



Combined Effects of Nutrient Management on Nutrient Content and Uptake of Transplant Aus Rice (BRRI Dhan48)

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Abstract

A field experiment was conducted at Sutiakhali, Mymensingh for crop production and chemical analysis was performed at Department of soil science, Bangladesh Agricultural University, Mymensingh to see the combined effect of nutrient management on nutrient content and uptake of Transplant Aus rice (BRRI dhan48) during march to July 2015 following Randomized Complete Block Design with four replications. The treatments were T1: RD (N75 P12 K45 S9), T2: STB (N74 P11 K36 S7), T3: INM (N54 P5 K27 S5+ CD @ 5.0 t ha⁻¹), T4: Farmer's practice (N69 P30 K37), and T5: Control (no fertilizer). The NPKS content and uptake by BRRI dhan48 were also influenced significantly due to combined use of manure and fertilizers. 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 Integrated Nutrient Management. 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 T5: 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 T3: 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 T5 (Control). The performance of the treatment T3 was better than T1, T2, T4 and T5 in nutrient content and uptake of BRRI dhan48. Considering nutrient content and uptake, the application of chemical fertilizers in combination with manure based on INM could be recommended for BRRI dhan48 production in aus season.

Keywords: nitrogen, phosphorous, potassium, sulphur, grain, straw, fertilizer, BRRI dhan48, soil

1. Introduction

Rice is the staple food crop in Bangladesh. Plant nutrients are essential for proper crop development, plant growth and also of their internal metabolism. Soil with low organic matter, inappropriate use of chemical fertilizers, low use of organic manures made the situation difficult (Karim *et al.* 1994). Uneven use of fertilizers has an adverse effect on crop production (Rijpma and Jahiruddin, 2004). Crop production is not totally maintained only chemical fertilizers and not possible to obtain higher crop yield by using organic manures alone (Bair, 1990). Nambiar (1991) reviewed that, combined use of organic manure and chemical fertilizers would be important in providing greater stability in production and maintaining soil fertility status.

Combined Nutrient Management (CNM) is a technique where organic, inorganic, and biofertilizer can be combinedly applied to soils for crop growth and get good yield. The object of INM is to optimize crop nutrition, the functioning of the soil health, and minimize nutrient losses or avoiding adverse effect on the environment. 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). Combined nutrient application leads to higher yield. (Lin *et al.* 2009 and Qian *et al.* 2011). Application of manures and different doses of urea-N fertilizers significantly increased the yield contributing attributes of BRRI dhan29 (Rahman *et al.* 2009).

A proper combination of nutrients is important for sustainable agriculture for providing food with good quality. Cowdung, poultry manure and compost supply the macro and micronutrients for crop production. Cowdung is a good source of nutrients that can be mixed into most fertilizer schedules. Considering value, manure is most important sources. Manure application in association with recommended fertilizer dose plays important role in rice

production. Therefore, the present research work was undertaken to know the nutrient content and uptake of Transplant Aus rice (BRRI dhan48) in combined nutrient management.

2. Materials and Methods

2.1 Site and Weather Description

The field experiment was done at Sutiakhali, a village of Mymensingh Sadar upazila and laboratory analysis was done at The Department of soil science, Bangladesh Agricultural University District during January-July 2015. The experimental site is situated at latitude N: 24°40.982' and longitude E: 90°27.391'24"N at a height of 8.3 m above the mean sea level 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°C - 35.4°C & min. 11.3°C - 26.7°C) 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). 0-15 cm depth soil collected for samples. 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 done by Randomized Complete Block Design (RCBD) where the experimental area was divided into 4 blocks and each block was subdivided into 5 plots. Treatments distributed randomly to the unit plots in each block. Total unit plot was 20 and plot size was 4.5 m x 3.15 m and the spacing among the plots was 20 cm. There were five treatments as follows: T₁: RD (Recommended Dose (N₇₅ P₁₂ K₄₅ S₉)), T₂: STB (Soil Test Basis (N₇₄ P₁₁ K₃₆ S₇)), T₃: N₅₄ P₅ K₂₇ S₅ (Combined Nutrient Management (CNM) + CD (Cowdung) @ 5.0 t ha⁻¹, T₄: Farmer's practice (N₆₉ P₃₀ K₃₇) and T₅: Control (no fertilizer).

2.3 Name, Rates and Sources of Nutrients Application

Table 1. Name, rates and sources of nutrients applied as follows

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 Harvesting and Data Recording

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.

2.6 Chemical Analyses of Plant Samples

Preparation of plant samples

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

Digestion of plant samples for total nitrogen determination

An amount of 0.1 g of oven dry ground plant sample (both grain and straw separately) was taken in a micro-kjeldahl flask for nitrogen determination. 1.1 g catalyst mixture (K₂SO₄: CuSO₄. 5H₂O: Se = 100: 10:1), 2 ml 30% H₂O₂ and 3 ml H₂SO₄ were added into the flask. It was swirled and allowed to stand for 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.

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 (HNO₃: HClO₄= 2:1) was added into the flask. After leaving for a while, the flasks were heated at a temperature of 200^o C. When the flask became sufficiently clear and colorless, it boiled. After cooling, the digests was transferred into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. This digest was used for the determination of P, K and S.

2.7 Determination of N, P, K and S from Plant Samples

Nitrogen

Nitrogen content digests were determined by micro-kjeldahl method. 40% NaOH was added for distillation after digestion complete. The evolved ammonia was trapped into 4% H₃BO₃ solution and 5 drops of mixed indicator of bromocressol green (C₂₁H₁₄O₅Br₄S) and methyl red (C₁₀H₁₀N₃O₃) solution. Finally the distillate was titrated with standard 0.01 N H₂SO₄ until the color changed from green to pink.

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 NaHCO₃ solution at pH 8.5 following Olsen method. The extracted phosphorus was determined by developing blue color by SnCl₂ reduction of phosphomolybdate complex and measuring the intensity of color spectrophotometrically at 660 nm wavelength. The readings were calibrated to the standard P curve.

Potassium

5 ml of digest for the grain and 10 ml for the straw was taken with 1.0 N NH₄OAc (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.

Sulphur

Sulphur was determined by using 10 ml of digest (both for grain and straw) from 100 ml extract with CaCl₂ solution (0.15%). The S content in the extract was estimated turbidimetrically and readings were taken by spectrophotometer at 420 nm.

2.8 Determination of 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:

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

Statistical analysis

The analysis of variance for 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 Nutrient Content in Rice Grain and Straw of BRR1 dhan48

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.

Table 2. N, P, K and S content in grain and straw of BRR1 dhan48 as influenced by combined nutrient management

Treatment	N (%)		P (%)		K (%)		S (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T ₁	0.734a	0.441c	0.138ab	0.073b	0.293b	1.423b	0.067a	0.113a
T ₂	0.698b	0.469b	0.141a	0.082a	0.315ab	1.519a	0.068a	0.111a
T ₃	0.737a	0.540a	0.145a	0.084a	0.315a	1.535a	0.070a	0.114a
T ₄	0.700b	0.443c	0.125bc	0.073b	0.301b	1.420b	0.059b	0.105b
T ₅	0.657c	0.413d	0.119c	0.071b	0.273c	1.324c	0.057b	0.103b
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

Nitrogen content

The highest N content of 0.737% was observed in T₃: CNM and the lowest N content of 0.657% noted in T₅: Control (Table 2). Application of cowdung with chemical fertilizers increased the N content in rice grain markedly in T₃: CNM. In the straw of BRR1 dhan48, the N content varied significantly due to different treatments (Table 4). The N content in the straw ranged from 0.413% in T₁ to 0.54% in T₃. Akhter, S. (2011), 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.

Phosphorus content

Results in Table 1 indicated that phosphorus content in the grain of BRR1 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 T₃: CNM and the lowest value (0.119 %) noted in T₅: Control. Phosphorus content in rice straw was influenced significantly due to use of cowdung and fertilizers as shown in Table 3. Khan *et al.* (2007) observed that the combined application of NPK and organic manures (GM or FYM) significantly increased the paddy and straw yields of rice crop. The highest P content in straw (0.084%) was observed in T₃: CNM and the lowest value (0.071%) recorded in T₅: Control.

Potassium content

The potassium content both in grain and straw of BRR1 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 2). The highest K content in rice grain (0.315%) and straw (1.535%) was recorded in T₃: CNM. This is supported by Saleque *et al.* (1998). The lowest K content in grain (0.273%) and straw (1.324%) was observed in T₅: Control.

Sulphur content

The sulphur content both in grain and straw of BRR1 dhan48 was influenced significantly by the combined use of cowdung and fertilizers (Table 2). The highest S content of 0.07% in grain was obtained in T₃: CNM and the lowest value of 0.057% noted in T₅: Control. All the treatments caused an increasing effect on the S content of rice grain and the effect of CNM was better compared to fertilizer doses. In case of straw, S content ranging was from 0.103 to 0.114%. The highest S content in straw (0.114%) was recorded in T₃: CNM and the lowest S content in straw (0.103%) observed in T₅: Control and supported by Chandel *et al.* (2003).

3.2 Nutrient Uptake by Grain and Straw of BRR1 Dhan48

The results of N, P, K and S uptake of BRR1 dhan48 have been presented and discussed below:

Table 3. Effect of combined nutrient management on N and P uptake by BRR1 dhan48

Treatment	N uptake (kg)			P uptake (kg)		
	Grain	Straw	Total	Grain	Straw	Total
T1	28.05b	2.560c	52.63c	5.27bc	4.07b	9.34c
T2	28.62b	2.790b	58.43b	5.78b	5.21a	10.99b
T3	35.55a	3.380a	70.47a	6.99a	5.43a	12.43a
T4	25.62c	2.160d	48.53d	4.57c	3.78b	8.35d
T5	20.08d	1.74e	35.58e	3.64d	2.67c	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

Nitrogen uptake

Results indicate that, the N uptake both by grain and straw of BRR1 dhan48 varied significantly due to application of manure and fertilizers (Table 3). The N uptake by grain ranging was 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 and 3.38 kg ha⁻¹ in T₃: CNM, respectively. Duhan and Singh (2002) reported that the rice yield and uptake of nutrients increased significantly with increasing N levels. The lowest N uptake by grain (20.08 kg ha⁻¹) and by straw (1.74 kg ha⁻¹) found in T₅: Control. The highest total N uptake (70.47 kg ha⁻¹) was observed in T₃: INM and the lowest value (35.58 kg ha⁻¹) found in T₅: Control. This result is an agreement with the findings of Nakashgir *et al.* (2000).

Phosphorus uptake

The results presented shows that, the P uptake both by grain and straw of BRR1 dhan48 was influenced significantly by the application of cowdung and fertilizers (Table 3). The P uptake by grain ranging was 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 T₃: CNM. The minimum P uptake by grain (3.64 kg ha⁻¹) and straw (2.67 kg ha⁻¹) was found in T₅: 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 BRR1 dhan48 (Table 2). The highest total P uptake (12.43 kg ha⁻¹) was obtained in T₃: CNM and the lowest total P uptake (6.307 kg ha⁻¹) observed in T₅: Control and supported by Akhter, S. (2011).

Table 4. Uptake of K and S by BRRI dhan48 as influenced by the application of combined nutrient management

Treatment	K uptake (kg)			S uptake (kg)		
	Grain	Straw	Total	Grain	Straw	Total
T1	11.00c	79.30c	90.50c	2.56c	6.30b	8.86c
T2	12.92b	96.54b	109.50b	2.79b	7.05a	9.84b
T3	15.20a	99.25a	114.4a	3.38a	7.37a	10.75a
T4	11.02c	73.44d	84.46d	2.16d	5.43c	7.59d
T5	8.35d	49.70e	58.05e	1.74e	3.87d	5.61e
LSD0.05	0.999	2.69	3.20	2.23	0.367	0.424
SE (\pm)	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 (\pm) = Standard Error of means, CV (%) = Co-efficient of Variation

Potassium uptake

The results indicate that the K uptake by grain and straw of BRRI dhan48 varied significantly by different treatments (Table 4). The K uptake by grain increase from 8.35 in T₅: Control to 15.20 kg ha⁻¹ in T₃: CNM. The K uptake by straw ranging was from 49.70 in T₅: Control to 99.25 kg ha⁻¹ in T₃: CNM, respectively. The total K uptake by grain and straw was also affected significantly by different treatments. The highest total K uptake (114.4) was obtained in T₃: CNM and the lowest value (58.05) in T₅: Control. This result is strongly supported by Nakashgir *et al.* (2000). The results are also in agreement with Meena *et al.* (2003)

Sulphur uptake

Sulphur uptake by grain and straw was influenced significantly due to application of different treatments (Table 4). The S uptake by grain and straw ranging was from 1.74 to 3.38 and 3.87 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: CNM. The lowest S uptake by grain (1.74) and straw (3.87) was found in T₅ (control). The total S uptake by grain and straw was also influenced significantly by different treatments (Table 4). The highest total S uptake (10.75) was found in T₃: CNM and the lowest value (5.61) in T₅: Control. This result is similar to Sarfaraz *et al.* (2002).

4. Conclusion

It can be concluded that combined use of manure and fertilizers significantly increased nutrient content and uptake by BRRI dhan48. The treatment T₃: CNM revealed the highest NPKS uptake while the lowest value was recorded over the control. Integrated Nutrient Management practice keeps soil healthy with higher yield of BRRI dhan48. So, farmer's should follow this technique to minimize soil pollution and get economically benefitted for rice cultivation. Further research should be recommended for more confirmation of the result.

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Conflict of Interest

The authors have no conflict of interest to report.

Authors' Contributions

Nahid Kaiser conducted the experiment and analyzed the data. Abu Zofar Md. Moslehuddin and Mahbulul 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 and writing of this article. This article was read and approved by all authors for final Publication.

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