



Effect of Fertilizers on Yield and Nutrient Uptake by Binadhan-7 Rice Grown in old Brahmaputra Floodplain Soils

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Abstract: The economic rate of nutrients was determined with eight different fertilizer treatment applied on T. aman rice (var. Binadhan-7) in Old Brahmaputra Floodplain Soils (AEZ-9) during 2012 and 2013 at Trisal, Mymensingh. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatment combinations were: T₁ (N₆₄ P₁₄ K₂₈ S₆ Zn₁), T₂ (N₈₀ P₁₄ K₂₈ S₆ Zn₁), T₃ (N₈₀ P_{17.5} K₂₈ S₆ Zn₁), T₄ (N₈₀ P₁₄ K₃₅ S₆ Zn₁), T₅ (N₆₄ P_{17.5} K₃₅ S₆ Zn₁), T₆ (N₈₀ P_{17.5} K₃₅ S₆ Zn₁), T₇ (N₄₈ P_{10.5} K₂₁ S_{4.5} Zn_{0.75}), and T₈ (control). Grain and straw yields were significantly affected by the application of fertilizers at different rates. Results revealed that the average highest grain (4.86 t ha⁻¹) was recorded in T₆ (N₈₀ P_{17.5} K₃₅ S₆ Zn₁) treatment and straw yield (5.34 t ha⁻¹) was recorded in treatment T₃ (N₈₀ P_{17.5} K₂₈ S₆ Zn₁) which is 132.54% and 86.06% respectively higher over control treatment. The second highest grain yield (4.77 t ha⁻¹) was obtained in T₃ treatment and straw (5.18 t ha⁻¹) was recorded in T₆ treatment. Average (2012 & 2013) nutrient uptake (grain and straw) was the highest in T₃ treatment. Partial budget analysis demonstrated the highest net benefit of Tk. 69,673 ha⁻¹ in T₆ followed by Tk. 68,833 ha⁻¹ in T₃ and the highest MBCR (4.29) was obtained in T₃ treatment. The present investigation suggests that treatment T₃ (N₈₀ P₁₈ K₂₈ S₆ Zn₁) might be the best profitable fertilizers dose to sustain Binadhan-7 rice production in Old Brahmaputra Floodplain Soils.

Key words: AEZ-9, Binadhan-7, Fertilizers, T. aman season and Yield.

Introduction

Rice is the main staple food for above 150 million populations of the world. The current population growth rate is 2 million per year. According to this rate, the total population will become 233.2 million within 2050 (Bangladesh Economics Review, 2009). It's a tremendous challenge for providing food security to the increasing population. The diverse climatic phenomena like cyclone, drought, changing rainfall patterns and temperature has a significant role in food grain production. The impact of climate change on agriculture is global concerns and this is special for Bangladesh where lives and livelihoods depend mainly on agriculture. Binadhan-7 is a high yielding short duration (110-120 days) rice variety for transplanted aman season. Due to its short duration, rabi crops such as potato, mustard, and certain varieties of wheat, and some other crops can be planted after the harvest of early rice varieties, thus providing farmers an opportunity to plant more crops a year. Binadhan-7 is also used along with BRRIdhan 33 (115-120 days) to mitigate the suffering of MONGA affected farmers by fitting this rice variety to existing cropping pattern in the Northern Region of Bangladesh. There is no alternative, than to use more plant nutrients for high productivity (Ahmad, 1992). A huge quantity of nutrients removed from most of the floodplains and large portion of the terrace soils with the intensification of agriculture in Bangladesh. As a result the level of soil fertility is depleting gradually reflecting the needs of more fertilizer application in the soil for sustaining crop productivity. The application of fertilizers either in excess or less than optimum rate affect both yield and quality of rice to

remarkable extent, hence proper management of crop nutrition is of immense importance (Nawaz, 2002; Meena *et al.* 2003). Therefore, to determine economic doses of fertilizers a field trial was done with T. aman rice (var. Binadhan-7) in Old Brahmaputra Floodplain Soils (AEZ-9) at Trisal, Mymensingh.

Materials and Methods

Description of the experimental site, soil sampling and analysis

The experiment was conducted at T. aman (kharif II) season consecutively two years during 2012 and 2013 using Binadhan-7 rice to determine the economic rate of nutrients (N, P, K, S and Zn) in Old Brahmaputra Floodplain Soils at Trisal, Mymensingh. Before setting up of the experiment, initial soil sample was collected. After removal of weeds and stubbles, the sample was air dried, ground to pass through a 20 mesh sieve and stored in clean plastic bags for physical and chemical analysis. The soil sample was analyzed following standard methods viz. particle size distribution by a hydrometer, soil pH by glass electrode pH meter, organic matter by wet oxidation and total nitrogen by micro-Kjeldahl method, available phosphorus and available sulphur were extracted from soil by dilute acid solutions and determined by a spectrophotometer, exchangeable potassium was extracted with ammonium acetate solution and was determined by a flame photometer. The soil of the experimental plot was clayey in texture and slightly acidic in reaction. The total nitrogen and available phosphorus contents were very low, exchangeable potassium content was low and available sulphur content was medium in the experimental plot.

Transplanting, fertilization and intercultural operations

The experiment was laid out in a randomized complete block design (RCBD) with eight treatments and three replications. The unit plot size was 5m x 4m. Before transplantation the land was well ploughed following laddering. The fertilizer treatments were: T₁ (N₆₄ P₁₄ K₂₈ S₆ Zn₁), T₂ (N₈₀ P₁₄ K₂₈ S₆ Zn₁), T₃ (N₈₀ P_{17.5} K₂₈ S₆ Zn₁), T₄ (N₈₀ P₁₄ K₃₅ S₆ Zn₁), T₅ (N₆₄ P_{17.5} K₃₅ S₆ Zn₁), T₆ (N₈₀ P_{17.5} K₃₅ S₆ Zn₁), T₇ (N₄₈ P_{10.5} K₂₁ S_{4.5} Zn_{0.75}), and T₈ (control). Three healthy seedlings of 20-days of Binadhan-7 rice were transplanted per hill in the plots on 28 July, 2012 and 29 July, 2013 respectively. Fertilizer applied to each plot as per treatments. Entire amount of TSP, MoP, gypsum and zinc sulphate were applied as basal at the time of final land preparation. Urea was applied in two equal installments on the 4th and 7th week (i.e. about 25 days and 45 days) after transplanting. Gap filling was done on the 2nd week (i.e. about 10 days) after transplanting to make uniform plant population density for each treatment. Weeding was done three times at 2nd, 4th and 7th week (i.e. about 10, 25 and 45 days) after transplanting of the seedlings. Spraying was done whenever necessary. The crop of Binadhan-7 rice was harvested on 25 October, 2012 and 30 October, 2013 respectively. Data on yield contributing characters were recorded from ten randomly selected plants per hill from each plot. The grain and straw samples were stored for chemical analysis.

Chemical analysis of grain and straw samples

The grain and straw samples were analyzed for the determination of N, P, K and S contents. The samples were dried in an oven at about 65°C for 48 hours and then ground in a grinding mill to pass through a 20 mesh sieve. The ground grain and straw samples were stored in small paper bags and placed in desiccators for the analysis of different elements.

For nitrogen determination, 0.50 g of oven dried ground plant sample was taken in a micro-Kjeldahl flask. 1.10 g of catalyst mixture (K₂SO₄: CuSO₄: 5H₂O: Se powder =100: 10: 1), 3 ml of 30% HClO₄ and 5 ml of conc. H₂SO₄ were added to the flask. The flask was swirled and allowed to stand for about 1.5-2 hours. Then the flask was heated on an electric hot plate for heating at 150°C and continued until the digest become colorless. After cooling the digest was transferred into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared similarly. From the digests, nitrogen was determined.

0.50 g oven-dried, ground samples (straw or grain) was taken in a digestion flask. 8 ml of di-acid mixture

(HNO₃: HClO₄ in the ratio 5:3) was added into flask and kept for 1 hour. Then the flask was heated on an electric hot plate for heating at 150°C and continued until the digest become colorless. After cooling the digest was transferred into a 50 ml volumetric flask and the volume was made up to mark with distilled water. From the digests P, K and S contents were determined.

Statistical analysis

The data were statistically analyzed on various plant characters with the help of a MSTAT program and mean differences were compared by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Result and Discussion

Yield contributing characters

Yield contributing characters were influenced by different treatments (Table 1). Plant height was significantly varied among the treatments in both years of 2012 and 2013. In 2012, plant height of all the treatments was statistically similar except T₈. In 2013, the highest plant height (94.13 cm) was obtained in treatment T₅. Treatment T₃, T₇ and T₈ produced the lowest and statistically similar plant height. Faraji *et al.* (1998) reported that plant height increased with an increase in the rate of fertilizer application.

The different treatment combinations of fertilizers significantly influenced the panicle length in 2012 year. The highest panicle length (24.27 cm) was found in T₆ followed by T₃ and lowest panicle length was found in T₈ (control). Panicle length was not significantly varied among the treatments in 2013. Manzoor *et al.* (2006) found highest panicle length (29.75 cm) at 225 Kg N per hectare level.

Number of effective tiller varied significantly under different treatments in both years. Treatment T₅ produced the highest number of effective tiller (12.87) and lowest number (9.80) was found in T₈ in 2012. Treatment T₂ produced the highest (14.00) number of effective tillers per hill and T₁ produced the second highest (13.93) and the lowest (6.80) was found in control treatment in 2013. Manzoor *et al.* (2006) observed maximum number of productive tillers per hill (23.42) at 225 Kg N per hectare.

The highest 1000 grain weight (24.02 g) was found in T₃ and the lowest (21.64 g) was found in treatment T₈ in 2012. In 2013, T₆ produced the highest (22.67 g) 1000 grain weight and the other treatments were statistically similar. Similar results of plant height, number of effective tillers and 1000 grain weight were also observed by Quddus *et al.* (2012).

Table 1. The effects of different treatments on yield parameters of Binadhan-7 during 2012 and 2013 at Trisal, Mymensingh

Treatments	2012				2013			
	Plant height (cm)	Panicle length (cm)	Tillers/hill (no)	1000seed weight(g)	Plant height (cm)	Panicle length(cm)	Tillers/hill (no)	1000 seed weight(g)
T ₁ (N ₆₄ P ₁₄ K ₂₈ S ₆ Zn ₁)	91.87a	23.40bc	11.47bc	22.62bc	92.47ab	23.00	13.93a	20.85b
T ₂ (N ₈₀ P ₁₄ K ₂₈ S ₆ Zn ₁)	92.73a	23.27c	11.07bcd	23.19ab	92.4ab	22.13	14.00a	21.05b
T ₃ (N ₈₀ P _{17.5} K ₂₈ S ₆ Zn ₁)	94.20a	24.20a	10.60cde	24.02a	89.13c	22.13	10.60bc	21.11ab
T ₄ (N ₈₀ P ₁₄ K ₃₅ S ₆ Zn ₁)	93.67a	23.20c	11.80b	23.20ab	90.87bc	22.40	10.27bc	22.02ab
T ₅ (N ₆₄ P _{17.5} K ₃₅ S ₆ Zn ₁)	94.00a	24.07ab	12.87a	22.00c	94.13a	23.27	9.60c	21.54ab
T ₆ (N ₈₀ P _{17.5} K ₃₅ S ₆ Zn ₁)	93.07a	24.27a	11.60b	22.80bc	93.67a	22.73	12.47ab	22.67a
T ₇ (N ₄₈ P _{10.5} K ₂₁ S _{4.5} Zn _{0.75})	92.27a	22.67c	10.33de	22.00c	89.87c	22.87	11.27bc	20.96b
T ₈ (Control)	87.87b	21.60d	9.80e	21.64c	89.33c	22.93	6.80d	20.16b
CV (%)	1.96	1.84	4.23	2.71	3.29	2.89	11.98	6.33

In a column, same letter (s) are not significantly different at 5% level, CV = Coefficient of variation

Grain and straw yields

The grain and straw yields of Binadhan-7 were significantly influenced by application of fertilizers (Table 2). The highest grain yield (4.93 t ha⁻¹) was found in treatment T₅ and the lowest (2.06 t ha⁻¹) was found in T₈ in 2012. In 2013, treatment T₆ produced the highest grain yield (5.02 t ha⁻¹) which was statistically similar to T₃. Treatment T₈ produced the lowest grain yield (2.11 t ha⁻¹). The average highest grain yield (4.86 t ha⁻¹) was found in T₆ followed by T₃ treatment (4.77 t ha⁻¹) and the lowest yield (2.09 t ha⁻¹) was found in T₈ treatment. Adhikary and Rahman (1996) reported that the highest rice grain yield was obtained from 100 kg N ha⁻¹ (4.25 t ha⁻¹). Idris and Matin (1990) observed that grain yield increased gradually with an increase in N levels up to

120 kg ha⁻¹. Manzoor *et al.* (2006) obtained maximum paddy yield (4.24 t ha⁻¹) from 175 Kg N per ha.

The highest straw yield (5.20 t ha⁻¹) was found in T₆ and the lowest (2.64 t ha⁻¹) was found in T₈ treatment in 2012. In 2013, treatment T₆ produced the highest straw yield (5.88 t ha⁻¹) and treatment T₈ produced the lowest straw yield (3.10 t ha⁻¹). The average highest straw (5.34 t ha⁻¹) was found in T₃ treatment and the lowest (2.87 t ha⁻¹) was found in T₈. Sheikh *et al.* (2009) found the highest grain (5.30 t ha⁻¹) and straw (6.55 t ha⁻¹) of T. aman rice against treatment T₂ (120-36-70-10 kg NPKS per hectare).

Table 2. The effects of different treatments on the grain and straw yields (t ha⁻¹) of Binadhan-7 at Trisal, Mymensingh

Treatments	2012		2013		Average	
	Grain	Straw	Grain	Straw	Grain	Straw
T ₁ (N ₆₄ P ₁₄ K ₂₈ S ₆ Zn ₁)	4.03bc	4.66c	4.20c	5.10bc	4.11	4.88
T ₂ (N ₈₀ P ₁₄ K ₂₈ S ₆ Zn ₁)	4.34ab	4.95b	4.68ab	5.41abc	4.51	5.18
T ₃ (N ₈₀ P _{17.5} K ₂₈ S ₆ Zn ₁)	4.67ab	5.13a	4.87a	5.54ab	4.77	5.34
T ₄ (N ₈₀ P ₁₄ K ₃₅ S ₆ Zn ₁)	4.70ab	4.07e	4.50bc	4.98c	4.60	4.53
T ₅ (N ₆₄ P _{17.5} K ₃₅ S ₆ Zn ₁)	4.93a	5.19a	4.30c	4.48d	4.62	4.84
T ₆ (N ₈₀ P _{17.5} K ₃₅ S ₆ Zn ₁)	4.70ab	4.50d	5.02a	5.88a	4.86	5.18
T ₇ (N ₄₈ P _{10.5} K ₂₁ S _{4.5} Zn _{0.75})	3.46c	5.20a	3.52d	4.15d	3.49	4.68
T ₈ (Control)	2.06d	2.64f	2.11e	3.10e	2.09	2.87
CV (%)	10.51	1.54	5.75	5.37	-	-

Same letter (s) in the column are not statistically significant at 5% level, CV = Coefficient of variation

Total Nutrient uptake

The highest average N uptake (97.4 kg ha⁻¹) was recorded in treatment T₃ and the lowest N uptake (36.62 kg ha⁻¹) was found in treatment T₈. The result showed that the total N uptake in rice was more prominent due to combined application of fertilizers (Table 3). Quddus *et al.* (2012) reported that total N content was higher with application of 130 Kg N per hectare in T. aman rice.

The highest average P uptake of 14.11 kg ha⁻¹ was obtained in treatment T₃ and the lowest P uptake of

4.94 kg ha⁻¹ was observed in treatment T₈ (control). Kadu *et al.* (1991) reported that grain P and K were the highest with NPK + FYM application.

The highest average K uptake (108.5 kg ha⁻¹) was obtained in treatment T₃. The lowest average K uptake (42.4 kg ha⁻¹) was observed in treatment T₈ (control). Islam *et al.* (2010) reported that the highest K uptake by both grain and straw was obtained from T₇ treatment and lowest from control in rice crop.

Table 3. Effect of fertilizers on the average (2012 and 2013) nutrient uptake (grain and straw) by Binadhan-7 at Trisal, Mymensingh

Treatment	Average nutrient uptake by Binadhan-7 (kg ha ⁻¹)			
	N	P	K	S
T ₁ (N ₆₄ P ₁₄ K ₂₈ S ₆ Zn ₁)	74.02	8.91	91.65	5.66
T ₂ (N ₈₀ P ₁₄ K ₂₈ S ₆ Zn ₁)	87.50	10.97	95.24	6.79
T ₃ (N ₈₀ P _{17.5} K ₂₈ S ₆ Zn ₁)	97.40	14.11	108.5	6.40
T ₄ (N ₈₀ P ₁₄ K ₃₅ S ₆ Zn ₁)	89.12	11.37	91.59	5.79
T ₅ (N ₆₄ P _{17.5} K ₃₅ S ₆ Zn ₁)	84.39	12.08	86.16	5.94
T ₆ (N ₈₀ P _{17.5} K ₃₅ S ₆ Zn ₁)	90.39	12.70	102.62	6.57
T ₇ (N ₄₈ P _{10.5} K ₂₁ S _{4.5} Zn _{0.75})	67.39	8.34	75.89	5.10
T ₈ (Control)	36.62	4.94	42.40	2.98

The highest amount of average S uptake of 6.79 kg ha⁻¹ was found in treatment T₂ and the lowest average S uptake of 2.98 kg ha⁻¹ was observed in T₈ (control). Islam *et al.* (1997) reported that application of S significantly increased S uptake by rice. This result correlated well with the works of Xie and Mamaril (1992) who observed a significant S uptake by rice plant due to S application.

Economics of fertilizers use

The results of partial budget analysis of Binadhan-7 (Table 4) showed that the highest net benefit of Tk. 69,673 ha⁻¹ was obtained in T₆ followed by Tk. 68,833 in T₃ treatment. The marginal benefit cost ratio (MBCR) also demonstrated against the treatments. The highest MBCR of 4.29 was obtained in T₃ followed by 4.22 in T₆ treatment.

Table 4. Partial budget analysis of fertilizer use

Treatments	Gross return (Tk.)	Fert. cost (Tk.)	Net return (Tk.)	Marginal return (Tk.)	MBCR
T ₁ (N ₆₄ P ₁₄ K ₂₈ S ₆ Zn ₁)	66530	6812	59718	25498	3.74
T ₂ (N ₈₀ P ₁₄ K ₂₈ S ₆ Zn ₁)	72830	7532	65298	31078	4.13
T ₃ (N ₈₀ P _{17.5} K ₂₈ S ₆ Zn ₁)	76890	8057	68833	34613	4.29
T ₄ (N ₈₀ P ₁₄ K ₃₅ S ₆ Zn ₁)	73530	7882	65648	31428	3.99
T ₅ (N ₆₄ P _{17.5} K ₃₅ S ₆ Zn ₁)	74140	7687	66453	32233	4.19
T ₆ (N ₈₀ P _{17.5} K ₃₅ S ₆ Zn ₁)	78080	8407	69673	35453	4.22
T ₇ (N ₄₈ P _{10.5} K ₂₁ S _{4.5} Zn _{0.75})	57030	5134.5	51895.5	17675.5	3.44
T ₈ (Control)	34220	0	34220	-	-

Grain = 15 Tk. Kg⁻¹; Straw = 1 Tk. kg⁻¹; N = 45 Tk. kg⁻¹; P = 150 Tk. kg⁻¹; K = 50 Tk. kg⁻¹; S = 55 Tk. kg⁻¹ and Zn = 102 Tk. kg⁻¹, MBCR = Marginal benefit cost ratio.

Conclusion

Application of N₈₀P₁₈K₂₈S₆Zn₁ fertilizers is economically more profitable for Binadhan-7 production than any other combinations. Thus, this

combination of fertilizers may be recommended for higher yield of Binadhan-7 rice and sustaining soil fertility.

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