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Effect of Cow Dung and Rice Hull on Yield Response of Rice (BRRI 65) in a Manipulated Soil

Shusmita Karmaker Munmun and Mahmudul Hasan Chowdhury *

Soil Resource Development Institute, Ministry of Agriculture, Bangladesh

* For correspondence: lipuchowdhury@gmail.com

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ABSTRACT

A pot experiment was conducted to evaluate the effect of Cow Dung (CD) and Rice Hull (RH) on yield response of rice (BRRI 65) in a manipulated soil (acid soil: calcareous soil=7:3). Cow dung treatments were 0, 5 &10 t ha^{-1} and rice hull treatments were 0, 2&4 t ha^{-1}. To assess the best mixing proportion an incubation study was carried out in the Department of Soil, Water and Environment, University of Dhaka. In case of soil, the pH, organic carbon and nutrients (N, P, K, S, Ca and Mg) status of manipulated soil were favorably influenced in manipulated soil. After harvest, the content of organic carbon decreased than the initial soil. Combined application of cow dung and rice hull influenced the available nutrient content (N, P, K, S, Ca and Mg) of the post-harvest manipulated soil. N, P, K, S, Ca and Mg showed better performance in post-harvest manipulated soil than individual acid and calcareous soil. Effects of CD (0, 5, 10 t ha^{-1}) and RH (0, 2, 4 t ha^{-1}) in response to rice (BRRI 65) in manipulated soil showed that agronomic attributes such as height, number of tillers and dry weight of rice plant increased significantly due to addition of CD and RH alone and their combinations. However, dry weight of rice plant did not increase due to interaction of their highest doses.

Keywords: Manipulated soil, Cow dung, Rice hull, Rice (BRRI 65), yield response

1. INTRODUCTION

Bangladesh has been known as one of the most fertile land in the world. Our agriculture has been using and providing the state-of-the-art techniques to increase its huge demand of food supply and it has succeeded almost 100% for feeding its 160 million of people with our own innovative ideas and techniques. A major worldwide agricultural and environmental concern is soil acidity, including Bangladesh and also the soils of Ganges alluvium and adjoining areas are experiencing calcareousness problem in quite a significant degree. An optimum soil pH is needed to maintain soil resources, maximize crop and pasture choice and avoid production losses. The availability of essential nutrients is mainly controlled by the soil reaction. The acidic soil is deficient in Ca, Mg and Mo. These soils are highly weathered and contain large quantities of Al and Fe hydrous oxide that have the ability to adsorb major elements onto their surfaces such that much of added nutrients are fixed instead of being made available for crop use [1]. Plants grown in acid soils may exhibit variety of symptoms and possesses high concentration of phytotoxic aluminum, iron and manganese. This has significant impact on economy and environment. On the contrary, calcareous soils are relatively alkaline, in other words they have a high pH. This is because of the very weak acidity of carbonic acid. They are characterized by the presence of $CaCO_3$ in the parent material and may have a calcic horizon, a layer of secondary accumulation of carbonates (usually calcium or Mg) in excess of 15% $CaCO_3$ equivalent. Calcareous soils are abundant of base forming elements but lack of Fe, Mn, Cu, Zn, B, and they generally have low contents of organic matter, N, P [2]. In both the soils, normal plant growth is hampered and yield tends to decrease. Hence, by mixing acidic and calcareous soils, we may have a manipulated soil that may contain almost all essential elements in adequate available form than their presence in individual entity. Mixing of soils in a suitable ratio we might attain a near neutral pH which could reduce the acidity and calcareousness of these soils resulting better growth of plants.

In Bangladesh rice is abundantly produced because of its growing characters, increasing demand and favorable weather condition. CD can also be used as a co- product in agriculture, such as manure, bio fertilizer, bio pesticides and pest repellent3. CD may not only act as a substitute for chemical fertilizers because it supplements organic matter, but also as a conditioner for soil4. RH from paddy (Oryza sativa) is one example of alternative material that has a great potential. Soil pH values significantly decreased with RHC application. A substantial area of Bangladesh is covered by problem soil of which acid soil was considered to improve its nutrient availability through mixing with requisite proportion of calcareous soil. The present study was undertaken to find out an environment-friendly way to defend soil acidity and calcareousness, also to observe the probable changes of the availability of soil nutrients after manipulation of soil and to evaluate the effects of CD and RH to follow the agronomic attribute of BRRI 65 variety of rice in the manipulated soil.

2. METHOD AND MATERIALS

A pot experiment with rice (BRRI 65) was carried out during Aus season in the green house of the premises of the Department of Soil, Water and Environment, University of Dhaka. To assess the best mixing proportion, an incubation study was carried out to attain the pH around 6.8 (acid: calcareous soil ratio was being 7:3). The pH of soil samples (initial and after harvest) was measured electrochemically by using combined electrode digital pH meter. The ratio of soil to water ratio was being 1:2.5 [3]. The organic carbon (OC) of the soil sample was determined volumetrically by wet oxidation method [4]. The organic matter was calculated by multiplying the percentage of OC with conventional Van-Bemmelen's factor of 1.724 [5].

Content (N, P, K, S, Ca and Mg) of soil were determined following standard method. Total N was determined by Kjeldahl's method from concentrated H_2SO_4-$HClO_4$ digest. On the other hand, available N was determined by extracting a known amount of soil with 1N KCl and distilling as proposed by Black 1965 [5]. The available P of soil samples were extracted by using the extractant and was determined colorometrically using a HACH spectrophotometer (model no. DR5000) following the ascorbic acid blue color method [6].The available K was determined by flame photometer (JENWAY, PFP 7) as outlined by Page et al., 1989 [7]. The available S was determined by developing turbidity of suspended barium sulphate using Tween-80 stabilizer after extracting with calcium dihydrogen phosphate

[Ca(H2PO4)] and measured by HACH spectrophotometer (model no. DR5000) as proposed by [7]. Available Ca and Mg in the soils were determined by the Atomic Absorption Spectrophotometer (VARIAN AA240) after extracting with 1N NH_4OAC (ammonium acetate) at pH 7.0 [3].

Five kilogram of air dried soil was taken in each earthen pot (25cm X 20cm). Three rates of each of CD (0, 5, 10, t ha^{-1}) and RH (0, 2, 4, t ha^{-1}) in all possible combinations were applied to the soil and nine treatments, in triplicate, were arranged in randomized block design. A basal dose of N, P and K at the rate of 120 kg ha^{-1}, 60 kg ha^{-1} and 80 kg ha^{-1} was applied as urea, triple super phosphate and murate of potash respectively. The fertilizers were mixed thoroughly with the soil as per treatment combinations. Soils in the pot were submerged for five days before transplantation. Five healthy seedlings of 4 weeks old, uniform in size, were transplanted in each pot. Agronomic characters were measured at harvest.

3. RESULT AND DISCUSSION

3.1. Available nutrients content and pH, organic carbon of post-harvest acid, calcareous and manipulated soils (without treatment)

The nutrient content (N, P, K, S, Ca and Mg) and (pH, organic carbon) of post-harvest acid, calcareous and manipulated soils soil have been quantified and the results thus obtained have presented in Table 1. Results showed that N, P, K, S, Ca, Mg, pH and organic carbon content of manipulated soil was improved than the individual acid and calcareous soil. In case of pH, the value of individual acid and calcareous soils was 6.11 and 8.23 respectively but in manipulated soil the value

Table 1. Available nutrients (N, P, K, S, Ca and Mg) content (mg kg^{-1}) and pH, organic carbon of post-harvest acid, calcareous and manipulated soils.

Soil	Nutrient content (mg kg^{-1})						pH	Organic carbon (%)
	N	P	K	S	Ca	Mg		
Acid	52.21	8.5	105.51	30.51	320.41	110.47	6.11	0.69
Calcareous	40.51	10.23	143.78	14.75	1685.53	258.75	8.23	0.62
Manipulated	62.58	12.31	167.67	16.28	450.51	135.23	7.60	0.75

Table 2. Effects of CD and RH on the available nutrient content (mg kg^{-1}) of post-harvest manipulated soil.

Treatments	Nutrient content (mg kg^{-1})						pH	Organic Carbon (%)
	N	P	K	S	Ca	Mg		
CD_0RH_0	62.58	12.31	167.67	0.65	0.25	0.105	7.60	0.75
CD_0RH_2	65.81	13.23	201.67	0.69	0.34	0.129	7.58	0.76
CD_0RH_4	66.49	15.19	206.29	0.71	0.35	0.126	7.50	0.79
CD_5RH_0	65.39	11.53	190.21	0.67	0.36	0.119	7.58	0.79
CD_5RH_2	69.45	12.38	206.45	0.72	0.35	0.127	7.53	0.75
CD_5RH_4	70.53	12.01	204.33	0.75	0.36	0.130	7.49	0.81
$CD_{10}RH_0$	68.78	10.67	191.21	0.75	0.39	0.116	7.47	0.83
$CD_{10}RH_2$	70.51	14.35	209.33	0.76	0.40	0.117	7.45	0.85
$CD_{10}RH_4$	72.45	16.98	209.33	0.78	0.41	0.127	7.42	0.89

CD (Cow dung) - 0, 5, 10 t ha^{-1}; RH (Rice hull) - 0, 2, 4 t ha

Table 3. Agronomic attributes of BRRI 65 grown in acid, calcareous and manipulated soils.

Rice plant grown in Soil	Height (cm)	Tiller (pot^{-1})	Dry weight (g)
Acid	44.97	20	9.57
Calcareous	47.51	23	10.34
Manipulated	49.9	27	11

Table 4. Effects of CD and RH on the agronomic attributes of rice (BRRI 65) plant.

Treatments	Height (cm)	Number of tiller (pot^{-1})	Dry weight (g pot^{-1})
CD_0RH_0	49.9	27	11
CD_0RH_2	53.7	31	10.9
CD_0RH_4	56	32.6	12.4
CD_5RH_0	53.3	31	11.9
CD_5RH_2	56.9	33	12.3
CD_5RH_4	58.9	35	13.7
$CD_{10}RH_0$	58.1	34	12.4
$CD_{10}RH_2$	62.7	35	13.8
$CD_{10}RH_4$	64.3	36.3	12.1

CD (Cow dung) - 0, 5, 10 t ha^{-1}; RH (Rice hull) - 0, 2, 4 t ha^{-1}

became 7.60 (Table 1). This might be the mixing effect of two different type of soils. However, the content of N, P, K, S, Ca, Mg and organic carbon increased in manipulated soil than individual acid and calcareous soil (Table 1). This also be due to the mixing effect of two different type of soils.

3.2. Effects of treatments on the available nutrients content and pH, organic carbon of post-harvest soil

3.2.1. N content

Manipulated soil treated with different treatments influenced the available N content of manipulated soil after harvest (Table 2). With the increasing doses of CD, the content of N in soil increased and similar trend was maintained in the case of RH too (Table 2). Addition of 5 and 10 t ha^{-1} of CD with 2 and 4 t ha^{-1} of RH increased the content of N of soil. Application of highest doses i.e. 10 t ha^{-1} of CD with 4 t ha^{-1} of RH increased 15.77% N content of soil over the control. The results agreed favorably well with the findings of Khatik et al. (2001) who reported that the availability of N increased in soil with the addition of organic amendments, either alone or in combination with inorganic fertilizers [8].

3.2.2. P content

Content of P in manipulated soil as influenced by added CD and RH alone and an increasing trend was maintained with the increasing doses of RH but a reverse trend was maintained with the increasing doses of CD alone. Combined application of CD and RH showed that available P content was increased around 37.94 % at the highest rate of both CD (10 t ha^{-1}) and RH (4 t ha^{-1}). When CD was applied at the rate of 5 t ha^{-1} with RH (2, 4 t ha^{-1}) showed approximately same result that is around 12 mg kg^{-1}. The interaction between cow dung and rice hull in most of the cases produced almost similar result and the content was ranging between around 11 to 13 mg kg^{-1} (Table 2). Brahmachari et al. (2005) stated that the maximum improvement of P content of soil after the crop harvest, when organic manure was incorporated along with chemical fertilizers [9].

3.2.3. K content

Single application of CD and RH caused an increase in the available K content of manipulated soil. Interaction of 5 t ha^{-1} CD with 2 t ha^{-1} and 4 t ha^{-1} of RH caused an increased and decreased respectively. However, interaction of 10 t ha^{-1} CD with 2 t ha^{-1} RH and 4 t ha^{-1} RH produced a similar effect (Table 2). Duhan et al. (2001) reported that available K content of soil increased due to the farmyard and organic manure application [10].

3.2.4. S content

Application of CD alone caused an increase in the available S content but in case of RH this trend was not maintained. Interaction of 5, 10 t ha^{-1} CD with 2, 4 t ha^{-1} of RH showed an increasing trend. The S content of manipulated soil was increased 12.71% in case of interaction of 10 t ha^{-1} CD with 4 t ha^{-1} RH than interaction of 5 t ha^{-1} CD with 4 t ha^{-1} RH (Table 2). Bellaki and Badanur (1997) reported that S content of soil improved due to addition of sulphur fertilizers incorporation with cow dung [11].

3.2.5. Ca content

When CD and RH were applied alone it caused an increase in available Ca content of manipulated soil Addition of CD with RH showed a gradual increase in the Ca content of soil. The highest Ca content was recorded due to the interaction of 10 t ha^{-1} CD with 4 t ha^{-1} with the RH (Table 2). Mban et al., (2000) reported that higher Ca and Mg contents were recorded in amended plots by using some animal amendment like cow dung, pig manure and poultry droppings [12].

3.2.6. Mg content

Addition of RH alone caused an increase in the available Mg contents of manipulated soil however this trend was not maintained by CD. RH alone at the rate of 2 and 4 t ha^{-1} caused an increase around 2.40% and 12.62% over the control respectively. In case of interaction between the doses of CD and RH it maintained increasing trend except the interaction between 5 t ha^{-1} CD with 2 t ha^{-1} RH. However, interaction of 10 t ha^{-1} CD with 4 t ha^{-1} RH caused 19.34% increase in Ca content over the control (Table 2). Whalen et al. (1999) reported that manure treatment increased available Mg content of the soils [13].

3.2.7. pH

The highest post-harvest pH (7.60) was measured in manipulated (control) soil. The lowest pH value (7.42) was recorded due to the application of 10 t ha^{-1} CD with 4 t ha^{-1} RH. It was noticed that there was a tendency of decreasing pH with the increasing rate of CD and RH (Table 2). This might be due to the mixing effect of two type of soil and also be the application of treatments at different rate. The results agreed favorably well with the findings of Hemalatha et al. (2000) who revealed that organic manures decreased soil pH [14].

3.2.8. Organic carbon

Application of CD and RH alone increased organic carbon content of post-harvest manipulated soil (Table 2). The maximum content of organic carbon was observed for the highest dost of CD (10 t ha^{-1}) and RH (4 t ha^{-1}) applied i.e. 0.89%. Interaction between CD (5 t ha^{-1}) with RH (2 t ha^{-1}) maintained a decreasing trend. However, the highest dose of CD (10 t ha^{-1}) with RH (4 t ha^{-1}) caused 18.67% increase in organic carbon content of post-harvest manipulated soil over the control (Table 2). Badiyala et al. (1990) reported that post harvest soil organic carbon content increased due to the increasing rate of organic amendment application either alone or in combination with biofertilizers [15].

3.3. Response of agronomic attributes of rice (BRRI 65) grown in acid, calcareous and manipulated soils (without treatment)

Results showed that maximum plant height (49.9 cm); tiller number (27) and dry weight (11g) were recorded in manipulated (control) soil. Plant height, tiller number and dry weight were observed lower in acid soil (44.97 cm) and calcareous soils (47.51 cm); acid soil (20) and calcareous soil (23); acid soil (9.57g) and calcareous soil (10.34g) respectively than that of the manipulated (control) soil.

3.4. Effects of treatments on the plant height, tiller number and dry weight of rice (BRRI 65) grown in manipulated soil

Results showed that application of CD (0, 5, 10 t ha^{-1}) and RH (0, 2, 4 t ha^{-1}) alone influenced the agronomic attributes viz. height, number of tiller, dry weight of shoot, of rice plant (Table 4).

3.5. Height (cm)

Interaction of CD and RH increased the height of the rice plant with the increase of doses of CD and RH (Table 4). However, increase in the rate of RH from 2 to 4 t ha^{-1} resulted significant increase in height of the plant. Similarly, addition of 10 t CD ha^{-1} along with RH resulted significant improvement in height of the plant. Intermediate dose of CD (5 t ha^{-1}) with 2 t RH ha^{-1} caused no significant change. In contrast, 5 t CD ha^{-1} together with 4 t RH ha^{-1} produced significant positive variation in height of the plant over control. The results agreed favorably well with the findings of Moghadam and Heidarzadeh (2014) who observed that the effect of rice husk on the height of rice plant was significant [16]. Islam (2008) also showed that the highest plant height, number of tillers $hill^{-1}$ and grain yield were obtained from the combination of 50% recommended dose of fertilizer with 5 t ha^{-1} CD [17].

3.6. Number of tiller (pot^{-1})

Interaction of CD and RH showed that increase of their doses increased the tiller number of rice plant. However, the application of lower dose of both CD and RH caused a significant change over the control. Results further showed that application of 5 t CD ha^{-1} in association with 2 and 4 t RH ha^{-1} caused a significant increase in tiller number of the plant. CD when applied at the rate of 10 t ha^{-1} with 4 t RH ha^{-1} resulted significant increase in number of tiller over the control (Table 4). Pratiwi and Shinogi (2016) reported that application of rice husk biochar increased the growth parameters of rice plant [18].

Dry weight of shoot (g pot^{-1})

Combined application of CD and RH showed that 2 t ha^{-1} RH with 5 and 10 t ha^{-1} CD application increased the dry weight of rice shoot. However, application of 4 t ha^{-1} RH with 5 t ha^{-1} CD increased the dry weight but a decrease was observed when 4 t ha^{-1} RH was applied with 10 t ha^{-1} CD (Table 4). Similarly, Moghadam and Heidarzadeh (2014) also stated that the yield of dry weight of rice plant was not significant due to organic fertilization [16].

4. CONCLUSION

A global agricultural, environmental and economic concern is soil acidity and calcareousness. The potential productivity of these soils could be high with application of appropriate methods and measures. Proportionate mixing of acid and calcareous soils result optimal and balanced pH and nutrients. We need to develop healthy soil for greater agricultural yields to feed our population with nutritious food, which is challenged by over-using fertilizers and gradual shortage of available lands for agriculture for many reasons. It can be suggested that to reclaim problem soil, manipulation of soils by very natural means could be effective and it is further recommended that CD and RH could be added for maintaining soil health and sustainable management.

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6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

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NA

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