Plant Archives Volume 20 No. 1, 2020 pp. 1859-1868 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF NITROGEN FERTILIZATION THROUGH INORGANIC, ORGANIC AND BIOFERTILIZERS SOURCES ON VEGETATIVE GROWTH, YIELD AND NUTRITIONAL STATUS IN MURCOTT TANGERINE TREES

Ahmed M. Fikry*, T.A.M. Abou Sayed-Ahmed, F.S. Mohsen and M.M. Ibrahim

Horticulture Department Faculty of Agriculture, Zagazig University, Egypt.

Abstract

This study was carried out during 2017/2018 and 2018/2019 seasons on 5 - year-old Murcott tangerine (*Citrus reticulata*, Blanco.) planted at 2.5 × 5 meters in sandy soil under drip irrigation system grown under Wady El-Mollak region, Sharkia Governorate, Egypt to evaluate the effect of replacement mineral Nitrogen fertilization using organic and biofertilizers on vegetative growth, yield and leaf mineral content. Trees fertilized with 75% (N) mineral + 25%(N) organic + 150 ml Em1/tree/ year gained the highest values on yield, number of fruits/ tree as well as cropping efficiency, leaf area, nutrients namely N, P, K, Ca and Mg. A great decline in all growth parameters, yield and leaf mineral content were recorded with using inorganic N at 100% N /tree/year or 25% (N) mineral + 75% (N) organic /tree/year either using EM1 nor without EM1. The best results with regard to growth, yield and nutritional status of Murcott tangerine trees were indicated at fertilizing trees with (500 and 600 g) N/tree/year in the first and second seasons, respectively, to increase the age of tree in the second season one, through 75 % inorganic as ammonium nitrate (33.5% N) + 25% organic as chicken manure (3 % N) + 150 ml EM1/ tree /year.

Key words: Murcott tangerine, fertilization, organic, biofertilizers, fruit set yield.

Introduction

Citrus is one of the most important fruit crops in the world and ranked first among fruit crops in Egypt. The cultivated area with citrus in Egypt has enormously increased through the last decades the fruiting area reached 429778.6 fed. Producing about 4388325 tons with average of 10.21 tons/ fed. Tangerine (*Citrus reticulata*, Blanco) is one of the most important citrus species. Total fruiting areas of mandarin and tangerine varieties occupy 109609.5 fed. producing about 1038753 tons with average of 9.48 tons/fed. representing 25.5% of total citrus production, according to (FAO statistics, 2017).

Murcott is believed to have come out of the USA department of agriculture citrus breeding program in Florida around 1916, which is a cross between a tangerine and sweet orange. Nutrition adequate of nitrogen for citrus trees is essential for optimum vegetative growth and top fruit yield and quality. Nitrogen is very important element in nutrition not only because of its high requirement by plants, but also because it has an extreme importance in plants as a constituent of proteins, nucleic acids, vitamins, hormones, chlorophyll pigments and many other organic compounds, meaning that it is structurally involved in most catalytic molecules (Sakakibara *et al.*, 2006 and Garnica *et al.*, 2010). Also, nitrogen affects the absorption and distribution of all other elements and it is particularly important to the tree during flowering and fruit set. (Obreza, 2001; Zekri and Obreza, 2002 and Obreza *et al.*, 2008).

Citrus trees needed nitrogen in the spring during flowering and fruit set when 75-95% of all new leaves are produced. For maximum yields, it's absolutely necessary that sufficient nitrogen should be in the leaves at the right time (Nijjar, 1985).

Because of the mineral fertilizers are expensive in Egypt, as well as the various disadvantages of it and danger to human health. Therefore, some natural organic materials were used to achieve great improvement in soil fertility and productivity of fruit trees.

Organic fertilization is used as a substitute for mineral N fertilization application of organic manure has numerous merits such as reducing soil pH, increasing the availability of all nutrients, reducing soil salinity, enhancing soil fertility, water retention, soil organic matter, as well as increasing biological activity of microflora, soil cation exchange, natural hormones and antibiotics (Nijjar, 1985) and reduced applying N chemical sources. (Abdelaal *et al.,* 2010).

Application of poultry manure can improve chemical, biological and physical quality for soil and plant growth (El-Morshedy, 1997; Canali *et al.,* 2004 and Hilimire *et al.,* 2012) in addition it is more cheap to mineral nitrogen fertilizers. (Granatstein, 2003).

Bio-fertilization based on altering the rhizosphere flora by seed or soil inoculation with certain organisms capable of inducing beneficial effects on a compatible host (El-Haddad *et al.,* 1993) Several processes other than nitrogen fixation could account for these positive effects, including production of growth regulators, protection from root pathogens and modification of nutrient uptake by the plant (Techan, 1988). Inoculation with N bio-fertilizers could save half the normal field rate of N chemical fertilizers and at the same time promote plant production (Isahac, 1989).

Effective microorganisms (EM1) is a biofertilizer, the basic purpose of EM is the restoration of healthy ecosystem in both soil and water by using three major genera of microorganisms which are found in nature: phototrophic bacteria (*Rhodopseudomonas*), lactic acid bacteria (*Lactobacillus*) and yeast (*Saccharomyces*). EM contains *Lactobacillus plantarum*, L. *casei*, L. *fermentum*, L. *delbrueckii*, *Saccharomyces cerevisiae* and *Rhodopseudomonas palustris* (Abd-Rabou, 2006 and Higa, 2010).

Higher yield in the EM treatments, can be correlated with improved soil chemical and physical conditions, determined by the use of effective microorganisms at the time the citrus plants were in bloom and fruits were forming in late winter (Paschoal *et al.,* 1999).

The main objective of this experiment is to estimate the effect of replacement mineral N fertilization using organic and biofertilizers on vegetative growth, yield and leaf mineral content of Murcott tangerine trees.

Materials and Methods

General consideration

This study was carried out during two successive seasons of 2017/2018 and 2018/2019 on 5 - year-old Murcott tangerine (*Citrus reticulata,* Blanco.) trees budded on volkamer lemon rootstock. The trees were grown in a private citrus orchard located at Wady El-Mollak region, Abo-Hamad district, Sharkia Governorate, Egypt. The trees were planted at 2.5 × 5 meters in sandy soil under drip irrigation system. The experimental trees were healthy and approximately similar in growth vigor and size and subjected to the normal agro-technical practices ordinary followed in the commercial citrus orchards in respect of irrigation, pruning and pest control. In addition, all trees were received 200Kg/fed calcium super phosphate (15.5% P_2O_5) and 200Kg/fed potassium sulphate (48.5% K_2O).

Fifty Murcott tangerine trees were chosen for this experiment and subjected to ten different fertilization treatments regarding the doses of mineral N fertilization in the form of (ammonium nitrate 33.5% N), organic manure (chicken manure 3% N) and biofertilizers in the form of (Effective Microorganisms EM1). The treatments were as follows:

1. Fertilization at 100% of the recommended N rate completely via inorganic as control. (T1)
2. T1 + 150 ml EM1 (biofertilizer/tree/year) (T2).
3. Fertilization at 75% of the recommended N rate through inorganic N + 25% organic N (chicken manure) / tree/ year (T3).
4. Fertilization at 50% of the recommended N rate through inorganic N + 50% organic N (chicken manure) / tree/year (T4).
5. Fertilization at 25% of the recommended N rate through inorganic N + 75% organic N (chicken manure) / tree/year (T5)
6. T3 + 150 ml EM1 /tree/year (T6).
7. T4 + 150 ml EM1/tree/year (T7).
8. T5 + 150 ml EM1/ tree/year (T8).
9. Application 100% of the recommended N rate through organic (chicken manure) + 150 ml EM1 / tree/year (T9).
10. Application 100% of the recommended N rate through organic (chicken manure) / tree/year (T10).

Table 1: Physical properties and chemical constituents of the tested soil.

Constituents	Value
Sand	77.62 %
Silt	8.82 %
Clay	13.55 %
Texture	Sandy
Ec	0.35 ds/m^{-1}
pH	7.56
Available N	19.41 mg/Kg
Available p	16.35 mg/Kg
Available K	190.66 mg/Kg

Table 2: Chemical analysis of the used Analysis of chicken manure.

Characters	Value
O.M	8.39 %
pH	9.02
Total N %	3 %
Total p %	0.108 %
Total K %	2.05 %
Fe ppm	869.70 ppm
Mn ppm	194.25 ppm
Zn ppm	317.25 ppm

The above-mentioned treatments were adapted to the same trees during the two experimental seasons.

All the selected trees were fertilized at fixed nitrogen rate 500 and 600 g N/tree/year in the first and second seasons, respectively to increase the age of tree in the second season one. The source of inorganic N fertilizer was ammonium nitrate (33.5% N) added at weekly intervals from mid-February until the end of September. The source of organic fertilizer was chicken manure (3% N) added once at the mid of December under the drippers and immediately covered with moist soil. The same stock of chicken manure was used in the two seasons to minimize the possible differences in composition. Chicken manure analysis is shown in table 2.

The amount of the EM1 added once in the third week of March at 150 ml per 5 liters of water and placed on the chicken manure after digging the trench at a depth of 10 cm. The source of biofertilizer was the central administration of afforestation and the environment at the Egyptian Ministry of Agriculture in collaboration with the Japanese research institution EMRO.

The responses of the tested Murcott tangerine to the applied fertilization treatments were evaluated through the following parameters:

- Fruit yield: At the commercial harvesting date of Murcott tangerine fruits, the remained fruits on each tree were picked out in the first week of February and weighted through each season. Then the total yield per tree (kg/tree) and the number of fruits/trees was registered.
- Fruiting efficiency was calculated by dividing tree fruit yield (Kg/tree) on the canopy volume (m^3). (Whitney *et al.*, 1995).
- Vegetative growth characteristics.
- Canopy volume (m^3) was calculated using the following: equation:

$$V = 2/3\ \pi\ r2h$$

Where V is the canopy volume; r is the canopy radius width and h are the canopy height. (Roose *et al.*, 1989).

- Leaf characteristics: A sample of 30 mature leaves were randomly collected on early September of each season from the medium position of non-fruiting shoots of spring growth cycle for each replicate to determine the following leaf characteristics:
- Average leaf surface area (cm^2) according to the equation reported by (Redday *et al.*, 1981) where:

  Leaf area = blade width × blade length × 0.62.

- Mineral nutrient determinations: About 0.2 g of the finely ground dry matter of leaves, branches and roots of each replicate were digested in a mixture of concentrated sulfuric and perchloric acids (2:1 v/v) for 15 minutes until the digestive solution became colorless, then transferred quantitively to 50 ml volumetric flasks (Kitson and Mellon, 1964). The considered mineral nutrients were determined as follows:

1. Total nitrogen (N) and phosphorus (P) were calorimetrically determined according to the methods described by (Naguib, 1969) and (Kitson and Mellon, 1964) respectively.

2. Potassium (K) was determined flame photometrically according to the method advocated by (Brown and Lilleland, 1964).

3. Calcium (Ca) and Magnesium (Mg) were determined in the same digestive solution according to the versinate titration method as described by (Barrows and Simpson, 1962).

Statistical analysis

This experiment was setted in a completely randomized block design with 10 treatments; each treatment was applied to five Murcott tangerine trees. The obtained data was subjected to analysis of variances (ANOVA) according to (Snedecor and Cochran, 1980) using Co-Stat program. The individual comparisons between the obtained means were compared using Duncan's multiple range test at 0.05 level (Duncan, 1958).

Results and Discussion

Yield and yield components

- **Yield/ Tree:**

As shown in table 3, the tested fertilization treatments significantly affected fruit yield per tree in the two seasons. However, the highest yield/ Murcott tangerine tree was gained by trees fertilized at 75% (N) min (mineral) + 25% (N) org (organic) + Em1 (87.84 and 92.76Kg/ tree) in the first and second seasons, respectively followed by

Table 3: Effect of some nitrogen fertilization treatments on yield (kg/tree) and yield components of Murcott tangerine trees (2017 / 2018, 2018/ 2019 seasons).

Fertilization treatments	First season (2017/2018)				Second season (2018/2019)			
	Yield (kg/ tree)	No. of fruits / tree	Fruit weight (g)	Cropping efficiency (Kg/m^3)	Yield (kg/ tree)	No. of fruits / tree	Fruit weight (g)	Cropping efficiency (Kg/m^3)
100% (N) Min.	76.20 d	458 e	161.8 d	5.95 cd	76.58 d	370 f	199.0 de	5.92 c
100% (N) Min.+ EM1	81.30 c	467cd	169.1 c	6.48 abc	78.92 c	377 e	208.0 c	6.23 bc
75% (N) Min.+ 25% (N) Org.	87.07 a	490 b	184.1 a	6.97 a	92.12 a	413 b	226.4 a	7.34 a
50% (N) Min.+ 50% (N) Org.	76.25 d	464d e	159.7 de	6.17 bcd	78.51 cd	392 d	196.4 e	6.28 bc
25% (N) Min.+ 75% (N) Org.	68.91 g	430 g	158.5 de	5.48 d	72.70 e	368 f	195.0 e	5.59 c
75% (N) Min.+ 25% (N) Org. + EM1	87.84 a	514 a	166.5 c	7.06 a	92.76 a	444 a	204.8 cd	7.35 a
50% (N) Min.+ 50% (N) Org. + EM1	84.75 b	472 c	176.4 b	6.78 ab	90.16 b	400 c	217.0 b	7.15 ab
25% (N) Min.+ 75% (N) Org. + EM1	72.09 f	470 cd	149.6 f	5.58 d	73.00 e	395 cd	184.1 f	5.72 c
100% (N) Org.+ EM1	74.30 e	449 f	161.7 d	6.11 bcd	77.03 cd	378 e	198.9 de	6.26 bc
100% (N) Org.	73.03 ef	464 de	156.8 e	5.93 cd	73.33 e	371 f	192.9 e	5.89 c

Means having the same letter (s) in each column are insignificantly different.
Min. = mineral (Ammonium nitrate 33.5%), Org. = organic N (chicken manure 3%), EM1= Effective microorganisms (150ml/tree/year).

those fertilized with 75% (N) min + 25% (N) org (87.07 and 92.12 Kg/tree) in the two seasons, respectively without significant differences between them in the two seasons. Murcott tangerine trees fertilized *at* 25% (N) min + 75% (N) org + Em1 (72.09 and 73.00kg/ tree) and trees fertilized with 100% (N) org (73.03 and 73.33kg/tree) produced the lowest yield/tree in the two studied seasons, respectively, without significant differences between them in the two seasons. The other tested fertilization treatments produced intermediate yields. Trees fertilized via nitrogen fertilizer through inorganic, organic and biofertilizer produced significantly higher yields than those of fertilized trees fertilized *via* nitrogen fertilizer through inorganic and organic without using biofertilizer throughout two seasons. Yield of fertilized trees through three sources (organic, inorganic and biofertilizer) was 5.10 and 4.91% higher than that of those fertilized by two sources (inorganic and organic) in the first and second seasons, respectively.

Generally, the average yield/ tree fertilized *via* 100 % of nitrogen trough organic fertilizer with em1 (74.30 and 77.03 Kg/tree) produced higher yields than those 100% organic without em1 (73.03 and 73.33 Kg/tree) throughout the two seasons. Regarding fertilized treatments with inorganic nitrogen only at 100% with Em1 (81.30 and 78.92 Kg/ tree) produced higher yields than those fertilized at 100% inorganic without EM1 (76.20 and 76.58 Kg/tree) in the first and second seasons, respectively.

The obtained results are in harmony with those reported by SoIaiman *et al.,* (2003); Medhi *et al.,* (2007); Mansour and Shaaban (2007); Wassel *et al.,* (2007b); Eman *et al.,* (2008); Abedel-Sattar *et al.,* (2011); Ahmed *et al.,* (2013); Khehra and Bal, (2014); Mostafa and Abdel-Rahman, (2015); El-Shazly *et al.,* (2015); Ennab, (2016); El-Salhy *et al.,* (2017); Jugnake *et al.,* (2017); Hazarika and Aheibam, (2019). They revealed that amending citrus trees with mixture of natural, bio and mineral NPK fertilizers significantly improved the yield. The obtained results are also in line with those reported by Salama, *et al.,* (2012) on Sewy date palm, Ahmed *et al.,* (2014) on Sakkoti date palm; Al-Wasfy and Abd El-Rahman, (2014) on Hayany date palms; Ahmed *et al.,* (2014) on Zaghloul date palms; Abd-Alhamid *et al.,* (2015) On olive trees cv. Manzanillo.

- **Number of Fruits/ Tree:**

It is quite evident from table 3, that the number of the harvested fruits per tree was significantly affected by the tested fertilization treatments. The highest fruit No./ Murcott tangerine tree was gained by trees fertilized at 75% (N) min + 25% (N) org + Em1 (514 and 444 fruits/ tree) in the first and second seasons, respectively, followed by those fertilized at 75% (N) min + 25% (N) org (490 and 413 fruits/tree) in the first and second seasons, respectively.

Murcott tangerine trees fertilized at 25% (N) min + 75% (N) gave the least number of fruits/trees org (430 and 368 fruits/tree) in the first and second seasons, respectively and without significant differences between this treatment and either 100% inorganic or 100% organic in the second season only. The other tested fertilization treatments produced intermediate fruit No./ tree.

Murcott tangerine Trees fertilized via nitrogen fertilizer through inorganic, organic and biofertilizer produced significantly higher number of fruits/tree than those Trees fertilized via nitrogen fertilizer through inorganic and organic without using biofertilizer throughout two seasons.

These findings are in agreement with those reported by Eman *et al.,* 2008; Ahmed *et al.,* (2013); Garhwal *et al.,* (2014); Khehra and Bal, (2014); Hadole *et al.,* 2015 and Shaimaa and Massoud, (2017) they reported that using organic, inorganic and biofertilizers gave the same trend in different citrus species.

- **Fruit Weight:**

Data in table 3, show that weight of Murcott tangerine fruits were significantly affected by the studied fertilization treatments during the two seasons. However, the highest fruit weight was recorded for 75% (N) min + 25% (N) org (184.1, 226.4 g), followed by those fertilized at 50% (N) min + 50% (N) org + Em1 (176.4, 217.0 g) in the first and second season, respectively. Murcott tangerine trees fertilized at 25% (N) min + 75% (N) org + Em1 gave the lowest values (149.6, 184.1 g) in the first and second season, respectively. The other tested fertilization treatments produced intermediate fruit weight in both seasons. Trees fertilized with 100% (N) min, 50% (N) min+ 50% (N) org, 25% (N) min + 75% (N) org, 100% (N) org + Em1 and 100% (N) org were gave lower fruit weight without significant differences between them.

As general, Murcott tangerine Trees fertilized via nitrogen fertilizer through inorganic, organic and biofertilizer produced significantly higher fruit weight than those trees fertilized via nitrogen fertilizer through inorganic and organic without using biofertilizer throughout two seasons.

These results are in line with those of Ahmed *et al.,* (2013); Garhwal *et al.,* (2014); Vadak *et al.,* (2014); Hadole *et al.,* (2015) and El-Shazly *et al.,* (2015). They reported that fruit weight and size were increased by using nitrogen fertilizers in different sources

- **Cropping Efficiency:**

Data in table 3, clearly show that the highest cropping efficiency of Murcott tangerine tress was recorded for trees fertilized *via* 75% (N) min + 25% (N) org + Em1 (7.06 and 7.35 Kg fruits/ m^3), followed by those fertilized 75% (N) min + 25% (N) org (6.97 and 7.34 Kg fruits/ m^3) without significant differences between them in the first and second seasons, respectively. The lowermost cropping efficiency was recorded for trees fertilized with 25% (N) min + 75% (N) org (5.48 and 5.59 Kg fruits/ m^3) and trees fertilized with 25% (N) min + 75% (N) org + Em1 (5.58 and 5.72 Kg fruits/m^3) in the first and second seasons, respectively. The other tested fertilization systems recorded significantly different intermediate cropping efficiencies ranged between 5.93 - 6.48 Kg fruits/ m^3 in the first season, 5.89-7.15 Kg fruits/m^3 in the second season.

As a general, the highest yield per Murcott tangerine tree and cropping efficiency were recorded for trees fertilized at 75% (N) min + 25% (N) org + EM1, followed by those 75% (N) min + 25% (N) org without significant differences between them in most cases. Organic and bio fertilized Murcott tangerine trees produced higher yields and gained higher cropping efficiency during the three tested seasons in addition to protect the environment of pollution not only, but also producing safe food of fruit and tangerine juice.

Table 4: Effect of some nitrogen fertilization treatments on Canopy volume m^3 and leaf area (cm^2) of Murcott tangerine trees (2017 / 2018, 2018/ 2019 seasons).

Fertilization treatments	First season (2017/2018)		Second season (2018/2019)	
	Canopy Volume (m^3)	Leaf area (cm^2)	Canopy Canopy (m^3)	Leaf Leaf (cm^2)
100% (N) Min.	12.83 a	20.25 bc	12.96 a	21.98 b
100% (N) Min.+ EM1	12.53 a	21.32 a	12.66 a	23.14 a
75% (N) Min.+ 25% (N) Org.	12.52 a	20.32 bc	12.64 a	22.05 b
50% (N) Min.+ 50% (N) Org.	12.38 a	19.73 cd	12.51 a	21.41 c
25% (N) Min.+ 75% (N) Org.	12.57 a	19.38 d	12.70 a	21.03 d
75% (N) Min.+ 25% (N) Org. + EM1	12.41 a	20.39 b	12.54 a	22.13 b
50% (N) Min.+ 50% (N) Org. + EM1	12.48 a	19.19 d	12.60 a	20.82 de
25% (N) Min.+ 75% (N) Org. + EM1	12.91 a	19.27 d	13.04 a	20.91 de
100% (N) Org. + EM1	12.21 a	19.13 d	12.33 a	20.76 e
100% (N) Org.	12.32 a	19.14 d	12.44 a	20.77 e

Means having the same letter (s) in each column are insignificantly different.
Min. = mineral (Ammonium nitrate 33.5%), Org. = organic N (chicken manure 3%),
EM1= Effective microorganisms (150ml/tree/year).

Physical leaf characteristics

- **Canopy volume:**

Data in table 4, clearly that canopy volume (m^3) was non-significantly affected by fertilization treatments in the two seasons. However, the largest canopy volume was recorded for trees fertilized at 25% (N) min + 75% (N) org + Em1 (12.91 and 13.04 m^3) in the first and second season, respectively. Trees fertilized with 100% (N) org + Em1 induced the smallest canopy volume (12.21 and 12.33 $m^{3)}$ in the two seasons, respectively. The other fertilization treatments recorded intermediate canopy volume values.

These findings came in line with those of Mansour and Shaaban, (2007);

Wassel *et al.*, (2007a); Barakat *et al.*, (2012); Ahmed *et al.,* (2013); Mostafa and Abdel-Rahman, (2015); Jahromi and Khankahdani, (2016); Shaimaa and Massoud, (2017) and Hazarika and Aheibam, (2019) they indicated that 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.

• Leaf area:

As shown in table 4, leaf area was significantly affected by the tested fertilization treatments in the two seasons. However, the largest leaf area was recorded from trees fertilized at 100% (N) min + Em1 (21.32 and 23.14 cm^2) in the first and second seasons, respectively. Followed by fertilized trees at 75% (N) min + 25% (N) org + Em1 (20.39 and 22.13 cm^2) in the two seasons. Fertilized Trees at 100% (N) org + Em1 produced the smallest leaf area (19.13 and 20.76 cm^2) in the first and second seasons, respectively, followed by trees fertilized at 25% (N) min + 75% (N) org + Em1 and 100% (N) org in both seasons without significant differences between them. The other treatments induced intermediate leaf area values in the two seasons. Murcott tangerine leaf area ranged between 19.13-21.32 cm^2 in the first season and 20.76-23.14 cm^2 in the second season.

These findings came in line with those of Mansour and Shaaban, (2007); Wassel *et al*, (2007a); Barakat *et al.,* (2012); Ahmed *et al.,* (2013); Mostafa and Abdel-Rahman, (2015); Jahromi and Khankahdani, (2016); Shaimaa and Massoud, (2017) and Hazarika and Aheibam, (2019) they indicated that the largest leaf area was recorded for trees fertilized with three N sources (inorganic, organic and bio fertilizers).

Leaf chemical constituents

• Nitrogen percentage:

Data in table 5, show that the tested N fertilization treatments significantly affected N percentage in leaves of Murcott tangerine trees in the two seasons. Trees fertilized with 75% (N) min + 25% (N) org + Em1 gained the highest N percentage in leaves (2.77 and 3.06%) in the first and second seasons, respectively, followed by those fertilized by 50% (N) min + 50% (N) org + Em1 (2.65%) without significant differences between them in the first season only and 25% (N) min + 75% (N) org + Em1 (3.03%), trees fertilized with 100% (N) min + Em1 (3.02%), trees fertilized at 75% (N) min + 25% (N) org (2.98%) and those fertilized at 50% (N) min + 50% (N) org + Em1 (2.93%) without significant differences between them in the second season only. However, trees fertilized at 100% (N) org recorded the lowest N percentage (1.97 and 2.15 %) in the first and second seasons, respectively.

Generally, it's worthy to mention that trees fertilized by using three sources of nitrogen *via* organic as (chicken manure), inorganic as (ammonium nitrate 33% N) and biofertilizers as (EM1) gave higher values than those that fertilized with two N sources without using EM1.

These results are in harmony with those found by Mansour and Shaaban, (2007) on Washington Navel orange, Wassel *et al*., (2007a) on Balady mandarin, Khan and Begum, (2007) on young acid lime; Eman *et al.*, (2008) on Washington Navel orange; Barakat *et al.*, (2012) on Newhall naval orange; Ahmed *et al.,* (2013) on Balady mandarin; El Khayat and Abdel Rehiem, (2013); Garhwal *et al.*, (2014), Hadole *et al.*, (2015), Shaimaa and Massoud, (2017) on Washington navel orange.

• Phosphorus percentage:

Data in table 5, clear that the tested N fertilization

Table 5: Effect of some nitrogen fertilization treatments on nitrogen, phosphorus, potassium percentage and N/k ratio in leaves of Murcott tangerine trees (2017 / 2018, 2018/ 2019 seasons).

Fertilization treatments	First season (2017/2018)				Second season (2018/2019)			
	N %	P %	K %	N/k ratio	N %	P %	K %	N/k ratio
100% (N) Min.	2.47 c	0.23 a	1.47 bc	1.68 bcd	2.97 ab	0.31 a	1.55 b	1.92 ab
100% (N) Min.+ EM1	2.53 bc	0.22 a	1.56 ab	1.63 cde	3.02 a	0.27 ab	1.49 bc	2.02 a
75% (N) Min.+ 25% (N) Org.	2.58 bc	0.23 a	1.41 bc	1.84 ab	2.98 a	0.23 bc	1.68 a	1.78 bc
50% (N) Min.+ 50% (N) Org.	2.48 c	0.20 ab	1.39 c	1.78 abc	2.82 b	0.27 ab	1.71 a	1.65 cd
25% (N) Min.+ 75% (N) Org.	2.26 d	0.16 b	1.47 bc	1.54 def	2.48 c	0.20 c	1.67 a	1.49 e
75% (N) Min.+ 25% (N) Org. + EM1	2.77 a	0.23 a	1.48 bc	1.87 a	3.06 a	0.23 bc	1.76 a	1.72 c
50% (N) Min.+ 50% (N) Org. + EM1	2.65 ab	0.22 a	1.38 c	1.92 a	2.93 ab	0.30 a	1.52 b	1.93 ab
25% (N) Min.+ 75% (N) Org. + EM1	2.48 c	0.23 a	1.70 a	1.47 efg	3.03 a	0.28 a	1.72 a	1.78 bc
100% (N) Org.+ EM1	2.02 e	0.20 ab	1.45 bc	1.40 fg	3.06 a	0.28 a	1.72 a	1.78 bc
100% (N) Org.	1.97 e	0.19 ab	1.48 bc	1.33 g	2.15 d	0.29 a	1.40 c	1.53 de

Means having the same letter (s) in each column are insignificantly different.
Min. = mineral (Ammonium nitrate 33.5%), Org. = organic N (chicken manure 3%), EM1= Effective microorganisms (150ml/tree/year).

treatments significantly affected phosphorus percentage in the leaves of Murcott tangerine trees in the two tested seasons. All fertilized trees with organic and inorganic and bio fertilizers were ranged phosphorus Percentage between (0.16-0.23%) in the first season Without significant difference with all fertilization treatment, while phosphorus Percentage were ranged between (0.20-0.31%) in the second season. Whereas, fertilized trees at 25% (N) min + 75% (N) org recorded the lowest phosphorus percentage (0.16 and 0.20 %), in the two seasons, respectively.

Generally, it's worthy to mention that trees fertilized by using three sources of nitrogen *via* organic as (chicken manure), inorganic as (ammonium nitrate 33%) and biofertilizers as (Em1) gave higher values of phosphorus percentage than those that fertilized with two N sources without using EM1.

In this concern, (Mansour and Shaaban, (2007) on Washington Navel orange, Khan and Begum (2007) on young acid lime, Eman *et al.*, (2008) on Washington Navel orange, Barakat *et al.*, (2012) on Newhall naval orange, El-Khayat and Abdel Rehiem, (2013), Garhwal, *et al.*, (2014), Hadole et *al.*, (2015), Shaimaa and Massoud, (2017) on Washington navel orange, they reported that 75% (N) mineral + 25% (N) organic + bio fertilizeres improved leaf nutrients percentage namely N, P, K and Mg, in relative to the other N management.

• Potassium percentage:

Data in table 5, show that the tested N fertilization treatments significantly affected potassium percentage in the leaves of Murcott tangerine trees throughout the two seasons. Trees fertilized with 25% (N) min + 75% (N) org + Em1 in the first season and those trees fertilized at 75% (N) min + 25% (N) org + Em1 in the second seasons gained the highest potassium percentage 1.70 and 1.76%, respectively. Followed by fertilized trees at 100% (N) min + Em1 (1.56%) in the first season and 75% (N) min + 25% (N) org (1.68%), 50% (N) min + 50% (N) org (1.71%), 25% (N) min + 75% (N) org (1.67%), 25% (N) min + 75% (N) org + Em1 (1.72 %) and fertilized trees with + Em1 (1.72%), without significant differences between them in the second season.

However, the lowermost potassium percentages were recorded by the treatment of application at 50% (N) min + 50% (N) org + Em1 (1.38 %) in the first season and application of 100% (N) org (1.40%) in the second season.

Generally, it's worthy to mention that trees fertilized by using three sources of nitrogen *via* organic as (chicken manure), inorganic as (ammonium nitrate 33%) and biofertilizers as (EM1) gave higher values of potassium percentage than those that fertilized with two N sources without using EM1.

These results are in harmony with those found by Mansour and Shaaban, (2007) on Washington Navel orange, Khan and Begum, (2007) on young acid lime, Eman *et al.*, (2008) on Washington Navel orange, Barakat *et al.*, (2012) on Newhall naval orange, El-Khayat and Abdel Rehiem, (2013); Garhwal *et al.*, (2014); Hadole *et al.*, (2015); Shaimaa and Massoud, (2017) on Washington navel orange.

• Nitrogen / potassium (N/ k) ratio

Data in table 5 clear that the tested fertilization treatments significantly affected N/K ratio in the leaves of Murcott tangerine trees in two tested seasons. Trees fertilized via 25% (N) min + 75% (N) org + Em1 (1.92) and 50% (N) min + 50% (N) org + Em1 (1.87) gained the highest N/ K ratio in the first season. But, fertilized trees at 100% (N) min + Em1 (2.02), 50% (N) min + 50% (N) org + Em1 (1.93) and 100% (N) min (1.92) were recorded the highest N/K ratio in the second season without significant differences between them. Trees fertilized at 100% (N) org gained the lowermost value of N/K ratio (1.33) in the first season and fertilized trees with 25% (N) min + 75% (N) org (1.49) in the second season.

These results are in a harmony with those obtained by Du plessis and Koen, (1988) Stated that the nitrogen

Table 6: Effect of some nitrogen fertilization treatments on Canopy volume m^3 and leaf area (cm^2) of Murcott tangerine trees (2017 / 2018, 2018/ 2019 seasons).

Fertilization treatments	First season (2017/2018)		Second season (2018/2019)	
	Ca %	Mg %	Ca %	Mg %
100% (N) Min.	4.32 ab	0.46 b	3.62 bc	0.53 a
100% (N) Min.+ EM1	3.97 b	0.46 b	4.08 ab	0.49 a
75% (N) Min.+ 25% (N) Org.	3.97 b	0.53 ab	4.08 ab	0.50 a
50% (N) Min.+ 50% (N) Org.	4.32 ab	0.55 a	3.85 abc	0.54 a
25% (N) Min.+ 75% (N) Org.	4.08 ab	0.46 b	3.50 bc	0.53 a
75% (N) Min.+ 25% (N) Org. + EM1	4.43 a	0.53ab	4.55 a	0.63 a
50% (N) Min.+ 50% (N) Org. + EM1	4.08 ab	0.53 ab	3.73 bc	0.62 a
25% (N) Min.+ 75% (N) Org. + EM1	4.32 ab	0.50 ab	4.20 ab	0.44 a
100% (N) Org. + EM1	4.32 ab	0.46 b	4.20 ab	0.44 a
100% (N) Org.	3.97 b	0.46 b	3.15 c	0.63 a

Means having the same letter (s) in each column are insignificantly different.
Min. = mineral (Ammonium nitrate 33.5%), Org. = organic N (chicken manure 3%),
EM1= Effective microorganisms (150ml/tree/year).

interaction with K has been widely studied. In general N and K levels are inversely related. However, the ratio between N and K has significant effect on yields and fruit size Maximum yield Valencia orange trees in South Africa was obtained at N:K ratio between 2.4 and 3.0 both N and K had to be at levels greater than 2.1 and 0.8 dry weight, respectively. In contrast, optimum fruit size was attained at a ratio between 1.6 and 2.2 with N greater than 1.8 and K greater than 0.9. Most importantly, greatest income was achieved at relatively low N levels.

• Calcium percentage:

Data in table 6, clear that the tested N fertilization treatments significantly affected calcium percentage in leaves Murcott tangerine trees in the two tested seasons. Trees fertilized with 75% (N) min + 25% (N) org + Em1 gained the highest percentage of calcium in leaves (4.43 and 4.55 %) in the first and second season, respectively, followed by trees fertilized with 100% (N) org + Em1 and 25% (N) min + 75% (N) org + Em1 without significant differences between them in both seasons. However, the lowermost calcium percentage were recorded by the treatments of fertilized at 100% (N) org (3.97 and 3.15%) in the first and second seasons, respectively, followed by trees fertilized 100% (N) min + Em1 and 75% (N) min + 25% (N) org (3.97%) without significant differences between them in the first season only.

Similarly, trends are obtained by Abedel-Sattar *et al.,* (2011) on Washington navel orange and Salama *et al.,* (2012) revealed that Sewy date palms fertilized with organic N + mineral N + biofertilizer tended to increase N, P, K, Ca and Mg leaf contents.

• Magnesium percentage:

Data in table 6, show that the tested N fertilization treatments significantly affected Mg percentage in leaves of Murcott tangerine trees in the first season and non-significant in the second. Trees fertilized with 50% (N) min + 50% (N) org (0.55%) recorded the highest percentage of Mg in leaves in the first season without significant differences between other treatments.

Trees fertilized with 100% (N) org (0.63%) recorded the highest percentage of Mg in leaves in the second season without significant differences between other treatments. Murcott tangerine trees Mg percentage in leaves ranged between (0.46 - 0.55 %, 0.44 - 0.63%) in the first and second seasons, respectively.

These findings came in a line with those found by Mansour and Shaaban, (2007); Wassel *et al.,* (2007); Khan and Begum (2007); Eman *et al.,* (2008); Barakat *et al.,* (2012); El-Khayat and Abdel Rehiem, (2013); Garhwal *et al.,* (2014); Hadole *et al.,* (2015); Shaimaa and Massoud, (2017).

Conclusion

The obtained data showed that the best results with regard to growth, yield and nutritional status of Murcott tangerine trees were indicated at fertilizing trees with 75% inorganic as ammonium nitrate (33.5% N) + 25% organic as chicken manure (3% N) + 150 ml EM1/ tree /year.

Acknowledgement

The article is part of the Doctoral thesis. The Authors are grateful of staff of the department of horticulture, faculty of Agriculture, Zagazig university, Egypt for their facilities and assistance.

References

Abd-Alhamid, N., L.F. Haggag, H.S.A. Hassan, A.A. Abdelhafez and A.M. Hassan (2015). Effect of mineral and bio-fertilization on yield and fruit quality of Manzanillo olive trees. *International Journal of Chem. Tech. Research*., **8(11):** 63-73.

Abdelaal, S.H., E. Mohamed and S.S. Kabeil (2010). Microbial bio-fertilization approaches to Improve yield and quality of Washington navel orange and reducing the survival of nematode in the soil. *J. American Sci*., **6(12):** 264-272.

Abd-Rabou, F.A. (2006). Effect of Microbien, Phosphorene and effective micro-organisms (EM) as bio-stimulants on growth of avocado and mango seedlings. *Egyptian J. Applied Sci*., **21(6B):** 673-693.

Abedel-Sattar, M., M. EL-Tanany and H.M. EL-Kouny (2011). Reducing mineral fertilizers by using organic manure to improve Washington Navel orange productivity and sandy soil characteristics. *ALEXANDRIA Science Exchange Journal.*, **32(4)**.

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

Ahmed, F.F., A.M.M.A. Akl, E.A.H. El- Mamlou and H.H.M. Saied (2014). Effect of partial replacement of inorganic N fertilizer partially by using EM, compost tea and humic acid on fruiting of Sakkoti date palms. *Stem Cell.,* **5(2):** 40-51.

Ahmed, F.F., H.I.M. Ibrahim and M. Kh. Kamel (2014). Reducing inorganic N partially in Zaghloul date palm orchards by using humic acid and effective microorganisms. *World Rural Observ.*, **6(2):**102-11037.

Al-Wasfy, M.M.M. and M.M.A. Abd El-Rahman (2014). Reducing inorganic N fertilizer partially in Hayany date palm orchards by using animal and chicken manures. *World Rural Observations*., **6(1)**.

Barakat, M.R., T.A. Yehia and B.M. Sayed (2012). Response of Newhall naval orange to bio-organic fertilization under newly reclaimed area conditions I: Vegetative growth and nutritional status. *Journal of Horticultural Science & Ornamental Plants.*, **4 (1):** 18-25.

Barrows, H.L. and E.C. Simpson (1962). An EDTA method for the direct routing determination of calcium and magnesium in soil and plant tissue. *Soil Sci. Soc. Amer. Proc*., **26:** 443-446.

Brown, J.D. and O. Lilliland (1964). Rapid determination of potassium and sodium in plant material and soil extracts by flamephotometer. *Proc. Amer. Soc. Hort. Sci*., **48:** 341-346.

Canali, S., A. Trinchera, F. Intrigliolo, L. Pompili, L. Nisini, S. Mocali and B. Torrisi (2004). Effect of long-term addition of composts and poultry manure on soil quality of citrus orchards in Southern Italy. *Biology and Fertility of Soils.*, **40(3):** 206-210.

Du plessis, S.F. and T.J. Koen (1988). The effect of N and K fertilisation on yield and fruit size of Valencia. Citriculture. Sixth International Citrus Congress, Middle-East, Tel Aviv, Israel, **6-11(2):** 663-672.

Duncan, D.B. (1958). Multiple Rang and Multiple F test. *Biomet*., **11:** 1-42.

El-Haddad, M.E., Y.Z. Ishac and Mostafa (1993). The role of biofertilizers in reducing agricultural costs, decreasing environment pollution and raising crop yield. *Arab Univ. Agric. Sci. Ain Shams Univ*., *cairo1*., **(1):** 147- 195.

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

El-Morshedy, F.A. (1997). Organic manure and sulphur interaction influence vegetative growth and element concentration of sour orange seedlings. *Journal of Agricultural Science*, Mansoura University., **22:** 4599-4614.

El-Salhy, A.M., A.M.A. El-Sese, M.F. Badran and Shima H. Gaber (2017). Partial replacement of nitrogen fertilization by humic acid and Seaweed extracts in Balady Mandarin orchards. *Assiut J. Agric. Sci*., **48 (4):** 185-199.

El-Shazly, S.A., A.A. El-Gazzar, E.M. Soliman, A.A. Abdelhafez, G.F. Abd El-Rahman and Sanaa M. Mohamed (2015). Effect of natural minerals compound, organic and Some biofertilizers application on yield, fruit quality and leaf mineral content of Balady mandarin Trees. *Egypt. J. Hort*., **42 (1):** 211-230.

Eman, A.A.A.E., A.S.E. Abd-Allah and S.E. Sanaa (2008). Effect of some organic and biofertilizer treatments on minimizing mineral nitrogen fertilization of Washington Navel orange trees. *Arab Universities Journal of Agricultural Sciences*., **16(2):** 451-457.

Ennab, H.A. (2016). Effect of organic manures, biofertilizers and npk on vegetative growth, yield, fruit quality and soil fertility of eureka lemon trees (*citrus limon* (L.) burm). *J. Soil Sci. and Agric. Eng*., Mansoura Univ., **7(10):** 767- 774.

FAO STAT (2017). http://www.fao.org/faostat/en.

Garhwal, P.C., P.K. Yadav, B.D. Sharma, R.S. Singh and A.S. Ramniw (2014). Effect of organic manure and nitrogen on growth yield and quality of kinnow mandarin in sandy soils of hot arid region. *African Journal of Agricultural Research*., **9 (34):** 2638-2647.

Garnica, M., F. Houdusse and A.M. Zamarreño (2010). Nitrate supply enhances active forms of cytokinins and indole acetic content and reduces abscisic acid in wheat plants grown with ammonium. *J. Plant Physiol*., **167:**1264-1272.

Granatstein, D. (2003). Tree fruit production with organic farming methods. Wenatchee (WA): Center for Sustaining Agriculture and Natural Resources, Washington State University. Retrieved from: http://organic.tfrec.wsu.edu/OrganicIFP/OrganicFruitProduction/OrganicMgt.PDF).

Hadole, S.S., S. Waghmare, S.D. Jadhao (2015). Integrated use of organic and inorganic fertilizers with bio-inoculants on yield, soil fertility and quality of Nagpur mandarin (Citrus reticulata Blanco). *International Journal of Agricultural Sciences*., **11(2):** 242-247.

Hazarika, T.K. and B. Aheibam (2019). Soil nutrient status, yield and quality of lemon (*Citrus limon* Burm.) cv. 'Assam lemon' as influenced by bio-fertilizers, organics and inorganic fertilizers. *Jour. of Plant Nutrition.*, **42(3):** 1-11.

Higa, T. (2010). Effective microorganisms as a commercial product. http:// econature. wordpress. com/ 2010/04/15/ effectivemicroorganisms-em.

Hilimire, K., S.R. Gliessman and J. Muramoto (2012). Soil fertility and crop growth under poultry/crop integration. *Renewable Agriculture and Food Systems*.

Isahac, Y.Z. (1989). Inoculation with associative N_2 fixers Egypt. Nitrogen fixation with non-legumes, Kluwer Academic publishers' 241-246.

Jahromi, A.A. and H.H. Khankahdani (2016). Effect of humic acid on some vegetative traits and ion concentrations of Mexican Lime (Citrus aurantifolia Swingle) seedlings under salt stress. *International Journal of Horticultural Science and Technology*., **3(2):** 255-264.

Jugnake, M.O, M.B. Patil and S.E. Shinde (2017). Effect of biofertilizer and chemical fertilizer on growth and yield of sweet orange (*Citrus sinensis* L. Osbeck). *International Journal of Chemical Studies.*, **5(6):** 1061-1064.

Khan, M.A.A. and H. Begum (2007). Effect of INM on available nutrient status of young acid lime (*Citrus aurantifolia* Swingle) orchards of A.P., India. *Asian Journal of Horticulture.*, **2(2):** 64-67.

Khehra, S. and J.S. Bal (2014). Influence of organic and inorganic nutrient sources on growth of lemon (*citrus limon* (l.) Burm.) cv. Baramas. *Journal of Experimental Biology and Agricultural Sciences.*, **2(3):** 2320 - 8694.

Kitson, R.E. and M.G. Mellon (1964). Colorimetric determination of phosphorus as molybdivanado phosphoric acid. *1nd-Eng. Chem. Anal.*, Ed., **16:** 379-383.

Mansour, A.E.M. 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. *Journal of Applied Sciences Research.,* **3(8):** 764-769.

Medhi, B.K., A.J. Saikia, S.C. Bora, T.K. Hazarika and A.C. Barbora (2007). Integrated use of concentrated organic manures, bio-fertilizers and inorganic npk on yield, quality and nutrient content of khasi mandarin (*Citrus reticulata* blanco.). *Indian Journal of Agricultural Research*., **41(4):** 235-241.

Mostafa, R.A.A.1 and M.M.A. Abdel-Rahman (2015). Effects of Natural and Bio-fertilization as a Partial Substitute for Mineral Fertilization on Vegetative Growth and Fruiting of Balady Mandarin Trees. *Assiut J. Agric. Sci*., **46 (1):** 34-47.

Naguib, M.I. (1969). Colorimetric determination of nitrogen components of plant tissues. *Bull. Fac. Sci. Cairo. Univ.*, **43:**1.

Nijjar, G.S. (1985). Nutrition of Fruit Trees. Mrs. MshaRaj Kumar for Kalyani Publishes, New Delhi, 10-52.

Obreza, T.A. (2001). Effects of P and K fertilization on young citrus tree growth. Cooperative Extension Service, *Insti. Food and Agric. Sci. Flor. Univ.,* 1-3.

Obreza, T.A., M. Zekri and E.W. Hanlon (2008). Soil and leaf tissue testing in nutrition of Florida citrus trees. 2nd Ed Florida Cooperative Extension Service, *Institute of food and Agriculture Science*, University of Florida, 24-32.

Paschoal, A.D., Y.D.A. Senanayakc and U.R. Sangak Kara (1999). Improved soil chemical and physical conditions and their relations to yield and fruit quality of orange in a field under Kyusei Nature Farming and EM. Technology in Brazil. Fifth International Conference on Kyusei Nature.

Redday, P.V., P.S. Sarma and A. Anjaneyulu (1981). A constant for calculating leaf area in sweet orange (*Citrus sinensis*). *Sci. and Culture.*, **47 (12):** 438-439.

Roose, M.L., D.A. Cole, D.A. Atkin and R.S. Kupper (1989). Yield and tree size of four citrus cultivars and 21 rootstocks in California. *J. Amer. Soc. Hort. Sci*., **114 (4):** 678-684.

Sakakibara, H., K. Takei and N. Hirose (2006). Interactions between nitrogen and cytokinin in the regulation of metabolism and development. *Trends Plant Sci*., **11:** 440-448.

Salama, M.I., A.F. El-Samak, A.A. El-Morsy and K.M.M. Aly (2012). The beneficial effect of minimizing mineral nitrogen fertilization on Sewy date palm trees by using organic and biofertilizers. *J. Plant Production, Mansoura Univ.,* **3(9):** 2411-2424.

Shaimaa, A.M. and O.N. Massoud (2017). Impact of inoculation with mycorrhiza and Azotobacter under different N and P rates on growth, nutrient status, yield and some soil characteristics of Washington Navel orange trees. *Middle East Journal of Agriculture Research*., **6(3):** 617-638.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods, 6th ed. lowa State Univ., Amess. lowa.

SoIaiman, B.M., A. Nadia and S.M. Ahmed (2003). Response of Balady orange trees productivity and some microbial activity to biofertilizer in reclaimed soil. *Society of Applied Microbiology*.

Techan, Y.T. (1988). Some aspects of non - rihzobial diazotrophs: Their past and their future. In Microbiology in action, Eds. W.G. Murrcll and I.R. Kennedy. 193-207. Research studies press Wicly, Chichester, UK. (cited by Kennedy and Tchan, 1992).

Vadak, Y., M.B. Patil, D. Kamlesh and A. Kadam (2014). Interaction effect of bio-fertilizers along with reducing level of chemical fertilizers on physico-chemical characters of sweet orange (*Citrus sinensis* Osback). *Asian J. Hort.*, **9(1):** 64-67.

Wassel, A.H., F.F. Ahmed, M.A. Ragab and M.M. Ragab (2007b). Response of Balady mandarin trees to drip irrigation and nitrogen fertigation. II - Effect of nitrogen fertigation and drip irrigation on fruit setting, number and quality of fruits of Balady mandarin trees (*Citrus deliciosa).* 8th African Crop Science Society Conference, El-Minia, Egypt, 27-31 October :513-522.

Wassel, A.H., F.F. Ahmed, M.A. Ragab and M.M. Ragab (2007a). Response of Balady mandarin trees to drip irrigation and nitrogen fertigation, I - Effect of nitrogen fertigation and drip irrigation on the vegetative growth and the yield of Balady mandarin trees (*Citrus deliciosa*). 8th African Crop Science Society Conference, El-Minia, Egypt, 27-31 October. :503-511.

Whitney, J.D., T.A. Wheaton, W.S. Castel and D.P. Tucker (1995). Tree height, fruit size and fruit yield affect manual orange harvesting rates. *Proc. Florida State Hort. Soc*., **108:** 112-118.

Zekri, M. and T.A. Obreza (2002). Plant Nutrients for Citrus Trees. Soil and leaf tissue testing in nutrition of Florida citrus trees. 2nd Ed Florida Cooperative Extension Service, *Inst. Food and Agric. Sci., Florida Univ*., 1 - 2.