YIELD RESPONSE OF MUSTARD, BORO AND T. AMAN RICE TO NPKS FERTILIZERS IN HIGH GANGES RIVER FLOODPLAIN SOIL

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Accepted for publication: December 18, 2008

ABSTRACT

Siddiky M.A., Ahammad K.U., Shaikh N.Y., Mahmud J.A. and Malakar J.C. 2009. *Yield Response of Mustard, Boro and T. Aman Rice to NPKS Fertilizers in High Ganges River Floodplain Soil*. **Int. J. Sustain. Crop Prod. 4(1):49-54**

The experiment was conducted at the Farming System Research site, Bagherpara, Jessore. during during three consecutive years of Mustard, Boro and T. Aman season of 2000 to 2003 to determine the response and to find out the optimum rate of nutrients (NPKS) for Mustard- Boro and T. aman rice on the yield under AEZ 11a. Four different levels of NPKS were assigned in RCB design with 4 replications. Average of three years study reveals that a considerable response of Mustard, Boro and T. aman rice to NPKS was observed. However, the response to N and P was more distinct in comparison to K and S. Similarly, the response was more evident in Boro rice compared with T. aman rice. Yield of Mustard increased up to the application of 86, 15 and 30 kg/ha of NP and S, respectively. Yield of Boro rice increased up to the application of 125, 7 and 12 kg/ha of N, P and S, respectively. But in T. aman yield was increased up to the application of 80, 8 and 14 kg/ha of NP and S, respectively. From the regression analysis it was found that the relationship was almost quadratic in nature. The application of 84-13-25 kg NPS/ha for Mustard, 121-6-10 kg NPS/ha for Boro rice and 75-7-12 kg NPS/ha for T. aman rice was the beneficial and most economically optimum fertilizer dose in High Ganges River Floodplain Soil under AEZ 11a.

Key words: Mustard, Boro, T. Aman, optimum fertilizer rate

INTRODUCTION

Intensive use of high yielding varieties of the crops has led to a sharp increase in removal of plant nutrients. In 1996, 421-71-457-44 million tons of N-P-K-S, respectively were removed in grain and straw while in the same 507-119-114-13 million tons of NPKS, respectively were added in the form of inorganic fertilizers (Islam and Haque 1998). Fertilizer has been responsible for nearly 50% yield increase registered in recent years (Islam and Haque 1998). Determining the fertilizer schedule for a crop is a complex problem because of many factors, such as loss, fixation and residual effect of applied nutrients (Palaniappan 1983). But due to high cost of fertilizers and economic condition of Bangladesh farmers its use should be economized.

The major cropping pattern in Bangladesh agriculture mostly consist of rice based cereal crops (Haque 1998). Mustard-Boro-T.aman rice cropping pattern is the dominant cropping pattern in medium high land area of Jessore region under high Ganges River floodplain (AEZ 11a). Soil fertility and productivity changes over time and this change is towards negative direction because of intensive cropping with modern varieties, improper and imbalance use of fertilizer and manure (BARC 2005). Again crops grown in different cropping patterns and environment responded differently to fertilizer nutrients. Mineral fertilizer inputs are the crucial factors to the overall nutrient balance in intensive cropping systems (Islam and Bhuiyan, 1998). Fertilizer recommendation for crops in a cropping pattern of a particular AEZ needs change after a certain period of time. Application of imbalance fertilizer to individual crop commonly found among the farmers of Jessore region is detrimental to soil. Some of the nutrients like P, K, S and Zn have residual effect and it should be considered for a judicious and economic fertilizer management. The application of fertilizer in proper amounts must be done to boost up agricultural production to an economically desirable level. Hence, the present study was carried out to determine an economically optimal dose of fertilizer nutrients for Mustad-Boro-T.aman rice cropping pattern at Bagarpara, Jessore under AEZ11a.

MATERIALS AND METHODS

A trial with Mustard-Boro-T. Aman cropping system was conducted at Bagherpara Farming System Research site, Jessore (AEZ-lla and land type-MHL) BARI during 2001, 2002 and 2003. The soil was silt loom having pH 7.5, initial Soil organic matter 1.88%, total N 0.06%, exchangeable K 0.20 meq/l00 g soil, Olsen's P 6.96 ppm, available S 19.3 ppm, available Zn 0.95 ppm and available B 0.40 ppm. The experimental plot of Mustard was laid out in randomized complete block design with four dispersed replications. The unit plot size was 5m x 3m. Four different levels of N(0, 61, 86 and 120), P(0, 11, 15 and 21), and S(0, 24, 30 and 42), for Mustard, Boro and T.aman rice was tested based on the soil analysis are shown. Mustard (var. Tori-7 seed rate was 80 (eighty) kg/ha was sown during 3rd week of November and harvested during the 2nd week of February. Forty days old seedlings of Boro (var. BRRI dhan-28) rice were transplanted during 3rd week of February with a spacing of 25cm X 15cm and harvested during the last week of May. Thirty days old seedlings of T.aman rice (var. BR-11) were

transplanted during last week of July with a spacing of 20cm X 15cm and were harvested during the last week of November. Fertilizer doses were calculated according to original soil status of the experimental plots using Fertilizer Recommendation Guide, 1997. In case of mustard, half of N and the whole amount of P, K, S, Zn were applied at the time of final land preparation. The rest half of N was top-dressed at 40 days after sowing. In case of rice the entire quantity of P, S and Zn were applied as basal dose at the time of final land preparation and N was applied in three equal splits as top dress at 15 Day after transplanting (DAT), at maximum tillering stage and before panicle initiation stage. Data on yield and yield attributes were recorded and analyzed statistically by Duncan's Multiple Range Test (DMRT). Regression analysis was done and the optimum and economic dose of fertilizer nutrients were calculated using the formula Y = - b/2c and Y= 1/2c (Pf/Py-b), respectively from the response curve (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect of NPKS on Mustard

Effect of different levels of NPKS on the yield of Mustard is shown in Table 1. All the nutrients showed some response towards the yield. Grain yield increased slowly up to the application of 86, 25 and 30 kg NPS ha^{-1} respectively, and then tended to decline. However the response to NPKS was not very sharp. Average of three years data showed that grain yield increased considerably with the increase of N, P and S up to 86, 15 and 30 kg ha^{-1} respectively and tended to decline after that. As the initial K status of the soil was high, its response was not verified. Response of Mustard to added NPS was observed and it was quadratic in nature. From the average data a response curve was drawn and optimum dose was found out.

Effect of NPKS on Boro rice

Effect of different levels of NPKS on the yield of Boro rice is shown in Table 1. Grain yield influenced significantly due to different rates of nutrients. However, the trend was not same over the years. Significantly the highest grain yield was obtained with 125 kg N/ha and yield was decreased less or beyond that level during 2001-02 and 2002-03. Average of three years data showed that grain yield increased considerably with the increase of nitrogen up to 125 kg ha^{-1} and tended to decline after that. About 49% yield increased with 125 kg N/ha over control and it was 40 and 44% for 90 and 175 kg N/ha, respectively. Tanaka (1986) reported that excess nitrogen gave higher dry weight around heading simultaneously becomes low, causing a yield decline due to reduced ripening percentage.

Response to phosphorus was also observed and yield increased linearly with the increase of phosphorus. The highest yield was obtained with 7 kg/ha, which was identical with 5 and 10kg P/ha during 2000-01. Average of three years data showed that yield increased by 22% over control up to application of 7 kg P/ha. However, about 9 and 20% yield increased with 5 and 10 kg P/ha over control. It might be due to very low status of phosphorus in the soil and Boro rice responded positively in yield increment at a higher dose of P. Abedin and Saleque (1998) reported that the general recommended dose of P fertilizer for rice in Bangladesh is 25 kg/ha and the frequency of P fertilizer application might vary from no application for several seasons to application in every year.

A considerable response to added S was observed. Average of three years data showed that yield increased up to the application of 12 kg S ha^{-1} and then tended to decline. On an average 16% yield increased with 12kg S/ha over control and it was 4 and 8% for 9 and 24 kg S/ha. Islam and Bhuiyan (1993) reported that to achieve yield target of rice fertilization with S along with N, P and K fertilization is extremely important especially in S–deficient soils. As the initial K status of the soil was high, its response was not verified

Effect of NPKS on T. aman rice

Grain yield influenced significantly due to different rates of nutrients (Table 1). Grain yield of T.aman rice differ significantly among 60, 80 and 105 kg N/ha, 15, 20 and 30kg P/ha and 11, 14 and 18 kg S/ha during 2000-2001 and 2001-2002 except 2002-2003. Grain yield increased sharply up to 60 kg N ha^{-1} and after that the trend was increasing but rate was slow and yield increased up to 80 kg N ha^{-1} and then tended to decline. About 39 % yield increased with 80 kg N/ha over control and it was 25 and 34% for 60 and 105 kg N/ha, respectively. Similarly, phosphorus also showed response towards the yield. Yield increased markedly up to 6 kg P ha^{-1} and then slowly increased up to 8 kg ha^{-1} and then declined. About 23 % yield increased with 8 kg P/ha over control and it was 12 and 21% for 6 and 11 kg P/ha, respectively. Sulphur also showed some response and yield increase markedly up to 14 kg S ha^{-1} and then decrees sharply. About 21 % yield increased with 14 kg S/ha over control and it was 9 and 14% for 11 and 18 kg S/ha, respectively. As the initial K status of the soil was high, its response was not verified

Table 1. Effect of different level of fertilizer nutrients on the yield of Mustard-Boro-T.Aman cropping pattern at ML T site Bagharpara, Jessore during 2000-2001 to 2002-03

Mustard						Boro rice						T.Aman rice					
Nutr-ient level (kg/ha)	Seed yield (t/ha)					Nutr-ient level (kg/ha)	Grain yield (t/ha)					Nutr-ient level (kg/ha)	Grain yield (t/ha)				
	2000-01	2001-02	2002-03	Mean	% yield increase over control		2000-01	2001-02	2002-03	Mean	% yield increase over control		2000-01	2001-02	2002-03	Mean	% yield increase over control
N						N						N					
0	0.23b	0.65c	0.58b	0.49		0	2.73c	3.45d	2.83c	3.00		0	2.10d	2.90d	2.65b	2.52	
61	0.56a	0.93b	1.00a	0.83	50	90	355b	4.77c	5.62b	4.67	40	60	2.57c	4.07c	3.35a	3.34	25
86	0.59a	1.22a	1.27a	1.03	54	125	4.83a	6.41a	6.49a	5.91	49	80	4.14a	4.81a	3.43a	4.13	39
120	0.56a	1.01a	1.23a	0.93	52	125	4.83a	6.41b	6.49b	5.39	44	105	3.48b	4.39b	3.36a	3.84	34
CV%	12.8	11.4	10.9			CV%	11.6	12.4	10.5			CV%	10.8	9.7	12.7		
P						P						P					
0	0.49b	0.81b	0.89b	0.72		0	3.06b	5.02c	5.73c	4.60		0	2.60c	3.51d	2.49b	3.20	
11	0.58a	1.02a	1.24a	0.95	24	5	4.02a	5.29b	5.95b	5.09	9	6	3.51b	3.81c	3.44a	3.65	12
15	0.57a	1.06a	1.27a	1.03	30	7	4.30a	5.87a	5.99b	5.91	22	8	4.14a	4.81a	3.43a	4.13	23
21	0.57a	1.03a	1.16a	0.92	22	10	4.72a	6.21a	6.34a	5.76	20	11	3.99a	4.17b	3.87a	4.05	21
CV%	11.9	10.7	11.24			CV%	12.4	11.5	13.4			CV%	12.6	10.7	11.3		
S						S						S					
0	0.50b	0.97b	0.82b	0.70		0	4.02c	5.14b	5.68b	4.95		0	2.86c	4.10b	2.30b	3.26	
16	0.57a	1.12a	1.27a	0.99	29	9	4.25b	5.44b	5.76b	5.15	4	11	3.28b	4.23b	3.34a	3.57	9
30	0.59a	1.22a	1.27a	1.03	32	12	4.67a	6.07a	6.32a	5.91	16	14	4.14a	4.81a	3.43a	4.13	21
42	0.56a	1.04a	1.25a	0.95	26	24	4.30b	5.87b	5.99b	5.39	8	18	4.04a	4.27b	3.39a	3.77	14
CV%	11.2	10.7	12.1			CV%	10.8	12.3	11.7			CV%	12.2	11.4	11.6		

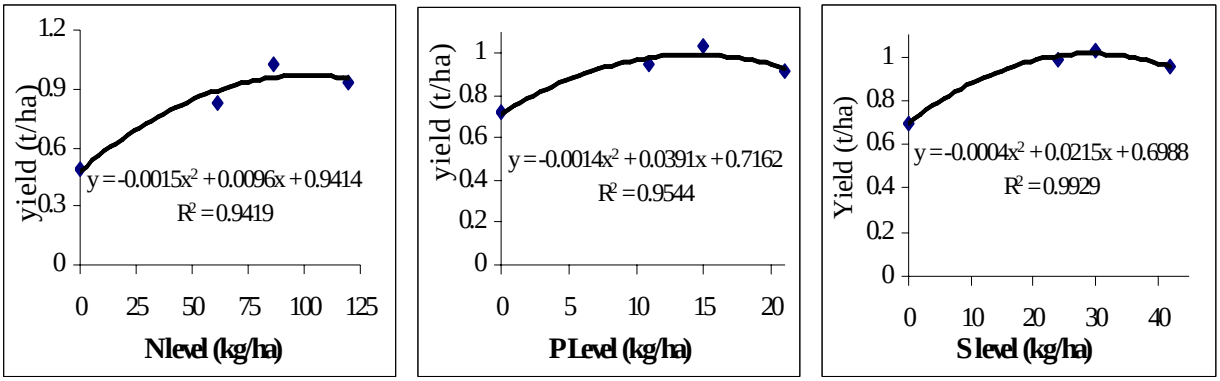

Figure 1. Response of Mustard to N, P and S at Bagarpara, Jessore

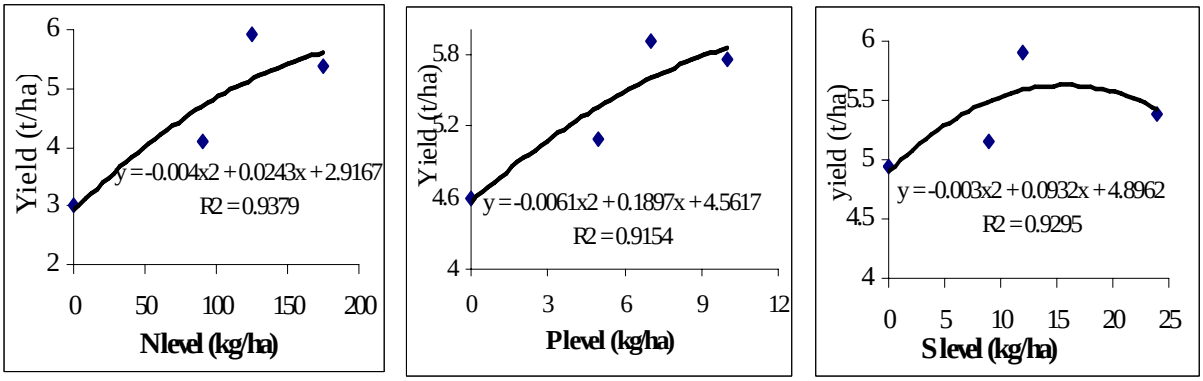

Figure 2. Response of Boro rice to N, P and S at Bagarpara, Jessore

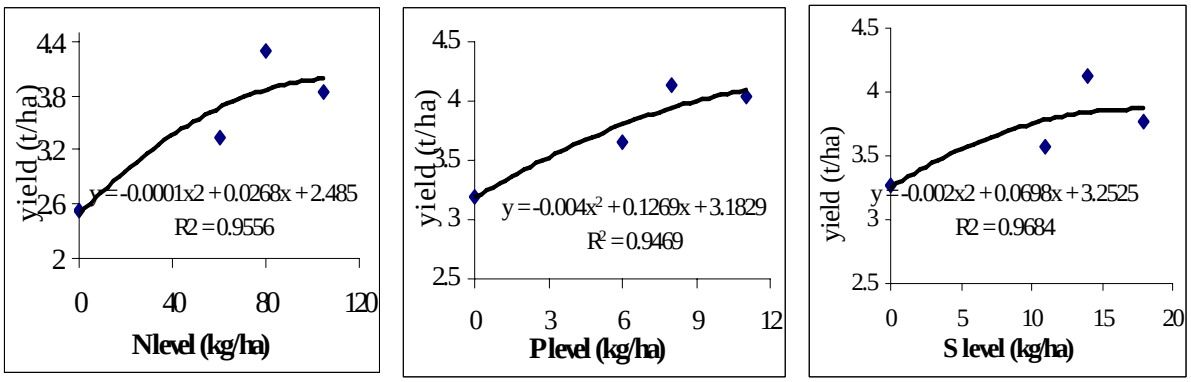

Figure 3. Response of T.aman rice to N, P and S at Bagarpara, Jessore

Table 2. Response function of Mustard yield to N, P and S fertilizer

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 0.9414 + 0.0096x - 0.0015x^2$	0.94	86	84	1.00
P	$Y = 0.7162 + 0.0391x - 0.0014x^2$	0.95	15	13	0.96
S	$Y = 0.6988 + 0.0215x - 0.0004x^2$	0.99	30	25	0.98

Table 3. Response function of Boro rice yield to N, P and S fertilizer

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 2.9167 + 0.0243x - 0.0045x^2$	0.94	125	121	5.70
P	$Y = 4.5617 + 0.1892x - 0.0061x^2$	0.91	7	6	5.40
S	$Y = 4.8962 + 0.0932x - 0.0031x^2$	0.93	12	10	5.20

Table 4. Response function of T.aman rice yield to N, P and S fertilizer

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 2.485 + 0.0268x - 0.00015x^2$	0.96	80	75	4.01
P	$Y = 3.1829 + 0.1269x - 0.0044x^2$	0.95	8	7	3.75
S	$Y = 3.2525 + 0.0628x - 0.002x^2$	0.99	14	12	3.80

Price of fertilizers
Urea = 6.00 Tk/kg
TSP = 14.00 Tk./kg
MP = 10.00 Tk./kg
Gypsum = 4.00 Tk./kg
Cowdung= 0.40 Tk. /kg

Price of rice and straw
Rice grain= 7.00 Tk./kg
Rice straw= 0.50 Tk./kg
Mustard grain= 15.00 Tk./kg
Mustard straw= 0.25 Tk./kg

Regression analysis

Regression analysis of Mustard, Boro and T.aman rice yield on an average of 3 years was done to fit the quadratic functions for estimating the optimum levels of each nutrient over the different levels of NPS/ha (Figure 1, 2 and 3). Dobermann and Fairhurst (2000) stated that the optimal rate of fertilizer application to a crop is that rate which produces the maximum economic returns at the minimum cost, and this can be derived from a nutrient response curve. Response curve shows that yield increased with the increasing of nutrients at certain level and thereafter yield was decreased. Figure 1 shows that yield of Mustard increased with increasing level of fertilizer nutrients to a certain limit and then decreased with further increase of nutrients level. But the increment of yield was prominent in case of N and the highest yield (1.03 t/ha) was obtained from 86 kg/ha. P has distinct effect on the yield. The highest grain yield (1.03 t/ha) was obtained from 15 kg P/ha. Application of 30 kg/ha of S produced the highest yield (1.03t/ha). From the regression equations for Boro (Table 3), the agronomically optimum levels of NPS/ha were estimated as 125-7-12 and the economically optimum fertilizer doses were 121-6-10 kg/ha for maximum yield of 5.70, 5.40 and 5.20 t/ha, respectively. Figure 3 shows that yield of T. aman rice increased with increasing level of fertilizer nutrients to a certain level and then decreased with further increase of nutrients level. But the yield increment was prominent in case of N and the highest yield (4.13 t/ha) was obtained from 80 kg/ha. Similar trend was observed with P. From the regression equation for T. aman rice (Table 4), the agronomically optimum levels of NPS/ha were estimated as 80-8-14 kg/ha and the economically optimum fertilizer doses were 75-7-12 kg NPS/ha for maximum yield of 4.01, 3.75, and 5.80 t/ha respectively. The economically optimal doses were less than the optimal agronomic dose that was economically viable at Bagharpara, Jessore during the experimentation years.

The cumulative result indicated that fertilizer dose that maximized yield of Mustard was 86-15-30 kg NPS/ha, Boro rice was 125-7-12 kg NPS/ha and 80-8-14 kg NPS/ha for T. aman rice while 84-13-25 kg NPS/ha was profitable for Mustard, 121-6-10 kg NPS/ha for Boro and 75-7-12 kg NPS/ha for T. aman in respect of yield and economics. The present recommended dose is relatively lower but judicious that ensures higher yield than that

of farmer's traditional practices; and it will be helpful to improve soil health for sustainable higher yield. So, 84-13-25 kg NPS/ha for mustard, 121-6-10 kg NPS/ha for Boro and 75-7-12 kg NPS/ha for T.aman rice could be proposed for recommendation in high Ganges river floodplain area under AEZ 11a.

ACKNOWLEDGEMENT

The research was conducted under Integrated Soil Fertility and Fertilizer management Project (SFFP) funded by DANIDA. The authors are grateful to DANIDA for financial assistance to carry out the experiment.

REFERENCES

Abedin, M. J. and Saleque, M. A. 1998. Effects of phosphorus fertilizer management on phosphorus sorptioncharacteristics of lowland rice soil. Thai J. Agric. Sci. 31(1): 122-129

BARC. 2005**.** Bangladesh Agricultural Research Council. Farmgate, Dhaka. p. 260

Dobermann, A. and Fairhurst, T. 2000. Economics of fertilizer use. Rice-Nutrient disorders and nutrient management. Potash and Phosphate Institute, Canada and International Rice Research Institute, Philippines.p.38

FRG (*Fertilizer Recommendation Guide)*. 1997. Bangladesh Agricutural Research Council. Farmgate, Dhaka.p.196

Gomez, K. A. and Gomez, A. A.1984. Statistical Procedure for Agricultural Research. 2nd edn., InternationalRice Research Institute, Los Banos, Philippines. John Willy and Sons. New York. p.324

Haque, M. S. 1998. Integrated nutrient management with inorganic and biofertilizers in legume based croppingpatterns. *Proc. of the national workshop on integrated nutrient management for crop production and soilfertility*. 24-25 March, 1998. BARC, Gazipur. pp.99-109

Islam, M. F. and Haque, M. F. 1998. Balanced fertilization with inorganic fertilizers in some dominant croppingpatterns. *Proc. of the national workshop on integrated nutrient management for crop production and soilfertility*. 24-25 March, 1998. BARC. Gazipur. pp.1-22

Islam, M. M. and Bhuiyan, N. I. 1993. Comparison of gypsum and thiovit as sources of sulphur for wetland rice.Bangladesh rice J. 4 (1&2): 73-75

Palanippan S.P. Integrated management of phosphate and farmyard manure in potato-radish cropping sequence on the acid soil. J. Indian Soc. Soil Sci. 1983, 40(4): 468-471

Tanaka, A. 1986. Historical changes in plant types of rice varieties in Hokkaido. J. Sci. Soil manure, Japan.39:526-534. *Cited from nitrogen and rice.* IRRI, Philippines. p.10