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# A COMPARATIVE STUDY ON THE EFFECT OF SOME ORGANIC AND INORGANIC AMENDMENTS ON SANDY SOIL PHYSICAL PROPERTIES AND YIELD OF CORN

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## ABSTRACT

A field experiment was carried out in sandy soil at Ismailia Agric. Res. St. To compare the effect of many soil amendments on physical properties and corn plant growth and yield. The experiment was designed in complete randomized. The investigated amendments were: 1) organic materials : 15 $m^3$ farmyard manure, 10 $m^3$ biofertile and 10 $m^3$ compost per feddan. 2) inorganic materials : 1000 kg Agrosoke and 1500 kg boligrow per feddan.

The studied physical and hydrophysical properties were bulk density, total porosity, hydraulic conductivity, water holding capacity, field capacity, welting point and available water.

The obtained results showed that, adding 15 $m^3$ farmyard manure gave the best results for improving soil physical and hydro-physical properties followed by biofertile and compost. Agrosok and boligrow additions had slightly effect. The improvement of physical and hydrophysical properties of the investigated sandy soil led to an increase in vegetative growth parameters and total grain yield of corn crop.

## INTRODUCTION

Most of the Egyptian soils out of Nile Delta and Valley are either sandy or sandy calcareous soils. There are no serious difficulties for growing crops on such soils, as long as, they are supplied with sufficient water and available nutrients. The major problem in cultivating sandy soils, however are their high infiltration rate, and the loss of water and nutrients far away from the root zone. Addition of natural or synthetic for changing soil conditioners could improve the retentive capacity of these soils and allow plants to have their requirements of water and nutrients.

The physical properties of sandy soil as affected by different improvement techniques were studied by many researchers. Fahim (1986), Omar (1990) and Sakina and Awad (1998). Awad (1998) reported that the use of gypsum and organic materials or organic materials alone led to the decrease of bulk density and the increase of total porosity. Hortmann *et al.,* (1975) mentioned that the addition of soil conditioners to sandy soil increase the soil- water contact angle, and hence the capillary rise will be increased.

The aim of the current work is to study the changes in physical and hydraphysical properties of sandy soil as a result of some soil amendments addition and efficiency of these materials on maize plant growth parameters and crop production.

## MATERIALS AND METHODS

A field experiment was conducted in sandy soil of Ismailia Agric. Res. Station to compare the efficiency of different application rates of some soil amendments (the best addition rates according to pervious studies on some soil properties) plant characteristics and crop production of corn.

The physical and chemical properties of the investigated soil are given in Tables (1 & 2). These properties were carried out according to Black *et al.,* (1982).

The used experimental design was a complete randomized with three replicates for each treatment. Treatments of soil amendments were added before corn cultivation as follows:

A- control
B- 1000 kg Agrosoke /fed. (Abdel Naim *et al.*, 1986)
C- 15 $m^3$ farmyard manure/fed., (Awad, 1998)
D- 10 $m^3$ Biofertile/fed., the recommended level by Soil, Water and Environment Res. Inst.
E-10 $m^3$ compost/fed., the recommended level by the Productive Green Valley Co.
F. 1500 kg boligrow, Awad (1989).

The plots were planted with corn (Vr. Single SD, 98 BANK , 351). The sowing was done on 16th June,1999.

All agricultural practices, as recommended in the farm, were followed. At the maximum growth stage (after 70 days from sowing), plant height in Cm, No. of leaves /plant, leaf length in cm and leaf wide in cm were measured and recorded. At harvest time, ear length (cm), ear diameter (cm) and number of rows/ear and grain yield (kg/feddan) of each plot were recorded. Representative surface soil samples (0-30 cm) were collected after harvesting to determinate certain physical and hydrophysical properties according to Black *et al.*, (1982).

**Table (1): Mechanical analysis and some physical properties of the studied soil.**

| Sand % | | Silt | Clay | $CaCO_3$ | O.M | Texture | B.D, | Total | H.C. |
|---|---|---|---|---|---|---|---|---|---|
| Coarse | Fine | % | % | % | % | | $g/cm^3$ | Porosity, % | cm./h |
| 85.20 | 6.13 | 7.02 | 1.65 | 1.62 | 0.03 | Sandy | 1.72 | 35.09 | 14.65 |

**Table (2): Chemical analysis in 1:5 soil water extract of the studied soil sample.**

| pH* | EC | Cations (me/100 g soil) | | | | Anions (me/100 g soil) | | | | S.S.P | C.E.C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ($dSm^{-1}$) | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{=}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{=}$ | % | Meq/ 100 g soil |
| 8.20 | 0.35 | 0.60 | 0.30 | 0.81 | 0.02 | - | 0.25 | 0.69 | 0.79 | 46.92 | 4.05 |

*** in 1:2.5 soil suspension.**

# RESULTS AND DISCUSSION

## A. Effect of different treatments on studied soil physical properties

### 1- Bulk density and total porosity:

Data presented in Table (3) show that the values of bulk density (BD) of the studied soil were decreased by soil conditioning with all different additions.

Data indicate that addition of 15 $m^3$ farmyard manure /feddan (treat. No. c) led to the lowest value of B. D. compared with the other additions, where the values decreased from 1.72 gm/$cm^3$ (the control treatment) to 1.65, 1.58, 1.60, 1.65 and 1.60 g/$cm^3$ for B, C, D, E and F treatments, respectively. It was noticed that, the investigated soil responded differently to conditioning treatments but the high effect was caused by farmyard manure addition. Such trend may be attributed to the high content of OM in FYM which gave it the ability to swell which caused an increase in the apparent volume and subsequently decrease in bulk density.

Regarding to the total porosity, data in Table (3) revealed that with bulk density decrease the total porosity increased where, the values increased from 35.09 with control treatment to 37.74, 40.38, 39.62, 37.74 and 39.625% for B, C, D, E and F treatments, respectively. The promotive effect due to the treatments on the bulk density and total porosity in treated soil could be arrange as follows: 15 $m^3$ farmyard manure > 10 $m^3$ biofertile > 10 $m^3$ compost > 1000 kg agrosoke > 1500 kg boligrow /feddan.

**Table (3): Effect of different treatments on some physical properties and moisture characteristics of the investigated soil.**

| Treatment | Soil physical properties | | | Soil moisture characteristics | | | |
|---|---|---|---|---|---|---|---|
| | B.D, | T.P, | H.C | W.H.C | F.C | W.P | A.W |
| | $g.cm^{-1}$ | % | $cm.h^{-1}$ | % | % | % | % |
| A | 1.72 | 35.09 | 23.92 | 17.31 | 6.93 | 1.65 | 5.28 |
| B | 1.65 | 37.74 | 20.93 | 20.06 | 8.08 | 2.00 | 6.08 |
| C | 1.58 | 40.38 | 17.68 | 22.95 | 9.95 | 2.35 | 7.60 |
| D | 1.60 | 39.62 | 18.28 | 21.18 | 8.76 | 2.12 | 6.64 |
| E | 1.65 | 37.74 | 18.95 | 20.56 | 8.45 | 1.98 | 6.47 |
| F | 1.60 | 39.62 | 21.16 | 19.15 | 7.50 | 2.00 | 5.50 |

Where:

**A : Control**
**B : 1000 kg agrosok / feddan.**
**C : 15 $m^3$ farmyard manure / feddan.**
**D : 10 $m^3$ biofertile / feddan.**
**E : 10 $m^3$ compost / feddan.**
**F : 1500 kg boligrow / feddan.**

**BD : Bulk density.**
**TP : Total porosity.**
**HC : Hydraulic conductivity.**
**W HC : Water holding capacity.**
**FC : Field capacity.**
**WP : Welting point.**
**AW : Available water.**

### 2- Hydraulic conductivity (K):

The improving effect on bulk density and total porosity reflected on soil hydraulic conductivity .

Data in Table (3) indicated that the hydraulic conductivity values of treated soils decreased at the end of experiment with using the different additions of organic materials (farmyard manure, biofertile and compost) or inorganic materials (agrosoke and boligrow). The results show that the treatment of 15 $m^3$ farmyard manure/feddan gave the highest decrease in K

values of the studied soil followed by 10 $m^3$ biofertile, 10 $m^3$ compost, 1000 kg agrosoke, 1500 kg boligrow /feddan and control treatment. The decrease in K values after soil conditioning could be attributed to the creation of micro pores among sand particles as a result of aggregates formation. These results are in agreement with those of El-Reweiny and Rushdi (1975); Dhoot *et al.* (1976) and Abdel Naim *et al.*, (1986).

**3- Soil moisture characteristics:**

Data in Table (3) show the final effects of the investigated treatments on soil moisture charai.e., water holding capacity (WHC), field capacity (FC), welting point (WP) and available water (AW).

Concerning the water holding capacity, the values increased with all organic and inorganic applications. On the overall, the fertilization in the presence of the farmyard manure (treatment No. C) clearly resulted in the best value, where the values increased by 15.9, 32.9, 22.4, 18.8 and 10.6% for B, C, D, E and F treatments respectively compared with control.

Regarding the field capacity (FC), data presented in Table (3) indicated that all additions led to marked increases in field capacity of the studied soil. The highest values were yielded by using farmyard manure followed by biofertile and compost. The addition of agrosoke and boligrow led to a slight increase in F.C. values compared with organic materials, where the values were 6.93, 8.08, 9.95, 8.76, 8.45 and 7.5 for A, B, C, D, E, and F treatments, respectively.

In proportion to this effect on welting point, the obtained results indicated that the investigated treatments of treated soil increased the moisture content at welting point. Moreover, the obtained trend for raising the values of soil moisture content at welting was similar to those obtained for field capacity and water holding capacity values.

The available moisture values were calculated for the studied soil as the difference between field capacity and welting point. Data in Table (3) elucidated that available moisture values increased with using all treatments. It is observed that the addition of farmyard manure had the highest percentage of soil available water, where these values increased from 5.28% in control to 6.08, 7.60, 6.64, 6.47 and 5.50% for B, C, D, E and F treatments, respectively. It was noticed that the improvement in soil moisture constants (W.H.C, F.C., W.P. and A.W) was due to changing soil physical properties.

These results are in agreement with those obtained by Gupta, *et al.*, (1977); Fahim (1986) and Hassan *et al.*, (1994).

**4- Plant characteristics and yield productivity:**

Corn crop (***zea mays***) was used as indicator plant to study the effect of the change in soil properties as affected by different treatments.

Concerning the plant characteristics (plant height, No. of leaves /plant, leaf length, leaf wide, ear length, ear diameter and No., of rows/ear), data presented in Table (4) indicated that the addition of organic materials (FYM, biofertile and compost) or inorganic materials agrosoke and boligrow) enhanced all these characteristics. The obtained results also illustrated that the addition of farmyard manure led to the maximum increase in plant growth and consequently yield productivity.

Regarding to the yield crop productivity (grains in kg/feddan) as affected by different addition, data presented in Table (4) illustrated that effect of the farmyard manure application is due to the maximum grain yield, where the values increased from 1875.5 kg/feddan for control treatment to 2728.0, 3627.0, 3071.7, 2846.8 and 2557.5 kg /feddan for B, C, D, E and F, respectively. It is suggested that raising farmyard manure addition had a good effect on improving soil physical and hydrophysical properties which in turn led to increasing nutrient availability in the treated soil which reflected on grain yield. Many investigators found similar effects on different crops, El-Reweiny (1975); Fahim (1986); Nagi *et al.*, (1988); Omar (1990) and Awad (1998).

Statistically, data in Table (4) show the values of calculated "F" and LSD for plant characteristics and yield of corn as affected by different treatments according to Snedecor and Cochran (1971).

**The efficiency of fertilization with organic and inorganic materials:**

Data in Table (5) illustrated the Economic Crop Production (E.C.P) and Agronomic Efficiency Index (A.E.I) of used treatment, where: E.C.P = grain yield (kg/fed.),

A.E.I = [( E.C.P - F) - (E.C.P. - U) [fertilizers applied], Coppola *et al.,* (1997).

where : F = fertilizered plots, U = unfertilizered plots.

**Table (4): Plant characteristics and grain yield of corn crop as affected by different treatments.**

| Treat. | Rep. | Plant height | No. of leaves/ | Leaf length | Max. wide | Ear length | Ear diameter | No. of rows/ | Grain yield |
|---|---|---|---|---|---|---|---|---|---|
| | | (cm) | plant | (cm) | Of leaf (cm) | (cm) | (cm) | Ear | (kg/fed) |
| | $R_1$ | 159.4 | 14 | 67.5 | 7.0 | 13.5 | 3.2 | 12.0 | 1844.5 |
| A | $R_2$ | 160.2 | 15 | 66.3 | 6.9 | 13.7 | 3.1 | 12.6 | 1860.0 |
| | $R_3$ | 159.5 | 14 | 64.2 | 7.2 | 14.0 | 3.3 | 12.0 | 1922.5 |
| | Mean | 159.7 | 14.33 | 66.00 | 7.03 | 13.73 | 3.20 | 12.20 | 1875.5 |
| | $R_1$ | 165.5 | 14 | 71.0 | 8.0 | 15.6 | 4.0 | 14.0 | 2635.0 |
| B | $R_2$ | 168.4 | 15 | 68.2 | 8.3 | 15.0 | 4.5 | 13.0 | 2821.0 |
| | $R_3$ | 162.5 | 15 | 70.5 | 8.0 | 15.0 | 4.5 | 13.0 | 2728.0 |
| | Mean | 165.5 | 14.66 | 69.90 | 8.1 | .2 | 4.33 | 13.33 | 2728.0 |
| | $R_1$ | 227.0 | 16 | 78.8 | 10.6 | 17.2 | 5.0 | 16.5 | 3565.0 |
| C | $R_2$ | 163.0 | 16 | 71.6 | 9.8 | 18.2 | 4.9 | 16.5 | 3642.5 |
| | $R_3$ | 183.0 | 16 | 72.9 | 9.9 | 18.5 | 5.2 | 16.0 | 3673.5 |
| | Mean | 191.0 | 16.00 | 74.43 | 10.1 | 18.0 | 5.03 | 16.33 | 3627.0 |
| | $R_1$ | 175.0 | 16 | 70.2 | 9.6 | 15.5 | 4.7 | 15.3 | 3007.0 |
| D | $R_2$ | 180.0 | 15 | 72.5 | 9.6 | 15.6 | 4.5 | 14.2 | 3132.5 |
| | $R_3$ | 203.0 | 15 | 72.1 | 8.8 | 17.0 | 4.8 | 14.0 | 3084.5 |
| | Mean | 186.0 | 15.33 | 71.6 | 9.33 | 16.03 | 4.67 | 14.50 | 3071.7 |
| | $R_1$ | 167.0 | 16 | 72.1 | 8.7 | 15.8 | 4.5 | 14.2 | 2774.5 |
| E | $R_2$ | 162.0 | 15 | 71.2 | 8.7 | 15.8 | 4.5 | 14.2 | 2821.0 |
| | $R_3$ | 180.0 | 15 | 69.0 | 9.0 | 15.8 | 4.0 | 13.9 | 2945.0 |
| | Mean | 169.0 | 15.33 | 70.77 | 8.8 | 15.8 | 4.33 | 14.10 | 2846.8 |
| | $R_1$ | 163.5 | 15 | 70.1 | 8.0 | 14.7 | 3.9 | 13.0 | 2650.5 |
| F | $R_2$ | 157.6 | 14 | 68.2 | 7.6 | 14.6 | 3.8 | 13.0 | 2557.5 |
| | $R_3$ | 161.7 | 15 | 68.2 | 7.8 | 14.5 | 4.0 | 13.2 | 2464.5 |
| | Mean | 160.9 | 14.66 | 68.23 | 7.8 | 14.6 | 3.90 | 13.07 | 2557.5 |
| F-values | | 22.36** | 3.25 | 7.18** | 41.00 | 28.54 | 30.75 | 23.61 | 18.97 |
| L.S.D | | 8.85 | - | 1.48 | 0.24 | 0.39 | 0.17 | 0.41 | 1.54 |

**Table (5): The efficiency of fertilization with organic and inorganic materials.**

| Treatments | E.C.P-F | E.C.P-U | (E.C.P.- F) - | A.E.I |
|---|---|---|---|---|
| | (kg/fed.) | (kg/fed.) | (E.C.P. -U) | |
| 15 $m^3$ FYM/fed. | 3627 | 1876 | 1751 | 116.7 kg/$m^3$ |
| 10 $m^3$ Biofert./fed. | 3072 | 1876 | 1196 | 119.6 kg/$m^3$ |
| 10 $m^3$ Compost/fed. | 2847 | 1876 | 971 | 97.1 kg/$m^3$ |
| 1000 kg Agrosoke/fed. | 2728 | 1876 | 852 | 0.85 kg/kg |
| 1500 kg boligrow/fed. | 2558 | 1876 | 682 | 0.45 kg/kg |

Data indicated that the treatment with FYM gave the maximum E.C.P. (kg/fed.), while the biofertile gave the maximum A.E.I. (kg/$m^3$). In the case of inorganic material, agrosoke gave the best E.C.P (kg/fed.) and A.E.I followed by boligrow. Finally, data suggests that the fertilization treatment with farmyard manure (FYM) could sustain profitable yield.

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## دراسة مقارنة تأثير استخدام بعض مصلحات التربة العضوية وغير العضوية على الخواص الطبيعية للأراضى الرملية ومحصول الذرة

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**معهد بحوث الأراضى والمياه والبيئة - مركز البحوث الزراعية**

أجريت تجربة حقلية فى الأرض الرملية بمحطة البحوث الزراعية بالإسماعيلية لدراسة مقارنة أثر استخدام بعض مصلحات التربة العضوية وغير العضوية على خواص التربة الطبيعية وكذلك محصول الذرة المنزرع بها، وتم اختيار أفضل معدلات الإضافة لهذه المصلحات والخواص الموصى بها فى أبحاث سابقة وهذه المعدلات هى: 15 م3 سماد مزروعة 10 م3 سماد حيوى ، 1000 كجم اجروسوك و 1500 كيلو جرام بولى جرو/فدان بالإضافة إلى معاملة الكنترول.

تم دراسة الخواص الطبيعية فى نهاية التجربة وهى: الكثافة الظاهرية ، المسامية الكلية، التوصيل الهيدروليكى، السعة المائية العظمى، السعة الحقلية ، نقطة الذبول والماء الميسر.

وكان من نتائج هذه الدراسة أن:

معاملة التربة باستخدام سماد المزرعة أعطى أعلى المعدلات فى تحسين الخواص الطبيعية للتربة حيث قلت قيم الكثافة الظاهرية والتوصيل الهيدروليكى بينما زادت قيم المسامية الكلية والسعة المائية العظمى والسعة الحقلية والماء الميسر للأراضى المعاملة بينما نقطة الذبول تأثرت قليلا.

المعاملة بالسماد الحيوى والكمبوست تأتيا فى المرتبة الثانية بعد سماد المزرعة فى تأثيرهما على تحسين خواص التربة.

أما الأجروسوك والبولى جرو (مركبات غير عضوية) فتأثيرهما قليل إذا ما قورن بالمواد العضوية المستخدمة.

التحسن فى الخواص الطبيعية أدى إلى تحسن فى صفات نمو نبات الذرة (ارتفاع النبات - عدد الأوراق /نبات - طول وعرض الورقة - ارتفاع وقطر الكوز عدد الصفوف /كوز) وكذلك محصول الحبوب. وكانت أفضل النتائج المتحصل عليها باستخدام 15م3 سماد مزرعة /فدان.