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Influence of Compost on Morphological and Chemical Properties of Sandy Soils, Egypt

M.M. Wahba

Soils & Water Use Dept., National Research Centre (NRC), Cairo, Egypt

Abstract: Compost material not only improves the structure of fine-textured soils but creates the structure coarse-textured soils as well. Compost was applied at the rates of 0 (Control) and 20 ton/ feddan /year to sandy soils (Typic Torripsamment) in order to investigate its potential for improving the soil properties. The experiment was conducted for two years in Wadi El–Natrun, El–Behaira Governorate, Egypt .The chemical and physical properties of the soils were affected directly by the compost application. Results from this study indicate that the soil structure and the cation exchange capacity were improved. Increasing in organic matter content and reduction in calcium carbonate content were due to the compost which is rich in humic acid. Thin sections of treated sandy samples were examined by polarized microscope. Macro and micro soil morphology were improved, especially the soil structure. Compared with the control treatment, the treated soil with compost had better aggregation in the surface layer due to change in fabric of ground mass and the altering changing of related distribution (C/F) from enaulic to chitonic and partly gefuric. The dominant voids (large vughs and chambers) were modified to simple packing voids. Organic materials can be seen as coatings on pore walls.

Key words: Compost, micromorphology, thin section.

INTRODUCTION

Compost has been used extensively in reclamation of marginal and low quality soils. It has the unique ability to improve soil properties and the growing media physically (structurally), chemically (nutritionally) and biologically. Addition of compost to soil improves soil structure and lowers bulk density. Composting materials can increase macro aggregation and rhizospheric aggregate stability,[6,4]. The effects of compost additions on soil structure may be short–lived although they are generally positive on structural[7] . In the field Lynch *et al.,*[10] applied compost derived from crop residue alone and with other materials. They found that the improvement in soil physical properties (soil bulk density and water content) were obtained for compost treatments alone. Composts alone influenced soil C:N ratio, substantially increased soil organic carbon and soil microbial biomass carbon concentrations. Recently, Pandey and Shukla[12] studied the effect of composted yard waste on the movement water in a sandy soil found that water and P retention in the soil were increased. Tsadials *et al.,*[21] found that after three years of compost application, organic matter content, water retention capacity, available water, and infiltration rate were significantly increased, whereas bulk density and aggregate instability index were decreased. The chemical properties of the soil were affected directly by the amendment compost. Speir *et al.,*[18] reported that in samples from the field trial , soil total C,N,P and Olsen P were increased markedly with increasing the compost application rate. Cation exchange capacity, exchangeable cation as will as total–extractable and EDTA – extractable metals (Cd, Cr, Cu, Ni, Pb and Zn) were also elevated. However, the total Cu reached to the allowable limit in biosolids compost amended soil. The physical properties of the amended soils were improved in all cases as far as the saturated and unsaturated hydraulic conductivity, water retention capacity, bulk density, total porosity, pore size distribution, soil resistance to penetration, aggregation and aggregate stability, were concerned,[1]. In this respect, Celik *et al.,*[5], reported that the addition of organic materials of various origins to soil have been one of the most common rehabilitation practices to improve soil physical properties. Rizzi *et al.,*[13] concluded that compost can help the formation of large number of water stable aggregates, through links between small particles, strong enough to stand the dispersing action of water. Shanjida and Sarwar[14] found that compost improved soil aggregation and increasing of water holding capacity. With respect to total porosity, Wanas and Omran[23] declared increasing the values of it as a result of applied compost. The value reached its maximum for banana compost to 50.91 % in the surface layer to the depth of 15cm. Wanas[22] reported that compost treatments increased micro pores of sandy soil which resulted in an increase

Corresponding Author: M.M. Wahba, Soils & Water Use Dept., National Research Centre (NRC), Cairo, Egypt.

in soil available water and decreased in large pore space. Tejada *et al.,*[20] stressed on the decrease of soil bulk density with compost addition . Finally Pagliai *et al.,*[11] reported that, both compost and manure improved soil pore system characteristics .

Therefore, the aim of this work is to study the effect of compost application to sandy soils through the examination of soil thin sections and investigation of some chemical characteristics.

MATERIALS AND METHODS

The compost was produced from manure, by Bio–Pianta Company, Egypt. Some properties of the used compost in this study were presented. Field experiment was conducted between the years 2005 and 2007 in a farm at Wadi El–Natrun which in located 30^0 $18^/$ $1^{//}$ N and 30^0 $20^/$ $5^{//}$ E and lies some 100 km north west to Cairo, Egypt. In this experiment compost was applied at the rates of 0 (control), 20 ton/feddan/year to sandy soils (feddan = 4200m^2). The compost incorporated by rottilling to the top 15 cm of the soil before seedling. Disturbed and undisturbed soil samples were taken from two different depths (0-15 and 15-30cm) of the treated and untreated soils after two years. Soil samples were analyzed for grain size distribution by dry sieving[16]. Soil pH and electrical conductivity (EC) were determined according to Smith and Doran[15]. Some soil chemical properties analyzed according to Black *et al.,*[2]. Thin sections were examined using polarizing microscope at 25 times magnification to observe microstructure according to terminology developed by Stoops[19] and Bullock *et al.,*[3].

RESULTS AND DISCUSSIONS

Grain size distribution and chemical properties of the soil of the current experiment are presented in table 1 . various analyses showed that the soils is sandy, non-saline, low in carbonate content, exchange cation and poor in organic matter content . Accordingly the is classified at the subgroup level as Typic Torripsamment, Soil Survey Staff[17].

The used compost in this experiment was rich in organic matter, (Table 2).

The effect of compost application on soil texture and some chemical properties after two years were presented in table 3.

Moreover, this application of compost on sandy soil is resulted in some improvements in the soil treated with compost especially for the 0-15 cm layer. The pH values and calcium carbonate content slightly decreased, compared to the

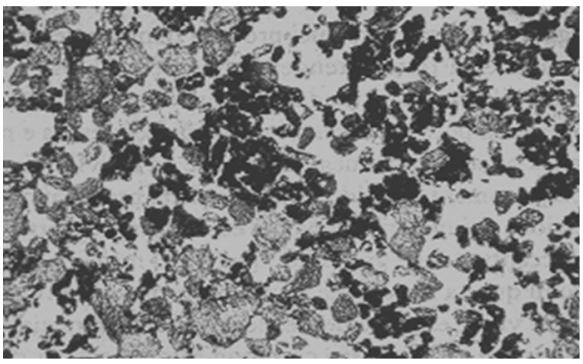

Photo 1: The groundmass is dominated by quartz grains and large chambers at 0-15cm depth of sandy untreated soil untreated.(X25).

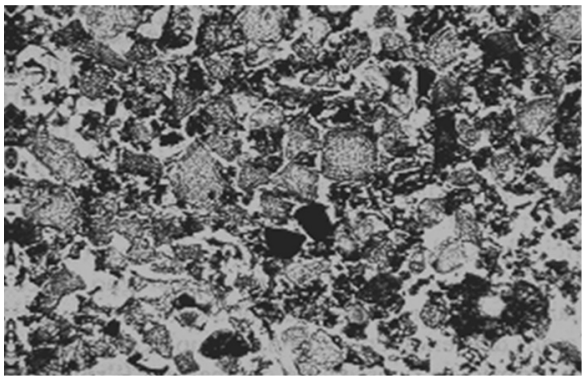

Photo 2: The reduction of porosity in treated soil at depth 0-15cm.(X25).

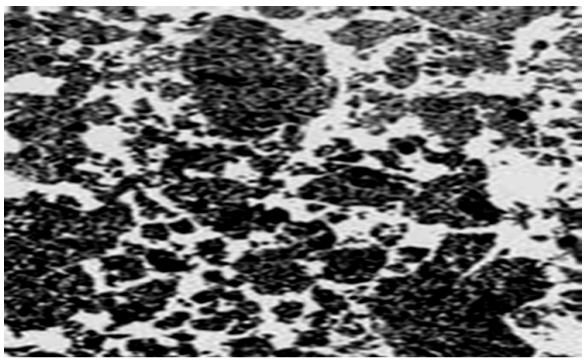

Photo 3: Small and large aggregates at depth 15-30cm (X25).

control. Similarly, Guidi and Hall[8] observed that the application of various organic materials decreased pH values since organic and inorganic acids formed when organic matter decomposed in the soil. Organic matter content and Cation exchange capacity of the compost treated soil are markedly increased In the surface 30cm of the soil

Table1. Some physical and chemical properties of the experimental soil.

		Grains size distribution									
Location	Depth cm	*C sand %	*F sand %	Silt %	Clay %	Texture	pH 1: 2.5	Ec ds/m	$CaCO_3$ %	OM %	CEC Cmol kg^{-1}
Wadi	0-15	50.1	40.6	4.2	5.1	Sand	8.35	1.23	3.24	0.51	5.32
El-Naturn	15-30	45.7	44.8	3.8	5.7	Sand	8.49	1.41	2.72	0.42	5.13

*C. sand: Coarse sand
*F. sand: Fine sand

Table 2 . Some chemical characteristics of the applied compost.

pH	Ec ds/m	C/Nratio	Organic C %	N %	P %	K %
8.1	4.15	1:12	30.44	1.53	0.29	1.13

Table 3. Some physical and chemical properties of the soil experiment after two years of compost application.

Depth cm	Grain size distribution					pH1:2.5	EC ds/m	$CaCO_3$ %	OM %	C.E.CCmol Kg^{-1}
	C. Sand %	F. Sand %	Silt %	Clay %	Texture					
0-15	43.4	38.7	6.4	11.5	L.S*	8.28	1.28	3.11	1.01	7.76
15-30	42.8	40.6	5.8	10.8	L.S*	8.41	1.47	2.62	0.95	7.23

* L.S Loamy sand

as it is compared with the control treatment. Similar results were reported by several authors,[20,9]. Due to the higher salt content of the used compost than the soil of the experiment, the total soluble salts of that soil is slightly increased in two years.

However, the use of such compost for long period may cause a considerable increase of the soluble salt content of the treated soil.

It is worth to mention that the morphological investigation of the soil samples after two years revealed that the soil colour became darker than that of the soil under 0 (control) compost application.

Most sandy soils always have a loose structure as a result of the soil aggregate absence. Compost is an important factor in the formation of soil aggregates and consequently their stability. Microscopic examination of thin sections revealed that the untreated soil contains groundmass which is dominated by coarse grains of mostly quartz with lots of air space and the related distribution (C/F) is enaulic with large vughs and chambers are dominated (photo1).

On the other hand, the compost treated soil had better aggregation in the surface layer. The compost fills the gaps between soil particles and the related distribution changed to chitonic and locally gefuric with packing voids (photo2).

The soil-binding properties of compost are due to its humus content. Humus is a stable residue resulting from a high degree of organic matter decomposition. The constituents of the humus act as a soil “glue”, holding soil particles together, forming soil aggregates, which lead to improve the soil’s ability to hold moisture (photo3).

The structure of sandy soil not only improves through the aggregate formation but also by coating the pore walls (photo 4). Therefore it will

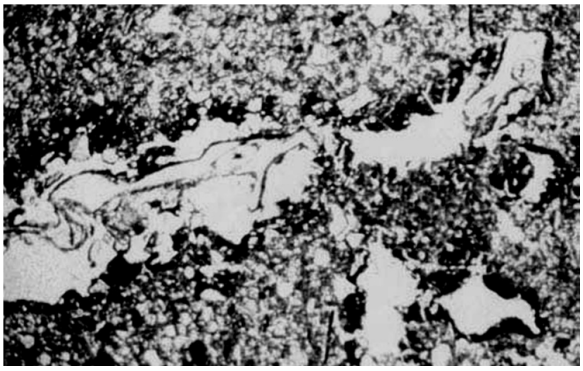

Photo 4: Pore walls are coated by the compost materials, at depth 15-30cm. (X25).

increase the water holding capacity and retain more nutrients in sandy soils. This finding is important in understanding the influence of compost application to coarse textured soils.

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Conclusion: Compost has an unique role in physical (soil structure), chemical (nutrionally), and biological (soil microbes). After two years organic matter content was increased and consequently humic acids content which helps in dissolving minerals in the soil resulting in more available nutrients to the plant. Compost can also improve the cation exchange cation capacity of soils, enabling them to retain nutrients longer.

The study of thin sections of the treated soil with compost clarified that the incorporating compost into sandy soils improves soil structure by changing type of voids and form of the related distribution (C/F concept)

as well as by filling the gaps and coating the pore walls. That will increase the soil water holding capacity and adsorption capacity of nutrients, which are the main factors to be improved through reclamation of the sandy soils.

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