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Effect of multi-ingredient of Bokashi on productivity of mandarin trees and soil properties under saline water irrigation

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Abstract: *This study was carried out during 2012 and 2013 seasons at El-Sheikh Zuwayid ,North Sinai Governorate, Egypt, to study the effect of mult-ingredient of bokashi on N, P, K, Fe, Zn, Cu, Ca, Mn and Mg in the leaves, yield as well as some physical and chemical characteristics of Clementine mandarin fruits and soil properties under saline water irrigation. Seven treatments were done as follows: T_1: control treatment (normal sandy soil), T_2: poultry manure 10 kg/ tree, T_3: bokashi1 (poultry manure + solid olive waste +EM+ molasses) 10 kg/ tree, and T_4: bokashi 2 (poultry manure + rice straw +EM+ molasses) 10 kg/ tree. T_5: bokashi 3 (poultry manure + rice husks +EM+ molasses) 10 kg/ tree, T_6: bokashi 4 (poultry manure + solid olive waste + rice straw +EM+ molasses) 10 kg/ tree and T_7: bokashi 5 (poultry manure + solid olive waste + rice husks+ EM+ molasses) 10 kg/ tree. The obtained results showed that all treatments were very effective on leaves mineral content, yield, physical and chemical characteristics of the fruits and chemical characteristics and micro flora soil. Generally, the best treatment was T_6 which improved the mineral content (N, K, Fe, Zn, Cu, Ca and Mn) in the leaves, yield, fruit length, fruit diameter, fruit weight, fruit volume, juice percentage, T.S.S, total sugar, and vitamin C. In addition , T_6 treatment increased the number of the soil micro flora, (total fungi (TF), total bacteria (TB) and total actinomycetes (TA) and some macro and micro elements (N, P, K, Fe, Zn, and Mn) while decreased the total acidity, peel thicknesses in fruits, ECe, pH and Na in soil as compared to the control.*
Key words: *clementine mandarin, bokashi, saline water*

I. Introduction

Citrus trees have an outstanding economical importance among fruit crops in Egypt. The total production of citrus fruit amounts to 3,522,953 tons. Mandarin occupies the second planted citrus species after orange **(FAO 2012).** Clementine is an easy-peeling mandarin cultivar widely grown in the world and is the most important mandarin in north Sinai of Egypt.

The majority of the new lands of Egypt are sandy and calcareous soils. The main problems of these soils are their poor structure, low availability of water and nutrients, low fertility and higher salinity, calcium carbonate content and the possibility of forming a surface crust and indurate layers at shallow depths. The reclamation of these soils was mainly depended upon the addition of many natural amendments such as sulphur, calcium with some organic material and biofertilization, compounds containing organic matters, antioxidants especially salicylic and citric acids and microorganism. These compounds shown to be very effective in alleviating the adverse effects of salinity on growth, nutritional status and fruiting of fruit crops **(Abada *et al.*, 2010; Kassem, 2012**).

Soil salinity is becoming a major problem in widespread areas of the cultivated land in Egypt. Newly reclaimed sandy soil may also be affected at various degrees by some sorts of salinity. It is well known that salt can impair the performance of production and growth of many horticultural plants especially fruit trees. Growth, fruit production and quality parameters are seriously affected by soil **(Bravdo, 2000 and Abd El-Hady, *et al.*, 2003)**. In addition, **Yeo (1998) and Grattan and Grieve (1999)** cleared that the direct effect of salts on plant growth maybe divided into three broad categories: (i) a reduction in the osmotic potential of the soil solution that reduces plant available water, (ii) a deterioration in the physical structure of the soil diminished water permeability and soil aeration, and (iii) increase in the concentration of certain ions that have an inhibitory effect on plant metabolism (specific in toxicity and mineral nutrient deficiencies). The relative contribution of osmotic effects and specific in toxicities on yield is difficult to quantify.

Salinity induces osmotic stress, ionic imbalance, ion toxicity and nutrient deficiency regarding plant growth **(Parida and Das, 2005).** Also salinity is involved as an oxidative stress which produces inactive oxygen species (free radicals) like superoxidase, hydroxyl radical , hydrogen peroxide and singlet oxygen that involved in promoting membrane lipid peroxidation as well as membrane leakage **(Ashraf, 2004 and Gunes *et al.*, 2007),** and these reactive oxygen species finally scratch chloroplast and mitochondria by distracting their cellular structures **(Mittler, 2002).**

Biofertilizers are the microbial inoculants having specific strains of bacteria and fungi, alone or in combination which is applied to soil for increasing crops productivity through their metabolic activities independently or in association with the plant root system **(Dadarwal, *et al*, 1997).** In general, biofertilizers are environment friendly, decreased agricultural costs with maximum out put. These biofertilizers play an important role in enhancing crop productivity through nitrogen fixation, phosphate solubilization, plant hormone production ammonia excretion and controlling various plant diseases (**Pathak, *et al.*, 1997** and **Hedge, *et al,* 1999).** In addition, **Subba (1999**) Mentioned that biofertilizers are carrier based on preparations containing beneficial microorganisms in a viable state intended for soil application and designed to improve soil fertility and help plant growth by increasing the number and biological activity of desired microorganisms in root environment.

Bokashi is a Japanese term means ‘fermented organic matter made by fermenting most of organic materials (such as solid olive waste and rice husks as Japanese standard) using effective microorganisms (EM), molasses and water for about two weeks and dried. The bokashi is usually a dry organic material that can be made with different ingredients for different uses. Therefore, bokashi is very effective physically, chemically, and biologically raising the fertility of salt-affected soil **(Shao Xiaohou *et al.,* 2008**). **Mohamed, et *al*., (2007)** study the effect of bokashi and EM application on the leaf mineral content, yield and fruit quality of Anna apple tress. They found that The Bokashi was more effective than the EM application and it is proved that using bokashi at T_3 (8 kg / tree / year) was superior to leaf mineral values, N, P, K, Fe, Zn and Mn, yield, fruit weight, dimensions, total sugars % and TSS % were improved and decrease total acidity %. The results has also indicated that all of the EM applications increased the number of the soil micro flora, (total fungi (TF), total bacteria (TB) and total actinomycetes (TA)) and some macro and micro elements (N, P, K, Fe, Zn, and Mn) in soil as compared to the control.

Effective microorganisms (EM) products had been in the market since 1983 in Japan **(Subba Rao, 2008).** EM consists of mixed cultures of beneficial a naturally-occurring microorganism that can be applied as inoculants to increase the microbial diversity of soil and plant. EM contains selected species of microorganisms including predominant populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms. All of these are mutually compatible with one another and can coexist in liquid culture **(Higa and Wididana, 1991a).** EM is not a substitute for other management practices. It is, however, an added dimension for optimizing our best soil and crop management practices such as crop rotations, use of organic amendments, conservation tillage, crop residue recycling, and bio control of pests. If used properly, EM can significantly enhance the soil fertility and promotes growth, flowering, fruit development and ripening in crops. It can increase crop yields and improve crop quality as well as accelerating the breakdown of organic matter from crop residues **(Higa and Wididana, 1991b**). In addition, Effective microorganisms (EM) with organic materials can be added to the soil, to stimulate the supply and release of nutrients **Jakubus *et al* (2012).** In addition, EM application caused a distinct acceleration of organic matter. Adding EM to the soil increased leaf mineral values (N, P, K, Fe, Zn, and Mn) as compared with the untreated Le Conte pear tree **(Abd-El-Messeih *et al.,* 2005).** In addition, **Osman *et al.* (2011)** mentioned that effective microorganisms (EM) application at 1.0 cm3/palm gave the best results in growth of "Bartamuda" date palm. Moreover, **El-Khawaga (2013)** reported that EM application improved growth of date palm cultivars "Sewy", "Zaghloul" and "Hayany". **Amro *et al.* (2014)** mentioned that effective microorganisms (EM) application at 90 ml/palm gave the best results in growth and leaf mineral content of "Hayany" date palm. Moreover **Higa (1991)** and **(Higa and Wididana, 1991b)** Saied that enhancement effect of EM on improving growth and leaf minerals content may be attributed to the fact that EM have beneficial effect on lowering soil pH, and increasing the uptake of water and nutrients. **Formowitz *et al.,* (2007) and Ibrahim, (2012)** reported that, EM is enhancing soil fertility

Rice straw and rice husks represent an important summer crop by-product in Egypt. About 3.5 million tons of rice straw and 0.5 million tons of rice hulls are produced every year from the rice fields and rice milling process respectively **(Ponamperuma, 1982).** Research has shown that rice straw with some amendments can significantly improve soil nutrients and soil properties by decreasing soil bulk density, enhancing soil pH increasing crop yields **(Williams *et al* 1972).**

Solid olive waste can be highly benefited for using as agricultural soil conditioners **(Majed and Al-Widyan 2002)**. Solid olive waste has a moderate acidity, a high content of organic matter 94%, potassium and nitrogen and high moisture content **(Cegarra *et al*., 2004).** However, solid olive waste production and nitrogen uptake by plants were improved after the amendment of the soil by the sludge with composting **(Khadija *et al*., 2004).** The application of the olive solid waste increased orange yield **(Madejon *et al.,* 2003).**

This trial aimed to study the effect of mult-ingredient of bokashi on productivity of Clementine mandarin trees and soil properties under saline water irrigation.

II. Materials And Methods

This study was conducted during 2012 and 2013 seasons on 42 uniform in vigor 10- years old Clementine mandarin trees onto sour orange rootstock grown in poor sandy soil (control in Table 9) under drip irrigation system (Table 1) at El-Sheikh Zuwayid, North Sinai Governorate, Egypt. Planting space was 4 × 4 m apart. This study included seven treatments. The treatments were established as follows T_1: control treatment (normal sandy soil), T_2: poultry manure 10 kg/ tree, T_3: bokashi1 (poultry manure+ solid olive waste +EM+ molasses) 10 kg/ tree, T_4: bokashi2 (poultry manure + rice straw +EM+ molasses) 10 kg/ tree, T_5 : bokashi 3 (poultry manure + rice husks +EM+ molasses) 10 kg/ tree, T_6 : bokashi 4 (poultry manure + solid olive waste + rice straw+ EM+ molasses) 10 kg/ tree and T_7 : bokashi 5 (poultry manure + solid olive waste + rice husks+ EM+ molasses) 10 kg/ tree. Bokashi is an organic fertilizer prepared by fermenting 100 kg of some organic materials for two weeks (raw rice, rice husks and solid olive waste) (Table 2) with adding 50 litters of water, 5 liter of molasses, 5 liter of effective microorganisms and 100 kg poultry manure and mixing the final bokashi as treatments. All treatments were adding in December for each season. Randomized complete block design. Each treatment was replicated three times, two tree per each.

Table 1: Irrigation water analysis

Characters		Values
PH		7.9
E.C. (ds /m)		3.84
Unit		**Epm.**
Soluble captions	Ca^{++}	6.21
	Mg^{++}	6.73
	Na^{+}	25.11
	K^{+}	0.21
Soluble anions	CO_3^{--}	0.0
	HCO_3^{-}	3.31
	SO^{--}_4	10.71
	Cl^{-}	25.24

Epm= equivalent per million.

Table 2. Chemical composition of rice straw, rice husks, solid olive waste and poultry manure .

Ingredient	Content %							
	Dry Matter	Ash	Crude fibre	Crude protein	Ether extract	N	P	K
Rice straw	90.93	20.32	35.39	4.62	1.14	1.04	0.13	2.21
Rice husks	96.40	20.51	48.55	1.79	0.83	0.23	0.60	1.23
solid olive waste	81.00	4.34	25.11	3.56	1.55	1.54	0.70	2.12
poultry manure	94.3□	20.5	1.48	10.52	1.58	1.96	0.60	2.30

The following parameters were measured for both seasons:

1- Macro and Micronutrients in leaves: before starting this trial (**Table 3**) and after the two experiments seasons (at the end of September), thirty leaves /tree were collected representing the four main directions. Collected samples prepared and analyzed for macro and micronutrients as described by **Peterburgski (1968) and Jones *et al.* (1991).** Total NPK are calorimetrically determined as described by **Cottenie, *et al.* (1982).** Fe, Zn, Cu, Mn, Ca and Mg were estimated by atomic absorption spectrophotometer as described by **Allan and prince, (1965).**

2-The tree yield in (Kg) was recorded.

3-Number of fruits per tree was recorded at harvest time (first of November) for all treatments in both seasons.

4-Fruit parameters: fruits sample was taken at the harvest time to be used for determining the physical properties (i.e., fruit length (cm), fruit diameter (cm), fruit weight (g), fruit volume (cm^2), juice percentage and peel thickness (mm).

5-Fruit quality: a sample of 10 ripe fruits of each tree was taken at the harvest time to be used for determining the chemical properties i.e., The total soluble solids percentage (T.S.S.%) was measured by using a hand refractometer and the acidity % as citric acid content using fresh juice with titration against 0.1 Na OH. The total sugars %, and content of vitamin C according to **A.O.A.C (1985)** were determined.

6- Soil microflora, macro and micro soil elements content: Soil microbial count was made on samples collected on September from three sites around each tree. Small portions of composted soil samples on both seasons were used for density estimation of colony forming units (CFU) of total bacteria (TB) using the soil extract agar medium according to **Allen (1953),** total fungi (TF) using the rosebengal streptomycin agar medium according to **Martin (1950)** and total actinomycetes (TA) using Jensen's medium to **Allen (1953)**. The same composted soil samples were used for determined N, P, K, Fe, Zn and Mn according to the methods of **Chapman and Pratt, 1961.**

Table 3: leaf mineral content before starting the experiment

N %	P %	K %	Fe %	Zn %	Cu%	Mn %	Ca%	Mg%
1.55	0.13	1.08	37	18	10	34	3.81	0.32

Statistical analysis:

The data were subjected to analysis of variance and Duncan's multiple range tests was used to differentiate means as described by **Duncan (1955).**

III. Results and Discussion

Leaf Mineral Content:

Leaf nitrogen, phosphorus and potassium content

Concerning the results in Table 4, nitrogen, phosphorus and potassium content in the leaves was significantly affected by all treatments in both seasons. However, T_6 gave the best leaf nitrogen content (2.69 in the 1st and 2.71% in the 2nd season) and potassium (2.35 in the 1st and 2.39% in the 2nd season) followed by T_5 on Clementine mandarin trees in both seasons. On the other hand, there no significant deference between T_6 and T_7 in phosphorus content in leaves in both seasons. In addition, control was the lowest leaf nitrogen content (1.76 in the 1st and 1.77% in the 2nd season), phosphorus (0.15%in the both seasons) and potassium (1.09 in the 1st and 1.18% in the 2nd season in both seasons.

This increase may be due to the content of EM, rice straw and solid olive waste which decomposed and fermented enriched the compost with NPK nutrients which become easily available for plant nutrition **(Higa and Wididana, 1991a**). Furthermore, the increased the number of the soil microflora, (total fungi (TF), total bacteria (TB) and total as compared with the untreated trees actinomycetes (TA)) and some macro and micro elements (N, P, K, Fe, Zn, and Mn) in soil occurred by bokashi promoted root activity and Cation exchange.

Generally, these results were in parallel with those found by **(Cegarra *et al.*, 2004)** who demonstrated that solid olive waste that mostly acidic with high organic matter content, potassium, nitrogen and high moisture content improved mineral nutrients uptake. Similarly **(Williams *et al.,* 1972)** and **(Khadija *et al.*, 2004)** satiated that rice straw acted as well as solid olive waste ether by amending the soil or improving mineral nutrient uptake. Moreover, **(Abd-El-Messeih *et al.,* 2005)** and **(Mohamed *et al.*, 2007)** add that EM application to ether solid olive waste or rice straw accelerate fermentation of the organic materials and increased the availability of (N, P and K) elements in the soil then enhanced growth and productivity.

Table 4. Effect of mult-ingredient of bokashi on N, P and K of Clementine mandarin trees during 2012 and 2013 seasons.

treatments	N %		P %		K %	
	2012	2013	2012	2013	2012	2013
T_1:control	1.76f	1.77f	0.15e	0.15d	1.09g	1.18g
T_2: poultry manure	2.01d	2.08e	0.17de	0.18cd	1.33f	1.38f
T_3:bokashi1	2.45b	2.50bc	0.22b	0.23b	2.12c	2.22c
T_4: bokashi2	2.30c	2.35cd	0.21bc	0.21bc	1.94d	1.99d
T_5:bokashi3	2.13c	2.25d	0.19cd	0.19c	1.72e	1.86e
T_6:bokashi4	2.69a	2.71a	0.29a	0.29a	2.35a	2.39a
T_7:bokashi5	2.51b	2.62ab	0.26a	0.27a	2.28b	2.30b

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Leaf iron, zinc, manganese, cupper, calcium and magnesium content

It is evident from the data in Table (5) that iron, zinc, manganese, cupper, calcium and magnesium content in the leaves was significantly affected by all treatments in both seasons. However, T_6 gave the best leaf iron content (57.12 in the 1st and 57.93% in the 2nd season), zinc (31.58 in the 1st and 32.89 %in the 2nd season), manganese (49.21 in the 1st and 49.51% in the 2nd season), cupper (13.83in the 1st and 13.90% in the 2nd season), calcium (5.64 %in the both seasons) and magnesium (0.54 in the 1st and 0.55% in the 2nd season) followed by T_7 in both seasons. On the other side, control was the lowest leaf iron content (38.24 in the 1st and 38.78 %in the 2nd season), zinc (20.05% in the both seasons), manganese (39.38 in the 1st and 39.71% in the 2nd season), cupper (10.13 in the 1st and 10.60% in the 2nd season), calcium (3.99 in the 1st and 4.02% in the 2nd season) and magnesium (0.43 in the 1st and 0.45% in the 2nd season).

These results could be due to the importance of bokashi which is very effective in raising the fertility of salt-affected soil physically, chemically and biologically resulting the improve in the elements level in the leaves

These results are in parallel with those of **Abd-El-Messeih *et al.,* (2005) (**who worked on Le Conte pear) and **Mohamed *et al.*, (2007) (**who worked on apple**)** added that EM application to ether solid olive waste or rice straw accelerate fermentation of the organic materials and increased the availability of (Fe, Zn and Mn) elements in the soil then enhanced growth and productivity.

Table 5. Effect of mult-ingredient of bokashi on Fe, Zn, Mn, Cu, Ca and Mg of Clementine mandarin trees during 2012 and 2013 seasons.

treatments	Fe%		Zn %		Mn %		Cu%		Ca%		Mg%	
	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012
T_1:control	38.24 g	38.78 g	20.05 g	20.05 g	39.38 g	39.71 g	10.13 g	10.60 g	3.99 g	4.02 g	0.43 e	0.45 e
T_2: poultry manure	39.16 f	41.42 f	22.48 f	22.84 f	40.21 f	40.99 f	10.84 f	11.00 f	4.62 f	4.77 f	0.45 de	0.46 de
T_3:bokashi1	50.21 c	52.15 c	28.52 c	29.44 c	45.15 c	45.22 c	12.07 c	12.19 c	5.14 c	5.21 c	0.50 bc	0.51 bc
T_4: bokashi2	46.48 d	50.11 d	26.25 d	27.18 d	43.34 d	44.00 d	11.88 d	11.99 d	5.01 d	5.11 d	0.48 cd	0.49 cd
T_5:bokashi3	40.09 e	45.12 e	23.86 e	24.09 e	41.01 e	41.58 e	11.00 e	11.30 e	4.79 e	4.96 e	0.47 d	0.48 de
T_6:bokashi4	57.12 a	57.93 a	31.58 a	32.89 a	49.21 a	49.51 a	13.83 a	13.90 a	5.64 a	5.64 a	0.54 a	0.55 a
T_7:bokashi5	51.49 b	54.89 b	30.08 b	31.00 b	47.209 b	47.48 b	13.67 b	13.77 b	5.25 b	5.32 b	0.52 ab	0.52 ab

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Yield /tree and Number of fruit/tree

Table 6, cleared that yield and number of fruits/tree of Clementine mandarin was significantly affected by all treatments in both seasons. Moreover, T_6 gave the best yield (95.63 in the 1^{st} and 99.89kg in the 2^{nd} season) and number of fruits (907.51 in the 2^{nd} season), but in the first season T_3 gave the best number of fruits (879.56 in the 1^{st}seson). Results cleared that control gave the minimum values of yield (49.89 in the 1^{st} and 53.55 kg in the 2^{nd} season) and number of fruits (625.90 in the 1^{st} and 649.80 in the 2^{nd} season).

These results could be due to bokashi which was very effective in raising the fertility of salt-affected soil physically, chemically and biologically improving the yield. These biofertilizers play an important role in enhancing crop productivity through nitrogen fixation, phosphate solubilization, plant hormone production ammonia excretion and controlling various plant diseases **(Pathak, *et al*, 1997 and Hedge, *et al*, 1999)**. In addition, rice straw improve soil nutrients and soil properties by decreasing soil bulk density, enhancing soil pH and increasing crop yield **(Williams *et al.,* 1972).** Solid olive waste that contains 94% organic matter can be highly benefited for using as agricultural soil conditioners **(Majed and Al-Widyan 2002)**.

These results are parallel with **Abd-El-Messeih *et al.,* (2005)** who found that bokashi increased yield of Le-Conte pear. In addition, **Mohamed *et al.,* (2007)** who indicated that the bokashi was more effective than added EM to the soil and it is proved that using bokashi at (8 kg / tree / year) was superior to increase yield in Anna apple tress as compared to the control. The application of the solid olive waste increased orange yield **(Madejon *et al.,* 2003).**

Table 6. Effect of mult-ingredient of bokashi on yield and number of fruits/ tree of Clementine mandarin trees during 2012 and 2013 seasons.

treatments	Yield (kg)/tree		Number of fruit/tree	
	2012	2013	2012	2013
T_1:control	49.89g	53.55g	625.90e	649.80g
T_2: poultry manure	65.79f	67.74f	771.49d	773.38f
T_3:bokashi1	87.93c	91.34c	879.56a	889.65b
T_4: bokashi2	78.96d	85.36d	824.05c	870.04c
T_5:bokashi3	70.66e	77.52e	797.25c	843.62e
T_6:bokashi4	95.63a	99.89a	876.46b	907.51a
T_7:bokashi5	91.44b	94.61b	866.57b	881.97d

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Physical Characteristics

Data in Table (7) revealed that fruit length, diameter, weight, volume, peel thickness and juice percentage of Clementine mandarin was significantly affected by all treatments in both seasons. It is cleared that T_6 gave the best fruit length (6.10 in the 1^{st} and 6.43cm in the 2^{nd} season), fruit diameter (6.89 in the 1^{st} and 6.97cm in the 2^{nd} season), fruit weight (109.11 in the 1^{st} and 110.07g in the 2^{nd} season), fruit volume (108.63in the 1^{st} and 109.22 cm^2 in the 2^{nd} season) and juice percentage (46.28 in the 1^{st} and 47.93% in the 2^{nd} season). On the other hand T_6 gave the lowest peel thickness (2.75in the 1^{st} and 2.71 mm in the 2^{nd} season)

On the other side, unfavorable effects on fruit physical characteristics were observed when the Clementine mandarin grown under salinity and untreated with each material. Control gave the lowest fruit length (3.90 in the 1st and 4.20cm in the 2nd season), fruit diameter (5.04 in the 1st and 5.11cm in the 2nd season), fruit weight (79.71 in the 1st and 82.41 g in the 2nd season), fruit volume (86.22 in the 1st and 89.00 cm^2 in the 2nd season) and juice percentage (36.60 in the 1st and 37.13% in the 2nd season) and gave high peel thickness (3.49in the 1st and 3.46 mm in the 2nd season).

The positive influence of these materials may be due to the increased of the availability of micronutrients in the soil that leading to an increase in total chlorophyll that may result in accumulating more carbohydrates thereby enhancing fruit ripening. In addition, bokashi increased the number of the soil microflora, (total fungi (TF), total bacteria (TB) and total actinomycetes (TA)) and some macro and micro elements (i.e. N, P, K, Fe, Zn, and Mn) in soil.

Generally, these results are in agreement with **Abd-El-Messeih *et al.,* (2005)** who found that bokashi increased fruit weight, their dimensions of Le-Conte pear fruits. In addition, **Mohamed *et al.,* (2007)** who found that bokashi at T_3 (8 kg / tree / year) was superior in increasing fruit weight and dimensions of Anna apple as compared to the control.

Table 7. Effect of mult-ingredient of bokashi on fruit length, fruit diameter, fruit weight, fruit volume, peel thickness and juice percentage of Clementine mandarin trees during 2012 and 2013 seasons.

treatments	Fruit length (cm)		fruit diameter (cm)		fruit weight (g)		fruit volume (cm^2)		peel thickness (mm)		Juice percentage %	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
T_1:control	3.90 e	4.20 e	5.04 e	5.11 f	79.71 g	82.41 g	86.22 g	89.00 g	3.49 a	3.46 a	36.60 g	37.13 g
T_2:poultry manure	4.82 d	5.11 d	5.63 d	5.73 e	85.16 f	87.59 f	92.03 f	93.22 f	3.13 b	3.12 b	37.81 f	38.33 f
T_3:bokashi1	5.73 b	5.77 bc	6.61 b	6.66 b	99.97 c	102.67 c	103.33 c	106.08 c	2.91 cde	2.85 e	41.56 c	42.88 c
T_4: bokashi2	5.30 c	5.51 bcd	6.22 c	6.37 c	95.82 d	98.11 d	100.22 d	102.63 d	2.94 cd	2.93 d	40.40 d	41.12 d
T_5:bokashi3	5.07 cd	5.30 cd	6.00 c	6.15 d	88.63 e	91.89 e	95.44 e	98.23 e	3.08 bc	3.07 c	38.66 e	39.33 e
T_6:bokashi4	6.10 a	6.43 a	6.89 a	6.97 a	109.11 a	110.07 a	108.63 a	109.22 a	2.75 e	2.71 g	46.28 a	47.93 a
T_7:bokashi5	5.90 ab	5.90 b	6.73 ab	6.74 b	105.52 b	107.26 b	107.45 b	108.59 b	2.82 de	2.77 f	43.87 b	44.85 b

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Chemical Characteristics

Concerning the results in Table (8) data showed that all treatments had a significantly difference in T.S.S., total sugar, total acidity and vitamin C of Clementine mandarin in both seasons. However, T_6 gave the best T.S.S. (12.25 in the 1st and 12.37 % in the 2nd season), total sugar (11.35 in the 1st and 11.41 % in the 2nd season) and vitamin C (66.22 in the 1st and 68.41% in the 2nd season). On the other side, T_6 decreased total acidity (0.95 in the 1st and 0.92% in the 2nd season).

On the other side, Unfavorable effects on fruit chemical characteristics were observed when the Clementine mandarin trees grown under salinity and untreated with each material. In general, salinity stress inhibited growth and development, also decreased translocation of photosynthetic products and nutrients uptake then the accumulation of total soluble solids %, total sugars form declined **(Nijjar, 1985; Gulser, 2005)**. Therefore, bokashi is very effective in raising the fertility of salt-affected soil in physically, chemically and biologically. Thus, removing the negative effects of salinity on the trees.

These results agreed with those obtained by **Abd-El-Messeih *et al.,* (2005)** who found that bokashi increased TSS% and total sugars % and a decreased acidity % of Le-Conte pear fruits. In addition, **Mohamed *et al.,* (2007)** who found that bokashi at T_3 (8 kg / tree / year) in Anna apple was superior in improving total sugars % and TSS % as compared to the control. In addition, the same treatments decreased total acidity % as compared to the control.

Chemical properties of treated soil with Bokashi

Soil salinity; *ECe,* Soil acidity *pH, Na,* K, Fe, Zn, Mn, Cu, P, NH4 and NO3

Table (9) data showed that all treatments had a significantly affected in soil salinity; *ECe,* soil acidity *pH*, Na, K, Fe, Zn, Mn, Cu, P, NH4 and NO3 in both seasons. Furthermore, T_6 decreased the soil salinity *ECe* (0.94 in the 1st and 0.51 in the 2nd season), soil acidity *pH* (7.21 in the both seasons), and Na (190.64 in the 1st and 170.53% in the 2nd season). However, T_6 gave the highest K (276.23 in the 1st and 283.4% in the 2nd season), Fe (24.10 in the 1st and 25.20% in the 2nd season), Zn (5.23 in the 1st and 5.55% in the 2nd season), Mn (9.50 in the 1st and 9.70% in the 2nd season), Cu (44.23in the 1st and 46.00% in the 2nd season) and NO3 (130.23 in the 1st and 132.14% in the 2nd season) in the soil. On the other hand, there no significant deference between T_6 and T_7 in P and NH4 in both seasons. On the other side, results cleared that control gave the minimum values of K, Fe, Zn, Mn, Cu, and NO3 in both seasons.

That could be attributed to the leaching of soil salt during water application and the nutrients intake by plants from the available adsorbed chemical on the soil surface**.** Compost amendments alleviated some effects on *ECe* of saline soil **(Pairintra and Pakdee 1991).** The reason of that increasing in N could be due to the presence of the photosynthetic bacteria, which enhances the coexistence and co-prosperity with *Azotobacter* in bokashi which fixed the air nitrogen. It should be noted that the Zn is essential for numerous enzyme systems and is capable of forming many stable bonds with nitrogen and sulfur ligands. Mn is involved in many enzyme systems and in electron transport. It is believed that organic matter decomposition aids manganese solubility. P is the second key plant nutrient. P is an essential part of nucleoproteins in the cell nuclei, which control cell division and growth, and deoxyribonucleic acid (DNA) molecules, which carry the inheritance characteristics of living organisms. In its many compounds P has roles in cell division, in stimulation of early root growth, in hastening plant maturity, in energy transformations within the cell **(Miller and Donahue,1990).**

These results agree with results that obtained by **Pairintra and Pakdee (1991)** and **Syed *et al.*, (2002)** who stated that the EM treated soil has more beneficial bacteria types such as Rhodobacter, Pseudomonas, Lactobacillus, Furababacterum, and Gluconobacter, which have the ability to convert NaCl to protein and cheats by de-ionzing the salts.

Table 8. Effect of mult-ingredient of bokashi on T.S.S., total acidity, total sugar, and vitamin C of Clementine mandarin trees during 2012 and 2013 seasons.

treatments	T.S.S. %		Total acidity %		Total sugar %		Vitamin C %	
	2012	2013	2012	2013	2012	2013	2012	2013
T_1:control	9.04g	9.75g	1.27a	1.19a	6.85g	6.92f	35.12g	37.18g
T_2: poultry manure	10.78f	10.91f	1.20b	1.13b	7.42f	8.89e	40.20f	46.38f
T_3:bokashi1	11.84c	11.98c	1.00d	0.97de	9.95c	10.85bc	56.01c	59.23c
T_4: bokashi2	11.45d	11.55d	1.08c	0.99cd	8.65d	10.73c	50.23d	53.90d
T_5:bokashi3	11.00e	11.11e	1.18b	1.01c	7.99e	9.95d	45.89e	51.78e
T_6:bokashi4	12.25a	12.37a	0.95e	0.92f	11.35a	11.41a	66.22a	68.41a
T_7:bokashi5	12.11b	12.15b	0.98de	0.95e	10.95b	10.99b	62.11b	63.42b

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Table (9): Effect of Bokashi on soil chemical properties .

treatments	*ECe* dS/m		*pH*		Na mg/kg soil		K mg/kg soil		Fe mg/ kg soil	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
T_1:control	2.04a	1.91a	8.50ab	8.39a	401.78a	389.76a	107.23g	123.60g	16.00g	17.02g
T_2:poultry manure	2.05a	1.92a	8.69a	8.59a	400.23a	389.75a	119.95f	128.20f	16.34f	17.55f
T_3:bokashi1	1.11d	0.62bcd	7.89d	7.78bc	210.34d	189.93d	255.76c	263.00c	21.37c	22.80c
T_4:bokashi 2	1.30c	0.73bc	8.01cd	7.83bc	220.54c	195.61c	238.57d	242.00d	20.46d	21.80d
T_5:bokashi3	1.50b	0.76b	8.30bc	8.00b	225.67b	205.69b	216.34e	222.70e	19.23e	20.70e
T_6:bokashi4	0.94f	0.51d	7.21e	7.21d	190.64f	170.53f	276.23a	283.40a	24.10a	25.20a
T_7:bokashi5	0.97e	0.54c	7.82d	7.71c	200.54e	178.21e	260.32b	274.80b	22.54b	23.89b

treatments	Zn mg/kg soil		Mn mg/kg soil		Cu mg/kg soil		P mg/kg soil		NH4 mg/kg soil		NO3 mg/kg soil	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
T_1:control	2.00g	2.05g	4.60g	4.82g	18.67g	21.08g	1.41e	1.43e	98.00e	99.01e	80.33g	81.73g
T_2: poultry manure	2.20f	2.26f	4.87f	4.95f	20.13f	22.40f	1.43e	1.51e	98.23e	99.62e	82.15f	84.71f
T_3:bokashi1	4.80c	4.90c	8.61c	8.80c	38.76c	39.45c	3.23b	3.44b	135.89b	136.74b	117.43c	119.62c
T_4:bokashi 2	4.50d	4.65d	8.36d	8.45d	36.45d	38.70d	2.26c	2.27c	129.11c	130.71c	110.12d	113.31d
T_5:bokashi3	4.25e	4.30e	8.21e	8.25e	34.98e	37.35e	2.01d	2.07d	117.32d	118.53d	90.32e	91.11e
T_6:bokashi4	5.23a	5.55a	9.50a	9.70a	44.23a	46.00a	4.89	5.00a	148.9a	149.92a	130.23a	132.14a
T_7:bokashi5	5.11b	5.25b	9.00b	9.10	40.15b	41.55b	4.81a	4.84a	148.23a	147.51a	122.89b	124.12b

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

Soil Micro Flora Content

The results in table (10), indicated that all treatments had a significantly affect on the number of CFU of TF, TA and TB /g of dry soil. In both seasons, T_6 gave the highest count of total fungi (TF) (25.8 in the 1st and 28.6 in the 2nd season), total bacteria (TB) (23.3 in the 1st and 27.80 in the 2nd season) and total actinomycetes (TA) (20.8 in the 1st and 21.9 in the 2nd season), followed by T_7. Also, it was noticed that the control gave the lowest in all soil micro flora counts.

These result was obtained by **(Eissa, 2003)** and (**Barnett *et al.*,1999)** who reported that, yeasts, which were provide in the soil EM treatment, produce B vitamins, therefore, they may enhance activity of other microorganisms. Actually, in this application of EM, which contains more than 60 strains of microorganisms, has greatly increased the number of various groups of microorganisms in the rhizosphere soil.

Table 10: Effect of mult-ingredient of bokashi on the number of various groups of rhizosphere micro flora (CFU x 106 g-1) during 2012 and 2013 seasons.

treatments	Total fungi (TF) /g dry soil		Total bacteria (TB) /g dry soil		Total actinomycetes (TA) /g dry soil	
	2012	2013	2012	2013	2012	2013
T_1:control	7.90 g	7.8 g	8.80 g	9.20 g	8.1 g	8.4g
T_2: poultry manure	15.1 f	18.6 f	12.2 f	14.11 f	10.1 f	11.3f
T_3:bokashi1	20.3 c	23.3 c	19.6 c	20.40 c	17.2 c	18.3c
T_4: bokashi2	19.4 d	22.7 d	18.11 d	19.40 d	16.6 d	17.4d
T_5:bokashi3	17.8 e	21.11 e	13.9 e	16.60 e	11.3 e	11.9e
T_6:bokashi4	25.8 a	28.6a	23.3 a	27.80 a	20.8 a	21.9a
T_7:bokashi5	22.2b	24.9 b	20.30 b	21.6 b	18.4 b	20.2b

Means having the same letter (s) in each column, row or interaction are not significantly different at 5% level.

IV. Conclusion

From the present study, it can be concluding that bokashi 4 (poultry manure + solid olive waste + rice straw+ EM+ molasses) improved the leaf nutrients namely N, K, Fe, Zn, Cu, Ca and Mn in the leaves, fruit length, fruit diameter, fruit weight, fruit volume, juice percentage, T.S.S, total sugar, and vitamin C on Clementine mandarin under salinity stress El-Sheikh Zuwayid ,North Sinai Governorate, Egypt.

In addition, this treatment also increased the number of the soil micro flora, (total fungi (TF), total bacteria (TB), actinomycetes (TA)), some macro and micro elements (N, P, K, Fe, Zn, and Mn), decrease *ECe* and *pH* in soil as compared to the control.

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