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EVALUATION OF COMPOST SUITABILITY AS A SOIL AMENDMENT

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Abstract: Crop trial was conducted for two years under controlled greenhouse conditions to evaluate compost suitability for amending clay soil in terms of both soil physical and chemical properties. Significant effects of compost addition as mixed or surface application on soil moisture status were noted after each irrigation event. The soil moisture content was slightly higher in the case of surface application than mixed application. Compost application caused significant improvements in the stability of aggregates compared to control. The mixed application of compost at all addition rates caused significant differences in the stability of aggregates in comparison to the equivalent addition rates of compost as surface application. After two compost applications, the aggregate stability increased significantly with increasing compost rate, reaching a maximum at the rate of 240 t ha^{-1} with no further increasing at the rate of 360 t ha^{-1}, exhibiting a diminishing return.

Addition of high rates of compost to clay soils significantly increased soil pH, O.M%, CEC, and the soluble salts compared to control. Compared to control, mixed application of compost at high rate of 360 t ha^{-1} increased the soil EC from 0.5 dS m^{-1} in the control to 4.36 dS m^{-1}. This increase in soluble salts could be harmful for plant growth and reduce the yields especially in the case of sensitive crops. Major consideration in application of compost on clay soils is the increase in soluble salts. The results of this study revealed that there are several physical and chemical potential benefits of applying compost to clay soils in the organic farming systems.

Key words: Compost, Dispersion ratio, Slaking ratio

Introduction

Composts are valuable resources when properly applied to the soil, both as a fertilizer or as a soil amendment. Composts can be applied to the agricultural soils to improve soil physical properties (e.g., soil structure, texture, aeration, water retention, infiltration, and aggregate stability), as well as the chemical characteristics of soils (e.g., cation exchange capacity, pH, EC) and the biological properties (Stratton, *et al.*, 1995, Stratton and Rechcigl 1997). Recently, composting has been recognized as a cost-effective and environmentally sound process for the treatment of organic wastes. Composts are often employed as soil conditioners because of well-known positive physical and chemical effects played by the humified organic matter which they contain (Genevini *et al.*, 1997 and Tambone, *et al.*, 2007).

Epstein (1973) reported that compost application at 5-10% by weight increased water retention at all water potentials and increased aggregate stability in sandy clay soil. Hydraulic conductivity initially increased then declined. Epstein (1997) stated that compost application at rates of 0, 40, 80, 120, and 240 metric tons ha^{-1} resulted in increases in both water content and water retention of a silt loam soil. Physical property responses to compost application were linear while aggregate stability and mean weight diameter of aggregates showed maximum effect at 60 Mg ha^{-1} application rate. The same results indicated that many of the observed changes in soil physical properties are likely due to the effects of added organic matter and these effects have persisted for at least 4 years (Genevini *et al.*, 1997).

The fact that application of compost can markedly improve soil physical properties is evidenced by increasing water content and retention, soil aeration, permeability, water infiltration, and decreasing bulk density and surface crusting. Such changes in soil physical properties contribute significantly to reducing soil erosion, the loss of plant nutrients by runoff, and restoring degraded soils (Sopper, 1992).

Several important soil chemical characteristics are affected by the addition of compost as a result of the interaction between compost organic matter and soil minerals. These chemical characteristics include organic matter itself, cation exchange capacity, soil pH, electrical conductivity, and availability of macro and micronutrients to plant.

The effect of compost on soil organic matter levels is well-documented (Epstein, 1997 and Tester, 1990). A literature review by McConnel *et al.*, (1993) found that compost applied at rates varying from 18 to 146 t ha^{-1} produced a 6% to 136% increase in soil organic matter content. Studying the effects of long-term multiple compost application on soil organic matter content (SOM), Mays and Giordano (1989) found that SOM in the 0-15 cm surface layer increased from 1.6 to 4.9%. At 15-30 cm soil depth, the organic matter percentage increased from 1.0 to 2.3% as a result of compost application. Tester (1990) found that the application of compost affected the organic matter content of a loamy sand soil several centimeters below the zone of application. This effect at the lower soil depths is probably due to the movement of soluble organic fraction in the compost.

Addition of organic matter to soil may increase soil cation exchange capacity significantly. For each percent of humus in the soil, CEC is increased 2 meq $100g^{-1}$ soil (Sopher and Baird, 1978). The CEC of soil was increased by compost applications (Epstein 1997). The CEC of the untreated soil ranged from 5.5 to 6.4 $cmol_c\ kg^{-1}$. No difference in the CEC was noted at the 40 t ha^{-1} treatment, but a very significant increase was noted with the 240 t ha^{-1} application.

Amending the soil with compost may alter pH (Tester, 1990). The pH of soils influences ion availability, solubility, movement, and adsorption by plants (Tadesse *et al.*, 1991). Mays *et al.* (1973) reported that application of compost increased pH from 5.4 for the control to 6.8 with an application of 327 t ha^{-1}. Tester (1990) found that the effect of pH extended well below the zone of compost application. The pH of the loamy sand soil remained above a pH of 7.5 to a depth of 50 cm and then decreased rapidly with soil depth.

Salinity level of compost needs to be assessed prior to utilization. Epstein (1997) showed that electrical conductivity (EC) increased with increasing application rates of compost. Specifically, EC values ranged from a low of 0.41 dS m^{-1} for a control to 4.15 dS m^{-1} with an application of 240 t ha^{-1}. At the end of the growing season, EC values dropped considerably as a result of leaching and by the following season EC values were at levels tolerable to most plants.

Several investigators have studied and focused separately on the agronomic benefits, environmental aspects and the changes in some chemical and physical properties of soil amended with compost ranging from sandy to clay. However, the overall agronomic benefits and environmental impacts needs to be calculated in combination with other soil chemical and physical properties that are induced by compost addition. Therefore, the aim of this research was to give better understanding to the changes in some soil physical and chemical properties owing to application of compost to the agricultural soils, with parallel attention to the agronomic benefits and environmental impacts .To achieve this aim the objectives of the crop trial were therefore, to evaluate changes in water retention, soil structure and chemical characteristics (O.M%, EC, CEC and pH) as a result of compost application to clay soil in tomato organic farming cultivation.

Materials and Methods

Two years trial was conducted in the greenhouse at village 8 located west El-Minia Governorate in the period from June 2004 to October 2006. The experiment was performed using a mixture of farmyard manure and sewage sludge compost to evaluate its suitability as a soil amendment for clay soil used in the organic farming of tomato. Clay soil samples were taken from a stockpile at the faculty of agriculture farm. Prior to the initiation of the greenhouse study, the soil was air-dried, sieved to < 2.0 mm and the moisture content was adjusted at 15 % before the addition of compost. Sub-samples of the dried and sieved soil were used to determine the soil properties using standard methods (MAFF, 1986). Table 1 summarized some physical and chemical properties of the investigated soils.

Table(1): Some physical and chemical properties of the investigated soil.

Particle-Size Distribution %	Coarse sand	Fine sand	Silt	Clay
	32.1	23.4	8.5	36.0
Texture grade	Clay			
F.C, WHC, P.W.P (%)	18.26, 23.54, 5.67, respectively.			
A.V(F.C-PWP) (%)	12.59			
A.V (WHC-PWP) (%)	17.87			
Bulk Density (g/cm^3)	1.55			
Particle Density (g/cm^3)	2.61			
Porosity (%)	40.61			
pH (1:2.5 suspension)	7.32			
CEC (meq/100g soil)	22.60			
O.M (%)	1.59			
EC ($dS\ m^{-1}$ at 25 ^0C)	0.49			
Total N PK (%)	0.089, 0.038, 0.52, respectively.			

- Each value represents the mean of three replication.

The compost was made from farmyard manure, sewage sludge and green wastes (include all types of green residuals, from crop debris to tree pruning and sugar beet wastes) using the tunnel-composting method (MAFF, 1986). Samples of the dried, ground, and sieved compost were used to determine some physical and chemical properties such as moisture, heavy metals and total N. Table 2 shows some physical and chemical characteristics of the compost used in this study. The compost was then added to the clay soil at rates of 0.0, 120, 240 and 360 t ha^{-1} (dry weight basis) by two methods of application (mixed and surface application).

The crop trial was composed of 24 trenches; each trench was dug inside the greenhouse (Length of 100 cm, width of 30 cm and depth of 30 cm) and covered with black polyethylene to maintain a high temperature environment. In June 2004, the trenches were filled with 140 kg soil and the weights of air dried-compost equivalent to the application rates were handly added into the soil trenches to a depth of 20 cm as surface or mixed application.In the case of mixed application compost, each trench was filled with soil to a depth of 10 cm and the rest of 140 kg of the soil was mixed with the compost and added to the trench.

Table(2): Some physical and chemical properties of the investigated compost.

pH(1:2.5 suspension)	8.25
EC(dS m^{-1} at 25 ^{0}C)	8.21
CEC (meq $100g^{-1}$ soil)	52.50
Moisture weight (%)	27.50
Dry solids (%)	72.50
Ash (%)	39.80
Total organic carbon % (D.M)	36.10
Total N % (D.M)	2.25
C/N Ratio	16.04

- Each value represents the mean of three repllcation..

In the case of compost as surface application, the trenches were filled with 140 kg soil and the compost was applied at the above mentioned rates. The trenches were watered by drip irrigation and left bare and undisturbed for 30 days to let the soil to settle down. In July 2004, the tomato trial commenced and ran for two seasons. The tomato plants were not fertilized other than compost application during the growth cycle and weed control was maintained by hand. Each trench was watered every third day to compensate the losses of water using a drip irrigation system which maintained moisture content at field capacity during the period of the experiment. In each plot, soil moisture content was determined at 10 cm depth by weighing soil samples dried in an oven for 24 h at 105°C.

In July 2005, bulk undisturbed soil samples were collected at 0.0 to 20 cm depths with a push tube (10 cm diameter), and then air dried for the determination of soil structure changes by aggregate stability and mean weight diameter, dispersion ratio, slaking ratio and aggregate stability procedure by dry sieving. Dry sieving analysis was performed on soil samples following the method of Kember and Rosenau (1986). The air dry fractions retained on each sieve were used to assess the size distribution and the main weight diameter (MWD) of the aggregates. The main weight diameter (MWD) was calculated for each sample by multiplying the mean of each sieve size range by the fraction of the total dry weight of the sample retained on the sieve and summing the results in according to Kemper and Rosenau (1986). Mean Weight Diameter (MWD) = $\sum$ (percent of the sample on each sieve $\times$ mean intersieve size).

The stability of aggregates was also evaluated using dispersion ratio and water slaking methods. Dispersion ratio was measured using the procedure of Areher and Marks (1978). Dispersion ratio (DR%) is a measure of the potential of the individual aggregates to resist breakdown upon contact with water molecules. Higher values indicate lower resistance. A known weight of the sample aggregates was soaked in either distilled water or sodium hexametaphosphate (5% calgon) followed by end over end shaking. Then, by determining the per cent silt + clay in water dispersed samples (L) and that in sodium-dispersed samples (H), thus the dispersion ratio calculated as (L /H) $\times$ 100. Slaking ratio (SR%) is a measure of the potential of the external aggregates to resist breakdown upon contact with water molecules. Higher values indicate lower resistance. Water slaking ratio was measured as the percentage change in volume of a column of 40 g of 4-6 mm aggregates when wetted from below (Williams and Cook, 1961).

Soil samples of all plots were taken before cultivation and after one year from cultivation for chemical analysis. Three samples were collected and composited for each plot. Soils were analyzed for the changes in chemical properties (such as EC, pH, CEC and O.M %) as a result of compost application and crop cultivation. The analyses were performed as soon as possible after sampling, but in any case, kept in the fridge and delayed by no more than 30 days. The basic chemical analyses of the soil and compost were achieved using the methods followed by (Avery and Bascombe, 1982 and Page *et al.*, 1982) and the standard methods published by MAFF, 1986.

In late October 2005, compost was added for the second year at the same rates as in the first year to each plot as surface applied or mixed by hand into the soil to a depth of 20 cm. In January 2006, the second year crop experiment commenced with the same procedures as used in the first year. All the crop experimental data for all parameters were analysed as a completely randomised block design, with three replicates. The experimental data were computed using the procedures available in the SAS computer program, ver. 6-11 (SAS Institute, 1996). The averages of three samples of each treatment in the three experiment replicates were compared using Least Significant Difference (LSD) test at the 0.05 probability level.

Results and Discussion

Changes in some soil physical properties.

Water retention.

Compared to control, significant effects of compost addition as mixed or surface application on soil water retention were noted. The soil water retention was slightly higher in the case of compost surface application than compost mixed application except for the highest application rate of 360 t ha^{-1}. There was no significant differences between different application rates regardless of the method of application. The moisture retention data revealed that, water-holding capacity (WHC) increased from 22.54 % where no compost was applied to 26.6, 29.1 and 30.23% for 120, 240 and 360 t ha^{-1} of compost mixed application. The field capacity increased from 18.26% for the control plots to 21.52, 23.44 and 25.85% for the amended plots with 120, 240 and 360 t ha^{-1} of compost mixed application. The increases in water holding capacity and field capacity (FC) led to higher available water to plants. The available water, the difference between water holding capacity and permanent wilting point, was increased from 17.87% for the control plots to 20.45, 22.45 and 23.24% for plots amended with 120, 240 and 360 t ha^{-1} compost as mixed application, respectively (Fig. 1). The available water was increased from 12.59% for the control plots to 15.37, 16.79 and 19.05% with 120, 240 and 360 t/ha compost as mixed application,

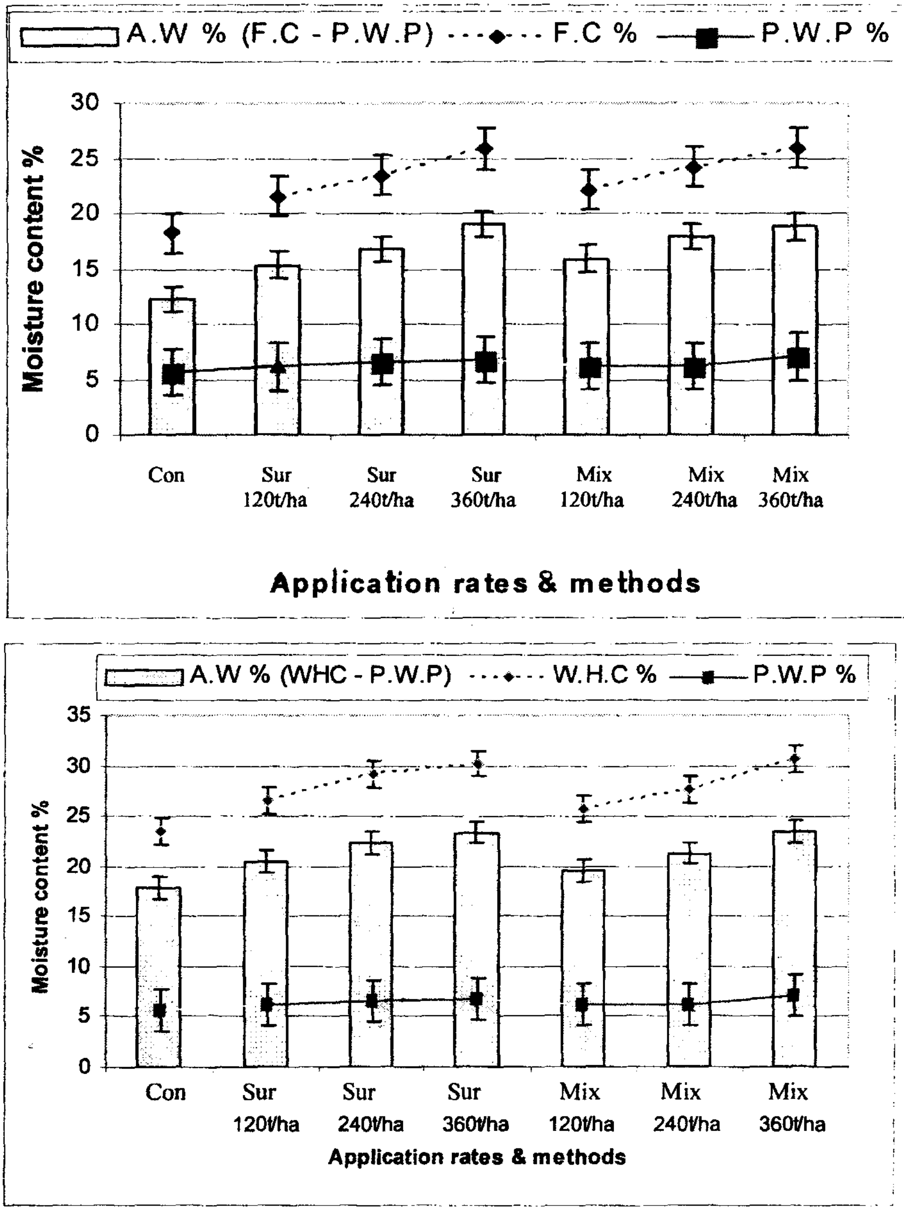

Fig.(1): Effects of compost addition on soil water retention. Vertical bars represent the value of L.S.D for compost application rates ($P \leq 0.05$).

respectively. In general, compost increases the water holding capacity of soils (Epstein and Wu, 1994). The increased water holding capacity provides for higher water availability to plants. Thus, under drought conditions plants can survive longer. Furthermore, where irrigation is used, less water is needed (Epstein, 1997).

The slightly lower moisture content in the case of compost mixed application plots could be due to the deeper rooting system, which encouraged efficient soil water extraction and therefore increased evapotranspiration. The other possibility is that the thick compost-mulching layer insulates the plots from greenhouse lights and thus reduces soil water evaporation. Epstein (1997) showed that the application of 240 t ha^{-1} of sewage sludge compost increased the water retained at specific water potentials. When compost was added to soils, the available water was 12.5% for the control and 14.5% for soil amended with 240 t ha^{-1} compost.

Avnimelech *et al.* (1990) found that compost increased the water holding capacity in the subsurface layer by 825% compared to 341% in the surface layer to which compost had been applied. They attributed this difference to the leaching of organic carbon in the surface layer, which consisted of the residues of applied compost. This finding suggests that the soluble organic carbon fractions are the ones that are principally responsible for water retention. Thus, in the present study, the leaching of soluble organic carbon from the mulching layer into the underlying clay soil may add additional evidence to the slight increase in moisture retention of compost surface application compared to mixed application.

Changes in soil structure.

Results of this experiment indicated that mixed application of compost transformed rapidly into products beneficial to plants and stabilized the soil structure compared to the surface application. The effects of compost addition on soil physical properties largely depend on the method of application, the compost organic matter content and the rate of decomposition of the compost and their contribution to soil organic carbon.

Mixed application of compost produced more large aggregates and less small aggregates than the surface application. At all application rate of compost , mixed application increased the percent of > 5 mm aggregates up to 2 to 4 % of the total sample compared to nil in the case of surface application (Figs. 2 and 3). The next largest size of >2 mm aggregates, was also higher and ranged from 8 to 16% in the case of mixed application compared to surface application which ranged

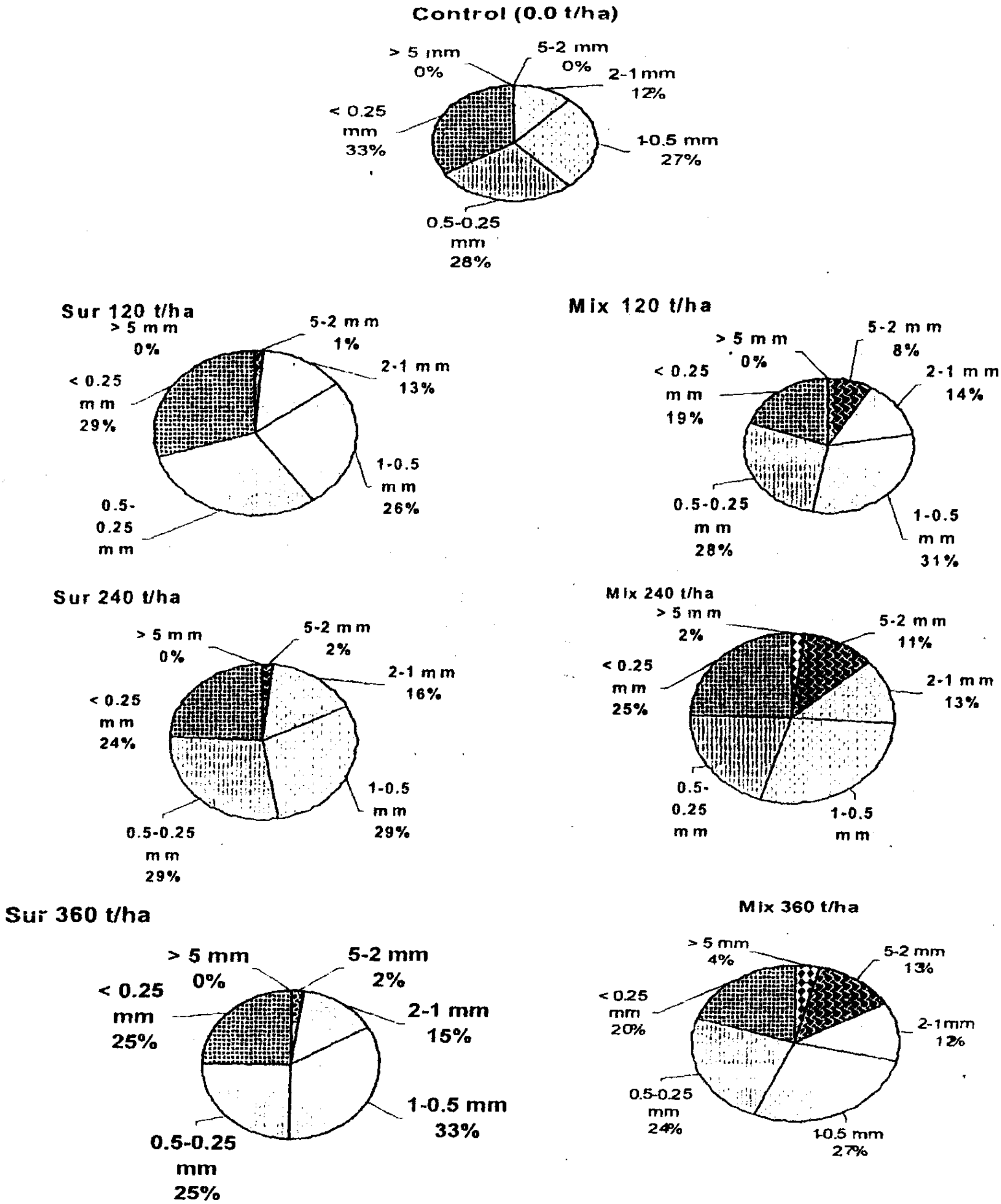

Fig. 2: Influence of the compost on the aggregate size distribution of the investigated clay soil one year after first compost application.

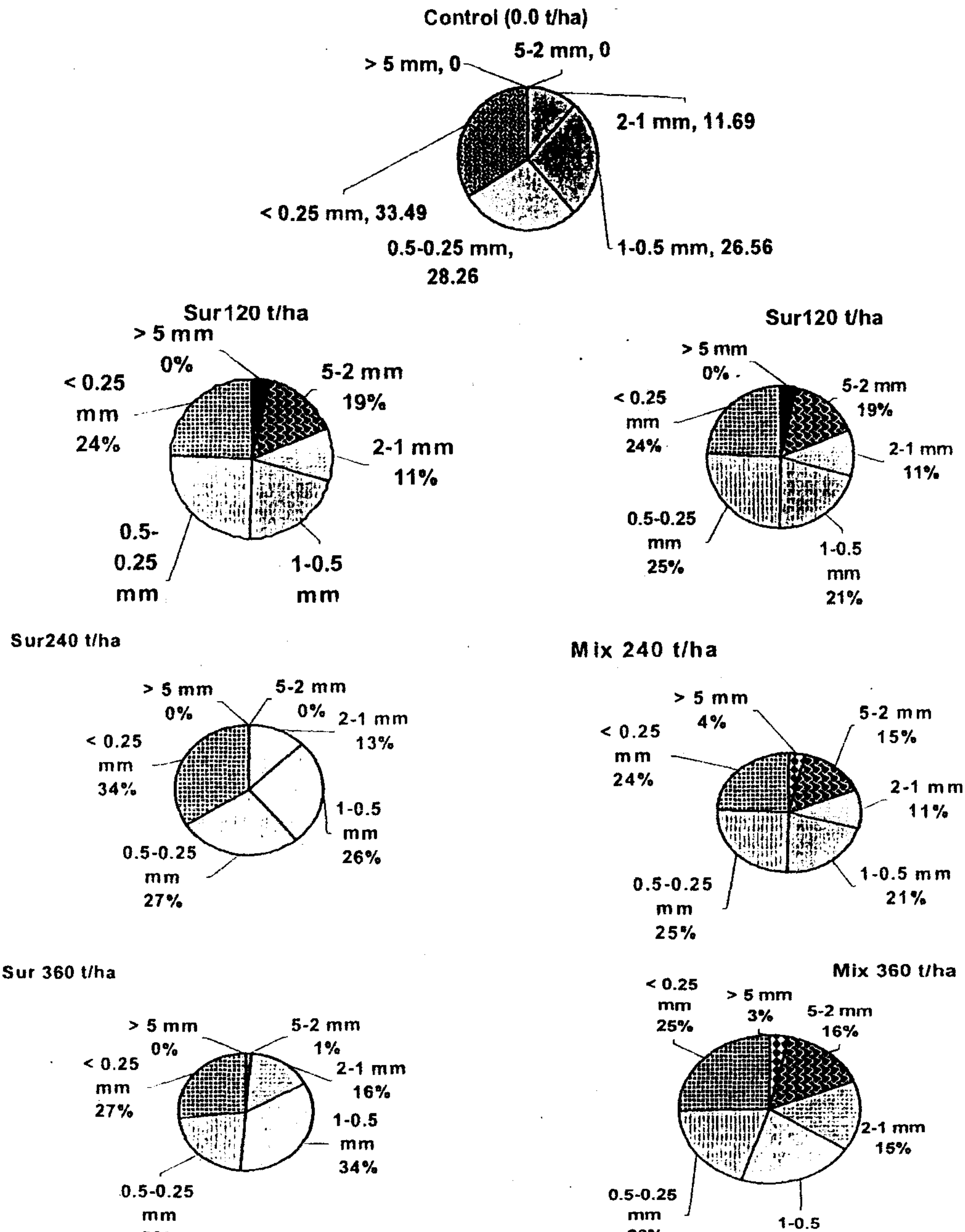

Fig. 3: Influence of the compost on the aggregate size distribution of the investigated clay soil two years after second compost application.

from 0.0 to 2%. In contrast, the other fractions were slightly higher in the case of surface application.

The increase in MWD was 0.52 mm for the mixed application compost at the lowest application rate of 120 t ha^{-1} (Table 3). This increase was higher than that of the surface application compost at all application rates, which was for example 0.15 mm at the highest application rate of 360 t ha^{-1}. The increase in the mean weight diameter (MWD) suggests that, incorporated of compost into the soil encouraged binding of smaller size aggregates into larger sizes and caused a shift in the aggregate size distribution for this clay soil towards bigger sizes.

Similar improvements in the soil physical properties have been reported elsewhere (Logan *et al.* 1996; Lindsay and Logan, 1998). They stated that many of the observed improvements in soil physical properties are due to effects of added organic matter and these effects have persisted for at least 4 years. Epstein, (1997) suggested that the effects would be transitory and only sustained by repeated application. Data given in Table (3) shows that the addition of compost to soil improved soil structure by increasing soil aggregates and mean weight diameter (MWD).

Table(3): Aggregate size distribution and mean weight diameter (MWD) of the investigated soil.

Aggregate size mm	Compost application rates and methods												
	Control	Surface-applied compost						Mix-applied compost					
	0.0t/ha	120 t/ha		240 t/ha		360 t/ha		120 t/ha		240 t/ha		360 t/ha	
		yr1	yr2	yr1	yr2	yr1	yr2	yr1	yr2	yr1	yr2	yr1	yr2
> 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	2.2	3.7	3.5	3.3
5-2	0.0	1.3	0.0	1.7	0.9	2.3	1.4	8.4	12.9	11.1	15.2	13.6	15.4
2-1	11.65	13.2	12.4	15.5	14.9	14.5	15.5	14.1	15.3	12.9	10.4	11.8	15.6
1-0.5	26.60	25.9	26.5	30.3	30.2	33.5	34.3	30.4	28.6	28.5	20.7	27.5	20.5
0.5-0.25	28.26	30.1	26.7	28.7	29.9	25.2	22.2	27.8	19.9	20.8	25.7	23.9	19.7
< 0.25	33.49	29.5	34.4	23.8	24.8	24.5	26.7	19.3	20.2	24.5	24.3	19.6	25.5
MWD	0.51	0.58	0.52	0.65	0.61	0.66	0.66	0.85	1.20	1.03	1.17	1.17	1.22

Data presented in Table 3 revealed that mixed application of Compost gave high and regular distribution of >5 mm size aggregates, ranging from 0.0 to 3.70 % of the total sample at all application. In the case of surface applied composting, the distribution of >5 mm size aggregates was nil at all application rates. The next largest size of >2 mm aggregates, was higher and ranged from 8.4 to 15.4% in the case of compost mixed application plots compared to compost surface application which ranged from 0.0 to 2.3%. In contrast, the other fractions were slightly higher in the case of compost surface application. In general, mixed application of compost had more large aggregates and less small aggregates than the surface application.

The MWD ranged from 0.85 to 1.22 mm for the mixed application compost. Which is higher than that in the case of applied compost at all application rates(ranged from 0.58 to 0.66 mm). In the case of compost mixed application, the mean weight diameter (MWD) increased with increasing compost rate, appearing to reach a maximum at both the240 and 360 t/ha application rates. This maximum effect reflects the low capacity of this clay soil to form aggregates in response to organic matter additions. The increase in the mean weight diameter (MWD) suggests that, mixed application of compost into soil encouraged binding of smaller size aggregates into larger sizes and caused a shift in the aggregate size distribution for this soil towards bigger sizes.

Compost addition increases aggregate stability through the addition of fats, waxes, and oils (ether-soluble), resins (alcohol-soluble), and water-soluble polysaccharides (Clapp *et al.*, 1986; Lindsay and Logan, 1998). Epstein (1973) reported that compost at application rates of 5-10% by weight, increased aggregate stability. Clapp *et al.* (1986) attributed the effects of compost to the addition of organic matter and suggested that the effects would be transitory and only sustained by repeated applications. Many studies have demonstrated the ability of compost to restore degraded soils (Sopper, 1 992). Logan *et al.* (1996) found that a one-time application of 25% by weight of digested sewage sludge improved soil physical properties as measured by aggregate stability. Greatest effects were seen on a poorly structured sandy soil.

Dispersion ratio (DR) is a measure of the potential of the individual aggregates to resist breakdown upon contact with water molecules (Mbagwu, 1990). The differences between the dispersion ratio of the compost-treated plots and control can be seen in table (4). After two compost applications, the stability of aggregates was increased by 3 to 24% at different application rates. Compared to control, the increases in the application rates up to 360 t ha^{-1} of compost had small and non-significant effects on the dispersion ratio.

Table (4): Dispersion ratio (DR), degree of aggregation (DA) and the slaking ratio (SR) of the investigated soil as affected by compost application.

Aggregate stability indices %	Growth seasons	Application rates and methods of compost						
		Control	Surface-applied compost			Mix-applied compost		
		0.0 t/ha	120 t/ha	240 t/ha	360 t/ha	120 t/ha	240 t/ha	360 t/ha
DR	yr1	92 a	88 ab	84 bc	81 bc	84 bc	78 c	70 d
	yr2	93 a	90 a	89 a	89 a	73 c	69 c	69 cd
*DA	yr1	8	12	16	19	16	22	30
	yr2	7	10	11	11	27	31	31
SR	yr1	42 a	39 a	35 b	35 b	34 b	29 c	30 c
	yr2	42 a	41 a	36 ab	36 ab	32 bc	30 c	29 c

Numbers within the rows followed by the same letter are not significantly different ($P \leq 0.05$) as measured by the Duncan method.

* Degree of aggregation = (100 – Dispersion ratio).

The results in Table (4) show clearly that in the case of mixed application of compost, all the application rates were effective in promoting the stability of aggregates. The decreases in the dispersion ratio and consequently the increases in aggregate stability in compost-incorporated plots were significant and superior to the compost surface applied plots. This finding could be attributed to the intimate contact between soil particles and the organic matter added with mix applied compost. This intimate contact encouraged the formation of organic complexes with soil particles or binding the soil particles by adhesion to increase the stability of aggregates. The dispersion ratio (DR%) index has been shown to be useful in predicting the tendency of soils to erode. The higher the DR the higher the amount of soils lost from simulated rainfall (Mbagwu, 1986).

Slaking ratio (SR%) is a measure of the potential of the aggregates to resist breakdown upon contact with water molecules. Higher values indicate lower resistance. The results of the SR% revealed that the compost-treated plots showed less slaking (%) in water than the control plots. The decrease in water slaking was only significant in the case of compost mixed application in comparison to control.

The results of the dispersion ratio and water slaking show clearly that the incorporation of compost at all application rates caused significant differences in promoting the stability of aggregates in comparison to the equivalent application rates of compost as surface applied. As a result, the increase in aggregate stability after one or two compost mixed applications was significantly superior to the compost surface applications. While the decrease in the dispersion ratio was from 11 to 4% and the decrease in water slaking was from 7 to 1 % with compost surface application. It was from 24 to 12% for the dispersion ratio and from 13 to 8% for the water slaking with compost mixed application of composting. The superiority of the mix-applied compost to the surface applied compost on aggregate stability was due to the stabilizing effects of the organic matter.

It is worthy mentioning that in the case of compost mixed application plots, the aggregate stability increased significantly with increasing compost rate, appearing to reach a maximum at both the240 and 360 t/ha application rates. This maximum effect reflects the low capacity of this clay soil to form aggregates in response to organic matter additions.

Changes in soil chemical properties

Chemical properties such as pH, CEC, EC and organic matter affect the mobility of ions and compounds by affecting the biological activities and affect the benefits that compost impart to soils. High loadings rates of compost on clay soil in the organic farming projects can add substantial amounts of N and heavy metals to soil, thereby increasing the total amounts of elements available for transport, uptake by plant, or downward movement into groundwater.

The results of this research revealed that soil pH increased from 7.3 to 7.65 as a result of compost addition (Table 5). The soil pH of the arid regions soils ranges from 7.5 to 9.0, thus, applying compost that could maintain the optimum soil pH (near neutral pH = 7.0) for most arable crops is essential.

The results of this study indicated significant increases in CEC of the investigated soil occurred at all rates and methods of application. A very significant increase in CEC was noted with the 360 t/ha application rate. It is also indicated that compost mixed into soil significantly increased CEC compared to compost surface application. This increase in CEC improved the retention of plant nutrients and made them available for plant uptake at the same time precluding the potential for leaching of heavy metals cations into groundwater. Soil adsorptive capacity varies with soil texture, kinds of clays, and organic matter.

Table(5): The effects of compost addition on some chemical properties of the investigated soil before and after cultivation.

Treatments		pH			EC dSm^{-1}			O.M %			CEC (meq/100 g soil)		
		B*	yr1	yr2	B	yr1	yr2	B	yr1	yr2	B	yr1	yr2
Control		7.32	7.33	7.32	0.55	0.61	0.55	1.56	1.57	1.58	22.6	23.4	23.2
Sur. 120t/ha		7.36	7.34	7.36	1.19	1.36	1.75	2.09	2.16	2.11	25.97	26.66	25.60
Sur. 240t/ha		7.44	7.41	7.34	1.51	1.78	1.66	4.21	4.30	2.34	27.98	28.33	26.45
Sur. 360t/ha		7.54	7.50	7.39	1.66	1.92	1.81	5.25	5.41	2.23	28.36	27.66	27.12
Mix 120 t/ha		7.50	7.46	7.63	1.72	1.91	3.1	2.02	2.21	4.23	29.66	29.35	31.66
Mix 240 t/ha		7.59	7.58	7.65	1.99	2.16	4.13	4.06	4.18	5.25	30.33	31.22	32.65
Mix 360 t/ha		7.65	7.60	7.65	2.20	2.25	4.36	5.04	5.15	5.52	32.31	34.25	35.29
L.S.D	Rate	0.22	0.16	0.25	0.23	0.35	1.8	0.44	0.52	0.49	2.14	1.66	2.04
($P \leq 0.05$)	Meth	0.16	0.13	0.31	0.34	0.33	2.13	1.15	1.31	0.98	1.32	2.54	4.13

* B refers to before cultivation.

The relatively high soluble salt concentrations (EC = 8.2 dSm^{-1}) in the investigated compost have resulted in an increase in soil EC from 0.5 dS m^{-1} in the control to 4.3 dS m^{-1} for mixed application compost at the highest application rate (360 t/ha). Compost mixed into soil significantly increased EC compared to compost surface application. There were no significant differences between compost surface application and the control in terms of salinity increase. Salinity problems usually do not occur in plants until the soil EC values are greater than 1.5 dSm^{-1} for salt-sensitive, 3.5 dSm^{-1} for moderately salt sensitive, or 6.5 dSm^{-1} for moderately salt-tolerant species (Maas, 1990).

In arid regions, salt accumulation as a result of compost application is of particular concern where high evaporation together with consumptive use of irrigation water may result in soils with elevated salt concentrations on long-term basis. The results of this research revealed that high salt concentrations in the compost-mulching layer reduced the water supplying capacity of this soil and consequently caused water stress. In soils under arid conditions, organic matter contributes more than half of the cation exchange capacity; therefore, efforts should be made to increase organic matter by compost addition, as it is the main source of the cation exchange capacity of the soils (Epstein, 1997).

Organic matter accumulation in soils under arid conditions is difficult to develop because the climatic and edaphic soil conditions are ideal for oxidation and depletion of organic matter and decomposition of compost organic matter. The enrichment of organic matter in soils is a function of compost decomposition rate, interaction with soil properties, and the C/N ratio of the compost (Stratton and Rechcigl, 1997).

The organic matter content of the control plots (1.5%) increased significantly following the compost addition as either mix applied or surface applied. An increase to approximately 5.68% was measured at the 360 t/ha rate as surface applied after two compost applications. The Increase in O.M% will result in an Increase in CEC and will improve soil physical properties such as water retention and soil structure.

Conclusion and Recommendations

Compost is typically applied to soil to enrich the soil with organic matter, improve the soil physical and chemical properties, and to recover its fertility value. The results of this research indicated that increasing compost addition as mixed application or surface application resulted in significant improvements in water retention and available water-holding capacity of the investigated soil. In addition, the application of compost to soil improved soil structure by increasing soil aggregates and mean weight diameter. Stable aggregates and mean weight diameter increased significantly with increasing compost rate, showing insignificant effects at the second compost application of 240 or 360 t ha^{-1}. This finding is a reflection to such clay soil's capacity to form aggregates in response to compost addition. Greatest effects were seen on the soil when compost was mixed with the soil.

The addition of compost to clay soil significantly increased the soil pH, EC, O.M%, and CEC compared to the control. These chemical properties of the clay soil increased as the rate of compost increased. The increased values of these soil parameters resulting from surface application of compost were lower than for equivalent application rates of mixed application. Organic matter level and decomposition rate under arid conditions needs to be assessed prior to termination of compost addition to soils. An increase in research effort is needed to address this under arid conditions. Organic matter is important for the development of soil structure and contributes to soil stability, soil adsorption capacity of heavy metals and nutrient sources.

The addition of compost did accumulate soluble salts in the soil to levels that might affect the performance of sensitive crops. The increase of soluble salts with high application rates of compost represents a major drawback to the use of such compost in the organic farming projects. Thus, maintenance of applying compost with favourable salt content at first place is a necessary precaution for a sustained and continued agricultural productive compost organic farming project. Soluble salt problems can be lessened by leaching of the compost prior to incorporation into the soil.

From the results of this study, compost incorporation into soils is not only serving primarily as a nutrient source for short-term plant growth but also as a soil amendment for long-term enhancement of soil quality. The incorporation of compost can add substantial amounts of C to the soils.

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تقييم ملائمة الكومبوست كمحسن للتربة

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تجربة محصولية أجريت لمدة عامين تحت ظروف الصوبة لتقييم ملائمة الكومبوست كمحسن للخواص الطبيعية والكيماوية لأحد الأراضى الطينية. إضافة الكومبوست للتربة بطريقة الخلط مع التربة أو الفرشة على سطحها أدى إلى حدوث تأثيرات معنوية فى رطوبة التربة بعد كل ريه. رطوبة التربة كانت أعلى قليلاً فى حالة إضافة الكومبوست كفرشه عنه فى حالة الخلط مع التربة. إضافة الكومبوست أدى إلى حدوث فروق معنوية فى ثبات التجمعات الأرضية بالمقارنة بالكنترول. خلط الكومبوست مع التربة عند مختلف نسب الإضافة أدى إلى حدوث تأثيرات معنوية فى ثبات التجمعات الأرضية بالمقارنة مع إضافة الكومبوست كفرشه على سطح التربة. ثبات التجمعات الأرضية زادت مع زيادة نسبة الكومبوست ولكن بنسب متقاربة عند نسبة 240 و360 طن/هكتار مما يدل على وجود نقص فى عائد وحدة الإضافة من الكومبوست.

إضافة الكومبوست بنسبة عالية إلى الأرض الطينية أدى إلى حدوث فروق معنوية فى زيادة رقم الحموضة والمادة العضوية والتبادل الكاتيونى وكذلك الأملاح الذائبة بالمقارنة بالكنترول. النتائج أوضحت أن أستعمال الكومبوست الذى يحتوى على نسبة عالية من الأملاح الذائبة نتج عنه زيادة فى ملوحة التربة من 0.5 إلى 4.36 ملليموز/سم وذلك عند إضافته بنسبة 360 طن/هكتار بطريقة الخلط. هذه الزيادة من الأملاح الذائبة كانت عند مستوى قد يقلل من انتاجية المحاصيل الحساسة للملوحة. نتائج هذه الدراسة أوضحت أن الأراضى الطينية المستعملة فى أنظمة الزراعة العضوية شهدت تحسن كبير فى عدد من صفاتها الطبيعية والكيماوية بعد إضافة الكومبوست.