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Effects of Rice Husk Application on Mechanical Properties and Cultivation of A Clay Soil with and without Planting

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ABSTRACT

In this study, effects of rice husk (RH) application on mechanical properties and cultivation of a clay textured soil were investigated with and without barley planting. A rate of 5% (w/w) rice husk as a dry weight basis was added to a clay textured soil by alone (RH) and with 5 kg N/da of ammonium sulphate (RHN) in order to increase the biological activity and the decomposition rate of rice husk in soil. Rice husk applied soils including control treatment were incubated at field capacity under greenhouse conditions for 2 months. After this period, barley was sown in a half number of the pots. All pots having barley planted and without planted were incubated together for 6 more months. Study was carried out in a factorial experimental design on barley planting and without planting pots in 3 treatments (control, RH and RHN) with 3 replications. At the end of the study, liquid limit (LL), plastic limit (PL), plasticity index (PI), consistency index (Ic), field capacity (FC), permanently wilting point (PWP) and organic matter (OM) contents of soils were determined. The highest values were determined for LL in RH+nitrogen+barley planting (RHNP), for PL in RH application without planting and for PI in control application with barley planting (CP). Barley planting increased LL and PI values of soil significantly. LL values of soils significantly correlated with PL (0.664**), PI (0.880**) and PWP (0.948**). PL values of soils significantly correlated with OM (0.699**) and PWP (0.821**). PI values of soils significantly correlated with FC (0.654**) and PWP (0.713**). Ic values gave the significant correlations with PL (0.908**), OM (0.787**), FC (-0.611**) and PWP (0.615**). Ic values in all RH treatments were higher than that in control treatments. It was concluded that clay textured soil in control treatment can have deformation when it is cultivated at the field capacity without RH application; however clay soils can be cultivated without deformation after application of RH.

Keywords: Clay, rice husk, atterberg limits, planting, soil cultivation.

INTRODUCTION

Management of soil mechanical properties is useful to people interested in soil workability. Basic soil mechanical properties which are liquid limit, plastic limit and plasticity indexes known as Atterberg limits define soil consistency as related with soil moisture content. In agriculture, these limits are generally used for evaluation of soil suitable workability. Soil moisture content is one of the most important factors for soil tillage operation. The optimum water content for tillage defined as the water content at which tillage produces the greatest proportion of small aggregates (Dexter and Bird 2001). It is known that intensive agricultural practices cause soil structural degradation. One of the most important factors for bad soil characteristic is organic matter deficiency in soils. Adding organic matter to soils is one of the most important ways to solve this problem. Organic matter affected positively soils physical, chemical and biological properties (Flaig et al., 1977). These positive effects depend on the organic matter content and the quality of organic matter (Clapp, 1986; Ünsal and Ok, 2001). Organic matter increases the porosity and water holding capacity, decreases ground flux losses and manage the aeration of clay textured soils (Boyle et al., 1989; Chenu et al., 2000; Marinari et al., 2000). It has determined that increasing soil organic matter content cause to increase soil field capacity, wilting point and available water content (Gupta et al., 1977; Bargezar et al., 2002). Gülser and Candemir (2004) reported that incorporating the different organic wastes in to the clay soil caused increases in liquid limit and plastic limit compared to the control application. The objective of this study was to determine the effects of rice husk application on mechanical properties and cultivation of a clay textured soil with and without barley planting.

MATERIALS and METHODS

Soil used in this study was taken from Kavak-Samsun. Some basic properties of clay textural soil are given in Table 1. Rice husk as an organic matter source was supplied from a private rice factory in Terme and grounded by 1mm open size before using in the experiment. Rice husk had 46.97% organic C, 0.38% N by dry weight basis and 126.6 C:N ratio. Soil sample was air dried and sieved through a sieve with 2 mm size opening. After adding the soil sample in to pots, a rate of 5% (w/w) rice husk as a dry weight basis was incorporated in each pot and mixed homogeneously. Study was conducted in 3 treatments which are control (C), rice husk (RH) and rice husk + N (RHN) applications. 5 kg N da^{-1} of ammonium sulphate was added in order to increase the biological activity and the decomposition rate of rice husk in soil. All pots were incubated in 2 months for organic residue decomposition. End of the incubation period half number of the pots planted with barley. All treatments were incubated at field capacity under greenhouse conditions for 6 more months. Organic matter (OM) contents of soils were determined by modified Walkley-Black method (Kacar, 1994). Moisture contents in field capacity (FC) and permanent wilting point (PWP) were determined after the soil samples saturated and waited in the pressured table set at 1/3 atm and 15 atm respectively. Liquid limit (LL), plastic limit (PL) and plasticity index (PI) values of the soil samples were determined according to Demiralay (1993). Index of consistency (Ic) was estimated using the following equation (Baumgarti, 2002); Ic= (LL-FC)/PI.

Table 1. Some physical and chemical properties of the soil

Sand, %	22.08	pH (1:1)	8.13
Loam, %	26.29	Organic Matter, %	1.46
Clay, %	51.63	EC_{25}°C, dS m^{-1}	0.52

Variance analysis of the experimental data was carried out in a factorial experimental design on 3 treatments (control, RH and RHN) with and without planting pots with 3 replications. Pairs of mean values were compared by least significant difference (LSD) and relations between the properties expressed by correlation factors (Yurtsever, 1984).

RESULTS and DISCUSSION

All rice husk treatments significantly increased the organic matter content values of soils when compared the control treatment. While the lowest OM (1.14%) was determined in control treatment with barley planting (CP), the highest OM (3.01%) content was determined in RH + nitrogen + planting treatment (RHNP) (Figure 1). Doran and Smith (1987) reported that soils organic matter contents were changed with the application of different type and amount of organic residues.

Rice husk applications significantly increased LL and PL values of the soil samples according to the control (Figure 2). The highest LL value (49.53%) was in rice husk+nitrogen+planting (RHNP) treatment. Demiralay and Güresinli (1979) reported that a soil can be classified as low, medium and high plastic according to the LL values ranged less than 30%, between 30 and 50% and higher than 50%, respectively. In this study LL values ranged between 39.27 and 49.53%. Therefore, soil samples in all treatments showed medium plasticity. While the highest value of PL (29.58%) was determined in RH treatment, the lowest PL (23.45%) was determined in C treatment (Figure 2). Control treatment with barley planting (CP) showed the highest PI value (23.49%). The lowest PI value (14.06%) was determined in RHN treatment (Figure 2). It has been known that if PI value is low, workability of soils is possible without muddy condition or structural damage, but if PI value is high, soil workability is impossible and muddy condition or structural damage can occur (Demiralay and Güresinli, 1979; Mueller et al. 2003). It indicates that increasing PL and decreasing PI by the application of rice husk in this study can help the soil workability without any structural damage.

Generally, rice husk treatments did not increase FC of soils according to the control (Figure 3). Moreover, FC values in RH+planting (RHP) and RH+nitrogen (RHN) treatments were significantly lower than that in control treatment. The highest FC value (29.40%) was determined in CP treatment and the lowest FC (25.81%) was determined in RHN. All rice husk treatments significantly increased PWP values according to control treatment (Figure 3). While the highest PWP (20.83%) was determined in RHNP, the lowest PWP (15.28%) was in the control treatment. Candemir (2005) reported that application of organic wastes increased the FC and PWP of the clay and loamy sand textural soils according to the control treatment.

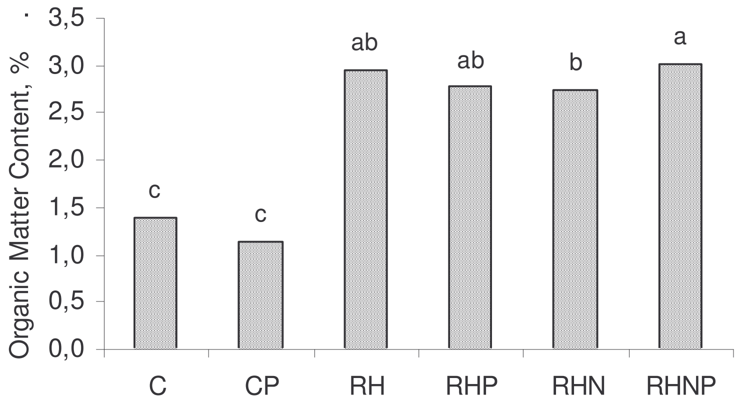

Figure 1. Effects of rice husk application on soil organic matter content (C:control, P:planting, RH:rice husk, N:nitrogen application).

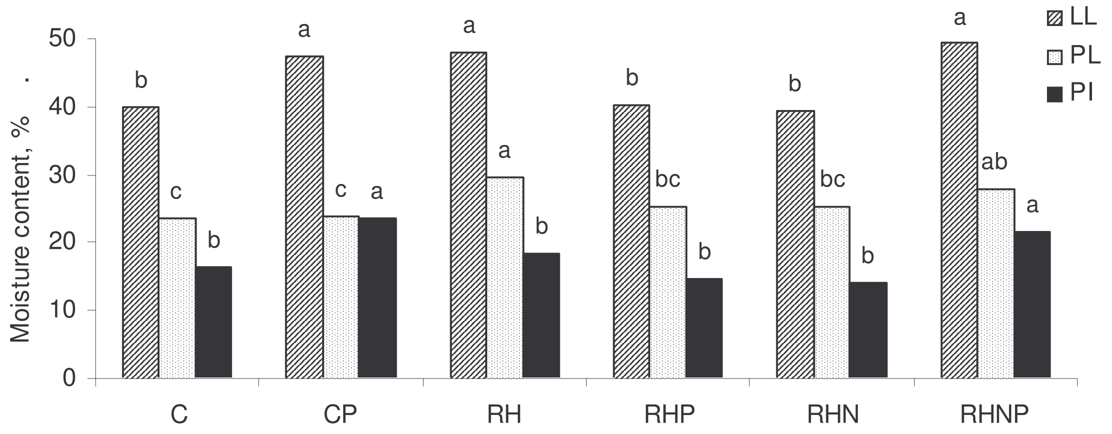

Figure 2. Effects of rice husk application on Atterberg limits with and without planting (C:control, P:planting, RH:rice husk, N:nitrogen application).

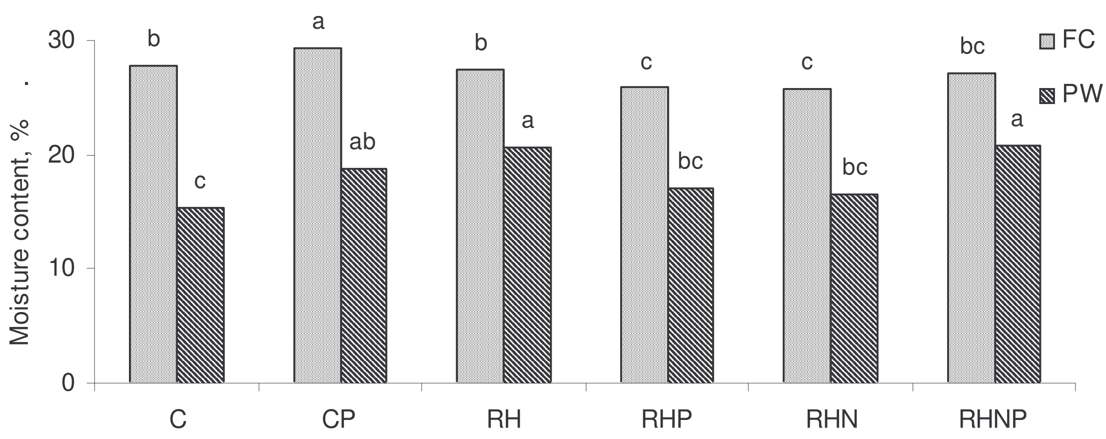

Figure 3. Effects of rice husk application on field capacity (FC) and permanent wilting point (PWP) values with and without planting (C:control, P:planting, RH:rice husk, N:nitrogen application).

All rice husk treatments increased consistency index (Ic) values when compared to the control treatments (Figure 4). While the highest Ic (1.11) was determined in RH treatment, the lowest Ic (0.73) was in the control treatment. Index of consistency value defines consistency condition of a soil at any given soil moisture content. If Ic value is becoming 1.0, soil is in plastic formation (PL at Ic=1.0), if this value is becoming 0, soil is in liquid formation (LL at Ic=0) (Baumgarti, 2002). In this study, Ic values were determined using the soil moisture contents at FC. Baumgarti (2002) reported that if a soil is cultivated when Ic is less than 0.75, soil structural deformation will occur. Ic values in this study ranged between 0.97 and 1.11 for all rice husk treatments, and between 0.73 and 0.75 for all control treatments. Therefore, it seems that soil cultivation in the control treatments at FC moisture contents would have structural deformation in clay soil. Increasing consistency index of the soil by the rice husk application will prevent the clay soil structural deformation when it is cultivated in FC moisture content.

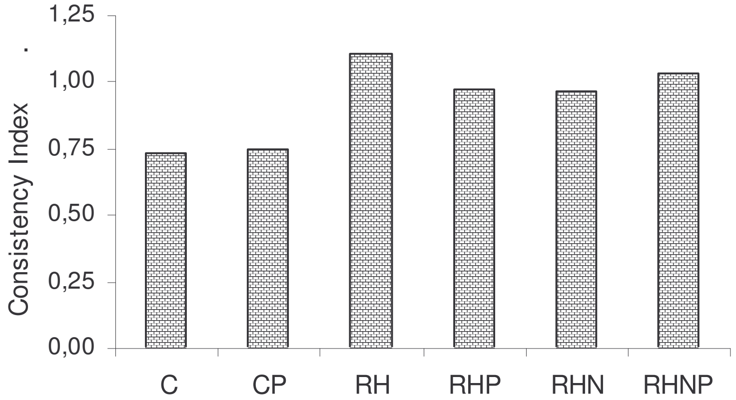

Figure 4. Effects of rice husk application on consistency index (Ic) with and without planting (C:control, P:planting, RH:rice husk, N:nitrogen application).

The relationships among the soil properties and Atterberg limits are given in Table 2. LL value of soils significantly correlated with PL (0.664**), PI (0.880**) and PWP (0.948**). Soil OM content showed a significant positive correlation with PL (0.699**). It has been known that LL and PL values generally increases when the organic matter and clay content increases (Demiralay and Güresinli, 1979; Baumgarti, 2002). Gülser and Candemir (2004) found that there were significant positive correlations between OC and Atterberg limits. They concluded that increasing application rates of organic wastes increased both LL and PL. Özdemir (1998) found that soil organic matter effects LL and PL positively but didn't affect PI significantly. PI values of soils significantly correlated with FC (0.654**) and PWP (0.713**). Consistency index values of soils gave the significant correlations with PL (0.908**), OM (0.787**), FC (-0.611**) and PWP (0.615**). It indicates that rice husk application increased the consistency index and the soil plasticity when the soil had moisture content at field capacity. Therefore, clay soil cultivation without soil structural deformation at the FC moisture content can be possible, if rice husk is applied in to a clay soil.

Table 2. Correlations among the soil properties and Atterberg limits.

	PL	PI	OM	FC	PWP	Ic
LL	0.664**	0.880**	0.091	0.376	0.948**	0.409
PL		0.230	0.699**	-0.259	0.821**	0.908**
PI			-0.325	0.654**	0.713**	-0.043
OM				-0.635**	0.382	0.787**
FC					0.165	-0.611**
PWP						0.615**

** Correlation is significant at the 0.01 level.

As a conclusion, it is possible that increasing organic matter content in a clay soil by addition of some organic wastes will increase PL and consistency index in soil. Increasing consistency index in soil gives us an ability to cultivate soil at higher moisture contents. In this study, addition of rice husk into a clay soil increased soil plasticity and consistency index when compared with the control treatments. It indicated that rice husk application in to clay soils is useful for the cultivation of soil in FC or in early spring season when soil has higher moisture content.

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