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# Reducing Mineral Fertilizers by Using Organic Manure to Improve Washington Navel Orange Productivity and Sandy Soil Characteristics

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## ABSTRACT

**A field experiment was conducted during 2007/ 2008 and 2008/ 2009 seasons in a private orchard at El- Boustan region, EL-Behera Governorate, on 15 year old Washington navel orange trees (*Citrus sinensis*, L.) budded on sour orange rootstock (*Citrus aurantium*, L.). Trees were fertilized with mineral and organic fertilizers alone or in combinations. The used mineral fertilizer ($T_1$) was 4.76 kg /tree ammonium sulphate added in three equal doses in March, May and August, 1.19 kg /tree potassium sulphate added in March and August in two equal doses and, 1.49 kg /tree calcium super phosphate added in March of both seasons. Moreover, the used organic manure (O.M) composed of 27.7 kg/ tree compost equal to 900 g N, 200g P2O and 500g K2O) added in November of both seasons. Results indicated an improvement in physical and chemical properties of the fruits by treatments including organic manure and mineral fertilizer. Moreover, the treatment ($T_6$) 80% M.F +20% O.M significantly resulted in the highest values of fruit set, fruit retention, yield, TSS, acidity and vitamin C content. In addition, all treatments which contain organic manure significantly increased leaf mineral contents.Application of organic manure alone or in combinations to sandy soil improved its physical and chemical properties which reflected on soil fertility and structure. This improvement in soil structure, which reflected on increasing values of cation exchange capacity(CEC), available water (A.W), field capacity (F.C), total porosity %(T- porosity), soil organic matter (S.O.M),and decreasing of bulk density (fB). In the same time, such increase was more pronounced in content of plant nutrients (NPK) which was obtained by applying 40% M.F + 60% O.M ($T_4$).**

## INTRODUCTION

Citrus are the most important fruit crops in Egypt. Economically; they are, especially oranges on the top over other Egyptian fruit crops. Hence, intensive efforts have been made to increase the productivity of citrus by improving the cultural practices in citrus orchards including fertilization programs. Soil characteristics have been reported to be of great effect on both growth and production of citrus trees such as; soil texture and aeration (Labanauskas *et al.*,1972); soil pH (Smith, 1972); soil fertility, water table level and soil salinity (Miah 2000; Abbas *et al.,* 2006). The type of the experimental soil in El- Boustan area, where many citrus orchards are located, is sandy. This type of soil is vulnerable to leaching of soluble nutrients and different chemicals and by time may become deficient in N, P, K, Mg and B (Tisdale and Nelson, 1978). In addition, sandy soil is known to be very poor in its organic matter contents as well as its primitive fertility. Organic materials such as crop residues, farmyard manure and compost are available in abundance and reach tremendous amount every day (Tester, 1990; Neilsen *et al*., 1997; Khadr *et al*., 2004). The influence of organic matter on plant growth is not just a matter of nutrient supply, but it also influences the physical and chemical properties of the soil (EL-Kouny *et al.,* 2004; Abbas *et al.,* 2006).Organic manure may be beneficial to crop and soil on the long term (Tirol-Padre *et al*., 2007), and their efficiency in enhancing crop growth and yield has been reported, in the short term, by combining them with mineral fertilizers (Kanal and Kuldkepp,1993; Mottaghian *et al*., 2008; Aisueni *et al*., 2009).

Nowadays, the organic produce with high quality characteristics is the most demanded product for exportation to both European and Arabian markets. Therefore, the present study was conducted in order to investigate the reduction of adding inorganic fertilizers using organic manure (compost) on fruit set, fruit retention, yield, fruit quality and leaf mineral contents of Washington navel orange trees grown in sandy soil under drip irrigation system in El-Boustan area, as well as the effect on soil fertility and some soil physical and chemical properties.

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## MATERIALS AND METHODS

### 2.1. Plant material and experimental design

A field experiment was conducted during 2007/ 2008 and 2008/ 2009 seasons in a private orchard at El-Boustan region, EL-Behera Governorate, on 15 year old Washington navel orange trees (*Citrus sinensis*, L. ) budded on sour orange rootstock (*Citrus aurantium*, L.). Trees were planted at 5×5m apart and irrigated with Nile water by surface drip irrigation system. The soil was sandy with pH 7.95 and the physical and chemical characteristics of the soil at the beginning of the study are presented in Table 1. Trees were fertilized with mineral or organic fertilizers alone or in combinations. The mineral fertilizers (M.F) used were 4.76 kg /tree ammonium sulphate (20.5%) added in three equal doses in March, May and August, 1.19 kg /tree potassium sulphate (48% $K_2O$) added in two equal doses in March and August and, 1.49 kg /tree calcium super phosphate (15.5 %) added in March of both seasons. Moreover, the organic manure (O.M.) used composed of 27.7 kg/ tree compost equal to 900 g N, 200g $P_2O$ and 500g $K_2O$) added at November in both seasons. These fertilizers were added under drippers at depth 10 cm from soil surface.

The organic manure (compost) had been prepared in Soil Salinity and Alkalinity Laboratory, Alexandria. The organic materials used were animal wastes and plant residues. Horn meal, poultry manure and rock phosphate was used as organic and natural activators. Mychrobin, Azotobactrim and Phosphorin were used as biological activators. The heap of organic wastes were watered to reach 50-55% humidity and mixed 4 times by machine of compost for mixing organic wastes. At compost cooling period the biological active were added at a rate 200 g per ton compost (0.02% w/w) (EL-Kouny, 1999). The compost analysis was carried out by using the standard procedures described by Bertran Kehres and Andrease (1994) and the analysis (average of both seasons) of the organic fertilizer applied in this study is presented in Table 2. In addition, eighteen Washington navel orange trees subjected to the normal cultural practices applied in the orchard were selected as uniform as possible and six soil application treatments were arranged in a complete randomized block design (RCBD) with three replicates (1 replicate = one tree) per treatment (i.e. 1×3×6= 18 tree). And the treatments were as follows:

$T_1$-100% M.F.

$T_2$-100% O.M.

$T_3$- 20% M.F + 80% O. M.

$T_4$- 40% M.F + 60% O.M.

$T_5$- 60% M.F + 40% O.M.

$T_6$- 80% M.F + 20% O.M.

**Table 1. Soil characteristics of the experimental soil at the beginning of the study**

**A- Physical properties:**

| Parameters | F.C. % | fB kg $m^{-3}$ | A.W % | T-porosity % | $CaCO_3$ % | Soil fraction % | | | Soil texture |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sand | Silt | Clay | |
| Values | 7.95 | 1.62 | 8.10 | 42.50 | 2.55 | 92.5 | 4.20 | 3.30 | sandy |

**B- Chemical properties:**

| Parameters | pH (1:2.5) (Soil: Water) | EC (1:2.5) $dSm^{-1}$ | Soluble cation meq/L | | | | Soluble anion meq/L | | | S.O.M % | T-N % | Av-P $mg.kg^{-1}$ | Av-K $mg.kg^{-1}$ | CEC mol $k_g^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $Na^+$ | $K^+$ | $Ca^{2+}$ | $Mg^{2+}$ | $Cl^-$ | $HCO_3^-$ | $SO_4^{2-}$ | | | | | |
| Values | 7.85 | 1.90 | 12.50 | 0.15 | 3.50 | 2.85 | 11.50 | 3.20 | 4.30 | 0.26 | 0.01 | 2.01 | 11.52 | 2.96 |

F.C: Field capacity, fB: Bulk density, A.W: Available water, T-porosity: Total porosity, CaCO3: Total calcium carbonate, EC: Electrical conductivity, S.O.M: Soil organic matter, T-N: Total nitrogen, Av-P: Available phosphorus, Av-K: Available potassium, CEC: Cation exchange capacity.

**Table 2. The analysis of the organic fertilizer applied.**

| Parameters | fB kg $m^{-3}$ | D.M % | pH (1:10) | EC $dSm^{-1}$ (1:10) | T-N % | T-P ($P_2O$) % | T-K ($K_2O$) % | O.C % | S.O.M % | M.C % | Ash Content % | H.S % | C/N ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Values | 615.00 | 82.25 | 6.55 | 4.25 | 3.25 | 1.65 | 2.16 | 46.39 | 79.97 | 17.75 | 20.02 | 15.75 | 14.27 |

DM: Dry matter, T-P: Total phosphorus in form of $P_2O_5$%, T-K: Total potassium in form of $K_2O$ %, H.S: Humic substances, M.C: Moisture content, O.C: Organic carbon.

### 2.2. Fruit set and fruit retention, splitting and yield

At flowering time (March) of both seasons; two main branches (4.5 cm circumference) at two different directions were selected in each replicate and fruit set, as well as fruit retention percentages at the end of May and July were calculated. At harvest (December) a sample of five fruits was taken randomly from each replicate and fruit weight (g), was recorded and the yield as number and weight in kilograms was calculated in both seasons. In addition, from October to December, the number of splitted fruits was recorded and the percentage of fruit splitting was calculated according to the following equation: Fruit splitting % = Total number of fruits – The number of splitted fruits/ Total number of fruits × 100.

### 2.3. Fruit physical and chemical characters

At harvest, a sample of five fruits was taken randomly from each replicate and fruit length (cm), diameter (cm) and rind thickness (cm) were recorded. Also, in the fruit juice; the percentage of total soluble solids (TSS) was determined using a hand refractometer, acidity and vitamin C contents were determined according to A.O.A.C. (1995).

### 2.4. Leaf mineral and sugar content

In mid- September, a sample of 30 leaves was taken from the non fruiting spring shoots in order to determine leaf mineral contents for each replicate. Leaf samples were washed with tap water, rinsed twice in distilled water and then dried in air drying oven at 70 ◦C. The dried leaves were ground and digested with $H_2O_2$ and $H_2SO_4$ according to Evenhuis and Dewaard (1980). Total nitrogen was determined according to Evenhuis (1976), phosphorus was determined by ascorbic acid method according to Murphy and Riley (1962) and potassium content was determined by flame photometer. Their concentrations were expressed as percentages. In addition, five grams were taken from the ground leaves and were extracted in 95% ethyl alcohol and total and reducing sugars were determined as percentage of fresh weight according to A.O.A.C. (1995). The starch was estimated in terms of glucose, using Nelson's method as described by (Malik and Singh, 1980).

### 2.5. Soil Characteristics

At the end of the experiment, a soil sample was taken from the soil under each treatment and analyzed in order to examine the changes in soil characteristics.

### 2.6. Statistical analysis

All data were tested for treatments effects on analyzed parameters by one-way analysis of variance (ANOVA) technique. Treatments means were separated and compared using the least significant differences (LSD) at 0.05 level of significance according to Snedecor and Cochran (1990).

## RESULTS AND DISCUSSION

### 3.1 Fruit set and fruit retention, splitting and yield

The data presented in Table 3 showed that, in both seasons, treatments $T_5$ (60% M.F+ 40% O.M) and $T_6$ (80% M.F +20% O.M) significantly increased fruit set, while the treatment $T_1$ (M.F) alone gave the lowest percentage of fruit set compared to other treatments. In addition, all treatments which contained organic manure generally increased fruit retention at the end of May and June, while the lowest retention percent was by using mineral fertilizer only ($T_1$)**.** It is quite evident from Table 3 that all treatments did not affect fruit weight in both seasons except treatment $T_2$ (O.M) in the second season which gave the lowest fruit weight value. As for yield, the data of the first season showed that, all treatments which contain organic manure significantly increased yield while the lowest was with treatment $T_1$ (M.F) compared to the other treatments. In the second season, yield increased significantly by adding 80% M.F +20% O.M ($T_6$), while treatment $T_1$ (M.F) gave the lowest yield compared to the other treatment. The percentage of splitting was significantly decreased by all the organic manure treatments as compared with mineral fertilization in both seasons (Table3).These results are in agreement with those obtained by by El-kobbia, 1999 and Youness, 2002.

### 3.2. Fruit physical and chemical characteristics

Concerning fruit physical and chemical characters, results in Table 4 indicated that, no significant difference among the different treatments was obtained in the first season concerning fruit length while in 2008/2009 season the treatments $T_5$ (60% M.F + 40% O.M) and $T_6$ (80% M.F +20% O.M) significantly increased fruit length than the remaining treatments. Furthermore, all treatments did not show a definite trend in the first season for fruit diameter. In the second season, the treatments $T_5$ (60% M.F + 40% O.M) and $T_6$ (80 % M.F +20% O.M) significantly increased fruit diameter while treatment $T_1$ (M.F) gave the lowest values. In addition, adding mineral fertilizer only $T_1$ (M.F) or $T_2$ (O.M) gave the lowest values of peel thickness in 2007/2008 season while in the second season all treatments did not affect peel thickness but significantly increased peel resistance to puncturing, the substance applied probably act on fruit splitting through an increase in peel resistance (Almela *et al*.,1994).

The data of the both seasons showed that, the juice TSS was increased by all treatments except $T_2$ (O.M)

**Table 3. The effect of the fertilizing treatments on fruit set, retention, yield and fruit splitting of Washington navel orange in 2007/2008 and 2008/2009 seasons**

| Parameters / Treatments | Fruit set (%) | | Fruit retention at May (%) | | Fruit retention at June (%) | | Fruit weight (g) | | Yield (Kg / tree | | Fruit splitting % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 |
| $T_1$(M.F) | 18.25$^{c}$ | 26.33$^{d}$ | 4.40$^{c}$ | 4.53$^{c}$ | 2.24$^{c}$ | 3.13$^{c}$ | 244.13$^{a}$ | 239.48$^{a}$ | 49.75$^{b}$ | 64.95$^{c}$ | 4. 44$^{a}$ | 2. 37$^{a}$ |
| $T_2$ (O.M) | 20.22$^{bc}$ | 34.00$^{bc}$ | 5.08$^{bc}$ | 6.85$^{ab}$ | 3.88$^{b}$ | 3.85$^{bc}$ | 226.95$^{a}$ | 205.15$^{b}$ | 57.97$^{ab}$ | 76.54$^{bc}$ | 0.98$^{c}$ | 0.54$^{c}$ |
| $T_3$(20% M.F + 80% O.M) | 19.55$^{c}$ | 31.00$^{cd}$ | 6.60$^{ab}$ | 6.30$^{b}$ | 3.05$^{bc}$ | 4.60$^{ab}$ | 244.63$^{a}$ | 216.73$^{ab}$ | 62.94$^{ab}$ | 80.79$^{bc}$ | 1.05$^{c}$ | 1.13$^{bc}$ |
| $T_4$ (40% M.F + 60% O.M) | 25.70$^{ab}$ | 34.00$^{bc}$ | 6.73$^{ab}$ | 7.13$^{ab}$ | 3.93$^{b}$ | 4.73$^{a}$ | 248.43$^{a}$ | 226.75$^{ab}$ | 71.57$^{a}$ | 84.08$^{bc}$ | 1.86$^{c}$ | 0.74$^{bc}$ |
| $T_5$ (60% M.F + 40% O.M) | 27.83$^{a}$ | 43.25$^{a}$ | 8.40$^{a}$ | 7.88$^{a}$ | 6.30$^{a}$ | 5.10$^{a}$ | 234.63$^{a}$ | 226.95$^{ab}$ | 72.25$^{a}$ | 91.79$^{b}$ | 2.33$^{b}$ | 1.51$^{b}$ |
| $T_6$ (80% M.F + 20% O.M) | 26.98$^{a}$ | 42.25$^{a}$ | 7.10$^{a}$ | 7.25$^{ab}$ | 5.95$^{a}$ | 4.95$^{a}$ | 236.98$^{a}$ | 240.30$^{a}$ | 75.82$^{a}$ | 116.76$^{a}$ | 1.01$^{c}$ | 0.60$^{c}$ |

Means followed by the same letter in each column are not significantly different at $P$=0.05.

**Table 4. The effect of the fertilizing treatments on fruit physical and chemical characteristics of Washington navel orange in 2007/2008 and 2008/2009 seasons**

| Parameters / Treatments | Fruit length (cm) | | Fruit diameter (cm) | | Peel thickness (cm) | | TSS % | | Acidity % | | V.C mg/100ml juice | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 | 2007/ 2008 | 2008/ 2009 |
| $T_1$(M.F) | 7.85$^{a}$ | 7.33$^{b}$ | 6.37$^{ab}$ | 6.90$^{d}$ | 0.55$^{c}$ | 0.47$^{a}$ | 11.86$^{a}$ | 11.68$^{ab}$ | 0.60$^{c}$ | 0.68$^{b}$ | 36.92$^{c}$ | 32.75$^{d}$ |
| $T_2$ (O.M) | 7.83$^{a}$ | 7.63$^{b}$ | 7.83$^{ab}$ | 7.48$^{abc}$ | 0.57$^{bc}$ | 0.55$^{a}$ | 11.02$^{b}$ | 11.40$^{b}$ | 0.64$^{bc}$ | 0.70$^{b}$ | 41.75$^{bc}$ | 36.18$^{bc}$ |
| $T_3$ (20% M.F + 80% O.M) | 7.85$^{a}$ | 7.58$^{b}$ | 7.85$^{a}$ | 7.45$^{bc}$ | 0.64$^{ab}$ | 0.60$^{a}$ | 11.06$^{b}$ | 11.50$^{b}$ | 0.74$^{b}$ | 0.67$^{b}$ | 48.00$^{ab}$ | 39.00$^{ab}$ |
| $T_4$ (40% M.F + 60% O.M) | 7.95$^{a}$ | 7.50$^{b}$ | 7.38$^{ab}$ | 7.23$^{cd}$ | 0.70$^{a}$ | 0.47$^{a}$ | 11.43$^{ab}$ | 11.73$^{ab}$ | 0.86$^{a}$ | 0.76$^{a}$ | 44.93$^{bc}$ | 35.82$^{bcd}$ |
| $T_5$ (60% M.F + 40% O.M) | 8.20$^{a}$ | 8.25$^{a}$ | 7.33$^{b}$ | 7.73$^{ab}$ | 0.66$^{a}$ | 0.48$^{a}$ | 11.26$^{ab}$ | 11.85$^{ab}$ | 0.96$^{a}$ | 0.76$^{a}$ | 43.80$^{bc}$ | 35.00$^{cd}$ |
| $T_6$ (80% M.F + 20% O.M) | 8.28$^{a}$ | 8.00$^{a}$ | 7.40$^{ab}$ | 7.81$^{a}$ | 0.65$^{ab}$ | 0.58$^{a}$ | 11.90$^{a}$ | 12.08$^{a}$ | 0.89$^{a}$ | 0.78$^{a}$ | 52.83$^{a}$ | 40.75$^{a}$ |

Means followed by the same letter in each column are not significantly different at $P$=0.05.

and $T_3$ (20% F.M + 80% O.M). As for the fruit juice acidity, results revealed was increased by treatments $T_4$ (40% M.F + 60% O.M), $T_5$ (60% M.F + 40% O.M) and $T_6$ (80 % M.F + 20% O.M). Furthermore treatments $T_3$ (20% M.F + 80% O.M) and $T_6$ (80% M.F +20% O.M) significantly increased juice vitamin C content compared with the other treatments. These results agreed with numerous investigators who reported similar responses such as Abdel-Migeed *et al*, 2007 working on Washington navel orange.

### 3.3. Leaf mineral and sugar content

The data in Table 5 showed that, the N percentage was significantly increased by all treatments which contained organic manure as compared with mineral fertilizer alone through the two seasons. In addition, phosphorus content was significantly higher by adding $T_5$ (60% M.F + 40% O.M) while, the lowest value was recorded by adding 100% mineral fertilizer ($T_1$). Moreover, data of the first season showed that the leaf potassium content was increased by applying organic manure ($T_2$) followed by the application of mineral fertilizer only ($T_1$), $T_6$ (80% M.F +20% O.M) and $T_5$ (60% M.F + 40% O.M). However, no significant difference among the different treatments was obtained in the second season concerning leaf potassium content. These results are partially in harmony with the findings of Goepfert *et al*., 1987; Maksoud and Haggag, 2004 who applied N, P and K fertilizers to orange trees and found that N fertilizers increased leaf N and decreased leaf K contents. Also, Nakhlla*.,* 1998 observed the positive correlation between N application to navel orange trees and content of N and K. In addition, results might conclude that organic manure is an important source of macro and micronutrients (Kassem and Marzouk, 2002). In the first season, all treatments of adding organic manure alone or in combination increased the starch percentage compared with the mineral fertilizer alone, while in the second season, starch content was significantly increased by adding 80% M.F +20% O.M ($T_6$) and lowest value by adding mineral fertilizer only ($T_1$).

In addition, the data of both seasons indicated that applying 20% M.F + 80% O.M ($T_3$) gave the highest value of reducing sugar content, while, $T_5$ (60% M.F + 40 %O.M) and $T_6$ (80% M.F + 20% O.M) gave significantly the lowest values in comparison with all other treatments. As for the total sugar content, the data revealed that applying mineral fertilizer only increased significantly fruit total sugars content while, the treatments ; $T_4$ (40% M.F + 60% O.M) and $T_5$ (60% M.F + 40% O.M) had significantly the lowest total sugars values compared to the other treatments. The effect of organic manure on increasing the percentage of starch and total sugar may be due to the role of nitrogen in increasing leaf area per plant and its physiological effects in synthesis and activating the enzymes that are involved in photosynthesis process (Nijjar, 1985). The obtained data were also in line with those of Hosam El-Dein and Boshra (2008).

### 3.4. Soil characteristics

#### 3.4.1. Physical properties:

Data given in Table 6 indicated that organic manure at the added rates have improved the field capacity F.C, available water A.W of sandy soil under study. The increases in F.C and A.W of the treated soil with organic manure (compost) or combination with mineral fertilizer may be attributed to their effect on increasing the amount of pores and to their action like a super sponge, absorbing and storing available water in the rate media. These results are in harmony with those of Shivaramu *et al.*, 1994 and EL-Hady *et al.,* 2004.Concerning bulk density (fB) and total porosity (T-porosity), the addition of compost improved its granulation and increased its porosity percent and turn, decrease the bulk density. Similar results were indicated by Haynes and Naidu, 1998 and EL-Hady and El-Dewing, 2006.

#### 3.4.2- Chemical properties:

As for chemical properties, data listed in Table 6 showed that at the end of study after two seasons;

A- pH values in the treated soil were slightly decreased .

B- Values of electrical conductivity (E.C) in the soil were slightly decreased.

C- Values of total calcium carbonate were not significantly affected by either organic manure (compost) or mineral fertilizers treatments.

D- Soil organic matter (S.O.M) was significantly affected by organic manure. The highest significant value (0.63%) was obtained with full organic manure (compost) treatment followed by those treatments of $T_3$ (20% M.F + 80 %O.M) and $T_4$ (40% M.F + 60% O.M). These results are in agreement with those of Tester, 1990; Neilsen *et al.,* 1997; EL-Kouny, 1999; Delibacak *et al.,* 2001and EL-Hady *et al.*, 2004.

E- Cation exchange capacity (CEC) in average was significantly affected by organic manure. Full organic manure (compost) treatment gave generally values (6.95 $mol.kg^{-1}$) than other treatments. In spite of the effect of soil organic manure (S.O.M) content and soil CEC were very low showing that the soil needs a long time to reach normal content. In this respect, Khadr *et al*., 2004 and Abbas *et al*., 2006

**Table 5. The effect of the fertilizing treatments on leaf mineral and sugar content of Washington navel orange in 2007/2008 and 2008/2009 seasons**

| Parameters / Treatments | N % | | P % | | K % | | Starch % | | Reducing sugar % | | Total sugar % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007/2008 | 2008/2009 | 2007/2008 | 2008/2009 | 2007/2008 | 2008/2009 | 2007/2008 | 2008/2009 | 2007/2008 | 2008/2009 | 2007/2008 | 2008/2009 |
| **$T_1$(M.F)** | $1.78^{b}$ | $2.06^{b}$ | $0.19^{e}$ | $0.23^{d}$ | $1.40^{ab}$ | $1.49^{a}$ | $3.67^{b}$ | $3.76^{d}$ | $0.63^{b}$ | $0.69^{b}$ | $2.29^{a}$ | $2.55^{a}$ |
| **$T_2$ (O.M)** | $2.49^{a}$ | $2.85^{a}$ | $0.38^{cd}$ | $0.40^{c}$ | $1.56^{a}$ | $1.65^{a}$ | $5.67^{a}$ | $6.07^{c}$ | $0.38^{c}$ | $0.50^{c}$ | $1.94^{b}$ | $2.24^{b}$ |
| **$T_3$ (20% M.F + 80% O.M)** | $2.39^{a}$ | $2.87^{a}$ | $0.34^{d}$ | $0.43^{c}$ | $1.27^{b}$ | $1.38^{a}$ | $6.46^{a}$ | $7.43^{ab}$ | $1.58^{a}$ | $1.64^{a}$ | $2.07^{b}$ | $2.23^{b}$ |
| **$T_4$ (40 % M.F + 60% O.M)** | $2.32^{a}$ | $2.87^{a}$ | $0.44^{bc}$ | $0.47^{c}$ | $1.28^{b}$ | $1.42^{a}$ | $5.9^{a}$ | $6.61^{b}$ | $0.42^{c}$ | $0.69^{c}$ | $1.56^{cd}$ | $1.62^{cd}$ |
| **$T_5$ (60 % M.F + 40% O.M)** | $2.79^{a}$ | $2.88^{a}$ | $0.68^{a}$ | $0.71^{a}$ | $1.33^{ab}$ | $1.42^{a}$ | $6.58^{a}$ | $7.36^{ab}$ | $0.20^{d}$ | $0.50^{c}$ | $1.48^{d}$ | $1.53^{d}$ |
| **$T_6$ (80 % M.F + 20% O.M)** | $2.65^{a}$ | $2.91^{a}$ | $0.47^{b}$ | $0.60^{b}$ | $1.40^{ab}$ | $1.60^{a}$ | $7.08^{a}$ | $7.86^{a}$ | $0.18^{d}$ | $0.44^{c}$ | $1.70^{c}$ | $1.78^{c}$ |

Means followed by the same letter in each column are not significantly different at $P$=0.05.

**Table 6. The effect of fertilizing treatments on soil characteristics at the end of the study 2007/2008 and 2008 /2009 seasons**

| Parameters / Treatments | pH (1:2.5) (Soil: Water) | EC $dSm^{-1}$ (1:2.5) | S.O.M % | T-N % | Av-P $mg.kg^{-1}$ | Av-K $mg.kg^{-1}$ | $CaCO_3$ % | CEC $mol.kg^{-1}$ | F.C % | fB $kg.m^{3}$ | T-porosity % | A.W % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$T_1$(M.F)** | 7.85 | 1.95 | 0.21 | 0.01 | 0.95 | 10.30 | 3.50 | 2.21 | 7.28 | 1.65 | 32.22 | 7.10 |
| **$T_2$ (O.M)** | 7.40 | 1.70 | 0.63 | 0.10 | 3.73 | 14.01 | 2.10 | 6.95 | 13.99 | 1.20 | 55.30 | 14.25 |
| **$T_3$ (20% M.F + 80% O.M)** | 7.65 | 1.82 | 0.59 | 0.08 | 4.12 | 14.23 | 2.20 | 6.67 | 13.65 | 1.21 | 50.25 | 11.95 |
| **$T_4$ (40% M.F + 60% O.M)** | 7.69 | 1.88 | 0.55 | 0.10 | 5.98 | 16.95 | 2.25 | 6.25 | 12.75 | 1.23 | 48.50 | 10.94 |
| **$T_5$ (60% M.F + 40% O.M)** | 7.80 | 1.90 | 0.47 | 0.08 | 5.05 | 14.97 | 2.35 | 5.35 | 8.80 | 1.37 | 42.70 | 8.48 |
| **$T_6$ (80% M.F + 20% O.M)** | 7.83 | 1.93 | 0.27 | 0.05 | 4.20 | 15.77 | 2.50 | 5.15 | 7.52 | 1.58 | 35.50 | 7.27 |
| **L.S.D.$_{0.05}$** | 0.16 | 0.08 | 0.15 | 0.03 | 0.25 | 0.85 | NS | 0.45 | 1.05 | 0.05 | 2.83 | 1.11 |

EC: Electrical conductivity, S.O.M: Soil organic matter, T-N: Total nitrogen, Av-P: Available phosphorus, Av-K: Available potassium, CaCO3: Total calcium carbonate, CEC: Cation exchange capacity, F.C: Field capacity, fB: Bulk density, T-porosity: Total porosity, A.W: Available water.

F- pointed out that application of organic manure increased soil organic manure (S.O.M) content and soil CEC.

**3.4.3- NPK content in soil studied:**

Data given in Table 6 showed an increase in total nitrogen (T-N), available P (Av-P) and available K (Av-K) after 2- year addition of mineral fertilizer only to Washington Navel orange trees.

A- Total nitrogen (T-N): The highest significant value of T-N (0.10%) was obtained with the organic ($T_2$) and $T_4$ (40% M.F + 60% O.M). In spite of increasing T-N after 2-years, these values are still low. In Rothamested Research Station, Johnston (1997) mentioned that for many annual crops little residual inorganic N remain in the soil when N is added in form mixture organic manure with inorganic fertilizer during active growth in the correct time.

B- Available phosphorus (Av-P): Values of Av-P content significantly increase (0.95 $mg.kg^{-1}$) as the rate of mineral fertilizer increased. Higher value (5.98 $mg.kg^{-1}$) was obtained with $T_4$ (40% M.F + 60% O.M). It is worth to mention that although the AV-P content in soil was improved after 2-years of addition, it is still insufficient for growing during many seasons since it falls in the low to medium range (low up 5 $mg.kg^{-1}$, medium 5-10 $mg.kg^{-1}$, Jackson, 1974). In this concern, Chater and Mattingly (1980), found that the total P pool in arable soil may be little affected by contrasting fertilization practices.

C- Available potassium (Av-K): Data of Av-K obtained indicated that the highest significant value (16.95 $mg.kg^{-1}$) was in the treated soil with $T_4$ (40% M.F + 60% O.M) compared with mineral fertilizer, followed by those treatments of $T_6$ (80% M.F + 20% O.M) and $T_5$ (60% M.F + 40% O.M). These results could be attributed to the relatively low clay and O.M content of such soil. Application of compost added relatively marked amount of nutrient to the soil specially K as shown in the analysis of the applied manure.

Generally, the data indicated the increases in T-N, Av-P and Av-K as indicators of improvement in the fertility in the treated soil. The high increase in nutrients content in the soil treated with $T_4$ (40% M.F + 60% O.M) at the end of study may be attributed to its decomposition and producing organic acids, and to the improvement in physical and chemical properties which increases the nutrients availability in the treated soil. Similar results were obtained by EL-Kouny *et al.*, 2004; Johnston, 1997; EL-Hady and El-Dewing, 2006 and Shaban and Omar 2006.

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# الملخص العربي

## تقليل التسميد المعدنى باستخدام التسميد العضوى لتحسين انتاجية أشجار البرتقال أبوسرة وصفات التربة الرملية

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أجريت تجربة حقلية خلال موسمى ٢٠٠٧/٢٠٠٨و ٢٠٠٨/٢٠٠٩ فى مزرعة خاصة بمنطقة البستان– محافظة البحيرة على أشجار برتقال أبوسرة عمرها ١٥ سنة مطعومة على أصل النارنج.و تم تسميد الأشجار بالتسميد المعدنى فقط أو عضوى فقط أو خليط منهم. وكان التسميد المعدنى المستخدم هو ٤,٧٦ كجم/شجرة سلفات أمونيوم أضيفت فى ثلاث جرعات متساوية فى مارس و مايو و أغسطس، و١,١٩ كجم/شجرة سلفات بوتاسيوم أضيفت فى جرعتين متساويتين فى مارس و أغسطس،و١,٤٩ كجم/شجرة سوبر فوسفات فى مارس.وكان التسميد العضوى المستخدم٢٧, ٧ كجم/شجرة كمبوست (يعادل ٩٠٠جم N، ٢٠٠جم P2O5، ٥٠٠جم K2O) تم إضافته فى شهر نوفمبر. وأوضحت النتائج أن هناك تحسين فى خواص الثمار الطبيعية والفيزيائية فى المعاملات المحتوية على خليط من التسميد العضوى والمعدنى.

وأعطت المعاملة ٨٠ % سماد معدنى +٢٠ % سماد عضوى أعلى قيمة فى نسبة عقد و بقاء الثمار و المحصول و نسبه المواد الصلبة الذائبة الكلية والحموضة و فيتامين ج بالإضافة إلى أن المعاملات المحتوية على سماد عضوى أدت إلى زيادة محتوى الأوراق من النتروجين والبوتاسيوم والفوسفور.و أشارت النتائج إلى أن إضافة الأسمدة العضوية والمعدنية أدت إلى تحسين الخواص الفيزيائية والكيمائية للأرض الرملية وبالتالى أنعكس على خصوبة التربة وانعكس تحسين بناء التربة على زيادة قيم السعة التبادلية الكاتيونية (CEC) والسعة الحقلية (F.C) والماء المتاح (A.W) و النسبة الكلية للمسام (T-P%) ومحتوى التربة من المادة العضوية (S.O.M) وانخفاض الكثافة الظاهرية للتربة (fB).مثل هذه الزيادة كانت أكثر وضوحاً فى محتوى التربة من المغذيات (NPK) عند إضافة٤٠ % سماد معدنى +٦٠ % سماد عضوى.