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Research paper

Effects of integrated nutrient management on performance of t. aus rice (BRRI dhan48) in old brahmaputra floodplain soil

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Abstract

A field experiment was conducted at Sutiakhali, Mymensingh to see the effect of integrated nutrient management on performance of T. Aus rice (BRRI dhan48) during March to July 2015 following Randomized Complete Block Design with five treatments and four replications. The treatments were T_1: RD ($N_{75}\,P_{12}\,K_{45}\,S_9$), T_2: STB ($N_{74}\,P_{11}\,K_{36}\,S_7$), T_3: INM ($N_{54}\,P_5\,K_{27}\,S_5$+ CD @ 5.0 t ha^{-1}), T_4: Farmer's practice ($N_{69}\,P_{30}\,K_{37}$), and T_5: Control (no fertilizer). The highest values for plant height (97.35 cm), effective tillers $hill^{-1}$(19.45) panicle length (23.49 cm), filled grains $panicle^{-1}$ (123.7), 1000-grain weight (25.39 g), grain yield (4.823t ha^{-1}), straw yield (8.462 t ha^{-1}) and biological yield (13.29 t ha^{-1}) were obtained from T_3: INM. Lowest values found in T_5: Control. The maximum N, P, K and S uptake by grain (35.55, 6.99, 15.20 and 3.38 kg/ha respectively) were obtained from the application of INM. The minimum N, P, K and S uptake by grain (20.08, 3.64, 8.35 and 1.74 kg/ha respectively) were found from T_5: Control. Similarly, the maximum N, P, K and S uptake by straw (3.38, 5.43, 99.25 and 7.37 kg/ha respectively) were found from T_3: INM. The minimum N, P, K and S uptake by straw (1.74, 2.67, 49.70 and 3.87 kg/ha respectively) were obtained from T_5 (Control). Among treatments, T_3 produced highest grain and straw of BRRI dhan48. Chemical fertilizers in combination with manure based on INM could be recommended for BRRI dhan48 production in aus season.

Keywords: *Integrated Nutrient Management; BRRI Dhan48; Nutrient Content; Nutrient Uptake and Soil.*

1. Introduction

Rice, the staple food crop in Bangladesh and the cropping pattern of the country is predominately rice-based. In Bangladesh, rice dominates over all other crops and covers 77 % of the total cropped area and 93% farmers grow rice. The total area and production of Aus rice are about 1.1 million hectares and 2.9 million tons respectively in 2019 (DAE, 2019). Plant nutrients are essential for proper crop development, plant growth and also of their internal metabolism. Low organic matter content of the soil, imbalanced use of chemical fertilizers, less use of organic manures and inadequate attention given for its improvement and maintenances have made the situation difficult (Karim et al. 1994). Imbalance use of fertilizers produces a negative impact on crop production (Rijpma and Jahiruddin, 2004). It is true that, production of crops cannot be maintained by using only chemical fertilizers and similarity it is not possible obtained higher crop yield by using organic manures alone (Bair, 1990). Nambiar (1991) reviewed that, integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining soil fertility status. Soil organic matter plays an important role in maintaining soil fertility and productivity.

Azarpour et al. (2014) indicated that with the increasing of nitrogen fertilizer application, grain yield increased significantly (17.13 and 57%). Yoseftabar (2013) revealed that the panicle length at harvesting stage and total grain increased significantly with an application of 300 kg/ha N-fertilizer at four stage. Devi et al. (2012) found that grain and straw yields obtained higher values with highest level of nitrogen. Yoseftabar (2012) investigated the effect of nitrogen and phosphorus fertilizer on growth and yield and found interaction effect of N and P- fertilizer was significant in fertile tiller and 1000-grain weight. Yaqub et al. (2010) showed that averaged across urea-N treatments, manuring significantly increased the number of tillers/plant (11% increases), rice grain yield (6% increases), grain N content (4% increase) and grain N uptake (9% increase). Lin et al. (2009) indicated that modification in the management practices can positively influence the rice crop outputs. Islam et al. (2008) said that the highest grain yield 4.27 t ha-1 was recorded with the N4S3 (100 kg N ha-1) and the lowest grain yield 2.60 t ha-1 was recorded from N1S3. Chaturvedi (2005) said all the growth characters and yield parameters, N was increased significantly with an application of sulphur containing N- fertilizer supernet. Mazumder et al. (2005) reported that different levels of nitrogen influenced grain yield. Wang (2004) reported deep placement of nitrogen fertilizer promoted N uptake, grain N content and N harvest index, resulted in a higher dry matter production, harvest index and a higher grain yield of rice plant compared with conventional N application. Dongarwar et al. (2003) resulted that there was a significant increase in grain yield with successive increase in fertilizer rate. Duhan and Singh (2002) reported that the rice yield and uptake of nutrients increased significantly with increasing N levels.

Balcha (2014) suggests that excess P supply beyond 3 g/m2 could result in low grain yield increase and low P recovery requiring soil P assessment prior to fertilizer. Hasanuzzaman et al. (2012) indicated that the effect of nitrogen and phosphorus showed significant variation in respect of yield contributing characters and yield.Yoseftabar (2012) reported that application of nitrogen and phosphorus fertilizer on growth and yield, fertile tiller, total grain, 1000-grain weight and yield were increased by the application of P-fertilizer. Dongarwar et al. (2003) observed that there was a significant increase in grain yield with successive increase in P fertilizer. Sahrawat et al. (2001) stated that grain yields of the rice cultivars were significantly increased by fertilizer P. Sarkunan et al. (1998) found that increasing levels of P from 0-100 mg/kg progressively increased the grain yield from 16.9 to 42.5 g/pot. Sulphur addition at 25 mg/kg resulted in 9% increase in grain yield. Wilson et al. (1996) found that grain yield significantly increased by P application (40 lb P205 acre-1) where the soil available P was 11 lb acre-1, but no response to K application was found. Subba Rao et al. (1995) reported that phosphorus applied @ 50 mg P /kg soil as SSP increased the grain and straw yields of rice significantly.

Haque et al. (2006) indicated that increasing potassium level up to 40 kg K ha-1 increased the rice yield and all yield components. Arivazhagan et al. (2005) found that application of 150:50:75 kg NPK /ha resulted in the highest number of panicles/hill (9.06), pancle length (19.6 cm), 1000-grain weight (20.50g), grain yield (5.06 t/ha) and straw yield (6.10 t/ha). Basal skipping of K2O resulted in the highest grain and straw yields (5.35 and 6.74 t/ha). Hu et al. (2004) resulted that grain yield and total K uptake by rice decreased significantly. The interaction effect between cropping history and K application was also significant. Sarfaraz et al. (2002) observed that the number of tillers/m2, 1000-grain weight, paddy and straw yield significantly increased with the application of N, P, K and S. Cong et al. (2001) found that K application improved yield of rice grown on an alluvial soil. Nakashgir et al. (2000) showed that combined mean grain yield of 59.66q/ha was obtained with combination of N90 K60 without the basal application of any form of organic manure. The increase in K and N uptake by the rice crop ranged from 24.14 to 57.58 and 4.73 to 11.53 kg/ha, respectively.

Chandel et al. (2003) found that increasing S levels in rice significantly improved leaf area index, tiller number, dry matter production, harvest index and S content in rice up to 45 kg S/ha. Peng et al. (2002) showed that there was a different yield increasing efficiency with application of S at the doses of 20-60 kg ha-1 to rice plant. The increasing rate of rice yield was 2.9-15.5% over control. Sarfaraz et al. (2002) found that the number of tillers m-2, 1000-grain weight, grain and straw yields were significantly increased with the application of NPK and S fertilizers compared to the control. They also found that NPK concentrations and their uptake in grain and straw significantly increased with the application of NPK+ S fertilizers compared to the control. Singh et al. (2002) reported that plant height, tillers/m2, dry matter production, panicle length and grains/panicle were significantly increased with increasing levels of S up to 40 kg/ha. Significant improvement in grain yield was observed due to sulphur application (Raju and Reddy,2001). Vaiyapuri and Srirama (2001) reported that the highest rice yield (5.3 t ha-1) was obtained when green manure was applied along with pyrite at 20 kg S ha-1 which was comparable with pyrite applied at 40 kg ha-1 in the absence of green manure. Yang et al. (2001) result's showed that the optimum ratio for NS fertilizer was 4:1.The combine application of these two elements (N and S) increased the straw S content only at tillering stage. The uptake of nutrient by the straw and grain improved significantly, which was reflected in the straw and grain yields (Mandal et al. 1998).

Hossain et al. (2010) overall findings suggest that the composted PM combined with 50 or 75% CF can be an efficient practice for ensuring higher rice yield without deteriorating soil fertility. Application of chemical fertilizer, cowdung and Azospirillum, individually or in combinations significantly increased the yield attributes over the control. The treatment comprising 80 kg N/ha + Azospirillum + 2.5 t cowdung/ha was superior over all other treatments in terms of rice yield (Singh et al. 2006). Manuring with cowdung up to 10 t ha-1 in addition to recommended inorganic fertilizers with N application improved gram and straw yields and qualities of transplant rice over inorganic fertilizers alone (Mashkar et al. 2005). Mobasser et al. (2005) reported that numbers of panicles hill-1 were significantly higher in cowdung treated plots compared with unfertilized control. Saitoh et al. (2001) revealed that the yield of organic manure treated and pesticide free plots were 10% lower than that of chemical fertilizer and pesticide-treated plot. Huang et al. (1999) reported that, the maximum number of filled grains panicle-1 was produced by 15 ton cowdung ha-1 and the minimum by the control. Bangladesh Institute of Nuclear Agriculture (BINA) (1996) reported that the highest number of productive tillers hill-1 was obtained from the highest level (15 ton ha-1) of cowdung. Rathore et al. (1996) found that 1000 grain weight was significantly higher in cowdung treated plots compared with the unfertilized control.

Integrated Nutrient Management (INM) is a practice where all sources of nutrients namely organic, inorganic (chemical fertilizer), biofertilizer can be combined and applied to soils so that crop growth is enhanced and we can get good yield. Application of manure in combination with recommended fertilizer dose can play important role in rice cultivation.

Maximum number of fertile tillers per plant (16.79), number of panicles per hill (8.41), 1000- grain weight (21.12 g), biological yield (10.19 t/ha), grain yield (4.47 t/ha) and harvest index (43.76%) were recorded from the plots receiving poultry manure @ 10 t/ha in combination with 50% of RDF (Arif et al. 2014). Application of manures and different doses of chemical fertilizers significantly increased the yield components and grain and straw yields of BINA dhan7 (Malika et al. 2011). Qian et al. (2011) revealed that organic manure application combined with chemical fertilizers treatments were 65.4%-71.5% ($P<0.05$) higher than CK, and 3.9%-7.8% ($P<0.05$) higher than NPK treatment in yield. Lin et al. (2009) concluded that application of mixed mineral-fertilizer-N and organic-fertilizers-N had a better or the same effects on the yields of rice grains and N use efficiency could be significantly increased compared with the single application of mineral nitrogen fertilizer. Application of manures and different doses of urea-N fertilizers significantly increased the yield components and grain and straw yields of BRRI dhan29 (Rahman et al. 2009). The treatment receiving 80% RFD with 3 t ha-1 poultry manure produced the higher grain yield of 4867 kg/ha and straw yield of 5797 kg/ha. The performance of manures may be ranked in order of PM> Dh> CD (Parvez et al. 2008).

2. Materials and methods

2.1. Site and weather description

The field experiment was conducted a typical rice growing silt loam soil at Sutiakhali village of Mymensingh Sadar upazila under Mymensingh district during January-July 2015.The experimental site is situated at latitude N: $24^{0}40.982'$ and longitude E: $90^{0}27.391'24°$N at a height of 8.3 m above the mean sea level. Soil type was Non-Calcareous Dark grey Floodplain Soil under Old Brahmaputra Floodplain Agro-ecological zone. Physical characteristics of soil were sand 27.06%, silt 63.40% and clay 9.54%. Textural class was silt loam. Drainage system was moderate. Chemical characteristics of soil were pH (6.53), organic matter (1.35%), total N (0.10%), available P (6.0 mg kg^{-1}), Exchangeable K (0.097cmol+ kg^{-1}), available S (9.3 mg kg^{-1}) and available Zn (0.41mg kg^{-1}). The weather information ranged temperature (max. 23.9^0c - 35.4^0c & min. 11.3^0c - 26.7^0c) rainfall (Nil -299.9 mm) and humidity (76-86.6%) prevailed at the experimental site during the cropping season of conducting the experiment. (Source: Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh).

Soil samples were collected at a depth of 0-15 cm from the surface. The samples were then stored in clean plastic bags for subsequent chemical and mechanical analysis. The planting material used for the experiment was transplanted aus rice. The variety was BRRI dhan48.

2.2. Experimental design and treatments

The experiment was laid out in a randomized complete block design (RCBD) where the experimental area was divided into 4 blocks representing the replications to reduce the heterogenic effects of soil. There were 5 different treatment combinations. Each block was subdivided into 5 plots and the treatments were randomly distributed to the unit plots in each block. Thus the total number of unit plot was 20. The size of each plot was 4.5 m x 3.15 m and the spacing among the plots were 20 cm. The land was prepared by ploughing and cross ploughing with power tiller. Then the land was laddered with traditional tools. All kinds of weeds and stubbles were removed from the field before final ploughing and leveling.

There were five treatments as follows: T_1: RD (N_{75} P_{12} K_{45} S_9),T_2: STB (N_{74} P_{11} K_{36} S_7),T_3: N_{54} P_5 K_{27} S_5 (INM) + CD @ 5.0 t ha^{-1} ,T_4: Farmer's practice (N_{69} P_{30} K_{37}) and T_5: Control (no fertilizer). (Here, RD=Recommended Dose, STB= Soil Test Basis, INM= Integrated Nutrient Management, CD=Cowdung).

2.3. Name, rates and sources of nutrients applied as folows

Name of fertilizer	Treatments	Nutrient rate (kg/ha)	Fertilizer rate (kg/ha)	Fertilizer rate (g/plot)
Urea	T_1	75	163.04	232
	T_2	74	160.51	228
	T_3	54	117.03	166
	T_4	69	149.81	213
TSP	T_1	12	60.00	85
	T_2	11	56.25	80
	T_3	5	26.25	37
	T_4	30	149.81	213
MoP	T_1	45	90.00	128
	T_2	36	71.87	102
	T_3	27	53.47	76
	T_4	37	74.90	106
Gypsum	T_1	9	50.00	71
	T_2	7	40.74	58
	T_3	5	26.30	37
CD	T_3		5000	7100

2.4. Application of manures and fertilizers

The amounts of nitrogen, phosphorus, potash and sulphur fertilizers required per plot were calculated as per the treatments. Cowdung was applied before one week of transplanting (9 April 2015). The full dose of TSP, MoP and Gypsum were applied one day before transplanting (15 April 2015). Nitrogen from urea was applied in 3 equal splits. The first split of urea was applied after 15 days of transplanting (1 May 2015). Second split was applied as top dressing after 30 days of transplanting (16 May 2015) and the third split of urea after 45 days of transplanting (31 May 2015) i.e. at panicle initiation stage.

2.5. Transplanting of seedling, intercultural operations, harvesting and data recording

Twenty-five days old seedlings were carefully uprooted from a seedling nursery and transplanted on the experimental plots maintaining plant spacing of 20cm x 20cm. Three seedlings were transplanted in each hill. The number of rows and hills per plot was equal in all the plots. Intercultural operations like irrigation, weedind, insect and pest control were done carefully. The crop was harvested at full maturity on 20 July 2015. The harvested crop from each plot was bundled separately and brought to the threshing floor and threshed plot-wise. Grain and straw yields were recorded plot-wise and expressed as t ha^{-1} on the basis of 14% moisture content. The plant data on yield and yield components of rice were recorded. The yield components were plant height, panicle length, number of effective tillers $hill^{-1}$, number of filled grains $panicle^{-1}$ and 1000-grain weight.

2.6. Chemical analyses of plant samples

2.6.1. Preparation of plant samples

The representative grain and straw samples were dried in an oven at 65^0 C for about 24 hours before they were ground by a grinding machine. The prepared samples were then stored in paper bags and finally they were kept into a dessicator until analysis was done.

2.6.2. Digestion of plant samples for total nitrogen determination

For the determination of nitrogen, 0.1g of oven dry ground plant sample (both grain and straw separately) was taken in a micro-kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se = 100: 10:1), 2 ml 30% H_2O_2 and 3 ml H_2SO_4 were added into the flask. The flask was swirled and allowed to stand for about 30 minutes. Then heating was continued until the digest was clear and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. The digest was used for nitrogen determination.

2.6.3. Digestion of plant samples for P, K and S determination

Plant sample of 0.5g (grain or straw) was transferred into dry clean 100 ml Kjeldahl flask. 10ml of di-acid mixture (HNO_3: $HClO_4$= 2:1) was added into the flask. After leaving for a while, the flasks were heated at a temperature of 200^0 C. The content of the flask was boiled until they became sufficiently clear and colorless. After cooling, the digests was transferred into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. The digest was used for the determination of P, K and S.

2.7. Determination of N, P, K and S from plant samples

2.7.1. Nitrogen

Nitrogen contents in the digests were determined by micro-kjeldahl method. After the completion of digestion, 40% NaOH was added with the digest for distillation. The evolved ammonia was trapped into 4% H_3BO_3 solution and 5 drops of mixed indicator of bromocressol green ($C_{21}H_{14}O_5Br_4S$) and methyl red ($C_{10}H_{10}N_3O_3$) solution. Finally the distillate was titrated with standard 0.01 N H_2SO_4 until the color changed from green to pink.

2.7.2. Phosphorus

Phosphorus was determined following the procedure of using 1ml digest for grain sample and 2 ml digest for straw sample from 100 ml extract. Then the sample was shaking with 0.5 M $NaHCO_3$ solution at pH 8.5 following Olsen method. The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolybdate complex and measuring the intensity of color spectrophotometrically at 660 nm wavelength. The readings were calibrated to the standard P curve.

2.7.3. Potassium

5 ml of digest for the grain and 10 ml for the straw was taken with 1.0 N NH_4OAc (pH 7) and diluted to 50 ml volume to make desired concentration. K was determined from the extract by using Flame photometer and calibrated with a standard curve.

2.7.4. Sulphur

Sulphur was determined by using 10 ml of digest (both for grain and straw) from 100 ml extract with $CaCl_2$ solution (0.15%). The S content in the extract was estimated turbidimetrically and readings were taken by spectrophotometer at 420 nm.

2.8. Nutrient uptake

After chemical analysis of grain and straw samples, the nutrient content were calculated and from the value of nutrient concentration. Nutrient uptakes were also calculated by the following formula:

$$\text{Nutrient uptake} = \frac{\text{Nutrient content (\%)} \times \text{Yield (kg/ha)}}{100}$$

2.8.1. Statistical analysis

The analysis of variance for crop characters and also for the nutrient content of the plant samples were done following the ANOVA technique and the mean results in case of significant F-value were adjudged by the Duncan's Multiple Range Test (DMRT).

3. Results

3.1. Effect of integrated nutrient management on yield contributing characters of BRRI dhan48

The yield contributing characters include the plant height, effective tillers/hill, panicle length, filled grains/panicle and 1000-grain weight. All data were statistically significant. These data are presented in Figure 1.

3.1.1. Plant height

Plant height of BRRI dhan48 responded significantly due to application of cowdung and fertilizers (Fig. 1. A). Plant height ranged from 70.85 cm to 97.35 cm. The tallest plant of 97.35 cm was found in T3: INM which was identical to T1: RD and T2: STB with the value of 96.97 cm and 94.30 cm, respectively. The shortest plant of 70.85 cm was observed in control treatment. The treatments may be ranked in the order of T3 > T1 > T2 > T4 > T5 in terms of plant height.

3.1.2. Effective tillers hill-1

Combined use of cowdung and fertilizers significantly influenced the number of effective tillers hill-1 of BRRI dhan 48. The highest number of effective tillers hill-1 of 19.45 was found in T3: INM and the lowest value of 15.10 observed in T5 (Fig. 1. B). The treatments T1: RD and T4: Farmer's practice (FP) demonstrated statistically similar effective tillers hill-1 with T2: STB. However, the treatments may be ranked in the order of T3 > T2 > T1 > T4 > T5 in terms of effective tillers hill-1.

3.1.3. Panicle length

The length of panicle was significantly influenced by the application of cowdung and fertilizers and showed similar to plant height (Fig. 1. C). The highest panicle length (23.49cm) was found in T3: INM. The lowest panicle length (21.91cm) was observed in T5. The treatments may be ranked in the order of T3 > T2 > T1 > T4 > T5 in terms of panicle length.

3.1.4. Filled grains panicle-1

Filled grains per panicle of BRRI dhan48 responded significantly to different treatments (Fig. 1. D). The number of filled grains panicle-1 varied from 92.85 to 123.7 with the highest value (123.7) in T3: INM. The treatments T1, T2 and T3 are statistically similar. The lowest number of filled grains panicle-1 (92.85) was found in T5. The treatments may be ranked in the order of T3 > T2 > T1 > T4 > T5 in terms of filled grain panicle-1.

3.1.5. 1000-grain weight

The 1000-grain weight of BRRI dhan48 varied significantly due to application of cowdung and fertilizers. The 1000-grain weight ranged from 25.39g in T3: INM to 19.59g in T5: control. The treatments may be ranked in the order of T3 > T1 > T2> T4 > T5 in respect of 1000-grain weight (Fig. 1. E).

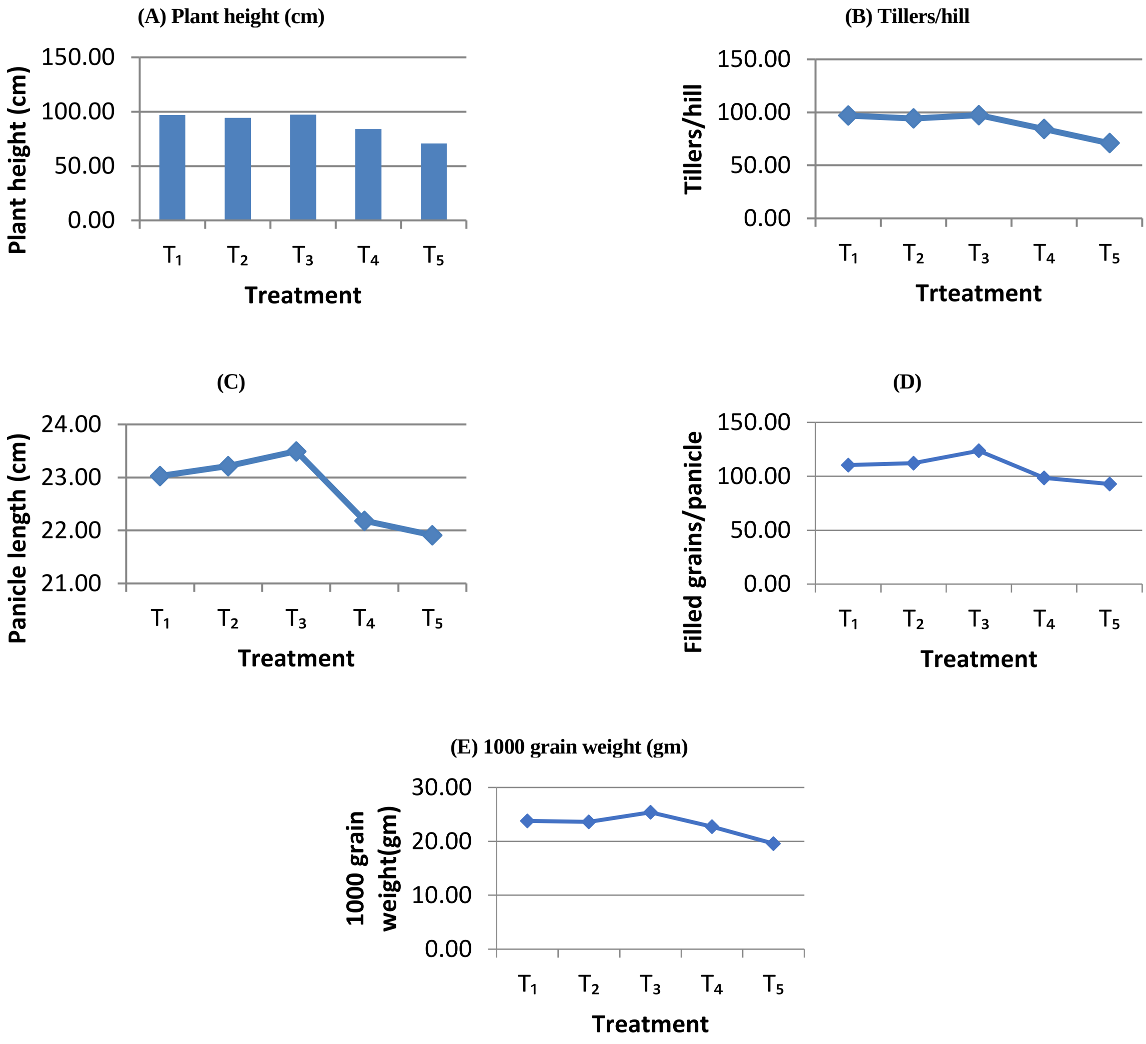

Fig. 1: Yield Attributes of BRRI Dhan48 as Affected by Integrated Nutrient Management: A. Plant Height (Cm), B. Tillers/Hill, C. Panicle Length (Cm), D. Filled Grains/Panicle and E. 1000 Grain Weight (Gm)

3.2. Effect of integrated nutrient management on grain and straw yield of BRRI dhan48

All data were statistically significant. These data are presented in Figure 2.

3.2.1. Grain yield

The grain yield of BRRI dhan48 varied significantly due to application of cowdung and fertilizers (Fig. 2. A). The grain yield ranged from 3.055 to 4.823 t ha-1. The highest grain yield (4.823 t ha-1) was observed in T3: INM and the lowest value (3.055 t ha-1) recorded in T5: Control. The grain yield produced by T2: STB was statistically similar with T1: RD and T4: Farmers practice (FP). Based on grain yield the treatments may be ranked in order of T3 > T2 > T1 > T4 > T5.

3.2.2. Straw yield

Straw yield of BRRI dhan48 also varied significantly by different treatments under study. The yields of straw ranged from 5.755 to 8.462 t ha-1 (Fig. 2. B). The highest straw yield of 8.462 t ha-1 was obtained in T3: INM and the lowest value of 5.755 t ha-1 noted in T5: Control. The treatments may be ranked in the order of T3 > T2 > T1 > T4 > T5 in terms of straw yield.

3.2.3. Biological yield

Results showed that different treatments had significant effect on the biological yield (Fig. 2. C). It was observed that the treatment T3: INM gave the highest biological yield (13.29 t ha-1).The lowest biological yield (8.81tha-1) was obtained from T5: Control. The treatments may be ranked in the order of T3 > T2 > T1 > T4 > T5 in terms of biological yield.

3.2.4. Harvest index (%)

The highest harvest index (36.35%) was recorded in the treatment T3: INM and the lowest harvest index (33.02%) observed in T2: STB. The treatments may be ranked in the order of T3 > T5 > T4 > T1 > T2 in terms of harvest index (Fig. 2. D).

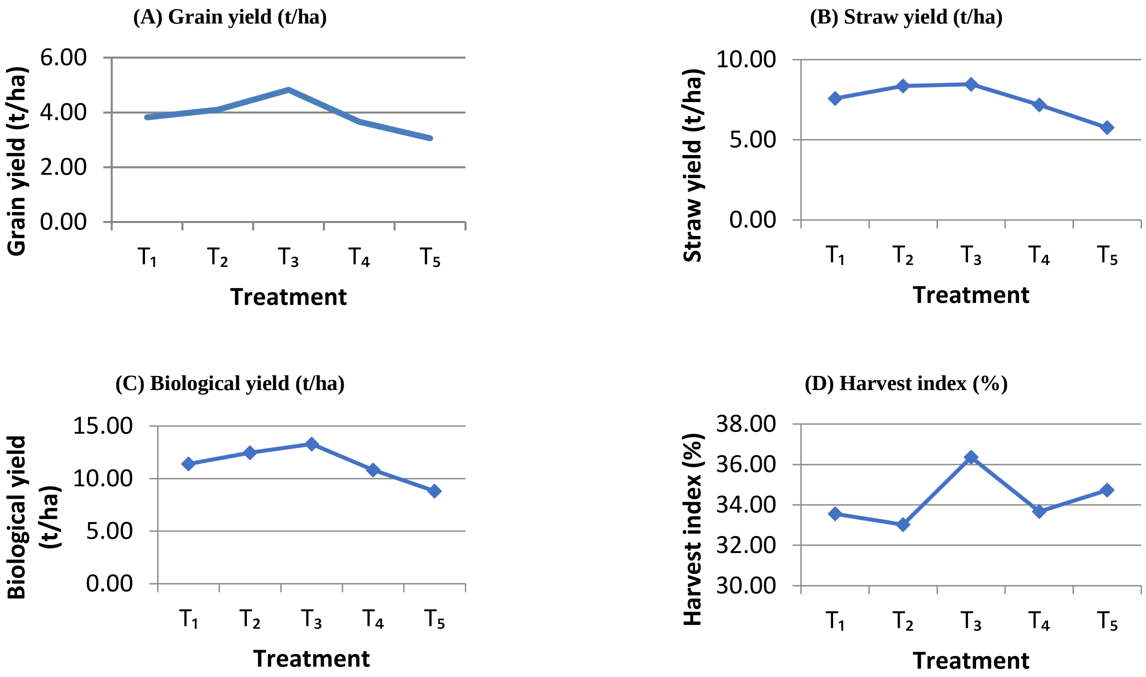

Fig. 2: Yield of BRRI Dhan48 As Affected by Integrated Nutrient Management: A. Grain Yield (T/Ha), B. Straw Yield (T/Ha), C. Biological Yield (T/Ha) and D. Har-Vest Index (%).

3.3. Nutrient content in rice grain and straw of BRRI dhan48

The grain and straw samples of BRRI dhan48 were analyzed for estimating N, P, K and S content. The results of N, P, K and S contents of grain and straw have discussed under the following sub-sections. All data were statistically significant.

3.3.1. Nitrogen content

The nitrogen content in rice grain was not significant by the application of manure and fertilizers (Table 1). The highest N content of 0.737% was observed in T_3: INM and the lowest N content of 0.657% noted in T_5: Control. Application of cowdung with chemical fertilizers increased the N content in rice grain markedly in T_3: INM. In the straw of BRRI dhan48, the N content varied significantly due to different treatments (Table 3). The N content in the straw ranged from 0.413% in T_1 to 0.54% in T_3.

3.3.2. Phosphorus content

Results in Table 1 indicated that phosphorus content in the grain of BRRI dhan48 varied significantly due to different treatments. Phosphorus content in grain ranged from 0.119 to 0.145%. The highest P content (0.145%) in grain was found in T_3: INM and the lowest value (0.119 %) noted in T_5: Control. Phosphorus content in rice straw was influenced significantly due to use of cowdung and fertilizers as shown in Table 3. The highest P content in straw (0.084%) was observed in T_3: INM and the lowest value (0.071%) recorded in T_5: Control.

3.3.3. Potassium content

The potassium content both in grain and straw of BRRI dhan48 varied significantly due to application of cowdung and fertilizers. The K content ranged from 0.273 to 0.315% in rice grain and 1.324 to 1.535% in straw (Table 1). The highest K content in rice grain (0.315%) and straw (1.535%) was recorded in T_3: INM. The lowest K content in grain (0.273%) and straw (1.324%) was observed in T_5: Control.

3.3.4. Sulphur content

The sulphur content both in grain and straw of BRRI dhan48 was influenced significantly by the combined use of cowdung and fertilizers (Table 1).The highest S content of 0.07% in grain was obtained in T_3: INM and the lowest value of 0.057% noted in T_5: Control. All the treatments caused an increasing effect on the S content of rice grain and the effect of INM was better compared to fertilizer doses. In case of straw, S content ranged from 0.103 to 0.114%. The highest S content in straw (0.114%) was recorded in T_3: INM and the lowest S content in straw (0.103%) observed in T_5: Control.

Table 1: N, P, K and S Content in Grain and Straw of BRRI Dhan48 As Influenced by Integrated Nutrient Management

Treatment	N (%)		P (%)		K (%)		S (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	0.734 a	0.441 c	0.138 ab	0.073 b	0.293 b	1.423 b	0.067 a	0.113 a
T_2	0.698 b	0.469 b	0.141 a	0.082 a	0.315 ab	1.519 a	0.068 a	0.111 a
T_3	0.737 a	0.540 a	0.145 a	0.084 a	0.315 a	1.535 a	0.070 a	0.114 a
T_4	0.700 b	0.443 c	0.125 bc	0.073 b	0.301 b	1.420 b	0.059 b	0.105 b
T_5	0.657 c	0.413 d	0.119 c	0.071 b	0.273 c	1.324 c	0.057 b	0.103 b
$LSD_{0.05}$	0.019	0.026	0.014	0.007	0.013	0.041	0.007	0.005
SE (±)	0.063	0.008	0.004	0.002	0.004	0.013	0.002	0.001
Level of significance	0.0424 **	0.0933 **	0.0049 **	0.0014 **	0.0101 **	0.3033 **	0.0013 **	0.0010 **
CV (%)	1.79	3.65	6.51	5.18	2.74	1.83	7.29	2.19

** = Significant at 1% level of probability, LSD= Least Significant Difference.
SE (±) = Standard Error of means, CV (%) = Co-efficient of Variation.

3.4. Nutrient uptake by grain and straw of BRRI dhan48

The results of N, P, K and S uptake by grain and straw of BRRI dhan48 have been presented and discussed below: All data were statistically significant.

3.4.1. Nitrogen uptake

Results indicate that, the N uptake both by grain and straw of BRRI dhan48 varied significantly due to application of manure and fertilizers (Table 2). The N uptake by grain ranged from 20.08 to 35.55 kg ha^{-1} and straw from 1.74 to 3.38 kg ha^{-1}. The highest N uptake by grain and straw was recorded 35.55 kg ha^{-1} and 3.38 kg ha^{-1} in T_3: INM, respectively. The lowest N uptake by grain (20.08 kg ha^{-1}) and by straw (1.74 kg ha^{-1}) found in T_5: Control. The highest total N uptake (70.47 Kg ha^{-1}) was observed in T_3: INM and the lowest value (35.58 Kg ha^{-1}) found in T_5: Control.

3.4.2. Phosphorus uptake

The results presented shows that, the P uptake both by grain and straw of BRRI dhan48 was influenced significantly by the application of cowdung and fertilizers (Table 2). The P uptake by grain ranged from 3.64 to 6.99 kg ha^{-1} and that by straw 2.67 to 5.43 kg ha^{-1}. The maximum P uptake by grain (6.99 kg ha^{-1}) and straw (5.43 kg ha^{-1}) was found in T_3: INM. The minimum P uptake by grain (3.64 kg ha^{-1}) and straw (2.67 kg ha^{-1}) was found in T_5: Control. Combined use of cowdung and chemical fertilizers is better than only use of chemical fertilizers. The application of cowdung and fertilizers showed significant effect on the uptake of total P by BRRI dhan48 (Table 2). The highest total P uptake (12.43 kg ha^{-1}) was obtained in T3: INM and the lowest total P uptake (6.307 kg ha^{-1}) observed in T_5: Control.

Table 2: Effect of Integrated Nutrient Management on N and P Uptake by BRRI Dhan48

Treatment	N uptake (kg)			P uptake (kg)		
	Grain	Straw	Total	Grain	Straw	Total
T1	28.05 b	2.560 c	52.63 c	5.27 bc	4.07 b	9.34 c
T2	28.62 b	2.790 b	58.43 b	5.78 b	5.21 a	10.99 b
T3	35.55 a	3.380 a	70.47 a	6.99 a	5.43 a	12.43 a
T4	25.62 c	2.160 d	48.53 d	4.57 c	3.78 b	8.35 d
T5	20.08 d	1.74 e	35.58 e	3.64 d	2.67 c	6.31 e
LSD0.05	1.54	0.223	3.31	0.748	0.592	0.742
SE (±)	0.500	0.072	1.08	0.242	0.192	0.240
Level of significance	124.91**	214.670**	657.82**	6.363**	5.062**	22.344**
CV (%)	3.63	4.98	4.05	9.25	9.09	5.08

** = Significant at 1% level of probability, LSD= Least Significant Difference.
SE (±) = Standard Error of means, CV (%) = Co-efficient of Variation.

3.4.3. Potassium uptake

The results indicate that the K uptake by grain and straw of BRRI dhan48 varied significantly by different treatments (Table 3). The K uptake by grain ranged from 8.35 kg ha^{-1} in T_5: Control to 15.20 kg ha^{-1} in T_3: INM. The K uptake by straw ranged from 49.70 kg ha^{-1} in T_5: Control to 99.25 kg ha^{-1} in T_3: INM, respectively. The total K uptake by grain and straw was also affected significantly by different treatments. The highest total K uptake (114.4 Kg ha^{-1}) was obtained in T_3: INM and the lowest value (58.05 Kg ha-^{1}) in T_5: Control.

3.4.4. Sulphur uptake

Sulphur uptake by grain and straw was influenced significantly due to application of different treatments (Table 3). The S uptake by grain and straw ranged from 1.74 Kg ha-1 to 3.38 Kg ha-1 and 3.87 Kg ha-1 to 7.37 kg ha-1, respectively. The highest S uptake by grain (3.38 kg ha-1) and straw (7.37 kg ha-1) was found in T3: INM. The lowest S uptake by grain (1.74 kg ha-1) and straw (3.87 kg ha-1) was found in T5 (control). The total S uptake by grain and straw was also influenced significantly by different treatments (Table 3). The highest total S uptake (10.75 kg ha-1) was found in T3: INM and the lowest value (5.61 kg ha-1) in T5: Control.

Table 3: Uptake of K and S by BRRI Dhan48 as Influenced by the Application of Integrated Nutrient Management

Treatment	K uptake (kg)			S uptake (kg)		
	Grain	Straw	Total	Grain	Straw	Total
T1	11.00 c	79.30 c	90.50 c	2.56 c	6.30 b	8.86 c
T2	12.92 b	96.54 b	109.50 b	2.79 b	7.05 a	9.84 b
T3	15.20 a	99.25 a	114.4 a	3.38 a	7.37 a	10.75 a
T4	11.02 c	73.44 d	84.46 d	2.16 d	5.43 c	7.59 d

T5	8.35 d	49.70 e	58.05 e	1.74 e	3.87 d	5.61 e
LSD0.05	0.999	2.69	3.20	2.23	0.367	0.424
SE (±)	0.324	0.874	1.04	0.072	0.119	0.137
Level of significance	25.913**	1605.12**	2018.72**	1.552**	7.931**	16.163**
CV (%)	5.55	2.20	2.28	5.74	3.96	3.24

** = Significant at 1% level of probability,LSD= Least Significant Difference.
SE (±) = Standard Error of means, CV (%) = Co-efficient of Variation.

4. Discussion

The organic matter content of Bangladesh soils is declining day by day due to intensive cropping with modern varieties with little or no use of manures. Combined use of manures and chemical fertilizers in soil is effective for soil health. It improves soil fertility and assures sustainable agriculture for future. The present study was conducted to evaluate the effects of combined use of manures and fertilizers on the growth and yield of BRRI dhan48. The results of the experiment show that the yield components of BRRI dhan48 were influenced significantly due to combined use of manure and fertilizers. In the present study, five nutrients rates viz. T_1: RD, T_2: STB, T_3: INM, T_4: Farmer's practice, T_5: Control were imposed on BRRI dhan48.

Yield components such as effective plant height, tillers/hill, panicle length, filled grains/panicle, 1000 grain weight, grain yield and straw yield of BRRI dhan48 responded positively with the application of fertilizers alone or in combination with cowdung. Plants height responded significantly due to application of cowdung and NPKS fertilizers. Azarpour et al. (2014) indicated that with the increasing of nitrogen fertilizer application, grain yield increased significantly (17.13 and 57%).Yoseftabar (2013) revealed that the panicle length at harvesting stage and total grain increased significantly with an application of 300 kg/ha N-fertilizer. Devi et al. (2012) found that grain and straw yields obtained higher values with highest level of nitrogen. Zhang and Wang (2002) showed that site specific nutrient management (SSNM) increases the rice yield significantly and improves N use efficiency substantially.

Sarfaraz et al. (2002) found that the number of tillers m^{-2}, 1000-grain weight, grain and straw yields were significantly increased with the application of NPK and S fertilizers compared to the control. Maximum number of fertile tillers per plant (16.79), number of panicles per hill (8.41), 1000- grain weight (21.12 g), biological yield (10.19 t/ha), grain yield (4.47 t/ha) and harvest index (43.76%) were recorded from the plots receiving poultry manure @ 10 t/ha in combination with 50% of RDF (Arif et al. 2014). Parvez et al. (2008) also observed that the plant height of rice was significantly influenced by the incorporation of manures and fertilizers. Singh et al. (2002) reported that plant height, tillers/m^2, dry matter production, panicle length and grains/panicle were significantly increased with increasing levels of S up to 40 kg/ha. Significant improvement in grain yield was observed due to sulphur application (Raju and Reddy,2001).Combined use of cowdung and NPKS fertilizers significantly influenced the number of effective tillers $hill^{-1}$ of BRRI dhan48. These results are well corroborated with the findings of Parvez et al. (2008) who found that, increased number of effective tillers $hill^{-1}$ with the integrated use of manures and fertilizer in rice. The length of panicle of BRRI dhan48 was significantly influenced by the application of manure and fertilizers. The number of filled grains per panicle of BRRI dhan48 was increased due to application of manures and fertilizers. Malika (2011), Parvez et al. (2008) and Rahman et al. (2009) also found, increased number of filled grains per panicle of rice with the use of manures and fertilizers. The 1000-grain weight of BRRI dhan48 varied insignificantly due to application of manure and fertilizers. Similar results were reported by Parvez et al. (2008) and Rahman et al. (2007). Sahrawat et al. (2001) stated that grain yields of the rice cultivars were significantly increased by fertilizer P.

The N uptake by grain and straw was influenced significantly due to application of manure and fertilizers. The highest total N uptake was observed in treatment T_3 and the lowest value was found in T_5 (Control). Akter et al. (2012), Parvez et al. (2008) and Chandel et al. (2003) reported that application of nitrogen from manures and fertilizers increased the N content both in grain and straw of rice. The maximum P uptake by grain and straw were found in T_3. Akter et al. (2012) observed that the P uptake by rice grain was increased with the combined application of manures and fertilizers. The highest total K uptake was obtained in T_3. The results are in agreement with Meena et al. (2003) who reported that application of organic manure and chemical fertilizers significantly increased the K uptake by rice. Qian et al. (2011) revealed that organic manure application combined with chemical fertilizers treatments increased yield. Combination of cowdung, poultry manure and compost with the chemical fertilizers showed better effects than other treatments in increasing S uptake (Malika, 2011). Khan et al. (2007) also observed that the combined application of NPK and organic manures (GM or FYM) significantly increased the paddy and straw yields of rice crop. Lin et al. (2009) reported that application of mixed mineral-fertilizer-N and organic-fertilizers-N had a better or the same effects on the yields of rice grains and N use efficiency could be significantly increased compared with the single application of mineral nitrogen fertilizer. Arivazhagan et al. (2005) found that application of 150:50:75 kg NPK /ha resulted in the highest number of panicles/hill (9.06), pancle length (19.6 cm), 1000-grain weight (20.50g), grain yield (5.06 t/ha) and straw yield (6.10 t/ha).

Nutrient content and mineralization of most of the organic manures is not sufficient enough to support the nutrient mining from the soil therefore, integrated nutrient management (INM) is recommended which ensures adequate nutrient supply for the entire growing period of the crop. Soil structure as well as soil health improvement is observed when practicing INM based fertilization of crops.

5. Conclusion

The overall results of the present study indicate that integrated use of manure and fertilizers significantly increased yield as well as nutrient content and uptake by BRRI dhan48. The treatment T_3: INM revealed the highest yield and NPKS uptake while the lowest value was recorded over the control. Finally, it can be concluded that the cowdung with chemical fertilizers can be used for maximum yield of BRRI dhan48.

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Conflict of interest

The authors have no conflict of interest to disclose.

Authors' contributions

Nahid Kaisar conducted the experiment and analyzed the data. Abu Zofar Md. Moslehuddin and Mahbubul Alam Tarafder provided help for the experimental design and supervised in the whole experiment. Md. Sohanur Rahman contributed in data presentation, analysing data, searching journal for publication and finally manuscript processing & writing of this article. This article was read and approved by all authors for final Publication.

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