Effects of Composted Tobacco Waste and Farmyard Manure on Some Soil Physical Properties and Lettuce Yield

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ABSTRACT
This research was held in Agriculture Faculty of Ege University Menemen Investigation and Practise Farmyard. Tobacco waste gathered from cigarette industry were composted and applied to the soil together with farmyard manure. lettuce (*Lactuca sativa L. var. capitata*) was grown as test plant. No mineral fertilizers or pestisides were applied. The effects of composted tobacco wastes and farmyard manures on soil physical properties and lettuce yield were investigated. All application rates provided increasing effects on soil's physical properties at different percentages. Also, similar effects were determined for lettuce yield. Maximum yield was 102,7 ton ha^{-1} at the plots where % 100 composted tobacco wastes were applied. The results show that there are positive effects on all soil properties by the applications of the studied material; (thus) and this organic material source shouldn't be destroyed. Enviroment is also kept clean.
Keywords: Composted tobacco waste, farmyard manure, lettuce (*Lactuca sativa L. var. Capitata*), physical properties of soil

INTRODUCTION

Soil needs nutrients as every ecosystem. It has been known that organic matter which is a nutrient for soil organisms have got positive effects on soil's physical, chemical and biological properties. Protection of soil's natural efficiency is related to its content of organic matter .

Addition of organic materials to soil provides improving soil microorganism activity and increase aggreagation. As protection of soil and increasing plant productions belong to amelioration and protection of soil structure. Water movement, root development, water in soil and soil air are related to soil structure (Darwish et al., 1995).

Farmyard manure (FYM) which is the most useful organic manure as an organic matter is provided from various plant and animal wastes. Due to the fact that FYM is an expensive material and not found enough, other organic materials can be used instead of FYM to improve soil properties. Incorporation of these wastes to the soil is important to evaluate them as organic matter and also to prevent enviromental pollution (Kütük et al., 1995; Okur and Delibacak, 1996; Hati et al., 2006).

The Head Lettuce (Lactuca sativa L. var. capitata) is a main group of lettuce. Production of lettuces are 21 000 000 ton in 1 000 000 ha area in the world. In Turkey, there are 18 700 ha production area and approximetly 360 000 ton lettuce production and 60 000 tons of these productions are head lettuce (Anonymous, 2002).

In our country, lettuces are generally being grown in Ege, Marmara, and Mediterranen regions. They can be grown on not only sandy soils but also on clay soils. Due to the fact that acid soils aren't suitable for lettuces, they souldn't be grown in a soil which has less than 5,6 pH.

The aim of current work was to compare effects of composted tobacco waste (CTW) and FYM on physical properties of soil and lettuce yield. Moreover, if using tobacco waste has got positive effects, this material which has rich organic matter content won't be destroyed and will be stopped before it harms the enviroment and ensured to soils as organic matter.

MATERIAL and METHODS

Experimental Design

This research was carried out in Agriculture Faculty of Ege University Menemen Investigation and Practise Farmyard. The experiment was conducted a randomized block design with 3 replications and 6 treatments. Each plot had an area of 6 m^2 (3 x 2 m) and 30 plants. CTW were applied to the soil together with FYM. Lettuce (*Lactuca sativa L. var. capitata*) was grown as a test plant.

Tobacco wastes gathered from Izmir Kemalpaşa Socotab factory were composed and applied on parcels with composted FYM gathered from Agriculture Faculty of Ege University Menemen Investigation and Practise Farmyard. The effects of these materials on soil's physical properties and the yield of grown lettuce was investigated.

The experiment was conducted on loam texture soil, 7.52 pH with low alkaline reaction. Total soluble salt concentration was determined that without salt at a level of 0,085 %. Soil $CaCO_3$ amount was classified as average calcic (calcareous) at a level of 5.38 %. Other soil samples amounts are analyzed as 2,53 % organic matter and 17,3 mg $100g^{-1}$ cation exchange capacity are given in Table 1. Also some physical and chemical properties of CTW and FYM are given in Table 2 and 3, respectively.

Table 1. Some physical and chemical properties of experimental soil.

Soil Texture	Loam	Agregation (%)	29.11
Sand (%)	44.26	Structure stability Ind. (%)	10.88
Cilt (%)	44.13	Available Water (%)	9.7
Clay (%)	11.61	Total Porosity (%)	50.44
pH	7.52	Total-N (%)	0.129
Total Soluble Salt (%)	0.085	Available P (mg kg^{-1})	8.88
$CaCO_3$ (%)	5.38	Available K (mg kg^{-1})	447.29
Organic Matter (%)	2.53	Available Ca (mg kg^{-1})	2752.5
Bulk Density (g cm^{-3})	1.28	Available Mg (mg kg^{-1})	529.46
Particle Density (g cm^{-3})	2.58	Available Na (mg kg^{-1})	217.92
CEC (me 100 g^{-1})	17.3		

Table 2. Some physical and chemical properties of CTW

60 C° Water Content (%)	7.19	CaCO3 (%)	2.43
105 C° Water Content (%)	29.79	Total N (%)	2.18
pH	9.17	Available P (mg kg^{-1})	4900
EC (dS m^{-1})	40	Total K (mg kg^{-1})	26880
Organic Matter (%)	65.3	Total Na (mg kg^{-1})	2552
C/N	17.37	Total Ca (mg kg^{-1})	12870
Organic C (%)	37.87	Total Mg (mg kg^{-1})	6552

Table 3. Some physical and chemical properties of FYM

60 C° Water Content (%)	5.50	CaCO3 (%)	2.09
105 C° Water Content (%)	25.13	Total N (%)	2.35
pH	8.70	Available P (mg kg^{-1})	5800
EC (dS m^{-1})	38.5	Total K (mg kg^{-1})	30720
Organic Matter (%)	67.2	Total Na (mg kg^{-1})	2816
C/N	16.5	Total Ca (mg kg^{-1})	15210
Organic C (%)	39	Total Mg (mg kg^{-1})	6152

CTW was mixed with FYM at various ratios. Treatments were as follows:

Soil without fertilization (control)

% 25 FYM+ % 75 CTW

% 50 FYM+ % 50 CTW

% 100 FYM

% 100 CTW

%75 FYM+ % 25 CTW

At the beginning of the experiment, according to the results of the analyzed soil nutrients, 50 t ha^{-1} manure was applied to the soil because lettuce plant needs 50-100 kg N ha^{-1} (IFA, 1991). Except this, no mineral fertilizers and pesticides were applied. 540 lettuce seedlings were planted in I. vegetation period, on 1st September, 2005 by furrow watering and then watering method was changed as irrigation. First harvest was on the 11th November, 2005. During the II. vegatation period, again 540 lettuce plants were planted on 25th November, 2005 by watering and they were not watered until the end of harvest because of rainy season. II. period lettuce harvest was performed on the 14 th April, 2006.

Soil Sampling and Analyses

During the experiment, undisturbed and disturbed soil samples (0-20 cm) were taken from the center of each plot after one week of planting and before 1st and 2nd harvest. The samples were air-dried and sieved using 2 and 8 mm sieves. Undisturbed soil samples were taken by using a steel cylinder of 100 cm^3 volume (5 cm in diameter, and 5 cm in height). Bulk density and field capacity were determined from these soil samples. Wilting point was determined using disturbed soil samples sieved through a 2 mm sieve. Dry bulk density was measured by the core method (Blake and Hartge, 1986), particle density was determined by pycnometer method (Soil Survey Staff, 1951), particle size distribution was determined by the Bouyoucos hydrometer method (Bouyoucos, 1962), nonaggregated silt+clay and total silt+clay were determined by using A.S.T.M. Soil testing cylinder (Soil Survey

Staff, 1972), structure stability index and aggregation percentage were calculated by formula (Soil Survey Staff, 1951). Total salt, OM concentration, calcium carbonate and pH were all determined according to Page et al., (1982). Available P was determined by the Mo blue method in a $NaHCO_3$ extract (Olsen et al., 1954). Available Ca, Mg, K and Na were analyzed with 1 N NH_4OAc extract method. Ca, K and Na were determined by flame emission spectrometry and Mg was determined by flame atomic absorption spectrometry (AAS) (Kacar, 1994). Some properties (total salt, OM concentration, calcium carbonate, pH, total N, P, K, Ca and Mg) of the experimental soil, CTW and FYM were also determined according to Page et al. (1982). Total porosity was calculated using bulk density and particle density values. Water retention capacity at -33kPa (field capacity) was determined in undisturbed soil samples and at -1500 kPa (permanent wilting point) in disturbed samples using a ceramic plate apparatus. Available Water Content (AWC) was calculated as the difference between water retained at -33kPa and at -1500 kPa (Klute, 1986).

Statistical Analyses

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 9 (SPSS, 1999). One-way analysis of variance was performed to determine the effects of CTW and FYM on some physical properties of Typic Xerofluvent soil, and Duncan test was used to find if differences in the treatments were significant at $P \leq 0.05$.

RESULTS

Effects of CTW and FYM on some physical properties of Typic xreofluvent soil and lettuce yield are given in Table 4.

Table 4. Effects of CTW and FYM on some physical properties of soil and lettuce yield.

Treatments	1st.sampling (After one week of planting) 1st.vegetation	2nd.sampling 1st.vegetation harvest	3rd.sampling 2nd.vegetation harvest
	Bulk Density (g cm^{-3})		
Control	1,28 A	1,26 A	1,28 A
25% M+75% CTW	1,25 AB	1,19 B	1,23 B
50%M+ 50% CTW	1,25 B	1,20 B	1,24 B
100%M	1,24 B	1,21 B	1,23 B
100%CTW	1,23 B	1,19 B	1,23 B
75%M+25%CTW	1,24 B	1,21 B	1,24 B

Means for CTW and FYM treatments applied in soil in the same period followed by the same letter are not significantly different (Duncan; $P \leq 0.05$)

Table 4. Effects of CTW and FYM on some physical properties of soil and lettuce yield (go on).

Treatments	1st.sampling (After one week of planting) 1st.vegetation	2nd.sampling 1st.vegetation harvest	3rd.sampling 2nd.vegetation harvest
	Particle Density(g cm^{-3})		
Control	2,58 A	2,64 A	2,61 A
25% M+75% CTW	2,57 A	2,58 B	2,58 AB
50%M+ 50% CTW	2,57 A	2,59 B	2,58 AB
100%M	2,57 A	2,57 B	2,57 B
100%CTW	2,57 A	2,56 B	2,56 B
75%M+25%CTW	2,57 A	2,58 B	2,56 B
	Total Porosity (%)		
Control	50,44 B	52,14 A	50,95 A
25% M+75% CTW	51,16 AB	53,93 A	52,18 A
50%M+ 50% CTW	51,48 AB	53,40 A	51,86 A
100%M	51,74 A	52,90 A	52,06 A
100%CTW	52,13 A	53,63 A	51,74 A
75%M+25%CTW	51,75 A	53,09 A	51,42 A
	Field Capacity (%)		
Control	18,73 C	18,65 B	18,27 B
25% M+75% CTW	21,38 A	21,68 A	20,33 A
50%M+ 50% CTW	20,30 B	20,97 A	20,07 A
100%M	20,83 AB	21,61 A	20,58 A
100%CTW	21,23 AB	21,90 A	20,69 A
75%M+25%CTW	21,35 A	21,14 A	20,43 A
	Wilting Point (%)		
Control	9,03 C	8,86 B	8,63 B
25% M+75% CTW	10,16 A	10,30 A	9,76 A
50%M+ 50% CTW	9,63 B	9,93 A	9,80 A
100%M	9,86 AB	10,23 A	9,90 A
100%CTW	10,06 AB	10,46 A	9,93 A
75%M+25%CTW	10,10 AB	10,00 A	9,86 A
	Available Water (%)		
Control	9,70 C	9,79 B	9,63 B
25% M+75% CTW	11,22 A	11,38 A	10,56 AB
50%M+ 50% CTW	10,67 B	11,04 A	10,27 AB
100%M	10,96 AB	11,37 A	10,68 AB
100%CTW	11,16 AB	11,44 A	10,76 A
75%M+25%CTW	11,25 A	11,14 A	10,56 AB
	Structure Stability Index		
Control	10,88 B	12,38 C	11,72 B
25% M+75% CTW	15,54 A	16,38 A	15,05 A
50%M+ 50% CTW	16,21 A	16,38 A	14,38 A
100%M	15,54 A	15,72 AB	14,38 A
100%CTW	14,88 A	14,38 B	15,05 A
75%M+25%CTW	14,21 A	15,72 AB	14,38 A
	Average Yield (t ha^{-1})		
	1st. vegetation	2nd. vegetation	Total
Control	50,7 B	31,0 C	81,7 B
25% M+75% CTW	60,8 A	38,0 AB	98,8 A
50%M+ 50% CTW	59,9 A	37,7 AB	97,6 A
100%M	60,9 A	37,4 AB	98,4 A
100%CTW	62,7 A	39,9 A	102,7 A
75%M+25%CTW	60,1 A	36,0 B	96,2 A

Means for CTW and FYM treatments applied in soil in the same period followed by the same letter are not significantly different (Duncan; $P \leq 0.05$)

DISCUSSION

Bulk density was decreased positively with increasing organic matter sources such as tobacco waste and manure. According to Hartge and Horne (1999), bulk density values are generally 1,67-1,19 g cm^{-3} for sandy soils, 1,96-1,19 g cm^{-3} for loam soils, 1,53-1,19 g cm^{-3} for silty soils, 1,32-0,92 g cm^{-3} for clay soils and 0,48-0,12 g cm^{-3} for organic soils.

High OM content of CTW and FYM decreased particle density of soil. OM, which weighs much less than an equal volume of mineral solids, decrease the particle density of soils. Some surface soils with high OM contents may exhibit particle density values of 2.4 g cm^{-3} (Tan, 1996).

Soil total porosity values were analyzed an measured as approximetly 50,44 % in experimental area soils. Depending on application of CTW and FYM, soil porosity increased. Especially after first harvest, total porosity of soil samples increased at a level of 7 % by 25 % FYM+ 75 % CTW treatment. Aggelides and Londra (2000) also found that organic compost application considerably improved soil physical properties by increasing soil porosity and changing distribution of pore sizes in loamy and clay textured soils.

Soil aggregation was significantly affected by the treatments. The highest value of soil agregation was found for 50 % FYM+ 50 % CTW treatment and 25 % FYM+ 75 % CTW treatment. Because of the fact that there is a strong correlation between structure stability and contents of high organic matter in CTW and FYM, application of these materials with different doses have increased soil aggregation and soil structure stability index. Aoyama et al. (1999) noted that manure and a combination of manure with N, P, and K fertilizers caused significant increases in the formation of water stable aggregates and soil organic matter; whereas, only N, P and K fertilizers application did not affect these soil properties.

The effect of organic treatments on water holding capacity was analyzed significantly. The CTW treatment was resulted in the highest values in both field capacity and available water capacity. Available water amount in soils related to soil is related to soil texture situation, structure and organic matter (Saatçı, 1975).

After application of CTW and manure, statistical differences on lettuce yield values were found. The highest yield was in 1st vegetation plants by application of 100 % CTW by 62,7 t ha^{-1}.

Due to the fact that II. vegetation period was winter season (Especially in December, January and February have been very cold) yield of Lettuce were decreased. Total yield of lettuce was determined on parcels which applicated % 100 CTW by 102,7 t ha^{-1}.

CONCLUSION

Application of CTW provided positive effects on soil physical properties at different percentages. It can be said that CTW is a soil conditioner. CTW is a nutrient and OM source, which increases the yield. These results demonstrate the importance of the incorporation of CTW in soil as an alternative organic amendment for improving soil properties in dryland and especially in Mediterranean soils, which are characterized by low organic matter content.

It is recommended that 50 t ha-1 CTW can be added for improving soil properties of Typic Xerofluvent soil, which are characterized by low OM content. In order to maintain and improve soil quality, further studies must be performed to confirm the positive long-term effects of CTW.

ACKNOWLEDGEMENT

The authors would like to thank the Ege University Scientific Research Found for providing financial supporting for project number 2005 ZRF 055.

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