Effect of rice straw application on Soil Physico-chemical Properties

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Abstract
This study was conducted to investigate the effects of residual rice straw cutting height on paddy soil fertility. The average amount of rice straw residue for different cutting heights were 1,420kg/ha at 10cm, 1,850kg/ha at 15cm, 2,400kg/ha at 20cm. Among the soil physical properties, soil hardness and bulk density were decreased and porosity was increased with rice straw retention. Organic matter, available silicate content, and cation exchange capacity were dramatically decreased when rice straw was collected. The number of spikelets/m^2 and the percentage of ripeness was high with rice straw reduction. Rice yield was increased by 32% and 28% for cutting heights of 20cm and 15cm.

Key words
Cutting height, paddy soil, rice straw, soil fertility, physical property

Introduction

Paddy fields with low crop productivity are occupy about 67 percent of Korea (ASI 1992). The main factor for reduced productivity is the inferiority of the soil parent material. However, a main factor in the rice crop systems is that there is no chance to improve soil fertility by continuous application of organic matter of good quality (rice straw, barley straw, etc.) and soil amendments as well as leaching of microelements, such as iron and manganese and excessive application of chemical fertilizer. Rice production is influenced by soil fertility but it is difficult to maintain soil fertility by reliance on chemical fertilizer. It is desirable to improve and maintain soil fertility by application of organic matter.
Application of organic matter can ameliorate physical properties: increase porosity by aggregation of soil structure, and decrease hardness and bulk density. Also application of organic matter has improved the work efficiency of agricultural machinery with amelioration of dynamic properties such as cone penetration resistance, and the Atterberg constant (Kwun *et al*. 1984; Lee *et al*. 1986; Shin *et al*. 1975).
In recent years, maintenance of soil fertility for paddy soil involved application of rice straw, but most rice straw is collected as fodder. Collection of rice straw affected the stable production of high quality rice and a lowered paddy soil fertility. This study was carried to establish of optimum cutting height at harvest time required to maintain soil fertility on deteriorated paddy soil resulting from incineration and collection of rice straw.

Methods

This study was conducted on the Jeonbuk series soil in a paddy field at Honam Agricultural Institute from 2005 to 2008. Rice straw was harvested at several values of cutting height (10cm, 15cm, 20 cm from the ground) with a combine at rice harvest time. Conventional practices were used to collect rice straw.
A machine was used to transplant medium seedlings in the last ten days of May. Amounts of applied fertilizer were decided after soil testing. Among soil physical properties measured, bulk density was determined by the core method and hardness was measured with a penetrometer (Yamanaka). Soil chemical analysis was carried out according to the analytical methods for soils and plants (NIAST 2000). Organic matter, available phosphate, and inorganic nitrogen was measured by the Tyurin, Lancaster and Kjeldahl distillation methods, repectively. Exchangeable cations were determined using a VISTA-MPX (USA) inductively coupled plasma emission spectrometer (ICP-ES) following soil extraction with 1M NH_4OAc.
Investigation of the yield and growth of rice was carried out according to the standard of investigation & research on agricultural science technology (RDA 2003).

Results

The change of soil physical properties with rice straw cutting height are shown in Table 1. Physical properties were improved by rice straw retention, that is the surface soil depth was deepened, soil hardness and bulk density were decreased while porosity increased. The improvements of physical properties tended to be higher with the higher cutting heights. Application of rice straw in paddy fields of Fluvio-marine deposits have effects on deep tillage and the amelioration of drainage by reducing the imperviousness of the plow pan(Lee *et al*. 1979).

Table 1. The change of physical properties in subsoil with retention of rice straw.

Division		Surface soil depth	Hardness	Bulk density	Porosity	Three phases(%)		
Division		(cm)	(mm)	(g cm^{-3})	(%)	Solid	Liquid	Gaseous
Control†		12.0	20.4	1.594	39.9	60.1	39.6	0.3
Cutting height (cm)	10	14.0	19.7	1.558	41.2	58.8	40.9	0.3
cutting height (cm)	15	14.0	19.5	1.474	44.4	55.6	43.0	1.4
cutting height (cm)	20	14.0	18.2	1.417	46.6	53.4	44.6	2.0

†Collection of rice straw

Table 2. The change of chemical properties in surface soil with retention of rice straw.

Division		OM (g/kg)	P_2O_5 (mg/kg)	SiO_2 (mg/kg)	CEC ($cmol_c$/kg)
Control†		Δ1.34	Δ1	Δ58	Δ0.33
Cutting height (cm)	10	Δ0.53	Δ7	Δ31	Δ0.28
	15	Δ0.49	Δ10	Δ27	Δ0.23
	20	Δ0.30	Δ27	Δ17	Δ0.22

†Collection of rice straw

The change of soil chemical properties with rice straw with cutting height are shown in Table 2. Cation exchangeable capacity (CEC), and content of available silicate, and organic matter decreased with rice straw retention. It is thought that application of organic matter will increase the holding capacity of nutrient due to the CEC increment. Organic matter contains trace element and nitrogen, phosphate, potassium, and the like. It has the function of nutrient supply and the buffering capacity of soil. Phosphate solubility increased according to high content of organic matter in soil (Lee *et al*. 1995).

Table 3. Rice yield and yield components

Division		Culm Length (cm)	Panicle length	No. of panicle (ea/plant)	No. of spikelets per m^2 (×1,000)	Ripened grain ratio (%)	1,000 grains weight (g)	Yield of milled rice (Mg/ha)	Yield index
Control†		72.6	19.5	9.3	21.7	68.2	19.7	3.67	100
Cutting height (cm)	10	71.0	19.6	9.4	25.4	70.0	20.0	4.45	121
	15	72.6	18.3	9.7	26.3	76.6	20.2	4.71	128
	20	72.6	19.2	10.2	27.3	80.5	20.4	4.84	132

†Collection of rice straw

Rice yield and yield components are related to rice straw reduction in cutting height as shown in Table3. The number of spikelets per m^2 and the percentage of ripeness were high with rice straw retention. Rice yield increased when compared to conventional method (3.67Mg/ha), by 32 and 28% for cutting heights of 20 and 15cm, respectively.

Conclusion

Among the soil physical properties, soil hardness and bulk density decreased and porosity increased with rice straw restoration. While organic matter, available silicate content, and cation exchange capacity were dramatically decreased when rice straw was collected. There was a little decrease when rice straw was restored to the soil, and these effects increased with the increase restored amount of rice straw as affected by cutting height. The number of spikelets/m^2 and the percentage of ripeness was high with rice straw reduction.

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