / tree of ammonium nitrate fertilizer (33.5% N) was divided into three equal batches and added in mid-March, May and July.**
- **150g / tree calcium super phosphate fertilizer (15.5% P_2O_5) was added during winter service at the mid of December.**
- **1Kg / tree of potassium sulphate fertilizer (50% K_2O) was divided into two equal batches and added in mid-March and June.**

Organic fertilizer

Enrichment compost with rock phosphate (20.36% P_2O_5) and feldspar (11.08% K_2O) were applied to the equivalent to mineral fertilizers content of NPK during winter service at the mid of December. Physical and chemical of enrichment compost with rock phosphate and feldspar are shown in Tables (2 & 3).

Bio-fertilizers

500g/tree of nitrobien (containing a combination of nitrogen (N)- fixing bacteria *Azotobacter chroococcum* and *Azospirillum liposerum*), 150g/tree of phosphorien (containing the phosphorus (P)-solubilizing bacteria *Bacillus megaterium*) and 250g/tree of potassiumag (containing the potassium (K)-solubilizing bacteria *Bacillus circulans*) were added in two equal doses during the months of March and July.

The following parameters were adopted to evaluate the tested treatments:-

1. Vegetative growth

Sixteen new shoots from spring growth cycle were chosen on four labeled branches, four shoots on four main directions. The average length of shoots (cm) and number of leaves were recorded. Furthermore, samples of twenty mature leaves were taken from the middle parts of the shoots to determine the leaf area according to Ahmed and Morsy (1999). Calculate the leaf area by the following formula:

Leaf area (cm^2) = 0.46 (maximum leaf length x maximum leaf width) + 1.81

2. Yield and its components

Harvesting was achieved during the regular harvesting time prevailing under Menoufia region conditions (mid of December) during the two seasons when TSS/acid ratio reached at least 8:1. Yield per tree expressed in weight (Kg) was estimated by multiplying fruit number per tree X average fruit weight.

Table 2. Physical and chemical analysis of the used compost

Properties	Values
Organic matter (%)	40.51
Organic carbon (%)	23.50
Moisture content (%)	30
Total nitrogen (%)	2.06
Soluble ammonium (ppm)	323
Soluble nitrate (ppm)	97
P (%)	1.43
K (%)	1.48
C/N ratio	11:1
pH value (1:10)	7.70
EC value (1:10) (mmohs/cm)	5.93

Source: Environmental wastage recycling unit, Moshtohor Agriculture Collage

Table 3. Chemical analysis of the used natural mixture rocks

Item	Rock phosphate (%)	Feldspar (%)
SiO2	13.17	71.13
TiO2	0.06	0.02
Al2O3	0.87	14.38
Fe2O3	1.55	0.29
MnO	0.10	0.01
MgO	2.09	0.01
CaO	43.38	0.16
Na2O	0.32	1.51
K2O	0.12	11.08
SO3	2.98	0.00
P2O5	20.36	0.05
L.O.I.	14.02	0.67
F	1.07	0.00

Source: Al Ahram mining and natural fertilizer company in Egypt

3. Fruit physical properties

At maturity stage, ten fruits at picking date were taken at random from constant height and from all directions of each tree.

- **Average fruit size (cm^3)**
- **Average fruit length (cm)**
- **Average fruit diameter (cm)**
- **Average fruit shape index**
- **Average fruit circumference (cm)**
- **Average pulp weight (%)**
- **Average peel thickness (mm)**

4. Fruit chemical properties

The following parameters were recorded, in the same sequences, as mentioned in fruit physical properties.

- **Total soluble solids (TSS%) of fruit juice was determined by using a hand refractometer.**
- **Total acidity (%) was determined by titrating fruit juice against (0.1 N) NaOH with phenolphthalein as an indicator and calculated as gram citric acid per 100 ml fruit juice according to the method of A.O.A.C. (2005).**
- **TSS/acid ratio was calculated by dividing TSS value by total acidity value.**
- **Total sugars (%) and reducing sugars (%) was determined according to Miller (1959).**

5. Leaf content of macro-elements

Fifty mature leaves seven months age from non-fruiting shoots in the spring growth cycle (1st week of Sept.) were taken according to Summer, (1985). The leaves were dried at 70 ˚c and digested using H_2SO_4 and H_2O_2 according to Wilde *et al.,* (1985). In the digested solutions nutrients namely N, P and K on dry weight basis were determined.

- **Total nitrogen (%) was determined by using the micro-Kjeldahl method as describe by (Piper, 1950).**
- **Phosphorus (%) was determined by using the method of Peach and Tracey (1968).**
- **Potassium (%) was determined by using Flame photometer according to the method of Wilde *et al.,* (1985).**

Experimental design and statistical analysis

The randomized complete block design was performed for the first experiment; while completely randomized design was adopted for the second experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the L.S.D. values at 5% level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1. Vegetative growth

Date presented in Table (4) indicated that all vegetative growth characteristics *i.e.* average shoot length, average number of leaves and average leaf area were significantly affected by mineral, organic and bio fertilization treatments of Balady Mandarin trees during 2017 and 2018 seasons.

Regarding average shoot length, it was evident that the longest significant shoot length was obtained with combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, whereas trees receiving 100% organic fertilizer or bio-fertilizer had the shortest one in both seasons.

With respect to average number of leaves, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest number of leaves followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Concerning average leaf area, it is obvious that the largest significant leaf area was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving 100% organic fertilizer or bio-fertilizer resulted in the smallest one in both seasons.

Table 4. Effect of mineral, organic and bio fertilization on vegetative growth characteristics of Balady Mandarin trees during 2017 and 2018 seasons

Treatment	Average shoot length (cm)	Average number of leaves	Average leaf area (cm^2)
		2017 season	
100% Mineral fertilizer (control)	9.50	10.33	5.40
100% Organic fertilizer	8.77	7.00	5.03
100% Bio-fertilizer	8.63	8.00	5.36
50% Mineral fertilizer + 50% Organic fertilizer	11.83	12.66	5.93
50% Mineral fertilizer + 50% Bio-fertilizer	13.36	13.66	6.33
50% Organic fertilizer + 50% Bio-fertilizer	9.86	12.00	5.60
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	14.13	16.33	7.16
L.S.D at 5 %	0.72	2.09	0.81
		2018 season	
100% Mineral fertilizer (control)	14.06	11.33	5.86
100% Organic fertilizer	12.66	9.66	4.86
100% Bio-fertilizer	13.00	10.00	5.60
50% Mineral fertilizer + 50% Organic fertilizer	15.46	14.33	6.33
50% Mineral fertilizer + 50% Bio-fertilizer	17.36	19.33	7.40
50% Organic fertilizer + 50% Bio-fertilizer	15.10	14.00	6.13
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	17.40	19.66	7.43
L.S.D at 5 %	1.24	3.27	0.52

The beneficial effect of organic fertilizers on vegetative growth traits of trees could be related to the improvement of physical conditions of the soil, providing energy from microorganism activity, increasing nutrient supply and improving the efficiency of macro elements as well as its ability to meet some micronutrient requirements (El-Nagar, 1996).

The increments in growth parameters due to inoculation biofertilizers might be attributed to its effect on increasing nitrogen fixation, production of growth promoting substances or organic acids and enhancing nutrient uptake (Samah, 2002).

These results are in accordance with those reported by Barakat *et al.* (2012) on Newhall Navel orange trees; Mahmoud (2012) on Balady mandarin trees; Abdel-Hak *et al.* (2012) on Valncia orange trees and Zayan *et al.* (2016) on Washington Navel orange trees, they revealed that organic fertilizers with bio-fertilizers improved vegetative growth characteristics.

2. Yield and its components

As shown in Table (5), data reveal that yield and its components expressed average yield per tree, average number of fruits per tree and average fruit weight were significantly affected by mineral, organic and bio fertilization treatments of Balady Mandarin trees during 2017 and 2018 seasons.

Highest significant yield per tree was obtained with combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, whereas trees receiving 100% organic fertilizer or bio-fertilizer had the lowest one in both seasons.

With respect to average number of fruits per tree, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest number of fruits per tree followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Concerning average fruit weight, it is obvious that the highest significant average fruit weight was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving 100% organic fertilizer or bio-fertilizer resulted in the lowest one in both seasons.

The beneficial effects of using organic fertilizers on increasing yield and its components could be due to their effect on providing vines with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the vines (Nijjar, 1985).

The increments in yield and its components due to inoculation biofertilizers might be attributed to its effect on improving nutritional status of vine as well as its ability to meet some micronutrient requirements (El-Nagar, 2004).

Table 5. Effect of mineral, organic and bio fertilization on yield and its components of Balady Mandarin trees during 2017 and 2018 seasons.

Treatment	Average yield per tree (kg)	Average number of fruits per tree	Average fruit weight (g)
		2017 season	
100% Mineral fertilizer (control)	59.64	350.6	170.1
100% Organic fertilizer	53.58	329.4	162.7
100% Bio-fertilizer	56.63	340.1	166.5
50% Mineral fertilizer + 50% Organic fertilizer	72.59	386.3	187.9
50% Mineral fertilizer + 50% Bio-fertilizer	79.15	412.7	191.8
50% Organic fertilizer + 50% Bio-fertilizer	64.26	360.6	178.2
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	81.47	421.4	193.3
L.S.D at 5 %	13.94	23.1	11.7
		2018 season	
100% Mineral fertilizer (control)	81.83	547.3	149.5
100% Organic fertilizer	72.06	517.2	139.3
100% Bio-fertilizer	74.81	521.7	143.4
50% Mineral fertilizer + 50% Organic fertilizer	91.52	574.4	159.3
50% Mineral fertilizer + 50% Bio-fertilizer	104.18	603.6	172.6
50% Organic fertilizer + 50% Bio-fertilizer	87.24	556.9	156.7
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	105.92	609.1	173.9
L.S.D at 5 %	9.27	29.7	8.3

These results are in harmony with those reported by Mahmoud (2012) on Balady mandarin trees; Abdel-Hak *et al.* (2012) on Valncia orange trees; Kumar *et al.* (2013) on Khasi mandarin trees and Zayan *et al.* (2016) on Washington Navel orange trees, they revealed that organic fertilizers with bio-fertilizers achieved the best fruit yield with its components as number of fruits/tree and average fruit weight (kg/tree).

3. Fruit physical properties

Date presented in Tables (6 & 7) showed that all fruit physical properties namely average fruit size, fruit dimensions, fruit shape index, fruit circumference, pulp weight and peel thickness were significantly affected by mineral, organic and bio fertilization treatments of Balady Mandarin trees during 2017 and 2018 seasons.

Regarding average fruit size, it was evident that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest average fruit size followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Table 6. Effect of mineral, organic and bio fertilization on average fruit size, fruit dimensions, fruit shape index of Balady Mandarin trees during 2017 and 2018 seasons

Treatment	Average fruit size (cm3)	Average fruit length (cm)	Average fruit diameter (cm)	Average fruit shape index
		2017 season		
100% Mineral fertilizer (control)	193.7	5.42	7.21	0.75
100% Organic fertilizer	183.3	5.31	7.16	0.74
100% Bio-fertilizer	191.7	5.34	7.19	0.74
50% Mineral fertilizer + 50% Organic fertilizer	201.0	5.67	7.31	0.78
50% Mineral fertilizer + 50% Bio-fertilizer	203.3	5.70	7.36	0.77
50% Organic fertilizer + 50% Bio-fertilizer	200.7	5.43	7.27	0.75
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	208.3	5.81	7.49	0.78
L.S.D at 5 %	9.4	0.09	0.11	N.S.
		2018 season		
100% Mineral fertilizer (control)	196.0	5.51	7.27	0.76
100% Organic fertilizer	190.7	5.44	7.18	0.76
100% Bio-fertilizer	194.3	5.47	7.23	0.76
50% Mineral fertilizer + 50% Organic fertilizer	198.0	5.56	7.39	0.75
50% Mineral fertilizer + 50% Bio-fertilizer	201.7	5.66	7.42	0.76
50% Organic fertilizer + 50% Bio-fertilizer	196.3	5.53	7.32	0.76
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	203.7	5.76	7.56	0.76
L.S.D at 5 %	9.7	0.07	0.08	N.S.

Table 7. Effect of mineral, organic and bio fertilization on average fruit circumference, pulp weight and peel thickness of Balady Mandarin trees during 2017 and 2018 seasons

Treatment	Average fruit circumference (cm)	Average pulp weight (%)	Average peel thickness (mm)
		2017 season	
100% Mineral fertilizer (control)	22.64	77.64	3.2
100% Organic fertilizer	22.48	76.24	3.1
100% Bio-fertilizer	22.58	77.53	3.2
50% Mineral fertilizer + 50% Organic fertilizer	22.95	79.26	3.4
50% Mineral fertilizer + 50% Bio-fertilizer	23.11	80.06	3.5
50% Organic fertilizer + 50% Bio-fertilizer	22.83	79.19	3.3
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	23.52	82.93	3.5
L.S.D at 5 %	0.37	3.53	N.S.
		2018 season	
100% Mineral fertilizer (control)	22.83	78.09	2.7
100% Organic fertilizer	22.55	74.89	2.6
100% Bio-fertilizer	22.70	76.26	2.6
50% Mineral fertilizer + 50% Organic fertilizer	23.20	80.19	2.8
50% Mineral fertilizer + 50% Bio-fertilizer	23.30	80.81	2.8
50% Organic fertilizer + 50% Bio-fertilizer	22.98	79.13	2.7
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	23.74	81.09	2.9
L.S.D at 5 %	0.31	4.34	N.S.

Concerning average fruit length, it is obvious that the highest significant average fruit length was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving

100% organic fertilizer or bio-fertilizer resulted in the lowest one in both seasons.

With respect to average fruit diameter, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest average fruit diameter followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Regarding fruit shape index, it is obvious that no significant difference was observed among fertilization treatments in both seasons.

With respect to average fruit circumference, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest average fruit circumference followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Highest significant pulp weight was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving 100% organic fertilizer or bio-fertilizer had the lowest one in both seasons.

Regarding average peel thickness, it is obvious that no significant difference was observed among fertilization treatments in both seasons.

The beneficial effects of using organic fertilizers on improving fruit physical properties could be due to their effect on providing vines with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the vines (Nijjar, 1985).

The improvement in fruit physical properties due to inoculation biofertilizers might be attributed to its effect on improving nutritional status of vine as well as its ability to meet some micronutrient requirements (El-Nagar, 2004).

These results are in agreement with those reported by Abdel-Hak *et al.* (2012) on Valncia orange fruits, Omar *et al*. (2012) on Navel orange fruits, Kumar *et al*. (2013) on Khasi mandarin fruits and El-Khayat and Abdel Rehiem (2013) on Mandarin fruits, they revealed that organic fertilizers with bio-fertilizers improved fruit physical characteristics.

4. Fruit chemical properties

As shown in Table (8), data reveal that fruit chemical properties expressed juice TSS, acidity, TSS/acid ratio, total sugars and reducing sugars were significantly affected by mineral, organic and bio fertilization treatments of Balady Mandarin trees during 2017 and 2018 seasons.

With respect to juice TSS, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest percentage followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest percentage of this one in both seasons.

Table 8. Effect of mineral, organic and bio fertilization on fruit chemical properties of Balady Mandarin trees during 2017 and 2018 seasons

Treatment	TSS (%)	Total acidity (%)	TSS/ acid ratio	Total sugars (%)	Reducing sugars (%)
			2017 season		
100% Mineral fertilizer (control)	12.41	1.39	8.93	8.81	4.41
100% Organic fertilizer	12.16	1.44	8.44	8.37	4.17
100% Bio-fertilizer	12.32	1.41	8.74	8.40	4.29
50% Mineral fertilizer + 50% Organic fertilizer	12.86	1.37	9.39	9.21	4.64
50% Mineral fertilizer + 50% Bio-fertilizer	13.02	1.34	9.72	9.33	4.71
50% Organic fertilizer + 50% Bio-fertilizer	12.57	1.38	9.11	8.99	4.60
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	13.34	1.28	10.42	9.75	4.83
L.S.D at 5 %	0.21	0.04	0.49	0.27	0.18
			2018 season		
100% Mineral fertilizer (control)	11.93	1.43	8.34	8.17	4.22
100% Organic fertilizer	11.67	1.46	7.99	8.01	4.01
100% Bio-fertilizer	11.82	1.44	8.21	8.15	4.13
50% Mineral fertilizer + 50% Organic fertilizer	12.34	1.38	8.94	8.38	4.25
50% Mineral fertilizer + 50% Bio-fertilizer	12.53	1.36	9.21	8.51	4.26
50% Organic fertilizer + 50% Bio-fertilizer	12.04	1.41	8.54	8.29	4.23
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	12.87	1.31	9.82	9.39	4.61
L.S.D at 5 %	0.17	0.03	0.43	0.19	0.13

Lowest significant juice acidity was obtained with combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in an ascending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, whereas trees receiving 100% organic fertilizer or bio-fertilizer had the highest percentage of this one in both seasons.

With respect to juice TSS/acid ratio, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest value followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer. On

the other hand, trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest value of this one in both seasons.

Concerning juice total sugars, it is obvious that the highest significant total sugars percentage was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving 100% organic fertilizer or bio-fertilizer resulted in the lowest percentage of this one in both seasons.

Regarding juice reducing sugars, it was evident that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest percentage followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, whereas trees receiving 100% organic fertilizer or bio-fertilizer had the lowest percentage of this one in both seasons.

The beneficial effects of using organic fertilizers on improving fruit chemical properties could be due to their content of macro and micro elements which led to enhance photosynthesis, this means that more sugar (glucose) is available for growth and fruit ripening (Keller *et al.,* 1998).

The promoting effect of biofertilization on fruit quality was mainly attributed to their essential role in enhancing organic foods especially total carbohydrates and plant pigments which is reflected on advancing fruit maturity (Nijjar, 1985).

These results are in accordance with those reported by Abdallah *et al.* (2011) on foster grapefruit, Abdelaal *et al.* (2013) on Valncia orange fruits, Omar *et al*. (2012) on Navel orange fruits and El-Khayat and Abdel Rehiem (2013) on Mandarin fruits; they revealed that organic fertilizers with bio-fertilizers improved fruit chemical characteristics.

5. Leaf content of macro-elements

Date presented in Table (9) showed that leaf content of macro-elements namely nitrogen, phosphorus and potassium were significantly affected by mineral, organic and bio fertilization treatments of Balady Mandarin trees during 2017 and 2018 seasons.

Highest significant leaf magnitude of nitrogen was occurred from combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer On the other hand, trees receiving 100% organic fertilizer or bio-fertilizer resulted in the lowest one in both seasons.

With respect to leaf magnitude of phosphorus, it worth mentioned that, trees receiving mineral, organic and bio-fertilizers at 33.3% of each significantly had the highest magnitude of phosphorus followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer, while trees receiving 100% organic fertilizer or bio-fertilizer recorded the lowest one in both seasons.

Concerning leaf magnitude of potassium, it is obvious that the highest significant leaf magnitude of potassium was obtained with combined application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) followed by in a descending order by 50% mineral NPK fertilizer + 50% bio-fertilizer followed by in a descending order by 50% mineral NPK fertilizer + 50% organic fertilizer,

whereas trees receiving 100% organic fertilizer or bio-fertilizer had the lowest one in both seasons.

The beneficial effect of organic fertilizers on leaf content of NPK could be attributed to their influence manifested in increasing the organic matter in the soil (Nijjar, 1985).

The increments in leaf content of NPK due to inoculation biofertilizers might be attributed to help in availability of mineral and their forms in the composted material and increase levels of extractable NPK (El-Karamany *et al.*, 2000).

These results are in agreement with those reported by Scherer *et al.* (2008) on Acuar orange trees, El-Wakeel and Eid (2011) on Navel orange trees and Abdel-Hak *et al.* (2012) on Valncia orange trees; they revealed that organic fertilizers with bio-fertilizers had a positive effect on leaf mineral content.

Table 9. Effect of mineral, organic and bio fertilization on leaf macro-elements content of Balady Mandarin trees during 2017 and 2018 seasons.

Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)
		2017 season	
100% Mineral fertilizer (control)	2.17	0.30	1.73
100% Organic fertilizer	2.01	0.27	1.69
100% Bio-fertilizer	2.13	0.30	1.72
50% Mineral fertilizer + 50% Organic fertilizer	2.37	0.34	1.77
50% Mineral fertilizer + 50% Bio-fertilizer	2.41	0.42	1.84
50% Organic fertilizer + 50% Bio-fertilizer	2.23	0.31	1.75
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	2.54	0.48	1.93
L.S.D at 5 %	0.11	0.04	0.08
		2018 season	
100% Mineral fertilizer (control)	2.24	0.31	1.76
100% Organic fertilizer	2.07	0.25	1.66
100% Bio-fertilizer	2.19	0.29	1.70
50% Mineral fertilizer + 50% Organic fertilizer	2.34	0.35	1.82
50% Mineral fertilizer + 50% Bio-fertilizer	2.51	0.43	1.88
50% Organic fertilizer + 50% Bio-fertilizer	2.29	0.33	1.77
33.3% Mineral fertilizer + 33.3% Organic fertilizer + 33.3% Bio-fertilizer	2.63	0.51	1.95
L.S.D at 5 %	0.07	0.03	0.05

From the foregoing results, it can be concluded that there is a possibility of using organic and biofertilizers as a partial substitute of mineral fertilizers. However, this study confirmed that application of mineral, organic and bio-fertilizers at equal ratios (1:1:1) was the best management system for ensuring the best vegetative growth traits, achieving the highest yield with its components, improving the physical and chemical characteristics of fruits and increasing leaf mineral content of Balady Mandarin trees.

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التأثيرات المفيدة لاستخدام الأسمدة الطبيعية والحيوية على النمو الخضرى و الاثمار لليوسفى البلدى

أحمد محمد فتح الله، عبد الله السيد حسن، أحمد على قاسم، بسمه صلاح الدين أحمد سلامه

قسم البساتين، كلية الزراعة، جامعة المنوفية

الملخص العربى

أجرى البحث خلال موسمي ٢٠١٧ و ٢٠١٨ على أشجار اليوسفي البلدي البالغة من العمر ٢١ عامًا والمطعومة على أصل النارنج بهدف دراسة إمكانية تقليل كمية الأسمدة المعدنية باستخدام الأسمدة العضوية والمخصبات الحيوية لأشجار اليوسفى البلدي، تم زراعة الأشجار في تربة طينية طميية، على أبعاد مسافة ٥ × ٥ متر، والمروية تحت نظام الري بالغمر. تم إجراء سبع معاملات تسميد على النحو التالي: ١٠٠ ٪ أسمدة معدنية من النيتروجين والفوسفور والبوتاسيوم (الكنترول)، ١٠٠٪ أسمدة عضوية (كمبوست مخصب بنوعين من الصخور الطبيعية وهما: صخر الفوسفات والفلسبار)، ١٠٠٪ مخصبات حيوية (نيتروبين، فوسفوريين، بوتاسيوميج)، ٥٠٪ أسمدة معدنية + ٥٠٪ أسمدة عضوية، ٥٠٪ أسمدة معدنية + ٥٠٪ مخصبات حيوية، ٥٠٪ سماد عضوي + ٥٠٪ مخصبات حيوي، ٣٣,٣٪ أسمدة معدنية + ٣٣,٣٪ أسمدة عضوية + ٣٣,٣٪ مخصبات حيوية. أشارت النتائج بأن هناك إمكانية لاستخدام الأسمدة العضوية والمخصبات الحيوية كبديل جزئي للأسمدة المعدنية. حيث أكدت هذه الدراسة أن استخدام الأسمدة المعدنية والعضوية والمخصبات الحيوية بنسب متساوية (١:١:١) كان أفضل نظام إدارة للحصول على أفضل صفات النمو الخضري، وتحقيق أعلى محصول بمكوناته، وتحسين الصفات الطبيعية الكيميائية للثمار وزيادة المحتوى المعدني للأوراق في أشجار اليوسفي البلدي.

الكلمات الدالة: اليوسفي البلدي، الأسمدة المعدنية، الأسمدة العضوية، الكمبوست، الصخور الطبيعية، المخصبات الحيوية، المحصول، الثمار

أسماء السادة المحكمين

أ.د/ محمد عبدالعزيز عبدالوهاب معهد بحوث البساتين – مركز البحوث الزراعية

أ.د/ مجدى رابح محمد رابح كلية الزراعة – جامعة المنوفية