The effect of rice straw and poultry waste addition on the soil physical properties
I- clay soil

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Abstract:

The study was conducted in fall 2009 at the College of Agriculture/ Babylon University. The purpose of the study is to show the effects of two types of organic matter on the physical properties of clay soil. The results show a significant increases in both of soil saturated hydraulic conductivity and soil porosity with the addition of chicken waste and rice straw. However; the increases were more pronounced with chicken waste than with rice straw. Moreover; the values of the bulk density decrease significantly with organic matter addition to the soil, nevertheless; the reduction was more pronounced with chicken waste addition than with rice straw addition.

Introduction:

Application of crop and plant biomass for improving soil organic matter and enhancing soil quality is well recognized in sustainable agriculture(Carter et al, 1988;Kay, 1998). Recycling of these surplus agricultural byproducts has the advantage to meet nutrient requirements for the crop and expanded use as effective soil amendments. Manure and composted manure have been studied for long time as the organic amendments.

During the last several decades much attention has been paid to the utilization of crop and plant residues as soil amendments as well as to evaluate the effects of existing organic matters on soil physical properties such as soil structure and aggregate stability (Tisdal and Oades, 1982; Debosz et al, 2002), porosity and pore size distribution (Schjonning et al, 2002), bulk density (Gupta et al, 1977) and water holding capacity (Rawls et al, 2003; Miller et al, 2002).

Addition of organic matter decreases bulk density due to the dilution effect of added organic matter with denser mineral fraction (Gupta et al, 1977).From their report, yearly addition of 450 ton/ha of anaerobically digested sewage sludge for two consecutive years decreased the bulk density of field course sandy soils by 28% .

Debosz et al, (2002) reported a 25% increase in water stable aggregates of sandy loam soil amended with house hold compost at constant temperature of (10 C°).

Several studies demonstrated with biosoilds and composted biosolids suggested increased soil water retention and aggregate stability in silt loam soils (Lindsay and Logan, 1998). Crop residues increase soil hydraulic conductivity and infiltration rate by modifying mainly soil structure, proportion of macro pores, and aggregate stability (Mando et al, 1996). Mando et al, 2004 found that farmyard manure and rice straw +farmyard manure treated plots had higher percentage of water stable aggregates (≥ 0.25 mm diameter), greater mean weight diameter, higher porosity, lower bulk density, higher available water capacity and higher hydraulic conductivity of saturated soil. The use of the compost is the need of the time. Soil physical properties like bulk density ,porosity, void ratio, water permeability, and hydraulic conductivity were significantly improved when farm yard manure (10 ton/ha) was applied in combination with chemical amendments, resulting in enhanced rice and wheat yield in sodic soil (Hussain et al, 2001).

Although manure and compost manure as organic amendments have been addressed in several studies, very little research has been done in order to observe the effects of rice straw and poultry waste as soil amendments on soil physical properties. To date there is little information on the

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effect of rice straw and poultry waste amendments on the hydraulic conductivity of the soils (Garnier et al,2004).Therefore, for optimal land application of these biomasses as soil amendments; understanding the influences of these amendments on soil physical and hydraulic properties is essential.

The purpose of this study is to evaluate the effects of rice straw and poultry waste as amendments on : soil hydraulic conductivity, soil bulk density, and soil porosity.

Materials and Methods :

The experiment were carried out during the period from November, 2009 to April, 2010. The first soil was a clay soil which were taken from 0-30 cm depth at Al Bakerilly county south of Al Haila city/ Babil Governorate. The other soil was sandy soil which was taken from Al Haila river shore. the result of the experiment with sandy soil will be presented and discussed in the second part of this paper.

Two kind of organic matter were used as soil amendment: Rice straw, and Poultry waste. Two rate of these amendments were added to 5 kg soil:(0.5%) and(1%) of the soil weight in addition to the control (0%) which were placed in 5 kg soil pots . The chemical analysis and particle size distribution of clay soil are shown in table 1.

Table 1 The chemical properties and the particle size distribution of the clay soil

SO4 mole/kg	CL mole/kg	HCO3 mole/kg	Mg mole/kg	Ca mole/kg	K mole/kg	Na mole/kg	Ec ds/m	PH	Sand %	Silt %	Clay %
13.72	26.50	3.12	13.11	19.20	0.83	10.20	2.50	7.8	4	16	80

All the above analyses were carried out according to Black, et al, 1965.Complete randomized block design with three replicates was applied to layout the experiment for each of the following treatments:

1- control : no organic matter addition (0%)
2- 20 ton/hectare addition of poultry waste (0.5%)
3- 40 ton/hectare addition of poultry waste (1%)
4- 20 ton/hectare addition of rice straw (0.5%)
5- 40 ton/hectare addition of rice straw (1%)

All these treatments were mixed thoroughly with 5 kg soil in each pot. Legume crop (alfalfa) was planted in all pots to ensure the nitrogen supply to the microorganisms responsible for organic matter decomposition. Moreover; on day 25 after planting the crop, 5 gm of urea were added to poultry waste pots treatment. All pots were irrigated regularly according to the plants need for water.
The texture of the soil samples were measured using the hydrometer method (Day,\z P., 1965). The bulk density of each soil sample is measured by using the core method (Blake, 1986). The partical density of the soil samples were measured by pyrometer method (Blake, 1965). The porosity of the soil samples were calculated by using the following equation:

$P = (1- \rho b/\rho s) \times 100$
Where: p is the porosity (%)

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ρb is the bulk density (gm/cm^3)
ρs is the particle density (gm/cm^3)

The saturated hydraulic conductivity of the soil samples were measured by using falling head method (Klute and Dirksen, 1986).

Results and Discussion :

1-Saturated hydraulic conductivity:

Figure 1 shows the relation between saturated hydraulic conductivity and the percentage of organic matter added. The increases in the value of saturated hydraulic conductivity with first addition (0.5%) and the second addition (1%) of both types of organic matter were significant at 5% probability level. However; the increases with the poultry waste addition were more than with rice straw addition. These results agree very well with Eusufzai, et al, 2007; Agbede, et al, 2008; Bhogal, et al, 2009; and Mbagwu, 1991.The differences in the effect of the two type of organic matter on the saturated hydraulic conductivity may be due to the stability of soil structure units is more with poultry waste added soil than with rice straw added soil. Nevertheless; this assumption need to be verified to be true.

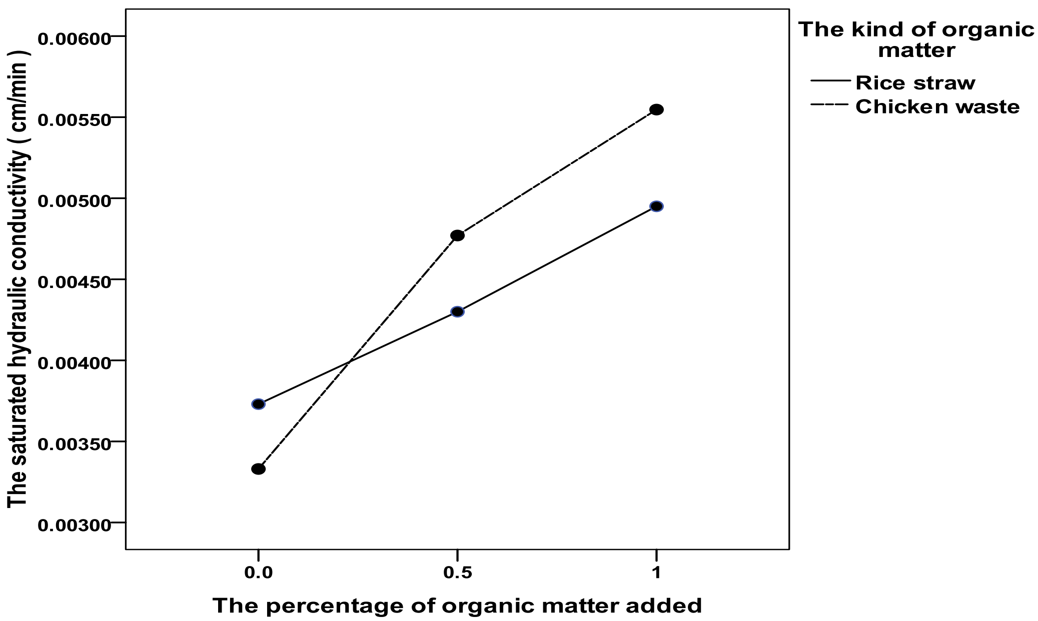

Figure 1 The relation between saturated hyraulic conductivity and the percentage of organic matter added

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Figure 2 shows the fitted lines for the relation between saturated hydraulic conductivity and the percentage of organic matter added. The R^2 values for these fitted lines are 0.941 and 0.927 for rice straw and poultry waste additions respectively.

This high values of R^2 indicate the ability to predicted the saturated hydraulic conductivity from the values of the percentage of the both types of organic matter added to the clay soil.

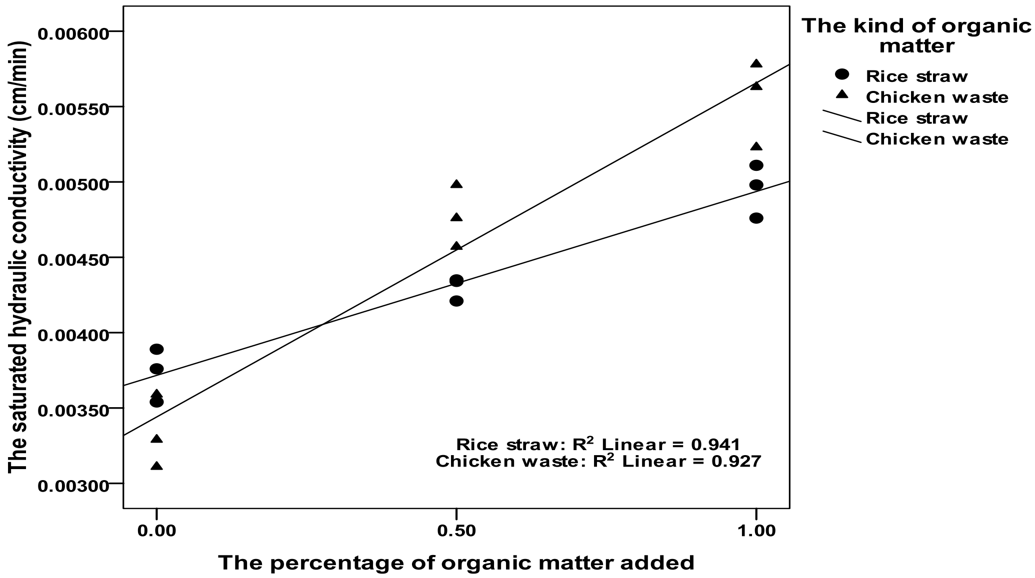

Figure 2 The fitted line for the relation between soil saturated hydraulic conductivity and percentage of organic matter added

2- Soil bulk density:

Figure 3 shows the relation between soil bulk density and the percentage of the organic matter added. The mean value of bulk density decreases significantly at 5% probability level from 1.31 and 1.34 gm/cm^3 for the control treatments to 1.21 and 1.08 gm/cm^3 with 1% addition of rice straw and chicken waste respectively. This decreases in the bulk density values indicate the formation of stable aggregates units with organic matter addition to the soil. This could cause increases in the total soil volume and decreases in the values of soil bulk density.

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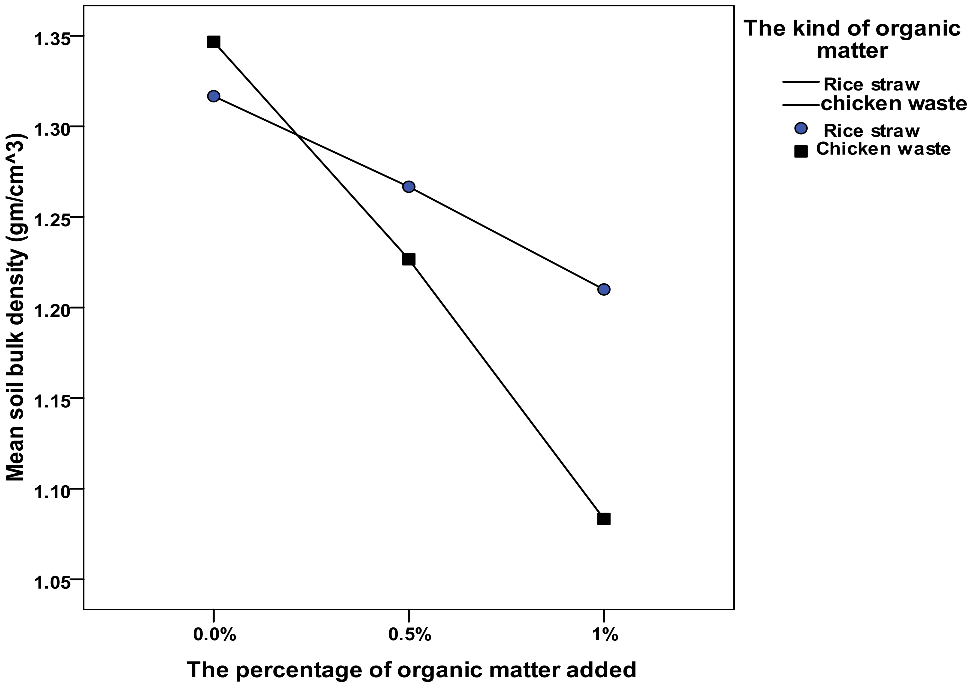

Figure 3 The relation between mean soil bulk density and the percentage of organic matter added

Moreover; this results have been supported by the fitted relationships between bulk density and percentage of organic matter added which show the R^2 values of 0.93 and 0,92 for rice straw and chicken waste addition respectively(figure 4). These results are supported by the finding of Ogbodo, E.N. , 2010; Agbede, et al, 2010; Brye,K.R. , et al, 2004; Eusufzai,M.K., et al , 2007.

3- Porosity:

Figure 5 shows the relation between soil porosity and the level of organic matter additions for both of rice straw and chicken waste.

The mean values of soil porosity percentage are significantly increased at 5% probability from 50.3% and 49% for the control treatments to 54.3% and 59% for the 1% addition of rice straw and chicken waste respectively.

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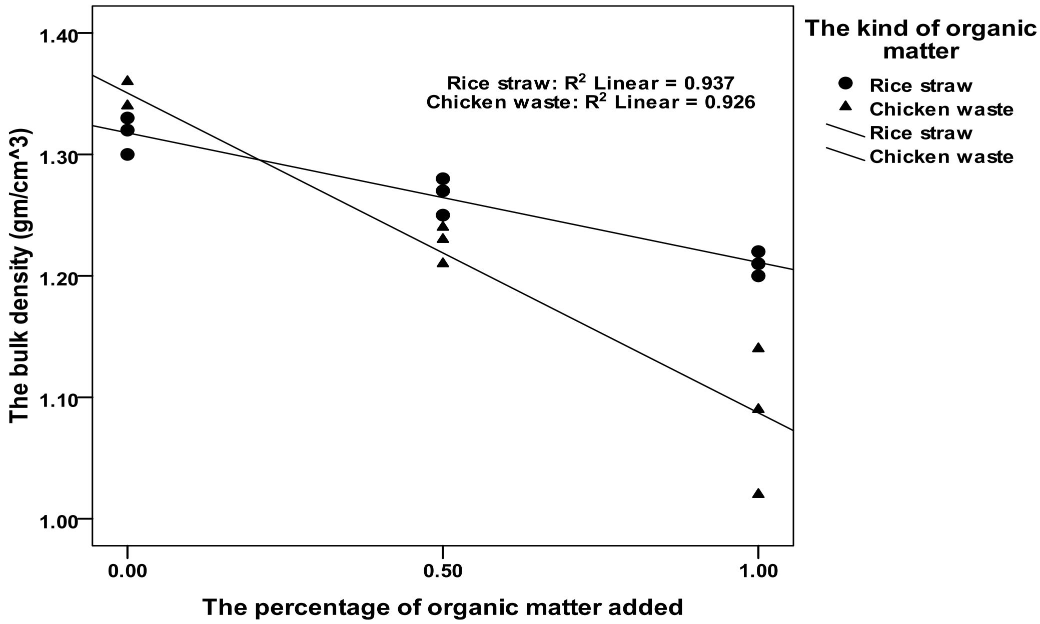

Figure 4 The fitted line for the relation between soil bulk density and percentage of organic matter added

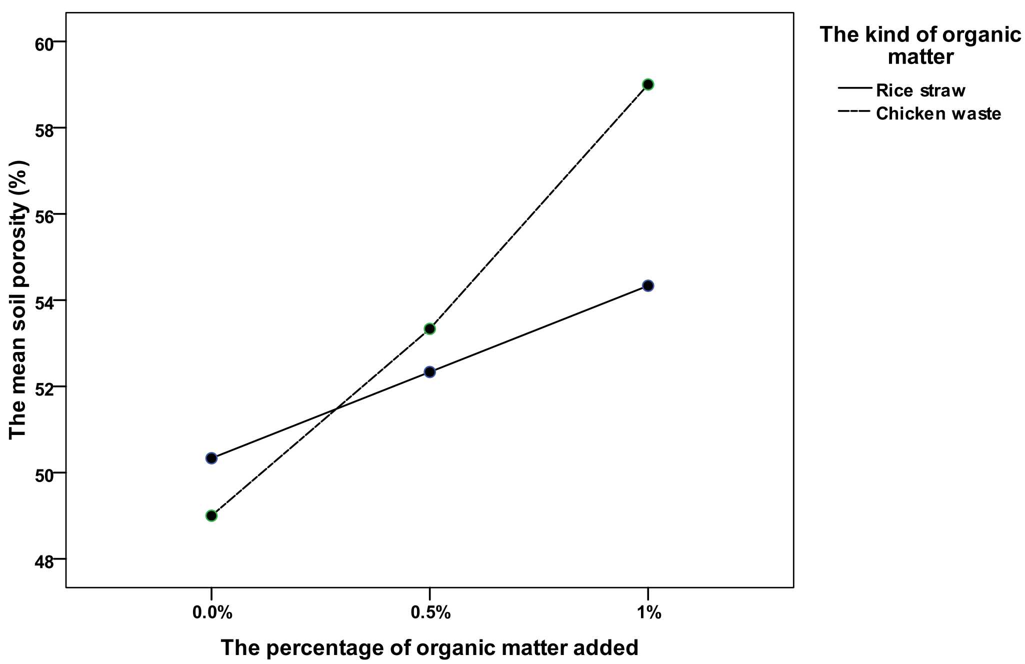

Figure 5 The relation between soil porosity and the percentage of organic matter added

Moreover; the increases in porosity with chicken waste addition were significantly higher than the increases in porosity with rice straw addition at 5% probability level.
The fitted line for the relationships between porosity and organic matter additions (figure 6) shows a R^2 of 0.92 and 0.94 for rice straw and chicken waste additions respectively.

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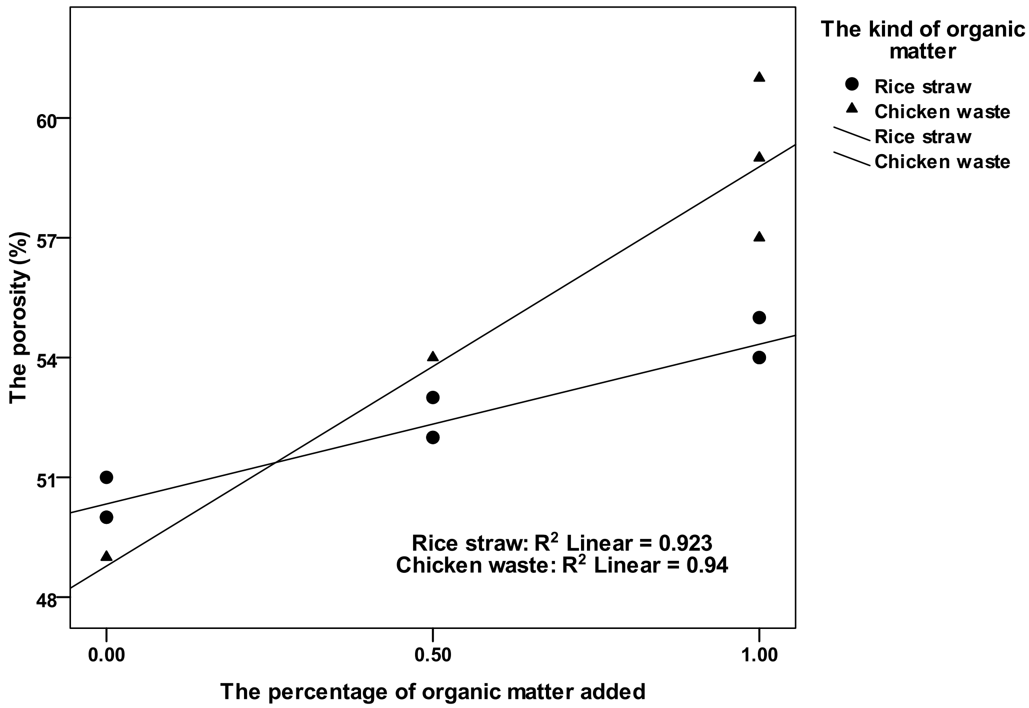

Figure 6 The fitted line for the relation between soil porosity and percentage of organic matter added

This high values of R^2 assure the prior finding in figure 5. Also these results agree very well with the finding of Ogbodo,E.N., 2010; Agbede, et al, 2008; Brye,K.R., et al,2004; Eusufzai,M.K., et al, 2007.

The results of this study shows the positive effects of organic matter addition to the heavy soil on the physical properties of the soil, it decreases the value of bulk density and increases the values of saturated hydraulic conductivity and porosity. However; this positive effects of organic matter addition to the clay soil were more with chicken waste than with rice straw addition. This may be due to the organic colloids that result from the decomposition of chicken waste is more effective in forming highly stable structure units than the one resulted from decomposition of rice straw.

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