Egypt. J. of Appl. Sci., 40 (1-2) 2025 *1-8*

EFFECT OF COMPOST AND CHEMICAL FERTILIZER ADDITION ON IMPROVING SOIL PHYSICAL AND CHEMICAL PROPERTIES AND PRODUCTIVITY.

Eman A. Mohammed* ; Diia S. M. Boulos ; Laila R. Salem and Dina S. Abu-Elnine

Department of Soil Physics and Chemistry, Desert Research Center, El-Matareya, Cairo, Egypt.

***E-mail-emanabdella25@yahoo.com**

ABSTRACT.

Field experiment was carried out on a calcareous loamy sand soil at Ras Sudr Station, South Sinai Governorate, during winter season of (2022/2023) cultivated by fennel plant (*Foeniculum vulgare* Mill.). The current work was aimed to assess the effect of compost application rates of 0, 2.5, 5, and 7.5 ton/fed, recommended chemical fertilizer and their combination on soil physical & chemical properties and its productivity. A complete randomize plot design used with three replications of treatments under studied. The results showed that, application of compost and combination treatments (compost + recommended chemical fertilizer) were significantly decreased effected soil bulk density, hydraulic conductivity, EC, pH and SAR values after season comparing to control. On contrary, in case of the recommended chemical fertilizer did not effect of these parameters. Meanwhile, soil available water and productivity of fennel plant were significantly increased.

Key Words: Compost, Chemical fertilizer, Calcareous soil, Fennel plant, Productivity

INTRODUCTION

Calcareous soils are ones in Egypt. The main problems of these soils are related to one or more of the following: high salinity, high pH, lack of adequate texture & structure, very poor in organic matter or biological activities, distractive effect of some macro and micro-nutrients availability. **Abd El-Moez *et al.*, (2002)**, found that application of composted materials to the saline calcareous soil decreased both EC and pH values. **Abd El-Moez and Saleh, (1999)**, found that the organic materials have a different effect in modifications of the properties of soil as well as their influence on their nutrition status and soil fertility. **Gilley and Risse, (2000)**, mentioned that long-term annual compost and manure treatments caused to improve structure. Compost is friendly to the environmental means because it does to reduce the waste going to soil. Also, the production of compost is considered an economic. Treated soil by compost can improve its physical and chemical properties, in addition the productivity as well as agricultural production was

sustainability by replenishing soil organic matter and supplying nutrients. Compost is the best component of a good healthy soil. This due to that compost plays an important role in soil physical, chemical and biological properties. The volume of the organic matter reduction during composting and the resulting compost is nutrient rich and more stable than the organic matter (feedstock) & can improvement of soil properties and its productivity, **(Barral *et al.*, 2009; Farrell and Jones, 2009)**. The cost of chemical fertilizers and the potential environmental risk posed by overuse have renewed the interest in using amendments such as plant residues, manures. According to **De Bertoldi *et al.* (1983) and Bernal *et al.* (2009)** composts have several advantages compared to plant residues when applied to soils, such as reduced volume, slower mineralization rates and recycling of municipal bio-solid wastes. Compost has two main effects on soils, particularly nutrient poor soils: replenish organic residual in soil and supply plant nutrients **(Tejada *et al.*, 2009)**. Organic matter plays a crucial role ameliorative physical, chemical and biological properties of soils.

The current work was aimed to assess the effect of compost application rates of 0, 2.5, 5, and 7.5 ton/fed, recommended chemical fertilizer and their combination on soil physical & chemical properties and its productivity.

MATERIALS AND METHODS

Field experiment

Field experiment was carried out during winter season (2022/2023) in Ras Sudr station South Sinai, calcareous loamy sand soil texture, to study the effect of application different rates of compost, recommended chemical fertilizer & their combination on some soil physical & chemical properties and productivity of fennel plant. The experimental treatments were control, recommended chemical fertilizer, compost (0, 2.5, 5, and 7.5 ton/fed), compost 2.5 ton/fed + recommended chemical fertilizer, compost 5 ton/fed + recommended chemical fertilizer and compost 7.5 ton/fed + recommended chemical fertilizer. Fennel plants (*Foeniculum vulgare* Mill.) were planted in November 2022/2023. The recommended chemical fertilizer was 300 kg/fed calcium super phosphate during land preparation. While 300 kg/fed ammonium sulphate and 100 kg/fed potassium sulphate were added during growth season. The experiment was under the drip irrigation system. The EC and SAR (Sodium Adsorbed Ratio) for irrigation water were, 8.96 dSm^{-1} and 22.74, respectively.

At the end of the growing season, the fennel (kg/fed) productivity was recorded. The soil samples were collected from the upper soil surface layer of each treated plots in the end of the season, for the physical and chemical analyses, which were determined using the standard methods given by **Klute (1986) and Jackson (1973)**. Data of soil analyses are tabulated in Table (1). The experimental is a complete randomize plot design with three replicates.

Table 1: Analysis data of the initial soil of Ras Sudr.

Sample	Course sand %	Fine sand %	Silt %	Clay %	Texture	Bulk density Mg/m^3	$CaCO_3$ %	pH	Ec dS/m
Value	23.56	54.86	12.45	9.13	Loamy sand	1.51	50.12	7.11	4.24

Statistical analysis

Statistical analysis of variance of all studied treatments was ANOVA and the least significant difference (L.S.D) at 0.05% level.

RESULTS AND DISCUSSION

Soil bulk density (BD)

Results in Table (2) reveal that all treatments application seemed to be highly effective relative on soil bulk density (Mg/m^3) except the recommended chemical fertilizer treatment. The application of compost 2.5, 5 and 7.5 ton/fed lead to, soil BD (Mg/m^3) values decreased by 1.46, 1.37 and 1.26 Mg/m^3. In addition, BD values decreased to 1.47, 1.39 and 1.28 Mg/m^3 by the application of compost 2.5 ton/fed + recommended chemical fertilizer, compost 5 ton/fed + recommended chemical fertilizer and compost 7.5 ton/fed + recommended chemical fertilizer, as compared with control, respectively. Also, data showed clearly that recommended chemical fertilizer had no significantly effect on soil bulk density. On the other hand, the compost and combinations between compost and recommended chemical fertilizer had significantly decreased of the soil bulk density relative to control. These results can be attributed to the redistribution of soil particles, the increase in bulk soil volume and the binding action of compost which assess to improve soil structure, mainly in aggregate formation. In addition, compost treatments reduced the BD of soil to its least, as it promotes total porosity because bacterial glue acts as soil particle binding agent. These binding agents decreased the bulk density of the soil by improving soil aggregation and increasing porosity. These findings are very close to that obtained by **Omran *et al.* (2002)**.

Soil available water

The influenced of compost and recommended chemical fertilizer as well as their combinations on the soil available water, has been given in Table (2). It is evident that, soil available water increased with increasing rates of compost and compost + recommended chemical fertilizer. Soil available water was increased to 13.65% with compost 2.5 ton/fed, 16.78% with compost 5 ton/fed, 17.46% with compost 7.5 ton/fed, 14.05% with compost 2.5 ton/fed + recommended chemical fertilizer, 16.52% with compost 5 ton/fed + recommended chemical fertilizer and 17.89% with compost 7.5 ton/fed + recommended chemical fertilizer, respectively. In addition, results in Table (2) clearly indicated that add of recommended chemical fertilizer had no significant affected on soil

available water. In the same trend, no significant affect among between compost and / or compost + recommended chemical fertilizer. In reverse, results reveal that soil available water as affected by different treatments rates and integrated application of compost and recommended chemical fertilizer was significant variations. This may be due to adding the compost to soil and hence increases the amount of available water in soil. The findings of this study are in agreement with the findings of **Candemir & Gülser (2011) and Cercioglu *et al.* (2012)**.

Saturated hydraulic conductivity

The effect of different compost and recommended chemical fertilizer as well as their combinations on soil hydraulic conductivity (HC), are shown in Table (2). Results showed clearly that, the hydraulic conductivity (cm/h) values were significantly decreased with the increasing rates of compost and combination treatments (compost + recommended chemical fertilizer) relatively to control. In reverse the recommended chemical fertilizer treatment had no significant effect on soil hydraulic conductivity. Also, it was observed that the lowest value of hydraulic conductivity was 4.79 cm/h at compost 7.5 ton/fed. Meanwhile, the highest value of hydraulic conductivity was 8.21 cm/h at recommended chemical fertilizer treatment.

Soil electrical conductivity

The effect of different rates of compost, recommended chemical fertilizer and their combination on soil salinity. Results in Table (3) show that the soil EC (dS/m) values decreased as a result of different treatments. The highest reduction of EC values, which was in the soil treated with different soil treatments, decrements were arranged as follow: compost 7.5 ton/fed > compost 7.5 ton/fed + recommended fertilizer > compost 5 ton/fed > compost 5 ton/fed + recommended fertilizer > compost 2.5 ton/fed > compost 2.5 ton/fed + recommended fertilizer > recommended chemical fertilizer > control.

Table 2: Effect of different treatments on some soil physical properties.

Treatment	BD (Mg/m^3)	AW (%)	HC (%)
Control	**1.51 a**	**8.89 c**	**8.06 a**
Recommended chemical fertilizer	**1.52 a**	**8.92 c**	**8.21 a**
compost 2.5 ton/fed	**1.46 b**	**13.65 b**	**6.58 ab**
compost 5 ton/fed	**1.37 c**	**16.78 a**	**5.43 b**
compost 7.5 ton/fed	**1.26 d**	**17.46 a**	**4.79 b**
compost 2.5 ton/fed + fertilizer	**1.47 ab**	**14.05 b**	**5.87 b**
compost 5 ton/fed + fertilizer	**1.39 c**	**16.52 a**	**5.76 b**
compost 7.5 ton/fed + fertilizer	**1.28 d**	**17.89 a**	**4.82 b**
Significant	***	***	**
$LSD_{0.05}$	**0.06**	**2.13**	**1.57**

Where, the change rates in soil EC were 22.31, 20.8, 18.53, 17.89, 15.52, 11.96, and 2.48% relatively to control. The reduction of soil EC

resulted from the addition of different treatments was highly significant relative to control except recommended chemical fertilizer. However, EC was insignificantly within compost 2.5 ton/fed and compost 5 ton/fed also compost 5 ton/fed + recommended chemical fertilizer and compost 7.5 ton/fed + recommended chemical fertilizer In reversely results show that no significant among different rates of compost and their combine with recommended chemical fertilizer. These results are in agreement with **Ashour, (2014) and El-Maaz *et al.*, (2014).** They revealed that the application of compost led to decrease of EC soil.

Sodium adsorption ratio

Application of compost, chemical fertilizer and their combination at different levels reduced sodium adsorption ratio (SAR) of soil significantly as compared to control as well as chemical fertilizer (Table 3). The highest values 8.91 of SAR were recorded in control. In addition the lowest values were 7.34 of compost 7.5 ton/fed. Studies of **Zaka *et al.*, (2003)**, also indicated that, the same trend of decrease in soil SAR with use of compost, rice straw and Sesbania green manure. They attributed that, the reduction in SAR of the soil with organic materials due to the release of organic acids causing mobilization of native calcium present as $CaCO_3$ in the soil. The values of SAR become lesser either due to an increase in divalent cations (Ca + Mg) or decrease in mono-valent cation (Na). Values of Na could decrease during leaching while Ca + Mg increase due to reactions of organic acids with $CaCO_3$ after the application of compost.

Table 3: Effect of different treatments on some soil chemical properties.

Treatment	EC (dS/m)	pH (1:2.5)	SAR
Control	**9.28 a**	**7.84 a**	**8.91 a**
Recommended chemical fertilizer	**9.05 a**	**7.71 b**	**8.95 a**
compost 2.5 ton/fed	**8.17 b**	**7.48 c**	**8.26 b**
compost 5 ton/fed	**7.84 bc**	**7.41 c**	**7.59 c**
compost 7.5 ton/fed	**7.62 bc**	**7.41 c**	**7.34 c**
compost 2.5 ton/fed + fertilizer	**7.56 bc**	**7.39 c**	**8.38 b**
compost 5 ton/fed + fertilizer	**7.35 bc**	**7.38 c**	**7.76 c**
compost 7.5 ton/fed + fertilizer	**7.21 c**	**7.36 c**	**7.41 c**
Significant	***	**	***
$LSD_{0.05}$	**0.65**	**0.13**	**0.4**

Soil pH

Application of compost to the investigated soil had a negative significant effect on soil pH. The added different treatments to the soil were highly significant decreased on the soil pH relative to control. In contrast that, in case of different treatments of compost, it was no significant effect on soil pH (Table 3). The pH of the compost treated soils decreased with increasing the rates of soil compost and combine compost + recommended chemical fertilizer, but slightly decrease with

alone recommended chemical fertilizer. The highest values 7.84 of the soil pH were observed for the soil control. The lowest values 7.36 of the soil pH were found for the soil treated with compost 7.5 ton/fed + recommended chemical fertilizer, respectively. These decreases in soil pH induced by the addition of compost treatments can be attributed to the acidic effect of decomposable products of organic materials. Soil pH can be decrease after application of compost from rice straw mixed with agro-industrial wastes due to the release of H^+ via nitrification and/or the production of organic acids during decomposition (**Rashad *et al.* 2011**). Also, addition of compost from manure has been reported to both increase and decrease soil pH and have the ability to buffer soil pH **(Johnson *et al*. 2006)**.

Soil productivity

The added compost, recommended chemical fertilizer and their combine to the studied soil had significant effects on productivity of fennel crop. The applied compost amendments varied in their effects on the productivity depending upon their type and the application level. Applying the compost amendments, recommended chemical fertilizer and their combine showed increases in the yield of fennel compared to the control soil. Also, the productivity increased gradually by increasing the rates of soil compost treatments alone. Moreover, combine of compost + recommended chemical fertilizer recorded the highest values of fennel as compared to those given by compost or recommended chemical fertilizer alone. Results in Tables (4) show that the weight of grains fennel Kg/fed increased significantly with soil compost application. The lowest value of productivity was 644 Kg/fed of control. Meanwhile the highest value was 963 Kg/fed of soil compost 7.5 ton/fed + recommended chemical fertilizer.

Table 4: Effect of different treatments on soil productivity.

Treatment	Fennel grains (Kg/fed)
Control	**644 f**
Recommended chemical fertilizer	**708 e**
compost 2.5 ton/fed	**729 de**
compost 5 ton/fed	**751 d**
compost 7.5 ton/fed	**793 c**
compost 2.5 ton/fed + fertilizer	**836 b**
compost 5 ton/fed + fertilizer	**857 b**
compost 7.5 ton/fed + fertilizer	**963 a**
Significant	***
LSD, $_{0.05}$	**35.56**

CONCLUSION

According to the results obtained, it can be concluded that, values of AW increased significantly by increasing the rate of compost combination of compost + recommended chemical fertilizer treatments were superior in increasing values of AW. Values of bulk density, hydraulic conductivity, EC,

pH and SAR were decreased with increasing the rates of compost. The superior for increasing values of fennel productivity increased significantly with the application combine of compost + recommended chemical fertilizer treatment, also increased gradually by increasing the rates combine of compost + recommended chemical fertilizer treatment.

REFERENCES

Abd El-Moez, M.R. and A.L. Saleh (1999). Effect of organic fertilizers application on growth, yield and mineral uptake of Roselle- plants as compared to chemical fertilizer. J. Agric. Sci. Mansoura Univ. 24(6): 3157-3165.

Abd El-Moez, M.R. ; O. Shaleby ; I.A. Abdel Latif and K.S. Abd El- Fattah (2002). Impact of some organic residues on some properties of calcareous soil and tomato germination. Egypt J. Soil Sci. 42, (2): 255-265.

Ashour, I.A. (2014). Evaluation of different vermicomposting sources as organic conditioners for conserving sandy soil under southern Kantara Shark, North Sinai. Egypt. J. Appl. Sci., 29 (7b): 634-647.

Barral, M.T. ; R. Paradelo ; A.B. Moldes ; M. Dominguez and F. Diaz-Fierros (2009). Utilization of MSW compost for organic matter conservation in agricultural soils of NW Spain. Resources Conservation and Recycling (53): 529-534.

Bernal, M.P. ; J.A. Alburquerque and R. Moral (2009). Composting of animal manures and chemical criteria for compost maturity assessment. A review. Bioresource Technol., (100): 5444-5453.

Candemir, F. and C. Gülser (2011). Effects of different agricultural wastes on some soil quality indexes in clay and loamy sand fields. Communications in Soil Sci. and Plant Anal., 42 (1):13-28.

Celik, I. ; I. Ortas and S. Kilic (2004). Effects of compost, mycorrhiza, manure and fertilizer on some physical properties of a Chromoxerert soil. Soil and Tillage Res., (78): 59-67.

Cercioglu, M. ; B. Okur ; S. Delibacak and A.R. Ongun (2012). Effects of tobacco waste and farmyard manure on soil properties and yield of lettuce (*Lactuca sativa* L. var. capitata). Communications in Soil Sci. and Plant Anal., (43):875-886.

De Bertoldi, M. ; G. Vallini and A. Pera (1983). The biology of composting: A review. Waste Manage. & Res., (1):157-176.

El-Maaz, E.I.M. ; H.M.R.M. Ahmed and Kh. A. Shaban (2014). Soil chemical properties and wheat productivity as affected by organic, bio-fertilization and cultivation methods in saline soil. Minufiya, J. Agric. Res., 39 (6): 1955-1968.

Farrell, M. and D.L. Jones (2009). Critical evaluation of municipal solid waste composting and potential compost markets. Bioresource Technol., (100): 4301-4310.

Gilley, J.E. and L.M. Risse (2000). Runoff and soil loss as affected by the application of manure. Trans. Am. Soc. Agric. Eng. (43):1583–1588.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of Indian Private limited. New Delhi, India.

Johnson, G.A. ; J.G. Davis ; Y.L. Qian and K.C. Doesken (2006). Topdressing turf with composted manure improves soil quality and protects water quality. Soil Sci. Soc. Am. J., (70): 2114-2121.

Klute, A. (1986). Methods of Soil Analysis : Part 1: Physical and Mineralogical Methods. (2nd Ed), Amer. Soc. Agron. Monograph No. 9, Madison, Wisconsin. U.S.A.

Omran, A.M. ; A.M Falatah and A.R. Al-Harbi (2002). The Use Of Natural Deposits As An Alternative For Polymers On Water Management In Arid Calcareous Sandy Soils Of Saudi Arabia. 17th World Congress Of Soil Science, 14-21 August, Thailand.

Rashad, F.M. ; H.H. Kesba ; W.D. Saleh and M.A. Moselhy (2011). Impact of rice straw composts on microbial population, plant growth, nutrient uptake and root-knot nematode under greenhouse conditions. Afr. J. Agric. Res., 6 (5): 1188-1203.

Tejada, M., M.T. Hernandez and C. Garcia (2009). Soil restoration using composted plant residues: Effects on soil properties. Soil and Tillage Res. (102): 109-117.

Zaka, M.A. ; F. Mujeeb ; G. Sarwar ; N.M. Hassan and G. Hassan (2003). Agromelioration of saline sodic soil. J. Bio. Sci. 3(3): 329-334.

تأثير إضافة السماد العضوي والسماد الكيماوي على تحسين الخواص الفيزيائية و الكيميائية للتربة وإنتاجيتها

ايمان عبد اللطيف محمد ، ضياء سعيد منيربولس ، ليلى رمضان سالم ، دينا سليمان أبو العينين

قسم كيمياء وطبيعة الأ راضي– مركز بحوث الصحراء– المطرية – القاهره – مصر

أجريت تجربة حقلية على تربة رملية طينية كلسية بمحطة رأس سدر بمحافظة جنوب سيناء خلال الموسم الشتوي (2023/2022) المزروعة بنبات الشمر (*Foeniculum vulgare* Mill.). حيث يهدف العمل الحالي إلى تقييم تأثير معدلات إضافة السماد العضوي وهي 0، 2.5، 5، 7.5 طن/فدان، والسماد الكيماوي الموصى به واضافتهما معاً على الخواص الفيزيائية والكيميائية للتربة وإنتاجيتها . تم تصميم القطع العشوائية الكاملة المستخدمة بثلاثة مكررات للمعاملات قيد الدراسة. أظهرت النتائج أن استخدام السماد والمعاملات المركبة (السماد العضوي + الأسمدة الكيماوية الموصى بها) أدى إلى انخفاض ملحوظ في كثافة التربة الظاهرية، والتوصيل الهيدروليكي، وقيم التوصيلية الكهربائية، ودرجة الحموضة، و نسبة الصوديوم الممتص بعد الموسم مقارنة بالكنترول. وعلى العكس من ذلك في حالة الأسمدة الكيماوية الموصى بها اظهرت النتائج عدم تأثير هذه المعايير. وفي الوقت نفسه، زادت المياه الميسرة للتربة وإنتاجية نبات الشمر بشكل ملحوظ.