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Effect of Different Organic Matter on Yield of Rice (*Oryza sativa*)

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Abstract: This experiment was conducted at the West Byde of BRRI farm, Gazipur during T. Aman'2016 and Boro'2016-2017 to determine the effect of kitchen waste, bio-slurry and poultry litter on yield of rice and evaluate the better source of organic matter for improvement of rice soil health. The treatments were five different nutrient management practices, such as BRRI recommended fertilizer, Kitchen waste, Cowdung bio-slurry; poultry litter and control (no nutrient supply). The treatments were arranged in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 5 m X 4 m. Thirty days old rice and 45 days old rice seedling and 2 seedlings per hill at 20 cm X 20 cm spacing were transplanted respectively T. Aman and Boro season. Kitchen waste, Cowdung bio-slurry and Poultry litter were applied as 3 tha^{-1}(dry weight base) in T. Aman and 4 tha^{-1} in Boro season. Grain yield, tiller number, panicle number, plant height and Straw yield were significantly affected by the different nutrient management practices during both T. Aman and Boro season. BRRI recommended fertilizer produced the tallest plant, highest number of tiller m^{-2}, panicle m^{-2}, grain $panicle^{-1}$ and grain yield than poultry litter, kitchen waste and bio-slurry, on the other hand control plot gave the lowest result.
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Introduction:

Rice (Oryza sativa) is the most demanding cereal in the world. It appears as an indispensable food for more than 50% of the world's population. Its requirement is increasing rapidly for fulfilling the demand of ever growing human population. To meet this rising demand, different approaches are being practiced, such as boosting rice production with the application of different fertilizers (Cassman et al. 1998), cultivating high yielding rice varieties and going forward with instructions issued by governments.

The application of nitrogen fertilizer promotes the rice yield, but it also has unfavorable effects on the environment and soil health (Leip et al. 2014). One of the most common steps taken in the direction of maintaining soil health and environment is the use of organic fertilizers. Such fertilizers provide essential nutrients to soil, and also improve other soil properties, such as water-holding capacity, nutrient-holding capacity and microbial activity of soil. However, a huge volume of organic fertilizer is required for achieving potential of high yielding rice varieties, which will directly step up the cost of farming (Baruah and Baruah 2015; Baruah et al. 2016). In addition, the decomposition of an organic matter under humid tropical condition is relatively hasty and its gathering is minimal in upland irrigated soils. A balanced approach that can be used to sustainably improve rice yield and soil quality is to apply wastes produced from kitchen, garden and farm (crop residues and farm yard manure) in combination with inorganic fertilizers.

The application of such a blended amendment will have a greater chance to endure a fairly lofty amount of nutrients required for a high yielding rice variety and also to improve soil traits. Moreover, composting of eco-friendly organic wastes is a good option to provide a high-quality green fertilizer as a supplement to inorganic fertilizer. The use of compost increases organic carbon and moisture retention ability of soil, while decreases its bulk density. Soil organic carbon and total nitrogen act as basic elements of green agriculture (Franzluebbers and Stuedemann 2009). Hence, restoration of soil organic carbon is required for enhancing rice production by maintaining soil quality, and also to raise the soil carbon store to decrease the release of carbon dioxide from soil. On the other hand, the renewal of nitrogen is desirable for lowering the need of nitrogen fertilizers by avoiding the percolation of nitrogen and release of nitrous oxide to the atmosphere.

Rice fields represent high capacity sources of SCS (Pan et al. 2004; Lu et al. 2009). However, various land management practices, such as tillage, straw management, fertilization, irrigation, and crop rotation, significantly affect GHG emissions (Huang et al. 2004; Arunrat et al. 2016), SCS (Pan et al. 2009; Bhattacharyya et al. 2010), rice production (Parry et al. 2004; Wassmann and Dobermann 2007), and food security (Nguyen 2006). In humid and tropical regions, several studies have been published on SOC and rice yield. These studies recommend that current nutrient management should involve a combination of manure and chemical fertilizers to improve nutrient efficiency for plant uptake (Zhang et al. 2009; Zhao et al. 2013) and to increase crop yield (Witt et al. 2000; Surekha et al. 2003). For instance, in subtropical China, the addition of manure to the soil enabled 18% higher rice yield (Bi et al. 2009) than that of chemical fertilizer alone. Only a study by Alam et al. (2013) has done well in Bangladesh, who evaluated the best management practices (BMP) integrated with farmers' crop management techniques in rice for productivity and profitability. Their results showed that 3–28% grain yield increases with BMP resulting in farmers' net profit increase of US$22 to 120 ha^{-1}. Soil organic carbon (SOC) loss is a key indicator of soil degradation that is accelerated by land use (Erb et al., 2016; Liu et al., 2018) and is widely associated with cultivation (Dungait et al., 2012; Amundson et al., 2015). The recently renewed recognition of SOC for soil health and quality has encouraged straw incorporation (SI) as a simple and environmentally friendly measure to effectively enhance cropland SOC levels (Pan et al., 2010; Liao et al., 2015) and to improve crop production (Zhao et al., 2015). Differences in climatic and edaphic conditions (Bolinder et al., 2007), fertilization strategies (Khan et al., 2007), cropping regimes (Huang et al., 2012) and duration of SI (Lehtinen et al., 2014) have resulted in large spatial and temporal variations in the effects of SI on SOC and crop yield in China (Li et al., 2003; Yu et al., 2012).

Motivated by above, a field trial was undertaken with the rice variety of *Naveen* in the summer cropping season. In particular, soil texture or structure can affect root production. Usually, bigger roots have greater potential in elongation and therefore can enhance better water and nutrient uptake, and overall root production. Root growth of the same cultivar can vary with soil texture. Therefore, it is critical to determine the impact of soil properties on different production systems related to water regime along with rice cultivar. With the aim of enhancing rice production, the investigation was concentrated on studying the effects of organic waste-blended inorganic fertilizer on rice growth, soil properties and rice yield. The objectives of this study were to 1) To find out the effect of kitchen waste, bio-slurry and poultry litter on yield of rice and 2) To evaluate the better source of organic matter for improvement of rice soil health.

Materials and Methods:

The experiment was initiated on a permanent layout at the BRRI farm, Gazipur since 2016 during T. Aman season. Five treatments in Randomized Complete Block Design with 3 replications were imposed and each treatment was assigned in 4-m X 5-m sized plot. The treatments were different sources of soil nutrient such as i) BRRI recommended fertilizer dose, ii) Kitchen waste, iii) Cowdung bio-slurry; iv) Poultry litter and v) control (No nutrient supply). Kitchen waste, Cowdung bio-slurry and Poultry litter were applied as 3 t ha^{-1}(dry weight base) in Aman and 4 t ha^{-1} in Boro season. All manures, soil and plant samples analysis were done by the help of Soil Science division BRRI, Gazipur. Initial soil (0-15 cm depth) properties were: soil texture, clay loam; pH, 7.0; organic matter, 1.40%; Nitrogen, 0.20%; Phosphorus, 9.80 ppm and Potassium, 0.23meq/100g soil. Kitchen waste had 2.94%, 0.72%, 0.62%, 0.74%; OC,N,P,K respectively in T. Aman and In Boro season 7.25%, 0.75%, 0.69%, 0.70%; OC,N,P,K respectively. In T. Aman Cowdung bio-slurry had 7.74%, 0.69%, 0.59%, 0.31%; OC,N,P,K and In Boro season 9.5%, 0.73%, 0.76%, 0.90; OC,N,P,K respectively. In T. Aman poultry litter had 6.5%, 0.94%, 1.20%, 0.21%; OC, N, P, K and 3.9%, 1.05%, 1.20%, 0.65%; OC, N, P, K respectively in Boro season. Thirty days old seedling of BRRI dhan49 in T. Aman and 45 days old seedling of BRRI dhan58 in Boro season were transplanted at 20-cm X 20-cm spacing. The flooded water level at 5-7 cm depth was maintained during rice cultivation, and then drained 21 days before rice harvesting. Before flowering and at harvesting stage, rice plants were collected for analysis of N, P, K content and nutrient uptake based on BRRI standard methods. Collected data were statistically analyzed using a standard statistical procedure (R-software 1).

Results and Discussion:

Grain yield, tiller number, panicle number, plant height and Straw yield were significantly affected by the different effect of organic matter in both T. Aman and Boro season. BRRI recommended dose performed the best in all the parameter except 1000-grain weight. On the other hand control plot (No nutrient supply) gave the lowest result. The details have been discussed below.

Plant height:

In T. Aman season (BRRI dhan49), different nutrient management have significant effects in rice plant height. The tallest rice plant (108.8 cm) was found in the BRRI recommended fertilizer management followed by 102.1 cm in Kitchen waste used plot, 100.53 cm in Poultry litter used plot and 100.27 cm in bio-slurry used plot. The smallest rice plant (98.6 cm) was found in the control plot (Table 1).

Similarly significant difference observed in plant height of BRRI dhan58 for different nutrient management in Boro season. BRRI recommended fertilizer management also produced the tallest plant (99.1 cm) followed by poultry litter (86 cm), kitchen waste (80.73 cm) and cow dung (77.93 cm) used plot. The shortest plant found in control plot (76.5 cm) (Table 1).

Tiller number:

Tiller production varies significantly among the different nutrient management in T. Aman season. BRRI recommended fertilizer gave the highest number of tiller (215 tiller m^{-2}) whereas control plot gave the lowest number of tiller (190 tiller m^{-2}) among all the treatments. But Kitchen waste, Bio-slurry and Poultry litter used plot produced statistically similar tiller number per square meter which were significantly differ from BRRI recommended doses plot (Table 1).

Similar results had been observed in tiller production in the boro season like as T. Aman. BRRI recommended fertilizer management gave the highest number of tiller (314 tiller m^{-2}) where control plot gave the lowest number of tiller (225 tiller m^{-2}). Bio-slurry and poultry litter used plot showed statistically similar tiller number per square meter but significantly differ from control, Kitchen waste and BRRI recommended fertilizer used plot (Table 1).

Panicle number:

Panicle production was significantly affected by all the nutrient management during T. Aman season. The highest number of panicle (200 panicle m^{-2}) found in BRRI recommended doses followed by 187 panicle m^{-2} in kitchen waste used plot. The lowest number of panicle (169 panicle m^{-2}) among all the treatments was observed in control plot. But bio-slurry and poultry litter used plot produced statistically similar number of panicle (Table 1).

On the other hand during Boro season panicle number was significantly affected by different nutrient management practices and similar result like T. Aman was observed here. Among all the treatments BRRI recommended nutrient management practice gave the highest panicle (305 panicle m^{-2}) and control plot gave the lowest panicle (184 panicle m^{-2}). Statistically similar number of panicle produced in bio-slurry and poultry litter (Table 1).

Grain number and grain weight:

During T. Aman season BRRI recommended dose, Kitchen waste and poultry litter used plot gave almost similar number of grain per panicle which was statistically significant from Bio-slurry and control plot. BRRI recommended Fertilizer provides the highest number of grain per panicle (174 grain panicle^{-} 1) whereas control plot gave the lowest number of grain (153 grain panicle^{-1}). And there was no significant difference among the treatments in case grain weight (Table 1). Statistically similar grain per panicle observed in kitchen waste, bio-slurry and poultry litter in Boro season. Here also BRRI fertilizer management produced the highest grain per panicle (142 grain panicle^{-1}) On the other hand control plot also produced the lowest number of grain (107 grain panicle^{-1}). No significant difference was found in grain weight among the treatment except control plot (Table 1).

Grain yield:

During T. Aman season, 2016, Grain yield was significantly affected by different nutrient management practices. BRRI recommended fertilizer management gave the highest grain yield (5.56 t ha^{-1}) followed by Kitchen waste (5.15 t ha^{-1}), poultry litter (5.09 t ha^{-1}) and Bio-slurry (4.73 t ha^{-1}) where Kitchen waste and poultry litter produced statistically similar grain yield. The lowest yield was observed in control plot (4.32 t ha^{-1}) (Table 1).

Grain yield of BRRI dhan58 was greatly affected by different nutrient management practices during Boro, 2016-17. In Boro season BRRI recommended fertilizer management again produced the highest grain yield of 5.99 t ha^{-1} followed by poultry litter (4.31 t ha^{-1}), Kitchen waste (3.15 t ha^{-1}) and bio-slurry (2.95 t ha^{-1}) used plot. And the lowest grain yield (2.05 t ha^{-1}) was also observed in control plot like T. Aman (Table 1).

Straw yield:

Significant effects of various nutrient management practices are also noticed in the production of straw as grain in T. Aman 2016. BRRI recommended dose produced the highest straw yield 6.36 t ha^{-1} followed by 6.12, 5.88 and 5.41 t ha^{-1} in Bio-slurry, kitchen waste and poultry litter used plot, respectively. The lowest straw yield 4.93 t ha^{-1}was observed in control plot (Table 1). Straw yield of BRRI dhan58 was also greatly affected by different nutrient management practices during Boro, 2016-17. BRRI recommended fertilizer management produced the highest straw yield of 5.94 t ha^{-1} followed by poultry litter (4.21 t ha^{-1}), Kitchen waste (3.56 t ha^{-1}) and bio-slurry (3.35 t ha^{-1}) used plot. And control plot gave the lowest (2.42 t ha^{-1}) straw yield (Table 1).

Average nutrient balance yield:

Average nutrient balance study indicated that organic matter 3 to 4 t ha^{-1} was not sufficient for rice cultivation and BRRI recommended dose better for rice production than Kitchen waste, Bio-slurry and Poultry litter (Table 2).

Table 1. Yield and agronomic parameter of different nutrient management practices during T. Aman 2016 and Boro 2016-17 in BRRI farm, Gazipur.

Treatments	Plant height (cm)	Tiller m^{-2} (no.)	Panicle m^{-2} (no.)	Grain panicle^{-1} (no.)	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T. Aman' 2016 (BRRI dhan49)							
Control	98.6	190	169	153	19.00	4.32	4.93
BRRI dose	108.8	215	200	174	20.10	5.56	6.36
Kitchen waste	102.1	202	187	172	20.03	5.15	5.88
Bio-slurry (cow-dung)	100.3	198	179	156	20.85	4.73	6.12
Poultry litter	100.5	199	177	168	20.57	5.09	5.41
LSD at 5% level	3.6	11.25	7.3	8.76	ns	0.40	0.45
Boro' 2016-17 (BRRI dhan58)							
Control	76.5	225	184	107	21.44	2.05	2.42
BRRI dose	99.10	314	305	142	22.50	5.99	5.94
Kitchen waste	80.70	288	248	120	22.26	3.15	3.56
Bio-slurry (cow-dung)	77.93	259	225	121	22.24	2.95	3.35
Poultry litter	86	265	233	127	22.56	4.31	4.21
LSD at 5% level	2.76	12.11	12.99	7.14	0.78	0.48	0.53

Table 2. Nutrient input, uptake and balance in T. Aman, 2016 and Boro, 2016-17.

T. Aman, 2016									
Treatment	Nutrient input (kg/ha)			Nutrient uptake (kg/ha)			Balance (kg/ha)		
	N*	P	K	N*	P	K	N*	P	K
Control	0.00	0.00	0.00	60.80	15.15	30.30	-60.8	-15.15	-30.30
BRRI dose	92.00	13.00	42	91.40	18.00	57.70	0.60	-5.0	-15.70
Kitchen waste	21.46	18.60	22.20	76.60	20.90	40.30	-55.14	-2.30	-18.10
Bio-slurry(cow-dung)	20.67	17.60	9.20	70.26	18.70	57.50	-49.59	-1.10	-48.30
Poultry litter	33.21	35.90	6.30	72.71	21.31	56.10	-39.50	14.59	-49.80
LSD at 5% level	1.97	6.15	1.1	12.75	4.67	6.34			
Boro, 2016-17									
Control	0.00	0.00	0.00	28.91	9.10	38.93	-28.91	-9.10	-38.93
BRRI dose	136.00	18.00	62.00	99.52	19.78	88.90	37.48	-1.78	-26.90
Kitchen waste	29.94	27.60	27.87	52.91	16.47	56.07	-22.97	11.13	-28.2
Bio-slurry(cow-dung)	29.22	30.56	36.00	50.35	16.27	35.04	-21.13	14.29	0.96
Poultry litter	42.11	48.62	44.13	67.22	19.58	68.23	-25.11	29.04	-24.1
LSD at 5% level	5.18	11.45	7.75	4.29	3.10	8.28			

Conclusion

Grain yield, tiller number, panicle number, plant height and Straw yield were significantly affected by the different effect of organic matter in both T. Aman and Boro season. Every parameter BRRI recommended dose has been performed the best. This study indicates organic matter from 3 to 4 t ha^{-1} is not sufficient for rice cultivation. We need to increase the organic dose for good yield or used combined fertilizer for good yield of rice. Further research may be needed to find out the suitable organic matter dose or combined fertilizer management.

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7/10/2020