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Effect of Different Fertilizer Management on Soil Properties and Yield of Fine Rice Cultivar

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Abstract
The experiment was conducted at the Research Farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur during 14 August to 7 December, 2008 to study the effect of (different organic and inorganic) fertilizer management on soil properties and yield of five fine rice cultivars viz., Rajshahi swarna, Silkumul, Kataribhog, Lal pajam and Sanla. The experiment was laid out in a split plot design with three replications. For post harvest soil, bulk density and pH gradually decreased in organic fertilizer management compared to inorganic fertilizer management. But percent organic carbon (0.68 to 0.80%) and organic matter (1.19 to 1.37%) of soil increased in organic management compared to inorganic management (0.53 to 0.66% and 0.91 to 1.14%, respectively). All the cultivars gave some-what better yield under inorganic management where the yield variation was minimum between organic and inorganic management. Conversely, organic culture had beneficial effects in improving soil properties and the sustainable agriculture mostly depends on soil organic matter. This organic matter will remain stable by using organic fertilizer.

Key words: Bulk density**,** Organic and inorganic culture, Fine rice, Soil pH

Introduction

Rice (*Oryza sativa* L.) is the second most important cereal crop next to wheat in terms of area and consider as staple food of a vast majority of people around the world (Rohilla *et al.*, 2000). In Bangladesh, transplanted local aman rice (fine rice, aromatic rice and other cultivars) grown in 1.66 million hectares of land and the production is 1.34 million metric tons (BBS, 2008). Consumer demands for the fine rice varieties are higher due to its good nutritional quality, palatability, taste, cooking quality and fragrance (Kaul *et al*., 1982). Over the past 50 years, agriculture production has increased dramatically, in part through the use of chemical fertilizers and pesticides that increased human and environment health risks (Pradhan, 1992). Nutrient supply either from organic or inorganic fertilizer is a must but continuous use of inorganic fertilizer to soil had a deleterious effect on soil productivity and steadily declining tend in rice productivity associated mainly with loss of inherent soil fertility (Nambiar *et al.*, 1998). A good soil should have at least 2.5% organic matter. But in Bangladesh, most of the soils have less than 1% organic matter (BARC, 2005) and it is increasing day by day, causing nutritional imbalance in soil. Organic fertilizer improves the physical, chemical and biological properties of soil and thus helps to increase the soil fertility and productivity. Now in Bangladesh many commercial institutes are preparing some nutrient-enriched organic fertilizers (namely, Moni Mukta, Agro-sar, Jaibo-sar, Super Greenfield, Chook-Chook 111) from cowdung, FYM and poultry manure have been evaluated for wetland rice cultivation effectively and could therefore reduce the use of chemical fertilizer (BRRI, 2007). Farmers' observations at present day are that fine aromatic rice gradually loses their aroma and other qualities such as yield and taste due to lack of organic matter content in soil, proper cultural management and changes of environment (Singh and Singh, 1997). For reducing environmental pollution and increasing the use of organic fertilizer in soil the present study was conducted to find out the effect of different fertilizer management on soil properties in fine rice cultivars.

Materials and Methods

The experiment was laid out in a split plot design with three replications. The unit plot size was 6 m^2 (3m x 2m) having a plot to plot and block to block distance of 0.75 m and 1.0 m, respectively . There were 30 plots in the experiment. The treatment factors A and B were: A. Main plot treatment: Two cultural conditions- Organic and Inorganic culture; B. Sub plot treatment**:** Five fine rice cultivars-Rajshahi swarna, Silkumul, Kataribhog, Lal pajam and Sanla. In inorganic culture a fertilizer dose of 90-75-60-60-10 kg ha^{-1} were applied in the form of Urea, TSP, MP, Gypsum, and Zinc oxide which supplied N, P_20_5, K_2O, S, and Zn respectively. Under organic culture organic fertilizer of Northern Agro Services Ltd. (NASL) was used at the dose 2 t ha^{-1} to fulfill the nutrient requirements. Thirty six days old seedlings were uprooted carefully from the seedbed in the morning and transplanted on 14th August 2008 in the main plot.

Other intercultural operations were done as per requirement. The initial and post harvest soil samples were analyzed in Soil Resources Development Institute (SRDI) for determining the soil bulk density, pH, organic carbon and organic matter for all cultivars. The post harvest soil was collected from each plot in 6 cm depth and determined the bulk density by core sampler method according to Trout and Hart (1982) using following equation: Bulk density (ρ_b) = (M_s/V_b) gcm^{-3}, where, M_s = Average mass of dry soil solids in gram and V_b = Volume of soil in cm^3. The soil pH was measured by glass electrode pH meter in 1: 2.5 soil water suspensions. The suspension was allowed to stand for one hour with occasional shocking before pH determination (Jackson, 1962). Organic carbon and organic matter content was estimated following the method developed by Black (1965). The principle underlying the method is to oxidize the organic matter with the excess of 1N $K_2Cr_2O_7$ solution in presence of concentrated H_2SO_4 and to titrate the remaining unreacted $Cr_2O_7^{-2}$ solution with NH_4FeSO_4. Finally, the organic carbon contents were then calculated by multiplying the percent organic carbon with the Van-Bemmelen factor 1.724 (Page *et al.*, 1982). Grains obtained from each unit plot were sun dried and weighed carefully. The dry weights of grains of five sample plants were added to the respective unit plot to record the trial grain yield per plot. The grain yield was finally converted ton ha^{-1}.

The findings were analyzed by partitioning the total variance with the help of computer by using MSTAT program. The treatment means were compared using Duncan's New Multiple Range Test (DMRT) as outlined by Gomez and Gomez, 1984.

Results and Discussion

Soil properties

Bulk density, soil pH, organic carbon and organic matter of the post harvest soil are presented in Table 1. Results showed that under inorganic fertilizer management the bulk density was slightly higher compared to organic management of post harvest soil. Though the initial bulk density ranged from 1.30 to 1.57 g cm^{-3}, the highest bulk density (1.44 g cm^{-3}) was found in soil covered with cultivar Silkumul and the lowest bulk density (1.37 g cm^{-3}) in Rajshahi swarna. On the other hand, under organic management bulk density was decreased to inorganic management and the highest value (1.27 g cm^{-3}) was found in soil covered with Rajshahi swarna whereas the lowest value (1.19 g cm^{-3}) found in Lal pajam. Results from other study like Santhi *et al*. (1999) observed that application of 100 % NPK plus FYM decreased the bulk density and increased the water holding capacity of soil. The decrease in bulk density in FYM treated plots might be ascribed to better aggregation. Sharma *et al*. (2000) were showed that the integrated application of farmyard manure and chemical fertilizer result in a significant reduction in bulk density with significant improvement in water holding capacity, CEC, available N, P, and S status of soil. From the results it was found that under inorganic culture condition soil pH was slightly higher compared to organic conditions of post harvest soil. Though the initial soil pH ranged from 5.40 to 5.50, the highest soil pH (5.52) was found in soil covered with cultivar Kataribhog and the lowest pH (5.49) showed by cultivar Sanla. In case of organic management the highest pH (5.46) was found in soil covered with Lal pajam and Silkumul whereas the lowest pH (5.40) found in Rajshahi swarna. The decreasing trend of pH might be due to the organic acids released from the decomposition of organic manures. Sarkar and Singh (1997) also showed that the soil pH decreased to 6.5-6.6 by the application of organic fertilizer alone compared to the initial pH of 6.7; however a combination of organic + inorganic fertilizer increased that to 6.6-6.8. The organic carbon and organic matter of the initial soil was 0.69% and 1.19%, respectively. Results showed that the organic carbon and organic matter content of the soils slightly decreased due to application of inorganic fertilizers while the results tended to increase in the soils treated with organic fertilizer. Under inorganic culture the highest value for organic carbon and organic matter (0.66% and 1.14%, respectively) were found in soil covered with cultivar Silkumul and the lowest value for organic carbon and organic matter (0.53% and 0.91%, respectively) were found in Rajshahi swarna. Under organic culture the highest value for organic carbon and organic matter (0.80% and 1.37%, respectively) were showed in soil covered with cultivar Lal pajam, whereas the lowest value for organic carbon and organic matter (0.69% and 1.19%, respectively) were found in soil covered with cultivar Kataribhog. Azim *et al*. (1999) reported that application of organic manure increased the organic carbon and organic matter content of the soil whereas a decreasing trend was detected with the application of chemical fertilizers.

Table 1. Effect of fertilizer management and cultivars on soil properties of post harvest soil

Cultivars	Bulk density ($g\ cm^{-3}$)		Soil pH		Organic carbon (%)		Organic matter (%)	
	Inorganic management	Organic management	Inorganic management	Organic management	Inorganic management	Organic management	Inorganic management	Organic management
Rajshahi swarna	1.37 ab	1.27 bc	5.48 ab	5.40 b	0.53 c	0.73 ab	0.91 b	1.26 ab
Silkumul	1.44 a	1.20 c	5.48 ab	5.46 ab	0.66 abc	0.72 ab	1.14 ab	1.24 ab
Kataribhog	1.38 ab	1.20 c	5.52 a	5.44 ab	0.56 bc	0.69 abc	0.96 b	1.19 ab
Lal pajam	1.40 a	1.19 c	5.50 a	5.46 ab	0.55 bc	0.80 a	0.96 b	1.37 a
Sanla	1.38 ab	1.23 c	5.49 a	5.46 ab	0.56 bc	0.68 abc	0.96 b	1.35 a
Initial	1.30-1.57		5.40-5.50		0.69		1.19	
CV (%)	4.70		1.00		7.37		5.50	

Mean followed by same letter(s) did not differ significantly at 5% level of significance

Grain yield

Grain yield of five fine rice cultivars at different cultural management is shown in Table 2. Results showed that the combined effect of cultural management and cultivars on grain yield was significant. Under inorganic culture condition the highest grain yield was produced by Rajshahi swarna (2.90 t ha^{-1}) which was at par with Silkumul and Kataribhog (2.85 t ha^{-1} and 2.71 t ha^{-1}, respectively), whereas the lowest grain yield was produced in Sanla (2.20 t ha^{-1}) corresponding with Lal pajam (2.44 t ha^{-1}). Under organic culture all the cultivars showed reduced grain yield compared to inorganic culture. Here the highest grain yield also found in Rajshahi swarna (2.74 t ha^{-1}) followed by Silkumul and Kataribhog (2.44 t ha^{-1} and 2.32 t ha^{-1}, respectively), whereas the lowest grain yield was found in Sanla (1.74 t ha^{-1}) corresponding with Lal pajam (2.28 t ha^{-1}). In this case Rajshahi swarna had greater relative performance (94.48%) than Lal pajam (93.56%) and the lower relative performance was found in Kataribhog, Silkumul, and Sanla (85.51%, 85.40% and 78.97%, respectively). BRRI (1999) reported that the fine grain aromatic rice cultivars viz. Khaskani, Basmati-D and Kataribhog gave 2.81, 2.75 and 2.04 t ha^{-1} grain yield respectively. Hossain (2008) also revealed that Kataribhog and Badshabhog were produced 2.30 and 2.12 tons grains ha^{-1} respectively.

Table 2. Effect of cultural conditions on grain yield of five fine rice cultivars

Cultivars	Grain yield (t ha^{-1})		Relative Performance (%)
	Inorganic management	Organic management	
Rajshahi swarna	2.90 a	2.74 ab	94.48
Silkumul	2.85 a	2.44 ab	85.40
Kataribhog	2.71 ab	2.32 abc	85.51
Lal pajam	2.44 ab	2.28 abc	93.56
Sanla	2.20 bc	1.74 c	78.97
CV (%)	5.21		-

Mean followed by same letter(s) did not differ significantly at 5% level of significance

Conclusions

From the results is clear that all cultivars showed some-what better performance under inorganic management than organic management. But the yield variation was very low between them. Moreover, based on sustainable agriculture concept use of organic fertilizer for fine rice cultivation is must. So it might be concluded that it is better to follow organic soil management for fine rice cultivars to consider good soil health and sustainable agriculture.

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