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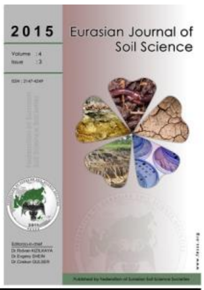

Effects of rice husk compost application on soil quality parameters in greenhouse conditions

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Abstract

Effects of rice husk compost (RHC) on some soil quality parameters under greenhouse conditions were investigated. Experiment were conducted in a randomized plot design with different application doses of RHC (0, 3, 6 and 9%) into surface soil (0-20 cm) with three replications in a greenhouse of Agricultural Faculty in Ondokuz Mayıs University. RHC application generally improved the soil quality parameters according to the control treatment during the experiment carried out with growing tomato plant in the greenhouse in 2010. The soil organic matter (OM) contents significantly increased by the application of RHC in the following order; 9%>6%>3%>0%. While RHC applications in the greenhouses significantly reduced pH contents of soils according to the control, the RHC application increased the values of respiration rate (CO_2), EC, NO_3-N and available phosphorus (P). While the exchangeable Ca values of soils generally decreased, the exchangeable Mg and K values generally increased according to the control with RHC application. Bulk density (BD) values in the greenhouse were reduced with RHC application doses in the following order 0%>3%> 6%>9%. The values of field capacity (FC), permanent wilting point (PWP) and available water capacity (AWC) generally increased according to the control with the application of RHC dosses in the following order 9%>6%>3%. The highest positive correlations among the physical, chemical and biological properties were found between OM and PWP (0.924**), AWC and FC (0.907**), OM and FC (0.897**), CO_2 and PWP (0.862**), PWP and FC (0.791**); while the highest negative correlations were found between BD and FC (-0.854**), BD and PWP (-0.871**), BD and OM (-0.868**), BD and CO_2 (-0.838**), BD and P (-0.821**), Ca and FC (-0.812**). The highest tomato yield (7.77 ton/da) was obtained with the 9% of RHC application. RHC application to the soil in greenhouse generally improved soil quality and tomato yield.

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Introduction

A large part of our country's soil is poor in organic matter. This condition have led to a significant deterioration of soil physical, chemical and biological properties in time. One of the most basic ways passing in front of this condition is to increase the content of the soil organic matter. For that reason, vegetable originated many organic wastes and compost obtained from that is recommended for use in agricultural land. Organic material added to the soils with the help of therapeutic effects on soil properties is to ensure the sustainability of the land and to protect the productivity. The natural wastes used as an organic fertilizer is very important in terms of increasing the efficiency of soils and nutritional value. Organic waste used as regulators meets especially the nutrient requirements of the plants as well as many functions of soils. Also

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the organic wastes improve the soil structure, water and air content of soil and increase microbiological activity of soil. Compost which is used as a source of organic matter is consists of partly separated and subjected to fermentation of organic waste. Especially in organic farming, the use of compost is one of the methods to increase the organic material contents of processed and unprocessed soil. With the use of compost, organic substances lost from soils in various ways are again given in to soils and thereby nutrient loss is reduced.

Improving and sustaining of soil quality reduces fertilizer and pesticide use, improves the air and water quality and helps to prevent the release of greenhouse gases into the atmosphere as well as increased the agricultural productivity of country. Soil organic matters are generally one of the most important criteria of soil quality. Soil organic matter has an influence on the processes occurring in the soil and many soil properties (Doran and Parkin, 1994; Gregorich et al., 1994; Lal and Kimble, 1997; Gülser and Candemir, 2012; Cercioğlu et al., 2014). However, intensive soil processing and taking product is lead to decrease organic matter in soil. Sustainability and soil quality in agriculture are interrelated. Therefore, functions of soil organic matter are also very important for sustainable agriculture and soil quality (Lal and Kimble, 1997). Addition of fertilizer as a regularly has a great impact on soil organic matter (Khaleel et al., 1981; Johnson, 1986). Especially, adequate levels of organic matter content in the soil surface will improve the physical, chemical and biological properties of soil and also will increase the soil quality (Sojka and Upchurch, 1999). Paddy husks, that is an important problem in paddy agriculture and is a residual after paddy harvest, is important in terms of recycling to agricultural lands by composting, as well as ensuring sustainability of soil productivity and also contributing to production by improving physical and chemical properties of soils. In this study, rice husk compost (RHC) in excess amounts which is residual of production in the Black Sea region were investigated on the effects of some soil quality parameters and their effects under greenhouse conditions.

Material and Methods

Rice husk was composted with manure under aerobic conditions in the greenhouse of Agricultural Faculty in Ondokuz Mayıs University for 13 months. Some properties of the organic residues used in the compost process were given in Table 1.

Table 1. Some properties of the organic residues used in the study

	C, %	N, %	Natural Moisture, %	C/N
Rice Husk	46.303	0.376	15.000	123.146
Manure	33.146	2.789	73.000	11.884
Rice Husk Compost	21.138	0.552	35.785	38.320

The study was conducted in the greenhouse of Agricultural Faculty of Ondokuz Mayıs University between June 1, and August 31, 2010. The rates of 3, 6, 9% of rice husk compost (RHC) were applied to the plots (2.0 x 1.0 x 0.2 m) in a randomized plot design with three replications. Sümela F1-RN tomato variety was used in the experiment as plant material. Eight tomato seedlings were planted in each plot. Changes in soil moisture content were measured using a TDR on a daily basis. Deficiencies in soil moisture content were completed by irrigation when plant available water in soil decreased to 30%. Soil samples were taken from the plots at the beginning, 40 and 100 days of the experiment.

After the soil samples were air dried and passed through a sieve with 2 mm size opening, some soil characteristics were determined as follows; particle size distribution by hydrometer method (Demiralay, 1993), soil reaction (pH) in 1:1 (w:v) soil water suspension by pH meter; electrical conductivity (EC_{25^oC}) in the same soil suspension by EC meter (Kacar, 1994); exchangeable cations by ammonia acetate extraction (Kacar, 1994); and available P by extraction with 0.5 M $NaHCO_3$ at pH 8.5 (Olsen et al., 1954). Organic matter (OM) content was determined by modified Walkley–Black method (Kacar, 1994). Moisture contents in field capacity (FC) and permanent wilting point (PWP) were determined at a pressure plate apparatus under 1/3 and 15 atm pressure after soils reached a hydraulic balance state. Bulk densities (BD) were determined on undisturbed soil samples (Tüzüner, 1990). TARIST package program was used for statistical analysis of data. Significant differences between means were shown with LSD test (Yurtsever, 1984).

Results and Discussion

Bulk density values of the soils decreased with RHC application according to the control treatment (Figure 1a). The highest bulk density value (0,916 gr/cm^3) was obtained in the control treatment while the lowest BD value (0,615 gr/cm^3) was in the 9% of RHC treatment. Adding green manure or plant residues to the soils to improve their physical properties cause an increase in organic matter content and a decrease in bulk density (Tirlok et al., 1980; Boparai et al., 1992). In numerous studies, it is reported that addition of organic matter to soils decreases soil bulk density values (Chenu et al., 2000; Marinari, 2000; Loveland and Webb, 2003). Candemir and Gülser (2011) determined very significant negative correlations between organic matter content and bulk density values of soils in their studies. Anikwe (2000) determined that addition of rice husk at increasing doses to the clay textured soil decreased bulk density and increased porosity of soils.

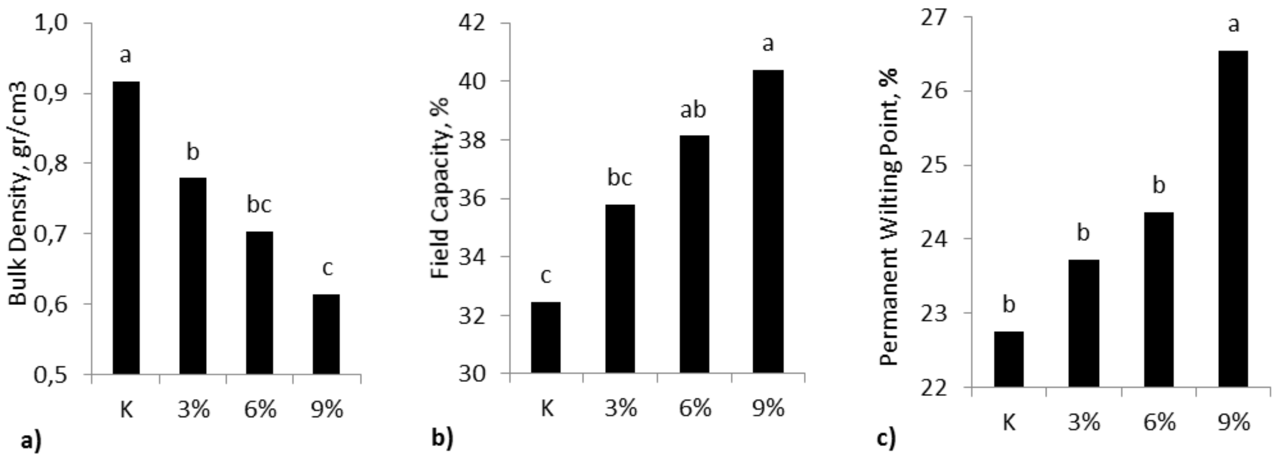

Figure 1. Effects of rice husk compost application on a) Bulk Density, b)Field Capacity and c)Permanent Wilting Point of the soil (LSD_{BD} = 0.136)

Field capacity and permanent wilting point values of the soil increased with RHC treatments compared with the control (Figure 1 b and c). While the highest FC (40,39%) and the PWP (26,55 %) were determined in 9% of RHC treatment, the lowest FC (32,45%) and the PWP (22,75%) were found in the control treatment. Addition of organic matter to soils increases water holding capacity with increasing field capacity and available moisture content (Gupta et al., 1977).

OM content of the soil significantly increased according to the control treatment with RHC application (Figure 2a). While the highest OM content (7.546%) was determined in 9% of RHC treatment, the lowest OM content (3.628%) was obtained in the control. The 9, 6 and 3% application rates of RHC increased OM content of the soil as 108.01, 54.08 and 32.34% according to the control, respectively. Soil pH values of the soil significantly decreased with RHC application according to the control treatment (Table 2). Soil pH values with the 9, 6 and 3% application rates of RHC treatments were determined as 7.66, 7.74 and 7.72, respectively. CO_2 released into soil atmosphere due to decomposition of organic wastes can be converted into carbonic acid (H_2CO_3) by reacting with water (H_2O) and decreases soil pH (Sağlam, 1997). Candemir and Gülser (2011) also reported that application of different agricultural wastes, especially tea waste, decreased soil pH values in different textured soils. EC values of the soils significantly increased with RHC application according to the control treatment (Table 2). While the highest EC (1.164 dS/m) was determined in 9% of RHC treatment, the lowest EC (0.930 dS/m) was obtained in the control. The 9, 6 and 3% application rates of RHC increased EC of the soil as 25.19, 20.15 and 18.95% according to the control, respectively. Many researchers reported that addition of organic matter and compost to the soils increased electrical conductivity, significantly (Eigenberg et al., 2002; Candemir and Gülser 2011).

Exchangeable Ca values of the soil decreased according to the control treatment with RHC application, (Table 2). While the lowest exch. Ca (35.201 me/100 g) was determined in 9% of RHC treatment, the highest exch. Ca (37.490 me/100 g) was obtained in the control. Organic waste applications cause an increase in biological activity and biomass in soils. Ca is one of the most important components of the biomass after nitrogen, phosphorus and potassium (Alexander, 1977). On the other hand, exch. Mg values of the soil significantly increased according to the control treatment with RHC application (Table 2). While the highest exch. Mg (13.324 me/100 g) was determined in 9% of RHC treatment, the lowest exch. Mg (12.217 me/100 g) was obtained in the control.

Table 2. Effects of rice husk compost treatments some chemical properties of the soil.

	pH (1:1)	EC, dS/m	OM, %	P, ppm	Exchangeable cations, me/100 g K,	Ca	Mg	Na
K	7,82 a	0,930 b	3,628 c	63,757 b	3,399 b	37,490 a	12,217 c	0,925
3%	7,72 ab	1,106 a	4,801 b	80,053 ab	3,722 b	37,214 a	12,375bc	0,849
6%	7,74 ab	1,117 a	5,590 b	97,893 ab	3,883 ab	36,885 a	13,182ab	0,824
9%	7,66 b	1,164 a	7,546 a	110,257 a	4,261 a	35,201 b	13,324 a	0,756
LSD	0.112	0.154	0.870	24.350	0.528	1,568	0.923	ns

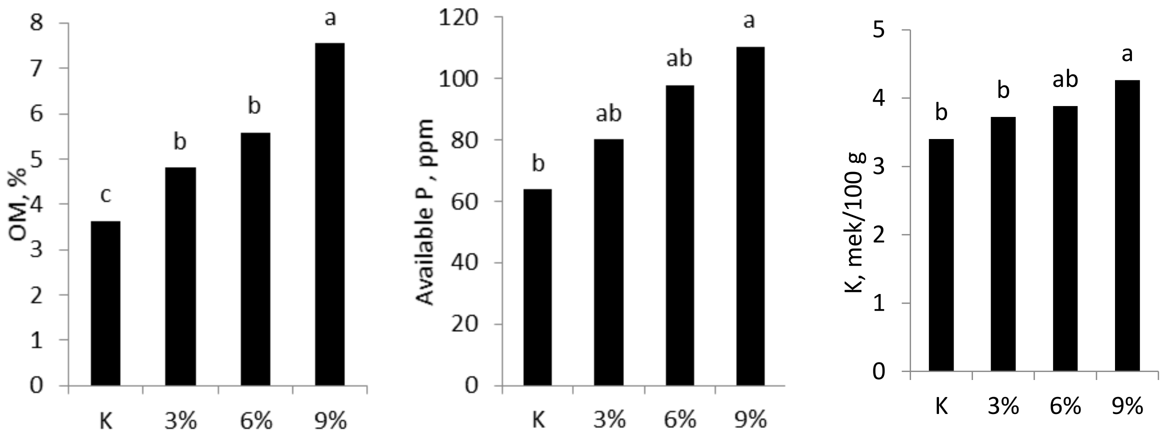

Figure 2. Changes in OM, Available P and Exchangeable K with Application of RHC in Different Doses

Available P, exch. K and Na contents of the soil significantly increased with RHC application according to the control treatment (Table 2, Figure 2 b and c). According to the control treatment, exch. K values of the soil increased with the 9, 6 and 3% application rates of RHC as 25.35, 14.23 and 9.49%, respectively. Whalen et al. (2000) reported that manure treatment increased available K and Mg contents of the soils. Candemir (2005) reported that application of different agricultural wastes increased available K, Mg and P contents in different textured soils. According to the control treatment, available P contents of the soil increased with the 9, 6 and 3% application rates of RHC as 72.93, 53.54 and 25.56%, respectively. Organic acids as a decomposition product of organic matters provide plant available nutrients, particularly phosphorus and micro-elements (Güneş et al. 2000). Vavoulidou et al. (2004) reported that as a result of organic treatments into the soils, productivity levels of soils increased with the increase of available P amounts.

Tomato yield values increased with RHC application according to the control treatment, (Figure 3). The highest plant yield (7.77 ton/da) was obtained with the 9% application rate of RHC. According to the control treatment, tomato yields increased with the 9% application rates of RHC as 58.56% ratio. Anaç et al. (1999) reported that tomato yield increased by 20% using agricultural waste compost in the cultivation. Aydın et al. (2001) investigated the effects of compost, farm yard manure and chemical fertilizer on tomato yield for two years. They found that the average yield of tomato increased by 61% with chemical fertilizers, 39 to 107 % with application doses of garbage compost and 54% with farmyard manure applications.

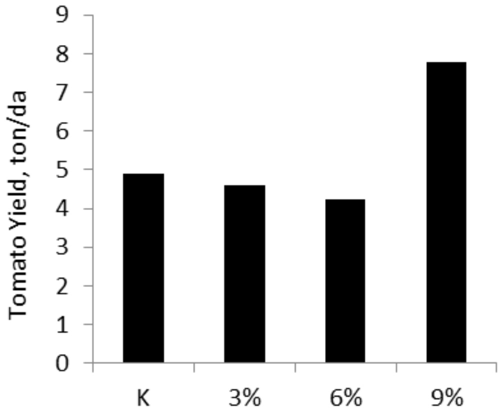

Figure 3. Effect of rice husk compost treatments on tomato plant yield , ton/da

Conclusion

The RHC applications improved soil physicochemical properties and increased tomato yield. RHC added into the soil as an organic matter source increased the FC, PWP, EC, OM content, exch. Mg, K and available P contents, and decreased the BD, soil pH, Na and exch. Ca of the soil. The tomato yields were higher in RHC treatments than in the control treatment. It was determined that RHC can be used as a soil conditioner to improve soil properties, sustain agricultural production and obtain high crop productivity. Recycling rice husk in agricultural lands by composting provides soil fertility and sustainability, and also makes a great contribution to the environment ecologically.

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