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Composts of Wood Industry Wastes for Clay Soil Conditioning. II. Effect on Physico - Chemical Properties of the Soil

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A TWO successive years completely randomized field experiment with four replications for each treatment was conducted on a heavy clay compacted soil at Abou- El Matameer, Behera governorate to study the changes in physico-chemical properties of the soil after treating with two application rates (10 and 20 m^3/fed.) of composted ligno -cellulosic materials (LCM) either solely or mixed with farmyard manure (FYM) or Kattamia compost (KC) at the ratio of 1:1 and planting with broad bean (*vicia faba L.Giza 2*) followed by corn (*Zea mays* L. hybrid 310).

Soil conditioning with the studied composts positively affect physico-chemical properties of heavy clay compacted soil. These effects are assembled in the following: A) Improving hydrophysical and mechanical properties of treated soil through 1-promoting good soil structure with suitable pore size distribution that provide the plant with balanced aeration and available water 2-modifying the dynamic soil water characteristics *i.e.* the downward water movement through infiltration and the upward ones via evaporation. 3-improving the mechanical strength of the soil that can be satisfactory tilled with lower power requirements. B) Improving chemical properties and nutritional status of the soil through 1-lowering pH and its effects on nutrients availability; 2-increasing organic matter and organic nitrogen % and modifying C/N ratio to be suitable for both growing plants and soil fauna; 3-increasing both CEC and specific surface area of the soil and their effect on increasing the rate of bio-chemical reactions in the soil 4- raising the concentration of available nutrients in the soil. With only one exception (soil salinity), improvements of soil physico- chemical properties are positively affected by the rate of applied composts.

Mixing the slow biodegraded materials with high C:N ratio (LCM) with other easily degraded residues with relatively lower C:N ratio (FYM or KC) speeds the improving effect of the former. This brings the C:N ratio down and closer to appropriate level, thus the improving effect of mixtures of composts appears earlier (after the 1st crop) compared to that of LCM compost only.

It is preferred to apply composts free of salts. High salt content of incorporated composts adversely affect soil salinity and accordingly plant growth. In the case of mixing organic manures with other composts; they must be free of weed seeds, nematode and pathogens.

Keywords: Clay soil, Composts, Soil conditioners, Wooden wastes, Physical properties, Chemical properties.

Land utilization of heavy clay compacted soils is faced by several difficulties namely: 1-timing of irrigation due to high water retention capacities, inadequate aeration and poor drainage. 2-low rate of infiltration, slow permeability, run off and reduction in wetting and rooting depth. 3-large volume changes *i.e.*, alternating expansion and contraction when wetted and dried. 4-crusting and cracking that adversely affect root penetration and seedling emergence. When dried cracks cause more evaporation and 5-great stickiness, plasticity and limited moisture range during which they can't be satisfactory tilled and the high power requirement needed to plow them. Of the natural soil conditioners that have been used for reclaiming such soils are organic manures and composts (Donahue *et al.,* 1977; Balba, 1989 and Brady, 1990).

Wood industry wastes include sawdust, bark, wood shavings, wood chips and finely divided wood fibers. Such ligno-cellulosic materials (LCM) are available in large quantities that reach 15% of the manufactured wood. A continuous removal of such wastes from the production sites to be transformed to effective and low price soil conditioners, through composting, has become necessary (Shaaban, 2002).

A two successive years field experiment was conducted on a heavy clay compacted soil at Abou- El Matameer, Behera governorate to study the effect of treating the soil with two application rates (10 and 20m^3/fed) of composted LCM either solely or after mixing with other manures or composts. Broad been (*vicia faba*) followed by corn (*Zea mays*) were the indicator crops. Examined conditioners increased vegetative growth, yields and both water and fertilizers use efficiency by the crops with different values being higher with the application rate of the conditioner (Shaaban, 2005).

The conditioning effects of examined composts on hydrophysical, mechanical and chemical properties of the soil after each of the two examined crops are the aim of the present work.

Material and Methods

A two successive years completely randomized field experiment with four replications for each treatment was conducted on a heavy clay compacted soil (clay 55.8%, pH=8.05, EC=1.08 dSm^{-1} and OM= 0.72%) at Abou- El Matameer, Behera governorate. Broad bean (*vicia faba L.Giza 2*) followed by corn (*Zea mays L.* cv. hybrid 310) were the indicator crops. The main analytical data of the soil and irrigation water were presented elsewhere (Shaaban, 2005). The soil was treated with composted ligno -cellulosic materials (LCM); mixtures of LCM and farmyard manure (FYM) or Kattamia compost (KC) at the ratio of 1:1 for mixture components at two application rates, *i.e,* 10 and 20m^3/feddan. The main properties of composts used are presented in Table 1.

TABLE 1. The main chemical properties of prepared composts.

Property	LCM	LCM+FYM (1:1)	LCM+KC (1:1)
PH (H_2O)	7.30	7.40	7.55
<u>Salinity:</u>			
EC (1:10) dSm^{-1}	1.25	2.35	3.16
Na^+ %	0.02	0.05	0.10
<u>Mineral content</u>:			
Ash %	41.15	51.05	49.5
<u>Organic</u>			
<u>component</u>	58.85	48.95	50.5
O.M %	34.13	28.39	29.30
O.C %	0.93	1.67	1.55
O.N %	36.7	17.0	18.9
C:N			
<u>Macro elements</u>:	0.96	1.69	1.58
N %	0.18	0.32	0.27
P_2O_5 %	0.35	0.42	0.46
K_2O %	0.61	0.49	0.88
Ca^{+2} %	0.18	0.24	0.42
Mg^{+2} %			
<u>Micro elements</u>:	110	215	280
Fe (μg/g)	19	63	88
Mn (μg/g)	31	52	69
Zn (μg/g)	10	19	44
Cu (μg/g)			
<u>Heavy metals</u>:	0.5	0.6	08
Cd (μg/g)	1.0	1.1	1.2
Co (μg/g)	2.9	3.6	4.1
Ni (μg/g)			
	101.4	112.6	118.4
CEC c mol kg^{-1}			

* On dry weight basis.

At the end of the growth seasons *i.e* after *vicia faba* and corn, some physio -- chemical properties of the soil were determined. These include stability of soil structure (micro and macro aggregation); bulk density; porosity and pore size distribution; water retention at different suctions from 0 to 15 bars and available moisture; water transmitting properties (infiltration rate, hydraulic conductivity, transmissivity for vertical flow through the profile, mean diameter of soil pores and adjusted evaporation); mechanical strength of the soil; soil pH, EC, CEC and surface area; OM and OC; organic N and C:N and available P and K. (Lowire 1961; Dewis & Freitas, 1970; Loveday, 1974; El-Shafei, & Ragab, 1976 and Cottenie *et al.*, 1982).

Results and Discussion

The conditioning effect of composted LCM either solely or after mixing with other organic materials, *i.e.,* farmyard manure (FYM) or kattamia compost (KC) on some physio -chemical properties of heavy clayey compacted soil after *vicia faba* and corn plantation are presented as follows:

I. *Hydro physical properties of the soil*

1.*Soil structuralization and stabilization*

a.Micro- aggregation

Data of the mechanical and micro structural analysis of clay soil under study after *vicia faba* and corn plantation are illustrated in Fig. 1. Percentages of improvement in the different water stable micro structural units are presented in Table 2. Concerning the untreated soil, the structural units <20 μ and <50 μ reached after the 1st crop 86.2 and 89.4%, respectively which clearly show the problems of the low stability and high dispersiability in such soil that greatly affect its agricultural use. More dispersion of the micro structural units <20 μ and< 50 μ were obtained through the next crop to reach 88.1 and 91.6%, respectively. On the other hand, it is generally noticed that soil conditioning improved -with varied degrees – the micro structure of the soil under study. This beneficial effect increases by doubling the rate of applied conditioners. With this respect, incorporating 10 tons/fed. of composted LCM raised the water stable micro structural units >20 μ and > 50 μ and after *vicia faba* to be ~ 2.0 μ times that of untreated soil for both diameters. Relevant values when mixing LCM with either FYM or KC at the ratio of 1:1 were ~2.0- 2.4 times for the structural units >20 μ and 2.2 – 2.4 times for those > 50 μ in diameters.

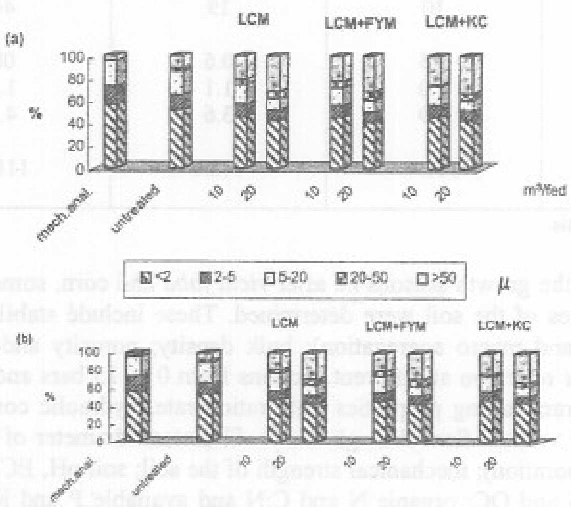

Fig 1. Effect of wooden waste composts on the distribution of water stable micro structural units in clayey soil after a. vicia faba b. corn.

TABLE 2. Effect of wooden waste composts on percent of improvement in water stable micro structural units in clayey soil after *vicia faba* and corn plantation.

Composts used	Application rate m^3/fed.	water stable micro structural units			
		>2 μ	>5 μ	>20 μ	>50 μ
a) after vicia faba.					
untreated	-	-	-	-	-
LCM	10	10.5	20.9	87.0	92.5
	20	18.9	37.3	174.6	199.1
50%LCM+	10	13.3	25.1	140.3	116.0
50%FYM	20	19.9	40.4	183.3	201.9
50%LCM+	10	11.5	24.0	98.6	139.6
50%KC	20	18.1	38.7	179.7	217.9
b) after corn.					
untreated	-	-	-	-	-
LCM	10	10.1	22.9	105.0	133.3
	20	20.0	38.4	205.0	261.9
50%LCM+	10	15.1	26.4	126.9	154.8
50%FYM	20	21.0	41.3	218.5	265.5
50%LCM+	10	10.7	23.5	123.5	176.2
50%KC	20	18.9	40.5	211.8	292.9

Doubling the application rate of the conditioners to be 20m^3/fed. increased micro structural units to be 2.75 – 2.85 times and 3.0 – 3.2 times that of untreated soil for the structural units > 20 μ and > 50 μ, respectively.

More improvement in water stable micro structural units in conditioned soils was obtained after the next crop (corn) to be for the units > 20 μ more than double (with 10m^3/fed conditioner) and more than triple (with 20m^3/fed conditioner) that of untreated soil. The same is true with the structural units > 50 μ, where they reached ~2.8 and 4 times that of untreated soil with 10m^3/fed and 20m^3/fed of the applied conditioners, in sequence. This indicates that examined organic composts are still fully effective after one year from their incorporation into the soil.

b. Macro- structure

The distribution of water stable structural units having the diameters of > 0.85, 0.85-0.425, 0.425-0.25 and <0.25 mm, as well as their mean weight diameter (MWD) after *vicia faba* and corn are shown in Table 3. Data show that incorporating 10m^3/fed of each of composted LCM, composted LCM + FYM (1:1) and composted LCM + KC (1:1) into clayey soil for ~7 months increased water stable structural units >0.25 mm in diameter by 21.2, 28.4 and 34.1%, respectively. Relevant values for 20m^3/fed treatments were 52.4, 57.5 and 60.7%, in sequence. After another 5 months, these increments were 20.6, 24.4 and 33.2% for 10m^3/fed composts mentioned above and 48.8, 53.5 and 56.0% for 20m^3/fed ones, in sequence.

Accordingly, MWD of the water stable structural units after *vicia faba* increased by 26.8, 35.8 and 39.8% over that of the untreated soil for $10m^3$/fed composted LCM; LCM + FYM (1:1) and LCM + KC (1:1), respectively. More improvement occurred by doubling the application rates of the conditioners. Calculated increments were 59.3, 65.0 and 71.5 % for the three composts mentioned above, in sequence. Such improvement in soil structure continued for the next crop (corn) being higher with the application rate of the conditioners to reach 157.3, 164.3 and 169.0% that of untreated soil for using $20m^3$/fed composts, respectively.

Values of structure coefficient (Cr) were also raised to be 1.4 and 2.1 times that of untreated soil when applying 10 and $20m^3$/fed composted LCM, respectively. More improvement was obtained by mixing LCM with the same amounts of other organic materials, *i.e.*, FYM and KC to be ~ 1.6 and ~2.4 times that of untreated soil for 10 and $20m^3$/fed composts, respectively. It is well known that the higher this index is the more stable is the soil structure. The same is true after the next crop. Values of Cr were 1.4 and 2.1 times that of untreated soil using 10 and $20m^3$ composted LCM/fed, respectively. Applying other composts increased Cr values of the soil to be 1.4 and 2.2 times for 10 and $20m^3$/fed composted LCM + FYM (1:1) and 1.6 and 2.3 times for 10 and $20m^3$/fed composted LCM + KC (1:1), in sequence.

TABLE 3. Effect of wooden waste composts on water stable structural units distribution in clayey soil after *vicia faba* and corn plantation.

Composts used	Application rate m^3/fed.	water stable structural units				MWD	Structure coefficient Cr
		>0.85 mm	0.85-0.425 mm	0.425-0.25 mm	< 0.25 mm		
a) after vicia faba.							
Untreated	-	2.16	15.04	17.54	65.26	0.246	0.532
LCM	10	5.02	17.78	19.3	57.9	0.312	0.727
	20	7.16	23.52	22.28	47.04	0.392	1.126
50%LCM + 50%FYM	10	5.78	19.84	19	55.38	0.334	0.806
	20	8.05	22.64	24.02	45.29	0.406	1.208
50%LCM + 50%KC	10	6.44	19.3	20.84	53.42	0.344	0.872
	20	9.08	23.58	23.16	44.18	0.422	1.263
b) after corn.							
Untreated	-	2.35	16.11	18.01	63.53	0.255	0.574
LCM	10	5.57	18.26	20.14	56.03	0.322	0.785
	20	7.64	23.78	22.86	45.72	0.401	1.187
50%LCM + 50%FYM	10	5.81	20.12	19.45	54.62	0.337	0.831
	20	8.87	22.95	24.16	44.02	0.419	1.272
50%LCM + 50%KC	10	6.91	20.62	21.05	51.42	0.358	0.945
	20	9.65	23.79	23.44	43.12	0.431	1.319

2.Bulk density, void ratio, total porosity and pore size distribution

Values of bulk density, void ratio, total porosity and macro and micro porosity after *vicia faba* and corn plantation as affected by treating the clayey soil with investigated composts are given in Table 4. Compared to the untreated soil, values of bulk density were decreased by 7.9 and 9.7%; 9.1 and 10.2% and 9.9 and 11.4% when 10 and 20m^3/fed of each of composted LCM, LCM + FYM(1:1) and LCM + KC(1:1) were respectively applied.

TABLE 4. Effect of wooden waste composts on soil porosity in clayey soil after *vicia faba* and corn plantation.

Composts used	Application rate m^3/fed.	Bulk density g/cm^3	Void ratio	Total prosity %	P.S.D.as a% of total porosity Macropores (D.P) >28.8 μ	Micropores (WHP) 28.8-0.19 μ	Micropores (N.U.P) < 0.19 μ
a) after vicia faba.							
Untreated	-	1.415	0.873	46.60	14.78	26.68	58.54
LCM	10	1.303	1.034	50.83	18.06	28.88	53.06
	20	1.278	1.074	51.77	18.69	29.81	51.50
50%LCM + 50%FYM	10	1.286	1.061	51.47	17.28	28.31	54.41
	20	1.27	1.087	52.08	18.21	28.82	52.98
50%LCM + 50%KC	10	1.275	1.078	51.89	17.25	28.92	53.84
	20	1.254	1.113	52.68	19.38	28.66	51.96
b) after corn.							
Untreated	-	1.401	0.892	47.13	13.77	27.62	58.61
LCM	10	1.286	1.061	51.47	17.61	30.17	52.22
	20	1.263	1.098	52.34	18.28	31.27	50.45
50%LCM + 50%FYM	10	1.28	1.070	51.70	17.60	29.85	52.55
	20	1.258	1.107	52.53	18.05	30.90	51.05
50%LCM + 50%KC	10	1.271	1.085	52.04	18.68	29.47	51.85
	20	1.246	1.127	52.98	18.50	31.28	50.22

P.S.D= Pore size distribution. WHP= Water holding pores.
N.U.P= Non useful pores. D.P =Drainable pores.

In regard to the effect of applied composts on void ratio, total porosity, macro porosity (>28.8μ) and water holding pores (28.8-0.19 μ), data took an opposite trend to that of bulk density. Increments relative to these of untreated soil amounted to 18.4 and 23.0 % for the void ratio; 9.1 and 11.1% for the total porosity; 25.0 and 33.0% for macro porosity (drainable pores) and 10.7 and 17.6 % for water holding pores when clayey soil was conditioned with 10 and 20m^3/fed composted LCM, respectively. When the soil was treated with 10 and 20m^3/fed composted LCM + FYM (1:1), the corresponding increments were 21.5 and 24.5 %; 10.4 and 11.8 %; 19.5 and 28.9% and 8.4 and 13.0 %, in sequence.

Regarding the effect of composted LCM + KC(1:1) on the aforementioned parameters, calculated increments due to applying 10 and 20m^3/fed composts were 23.5 and 27.5 %; 11.3 and 13.0%; 18.7 and 36.3% and 10.2 and 11.6%, respectively. The improving effect after corn is somewhat higher than, or more or less the same as, that obtained five months before.

3.Moisture retention in the soil

Retained moisture in clayey soil under different suctions as influenced by soil conditioning is shown in Table 5. and illustrated in Fig. 2. After 6 months from soil conditioning, increments in the total water holding capacity (WHC) of the soil ranged between 11.0 and 12.9% when incorporating 10m^3/fed composts into the soil. Doubling the application rate of the composts to be 20m^3/fed increased soil WHC by ~ 17%. At field capacity (FC), *i.e.*, at pF = 2.54, retained moisture into the soil also increased by 6.7, 9.15 and 9.6% when applying 10m^3/fed composted LCM, LCM + FYM(1:1) and LCM +KC(1:1), respectively. With 20m^3/fed composts, increments in moisture retained in the soil at its field capacity ranged between 11 and 12 %. Although the macro porosity was increased by soil conditioning on the expense of the micro ones, available moisture in the soil was also increased. Incorporating 10and 20m^3 composts/fed raised its available moisture to be ~1.2 and 1.3 times that of untreated soil, respectively. The same is true after corn. The improving effect of studied conditioners is still occurring.

TABLE 5. Effect of wooden waste composts on moisture retention and available moisture in clayey soil after *vicia faba* and corn plantation.

Composts Used	Application m^3/fed.	WHC* %	FC* %	WP* %	Available moisture* %
a) after vicia faba.					
Untreated	-	34.25	29.19	20.05	9.14
LCM	10	38.03	31.16	20.18	10.98
	20	39.90	32.44	20.55	11.89
50%LCM+ 50%FYM	10	38.52	31.86	20.96	10.90
	20	39.92	32.65	21.15	11.50
50%LCM+ 50%KC	10	38.66	31.99	20.81	11.18
	20	40.15	32.37	20.86	11.51
b) after corn.					
Untreated	-	34.73	29.95	20.36	9.59
LCM	10	38.51	31.73	20.11	11.62
	20	40.16	32.82	20.26	12.56
50%LCM+ 50%FYM	10	38.76	31.94	20.37	11.57
	20	40.11	32.87	20.48	12.39
50%LCM+ 50%KC	10	38.92	31.65	20.18	11.47
	20	40.26	32.81	20.22	12.59

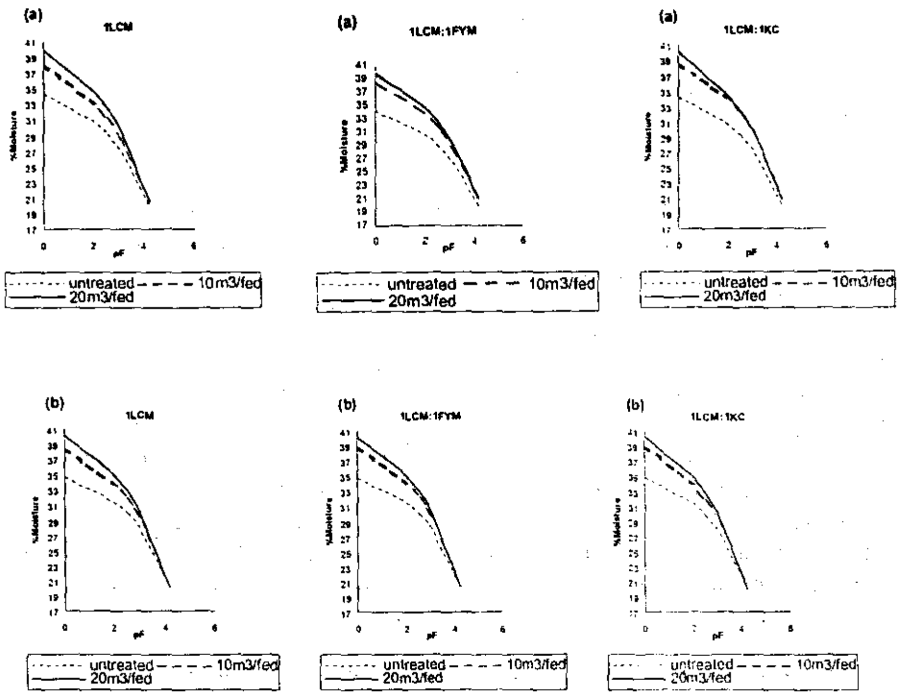

Fig. 2.Effect of wooden waste composts on pF curves in clayey soil after a. vicia faba b. corn.

4. Water transmitting properties

Some water transmitting properties of the clayey soil as influenced by soil conditioning are presented in Table 6. These properties include the infiltration rate of air-dry soil (cm h^{-1}), hydraulic conductivity of the soil under constant head (m day^{-1}), mean diameter of soil pores (μ), transmissivity for vertical flow of water through soil profile (Σ K/D day^{-1}) and adjusted evaporation (E adj).

With only one exception (water evaporation), applied composts raised the values of other parameters that describe water movement in the soil to reach after *vicia faba* and corn with $20m^3$/fed LCM compost 1.61 and 1.72 times for the infiltration rate; 3.71 and 4.11 times for the hydraulic conductivity; 2.64 and 2.87 times for water transmissivity; and 1.92 and 2.02 times for mean diameter of soil pores that of untreated soil. With $20m^3$/fed compost of LCM + FYM(1:1), values of studied parameters arranged as those mentioned above were 1.78 and 1.81 times; 4.43 and 4.78 times; 3.07 and 3.27 times and 2.10 and 2.17 times, respectively. Corresponding values for $20m^3$/fed compost of LCM + KC(1:1) were 1.93 and 2.02 times; 5.43 and 5.44 times; 3.67 and 3.67 times and 2.31 and 2.32 times, in sequence.

On the other hand, loss of water from the soil via evaporation, for all the studied treatments, was decreased by different percentages according to the type of added compost and its rate of application. In other words, values of E.adj was decreased by 10- 15% and by 20- 25% with the low and the high application rate of studied conditioners, respectively.

5.Mechanical strength of the soil

The effect of applied composts on the penetration resistance of the soil in kg.cm^{-2} -as a measure for its mechanical strength- is illustrated in Fig. 3. Data show that the mechanical strength of heavy clay compacted soil was lowered from 42.16 kg cm^{-2} for the untreated soil to be 26.57, 22.71 and 21.81 kg cm^{-2} after *vicia faba* grown in soil treated with 10m^3 of composted LCM, LCM + FYM (1:1) and LCM + KC(1:1), respectively. This means that soil mechanical strength was lowered by 36.9- 48.3% due to applying the investigated composts at this rate. More decrease in the mechanical strength of the soil was obtained by doubling the rate of applied conditioners. In other words, incorporating 20m^3/fed of the aforementioned composts into the soil lowered its mechanical strength to be 59.4, 65.5 and 63.8% that of untreated soil, respectively. Such decrease in the strength of the soil was continued for the other crop to reach 64.7, 69.7 and 65.6% that of untreated soil by incorporating 20m^3/fed of each of composted LCM, LCM + FYM(1:1) and LCM + KC(1:1) into the soil, in sequence.

TABLE 6. Effect of wooden waste composts on water movement in clayey soil after *vicia faba* and corn plantation.

Composts Used	Application rate m^3/fed.	Infiltration rate of air dry soil cm h^{-1}	Hydraulic conductivity m day^{-1}	Trans missivity (K/D) day^{-1}	Mean diameter of soil pores	Adjusted evaporation (E adj.)
a) after vicia faba.						
untreated	-	0.046	0.007	0.058	0.52	1.00
LCM	10	0.055	0.012	0.083	0.68	0.91
	20	0.074	0.026	0.153	1.00	0.86
50%LCM+	10	0.061	0.015	0.098	0.76	0.88
50%FYM	20	0.082	0.031	0.178	1.09	0.84
50%LCM+	10	0.063	0.017	0.108	0.81	0.86
50%KC	20	0.089	0.038	0.213	1.20	0.88
b) after corn.						
untreated	-	0.053	0.009	0.075	0.59	1.00
LCM	10	0.066	0.016	0.110	0.78	0.90
	20	0.091	0.037	0.215	1.19	0.85
50%LCM+	10	0.071	0.019	0.125	0.85	0.86
50%FYM	20	0.096	0.043	0.245	1.28	0.82
50%LCM+	10	0.074	0.020	0.130	0.87	0.85
50%KC	20	0.101	0.049	0.275	1.37	0.81

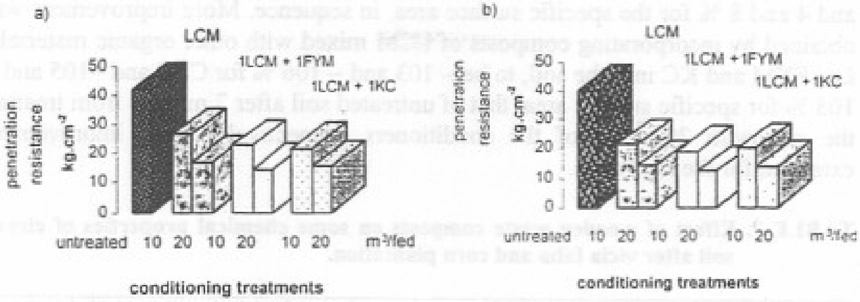

Fig 3. Effect of wooden waste composts on penetration resistance in clayey soil after a. vicia faba b. corn.

II.Chemical properties of the soil

Some Chemical properties of clayey soil as influenced by conditioning with LCM, LCM+FYM (1:1) and LCM +KC(1:1) composts after *vicia faba* and corn plantation are presented in Table 7. With only one exception, *i.e.* soil salinity, data reveal that all the studied properties were improved by varying degrees due to soil conditioning as follows:

1.Soil pH

Regarding soil pH, all examined conditioning treatments slightly decreased the values of this soil property. These decrease were calculated to be 0.23 and 0.29 units after *vicia faba* by applying 10 and 20m^3/fed LCM composts, respectively. More decrease in soil pH to be lower than that of untreated soil by 0.29 and 0.44 units or 0.3 and 0.4 units were obtained by treating the soil with the two application rates of [LCM + FYM (1:1)] or [LCM + TR (1:1)] composts, respectively. After corn plantation more decrease in soil pH was obtained. Such decrease ranged between 0.3 and 0.35 units with 10m^3/fed conditioner and 0.38 and 0.47 units with 20m^3/fed being lower with the composts of mixtures of LCM and other organic materials.

2.Soil salinity

Due to the salt content of added composts (Table 7), slight increase in soil salinity was noticed. Using 10m^3/fed composts raised soil salinity by 4.9, 3.9 and 9.8% for LCM, LCM + FYM (1:1) and LCM + KC(1:1) composts, respectively. Relevant values for 20m^3/fed treatments were 13.7, 11.8 and 15.7 %, in sequence. After corn, increments in soil salinity were calculated to be 3.7, 4.6 and 6.5 % for 10m^3/fed composts and 15.7, 12.0 and 13.9 % for 20m^3/fed composts mentioned above, respectively.

3.Cation exchange capacity and specific surface area

Conditioning the soil raised both parameters being higher with the application rate of the conditioner. By applying 10 and 20m^3/fed LCM compost and after *vicia faba* plantation, these increase were calculated to be ~3 and 6% for CEC and 4 and 8 % for the specific surface area, in sequence. More improvement was obtained by incorporating composts of LCM mixed with other organic materials, *i.e.*, FYM and KC into the soil, to be ~ 103 and ~ 106 % for CEC and ~105 and ~ 108 % for specific surface area, that of untreated soil after 7 months from treating the soil with 20m^3/fed of the conditioners, respectively. Such improvement extended for the next crop.

TABLE 7. Effect of wooden waste composts on some chemical properties of clayey soil after vicia faba and corn plantation.

Composts Used	Appl. rate m^3/fed	pH 1:2.5	EC dS m^{-1}	CEC c mole kg^{-1}	Specific surface area m^{2}g^{-1}	O.M %	O.C %	Organic Nitrogen %	C/N	Available P ppm	Available K ppm
a) after vicia faba.											
untreated	-	8.02	1.02	43.10	87.49	0.89	0.516	0.044	11.73	26.9	70.3
LCM	10	7.79	1.07	44.35	91.36	1.69	0.980	0.110	8.91	36.9	121.2
	20	7.73	1.16	45.59	94.37	2.55	1.479	0.230	6.43	51.7	168.7
50%LCM	10	7.73	1.06	44.56	91.79	1.88	1.090	0.120	9.08	39.8	133.1
+ 50%FYM	20	7.58	1.14	45.66	94.97	2.68	1.554	0.260	5.98	68.7	186.7
50%LCM	10	7.72	1.12	44.39	91.44	1.76	1.021	0.130	7.85	40.7	116.6
+ 50%KC	20	7.62	1.18	45.58	94.35	2.59	1.502	0.250	6.01	71.8	170.3
b) after corn.											
untreated	-	8.01	1.08	43.16	89.53	1.01	0.586	0.050	11.72	32.6	88.1
LCM	10	7.71	1.12	44.48	92.96	1.62	0.940	0.130	7.23	44.7	139.6
	20	7.63	1.25	45.68	95.13	2.49	1.444	0.280	5.16	56.7	172.1
50%LCM	10	7.66	1.13	44.63	92.17	1.80	1.044	0.140	7.46	47.3	143.3
+ 50%FYM	20	7.54	1.21	45.51	94.86	2.56	1.485	0.290	5.12	72.2	196.4
50%LCM	10	7.69	1.15	44.56	91.89	1.93	1.119	0.140	7.99	48.1	131.6
+ 50%KC	20	7.58	1.23	45.74	99.97	2.79	1.618	0.310	5.22	78.6	176.8

4.Soil organic matter content

As expected treating the soil with organic composts raises its organic matter (OM) percentage and accordingly its organic carbon (OC) content being higher with the rate of applied composts. In other words, using 10m^3 and 20m^3 LCM compost/fed increased OM % and OC % of the soil to be ~190 and ~286 % that of untreated soil, respectively. Mixing LCM with FYM or KC at the rate of 1:1 before applying to the soil raised both properties to reach 211 or 301 % that of untreated soil by applying 10m^3 or 20m^3 of the conditioners/fed. By time proceeding, *i.e.*, after corn, treated soil were still maintain higher percentages of OC.

5. Organic nitrogen and C/N ratio

Similarly, organic nitrogen content gave the same trend as OM % and O.C content. Compared with the control treatment, values of organic N were highly increased to be 150 and 423 %; 173 and 491 % and 196 and 468 % that of untreated soil after *vicia faba* grown in soil conditioned with $10m^3$ and $20m^3$ LCM; LCM + FYM (1:1) and LCM + KC(1:1) composts/fed, respectively. More increase in organic N was obtained at the end of the experiment, *i.e.*, after 12 months from conditioning to be 160 and 460 %; 180 and 480 %; and 180 and 520 % that of untreated soil for the aforementioned treatments, respectively.

Because the increase in O.C is far beyond that of organic N, C/N ratios are much narrower. While C/N of untreated soil was 11.73 it decreased to be 8.91 and 6.43 by treating the soil with $10m^3$and $20m^3$ LCM composts/fed, respectively. Using composts of mixtures of LCM + FYM (1:1) or LCM + KC(1:1), decreased C/N to be ~28% and~49% lower than that of untreated soil. After one year from soil conditioning the decrease in C/N was amounted to ~35 % and ~ 56 % for $10m^3$ and $20m^3$ composts/fed, respectively. Such decrease in C/N refer to the easiness of the mineralization of organic nitrogen compounds and the possibility to save and provide available forms of N to growing plants.

6. Available P and K

Although fertilization is the same for all treatments, available phosphorus increased by 37.2,48.0 and 51.3 % for $10m^3$/fed of LCM, LCM + FYM (1:1) and LCM + KC(1:1) composts, respectively. Doubling the rate of applied composts to be $20m^3$/fed raised the availability of phosphorus to be 192.2, 155.4 and 266.9 % that of untreated soil, in sequence. The same was true with potassium. With $10m^3$/fed conditioners, available potassium was calculated to be 172.4, 189.3 and 165.9% that of untreated soil for the previously mentioned composts in sequence. With $20m^3$/fed composts, increments in the availability of K as compared to that of untreated soil were 140.0 % for LCM compost; 165.6 % for LCM + FYM (1:1) compost and 142.2 % for LCM + KC(1:1) ones.

More increase in available phosphorus and available potassium were obtained at the end of the experiment (after corn plantation) where available P increased by 37.1, 45.1 and 47.5 % with $10m^3$/fed of each of LCM, LCM + FYM (1:1) and LCM + KC(1:1) composts, respectively. Relevant values for $20m^3$/fed treatment were 73.9, 121.5 and 141.1 %, in sequence. Regarding available K, corresponding increases with $10m^3$/fed composts were 58.5, 62.7 and 49.4 % and with $20m^3$/fed composts were 95.3, 122.9 and 100.7 %, respectively.

Obtained results show that incorporating organic composts in the soil have a three fold effect. It works physically, chemically and biologically. The combination of these effects has resulted in an integrated influence on the studied properties (Giusquiani *et al.*, 1995). This could be attributed to the following: a)promoting good soil structure through improving soil aggregation and increasing the percentages of water stable structural units with suitable pore size distribution (Caravaca *et al.*, 2001; Aguilar 2002; Carter; 2002, Whalen *et al.*, 2003; Mikha & Rice 2004). B)improving the dynamic soil water characteristics, *i.e.*, the downward movement of water through infiltration and the upward movement of it via evaporation (Aguilar, 2002). C)improving the mechanical strength of the soil that can be satisfactory tilled with lower power requirements (Aggelides & Londra, 2000 and Nusier, 2004). D)increasing the organic matter content in the soil and its contribution to the chemical properties and the nutritional status of the soil. This includes: 1)increasing the exchange capacity of the soil and in turn their specific surface area. It is essentially due to the carboxyl groups of organic compounds. Organic matter normally has about 200 cmol kg^{-1} of such carboxyl group (El-Kina & Konstantinova, 1998). 2)lowering soil pH that leads to more solubility of nutrients and increasing nutrient availability (Sttraton & Rechcigl, 1998). 3) serving as the principle store house for cations and anions for plant growth and acting as a complexing agent, therefore the loss of nutrients by leaching in soil treated with organic materials is slow. Hence they remain in soil within the reach of the plant roots for a longer period than inorganic fertilizers (Carter, 2002). 4)affecting N dinamics in the root zone (mineralization, denitrification, immobilization and plant uptake) towards increasing N availability and uptake by growing plants (Mooleki *et al.*, 2004 and Yang *et al.*, 2004). And 5)increasing soil microbial biomass and enzymes activity indicating an improvement in the biological fertility of the soil (Albiach *et al.*, 2000 and Crecchio *et al.*, 2004).

It is interesting to note that organisms largely responsible for the breakdown of the organic materials require large quantities of nitrogen. Therefore, adding materials supplying large amounts of nitrogen (such as fresh, green grass clippings or fresh farm animal manures) is necessary for rapid decomposition. A nitrogen- containing fertilizer may be added when a high nitrogen organic source is not available. This is why applying composts of mixture of LCM (slow decomposable materials) with other organic materials *i.e.* FYM or KC (rabid decomposable materials) gave better and earlier results than those of LCM compost solely. Studies of other investigators indicate our results. Of these are studies of Sommerfeldt & Mackay (1987) who used mixtures of bark, sawdust, wood shavings and peat moss and those of N'dayegamiye & Isfan (1991) for testing each of wood shavings, sawdust or peat moss mixed with cattle manure in 2:1 ratios by volume as soil amendments.

Due to the salt content of added composts and the slight increase in soil salinity, it is preferred to apply composts free of salts. Miller *et al.* (2005) concluded that manures should not increase soil salinity and sodicity. Bedding materials (straw or wood chips) to be mixed with manures may be a potential tool to manage certain salinity variables in the soil.

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مخلفات الصناعات الخشبية المكمورة كمحسنات للآراضى الطينية
٢-أثرها على الخواص الفيزيوكيمائية للتربة

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أجريت تجربة حقلية لمدة سنتين بنظام تام العشوائية ذو أربعة مكررات لكل معاملة بمنطقة أبو المطامير بمحافظة البحيرة لدراسة التغيرات فى الصفات الفيزيوكيمائية لتربة طينية مندمجة الناتجة عن معاملة التربة بمعدلين (٢٠،١٠ م^3/ فدان) من مكمور مخلفات الصناعات الخشبية بمفرده أو مخلوطا مع سماد المزرعة أو كمبوست القطامية بنسبة ١:١ وزراعتها بمحصولين متتاليين هما الفول البلدى (صنف جيزة ٢) والذرة (هجين ٣١٠).

كان تأثير المحسنات تحت الدراسه إيجابيا ومتمثلا فى الآتى:

أولا : تحسن الخواص الهيدروفيزيائيه للتربة بما يضمن:

أ- بناء أرضى جيد ذو توزيع مسامى مناسب يتوازن فيه مسام التهوية مع مسام حفظ الرطوبة .

ب- تعديل خواص حركة الماء فى التربة لأسفل (النفاذية والتوصيل الهيدروليكى) ولأعلى (التبخير) بما يؤدى إلى إحتفاظ التربة بقدر أكبر من الرطوبة للنبات وفى نفس الوقت تحسين ظروف الصرف وتوفير قدر كافى من التهوية للجذور .

جـ- تحسن الخواص الميكانيكية للتربة بحيث يمكن خدمتها بسهولة وبإحتياجات طاقة أقل.

ثانيا : تحسن الخواص الكيمائية والحالة الغذائية للتربة وتشمل:

أ- خفض pH للتربة ومايتبعه من زيادة تيسر العناصر وتحسن الحالة الغذائية للتربة.

ب- زيادة نسبة المادة العضوية والنيتروجين العضوى وتعديل نسبة الC:N لتصبح فى صالح كل من ميكروبات التربة والنبات.

جـ- زيادة السعة التبادلية الكاتيونية والسطح النوعى للتربة ومايتبع ذلك من إرتفاع كفاءة التفاعلات البيوكيمائية فى التربة.

د- زيادة تركيز العناصر الغذائية القابلة للإستفادة فى التربة.

وبإستثناء خاصية واحدة (تركيز الأملاح فى التربة) فإن التأثير التحسينى يزداد بزيادة معدل الإضافة.

خلط المواد العضوية بطيئة التحلل نسبيا وذات نسبة C:N عالية (مكمور مخلف الصناعات الخشبية) مع المواد العضوية الأخرى الأسهل تحللا وذات نسبة C:N أقل (سماد المزرعة وكمبوست القطامية) يسرع من التأثير التحسينى لمكمور مخلف الصناعات الخشبية ويخفض نسبة ال C:N لتصل لمستوى مناسب مما يؤدى لظهور التحسن مبكرا (بعد المحصول الأول) ويمتد هذا التأثير ليشمل المحصول التالى مما يعطى أفضلية لمخاليط المواد العضوية مع مخلف الصناعات الخشبية مقارنة بمخلف الصناعات الخشبية بمفرده.

يفضل إستخدام مواد عضوية مكمورة خالية من الأملاح حيث أن زيادة المحتوى الملحى للمواد العضوية المضافة يزيد من ملوحة التربة مما يؤثر عكسيا على نمو النبات. وفى حالة إستخدام سماد المزرعة يجب خلوه من بذور الحشائش والنيماتودا والممرضات.