YIELD RESPONSE OF CHILI AND T. AMAN RICE TO NPK FERTILIZERS IN GANGES TIDAL FLOODPLAIN

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ABSTRACT

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An experiment was conducted at farmers' field of Farming System Research and Development (FSRD) site, Lebukhali under Patuakhali district during 2001-2002, 2002-2003 and 2003-2004 to determine the response and the optimum rate of nutrients (NPK) for Chili- Fallow-T. aman cropping pattern under AEZ-13. Different three levels of NPK with control were assigned in randomized complete block design with 5 dispersed replications. Average of three years study reveals that a considerable response of Chili and T. aman rice to N, P and K was observed. The results indicated that fertilizer nutrient dose that maximized yield of Chili and T. aman rice were 119-97-92 kg/ha and 63-20-37 kg/ha NPK, respectively while 117-93-89 kg/ha NPK for chili and 60-19-36 kg/ha NPK for T. aman rice were in respect of yield and economics.

Key words: Chilli, T. aman, yield response, fertilizer

INTRODUCTION

The major cropping pattern in Bangladesh agriculture mostly consists of rice based cereal crops (Hoque, 1998). In Patuakhali district about 10% of non-saline cultivated land is occupied by Chili- Fallow-T. aman cropping pattern (Anonymous, 2005). 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 fertilizers and manures and also declining soil organic matter to a considerable extent. Again crops grown in different cropping patterns and environment responded differently to fertilizer nutrients. A crop production system with high yield targets can not be sustain unless balanced nutrient inputs are supplied to soil against nutrient removal by crops (Bhuiyan et. al., 1991). Mineral fertilizer inputs are the crucial factors to the overall nutrient balance in intensive cropping system (Islam and Haq, 1998). Farmers in Patuakhali region use only nitrogenous fertilizer in most cases and very limited cases they use phosphorus (P) and potassium (K) fertilizers is detrimental to soil fertility and productivity. Soils and fertilizer management is very complex and dynamic in nature. Fertilizer recommendation for crops in a cropping pattern needs change after a certain period of time. With the advancement of technology and with a progress of fertility and fertilizer management research in the country, there has been a continuous need for updating the Fertilizer Recommendation Guide. Assessment of the nutrient requirements of the different crops for desired yield levels from a cropping sequence is an important first step in developing fertilizer management practices (FRG, 1997a). The typical behavior of fertilizer response ensures suggests that a high fertilizer dose beyond certain limit may not only reduce the marginal productivity but also reduce the total productivity. Fertilizers behave differently in the soil-plant system. Some fertilizers, namely those of P, K, S and Zn have considerable residual effect and only a fraction of the total applied amount is recovered by a single crop (FRG, 2005). 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 (Panaullah *et. al.*, 1998). Therefore, the present study was carried out to determine an economically optimal dose of fertilizer nutrients for Chili- Fallow-T. aman cropping pattern at Patuakhali under AEZ-13.

MATERIALS AND METHODS

The experiment was conducted at farmers' field of Farming System Research and Development (FSRD) site, Lebukhali under Patuakhali District during 2001-2002, 2002-2003 and 2003-2004. The land type was medium high land with pH 5.3. The initial soil nutrient status of the experimental plot was total nitrogen (N) 0.08%, P, S and Zn level 4.4, 33.46 and 3.69 µg g^{-1} soil, respectively and K level 0.28 meq $100g^{-1}$ soil. Soil organic matter was 1.44% (Appendix-1). The experiment was laid out in a randomized complete block (RCB) design with five dispersed replications. The unit plot size was 5m × 4m. The crop variety was local for Chili and BRRI dhan-23 for T. aman rice. Four different levels of N, P and K (Table 1) for Chili and T. aman were tested on the basis of soil analysis. The experiment was initiated with Chili. 30 days old Chili seedling was transplanted on 14-18 January with a spacing of 30 cm × 20 cm and was harvested two times on 05-25 May. 40 days old seedling of T. aman rice was transplanted on 19-24 August with a spacing of 25 cm × 15 cm and was harvested on 23-30 December. Fertilizer doses were calculated according to initial soil status of the experimental plots using

Fertilizer Recommendation Guide 1997 (FRG, 1997b). Entire amount of P and K fertilizers was applied as basal dose both in Chili and T. aman rice at the time of final land preparation. In Chili urea was applied as top dressing at 25, 50 and 70 days after transplanting (DAT) and in T. aman it was applied in three equal splits as top dressing at 15 DAT, at maximum tillering stage and before panicle initiation. The source of N, P and K was urea, TSP and MP, respectively. Weeding and other intercultural operations were done as and when necessary. No disease or pest was reported in any of the crops. Data on yield and yield attributes were recorded and analyzed statistically. Regression analysis was done and optimum and economic dose of fertilizer were calculated using the formula Y = -b/2c and Y = 1/2c (P_f/P_y - b), respectively from the response curve (Gomez and Gomez, 1984).

Table 1. Different nutrient doses for Chilli-Fallow-T. aman cropping pattern

Level	Nutrient (kg/ha) for Chili			Level	Nutrient (kg/ha) for T. aman		
	N	P	K		N	P	K
1	0	0	0	1	0	0	0
2	80	75	60	2	40	15	20
3	110	100	90	3	60	20	30
4	140	125	120	4	80	25	40

RESULTS AND DISCUSSION

Effect of NPK on Chili

Effect of different levels of NPK on the yield of Chili is shown in Table 2. Capsule yield was influenced to a greater extent due to application of different rates of nutrients. However the trend was more or less similar over the three experimental years. It was observed that higher amount of nutrient increases vigorous plant growth and also number and size of capsule as compared to farmers practice i.e., less amount of fertilizer or even no fertilizer. Capsule yield increased up to 110 kg N/ha and yield decreased less or beyond that level. In case of P yield increased up to 75 kg P/ha and then yield declined slightly in case of 100 kg P/ha application. Identical yield increased over control was observed due to application of 75, 100 and 125 kg P/ha. Application of 90 kg K/ha gave the highest capsule yield in 2001-2002 and 2003-2004 but in 2002-2003 the highest capsule yield was observed due to 120 kg K/ha. The highest yield increased over control (56.39%) was observed in N application, while it was the lowest in K. It indicates that chili is more responsive to N and less responsive to K.

Table 2. Yield of dry capsules of Chili as affected by different levels of nutrients

Nutrient levels (kg/ha)	Dry capsule yield (kg/ha)			Mean (kg/ha)	% Yield increased over control
	2001-2002	2002-2003	2003-2004		
N level					
0	648	670	677	665	-
80	980	997	1008	995	49.62
110	1038	1030	1052	1040	56.39
140	1012	1029	1034	1025	54.14
P level					
0	682	713	720	705	-
75	1036	1058	1050	1048	48.62
100	1024	1044	1052	1040	47.52
125	1023	1028	1045	1032	46.38
K level					
0	780	778	797	785	-
60	1018	1014	1034	1022	30.19
90	1048	1020	1052	1040	32.48
120	1020	1038	1026	1028	30.96

Effect of NPK on T. aman rice

Effect of different levels of NPK on the gain yield of T. aman rice is shown in Table 3. Grain yield influenced significantly due to application of different rates of nutrients. The highest yield was obtained with 60 kg N/ha and yield deceased less or beyond this limit. Similar trend was observed over the years. Grain yield increased over control was 26.30% when 60 kg N/ha was applied and the increment was 22.48% and 23.91% over control

with application of 40 and 80 kg N/ha, respectively. Tanka (1986) reported that excess N gave higher dry weight around heading simultaneously becomes low, causing a yield decline due to reduced ripening percentage. Response of P to T. aman rice was less than that of N. Grain yield of T. aman rice do not differ significantly with 15, 20 and 25 kg P/ha. However, the highest average yield (4130 kg/ha) was obtained from 20 kg P/ha and yield increment was 19.71% over control and grain yield decreased beyond this level of P application. Almost similar trend was observed over the years. The highest grain yield was observed in T. aman rice in Koira, Khulna when 16 kg P/ha was applied (Anonymous, 2006). Response of different levels of K to T. aman rice was not too high. However, application of 30 kg K/ha produced 28.26% higher yield over control and it was very much closer with that of 40 kg K/ha application. Zaman *et. al.* (2007) observed identical yield increment in T. aman rice when applied 15 and 20 kg K/ha. It might be due to optimum initial K status of the experimental field. Singh *et. al.* (1985) did not find significant response due to K alone and combination with P due to high available status of K in the experimental soil.

Table 3. Yield of T. aman rice as affected by different levels of nutrients

Nutrient levels (kg/ha)	Grain yield (kg/ha)			Mean (kg/ha)	% Yield increased over control
	2001-2002	2002-2003	2003-2004		
N level					
0	3266	3258	3286	3270	-
40	4008	3990	4017	4005	22.48
60	4129	4006	4145	4130	26.30
80	4048	4046	4062	4052	23.91
P level					
0	3455	3434	3461	3450	-
15	4126	4112	4128	4122	19.48
20	4130	4118	4142	4130	19.71
25	4114	4110	4130	4118	19.36
K level					
0	3228	3197	3235	3220	-
20	3897	3867	3912	3892	20.81
30	4138	4110	4142	4130	28.26
40	4001	4099	4112	4104	27.45

Regression analysis

Regression analysis of Chili and T. aman rice yield on an average of three years was done to fit the quadratic functions for estimating the optimum levels of each nutrient over the different levels of NPK/ha (Figure 1 and Figure 2). 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. The large and significant R^2 value in case of NPK in Chili and T. aman rice indicates that the quadratic response fitted the data. 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 Chili increased with increasing level of nutrients to a certain limit and then decreased with further increase of nutrient level. The increment of yield was prominent in case of all the three nutrients. The highest dry capsule yield 1038, 1055 and 1048 kg/ha was obtained from 119, 97 and 92 kg/ha N, P and K, respectively. From the regression equation of Chili (Table 4) the agronomical optimum levels of NPK/ha were estimated as 119-97-92 and the economically optimum nutrient dose were 117-93-89 kg/ha for maximum capsule yield of 1038, 1055 and 1048 kg/ha, respectively.

Figure 2 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 grain yield (4118 kg/ha) was obtained from 63 kg/ha. Similar trend was observed with P and K. From the regression equation of T. aman rice (Table 4) agronomical optimum levels of NPK/ha were estimated as 63-20-67 kg/ha and the economically optimum fertilizer nutrient dose was 60-19-36 kg/ha NPK for maximum yield of 4118, 4169 and 4120 kg/ha, respectively. Hawlader *et. al.* (2007) observed 45-11-13 kg NPK/ha for local T. aman rice (Sada mota). The economically optimal doses were less than the optimal agronomic doses that was economically viable for Patuakhali region during the experimentation years.

Table 4. Response function of Chili and T. aman rice to N, P and K for dry capsule and grain yield, respectively (average of 3 years)

Nutrient	Regression equation	R^2	Optimum rates of nutrient (kg/ha)	Maximum yield (kg/ha) at optimum levels of nutrients
Chili				
N	$y = -0.0263x^2 + 6.2698x + 664.67$	0.9997	117	1038
P	$y = -0.0373x^2 + 7.2228x + 706.01$	0.9956	93	1055
K	$y = -0.0307x^2 + 5.6732x + 786.01$	0.9975	89	1048
T. aman rice				
N	$y = -0.2185x^2 + 27.313x + 3268.9$	0.9997	60	4118
P	$y = -1.7419x^2 + 69.859x + 3451.5$	0.9977	19	4169
K	$y = -0.6455x^2 + 48.382x + 3214.4$	0.9935	36	4120

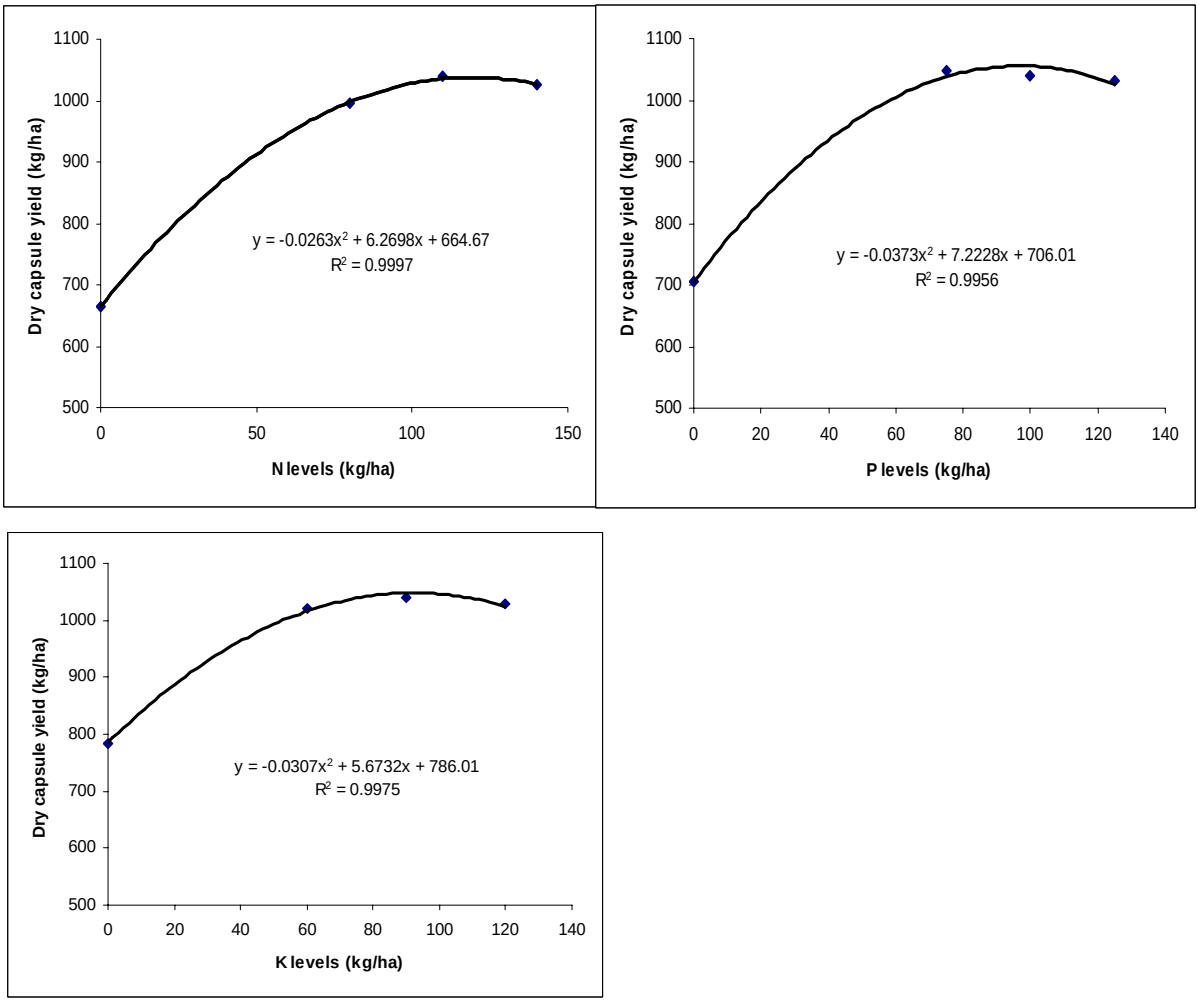

Figure 1. Response of chili to N, P and K at Lebukhali, Patuakhali

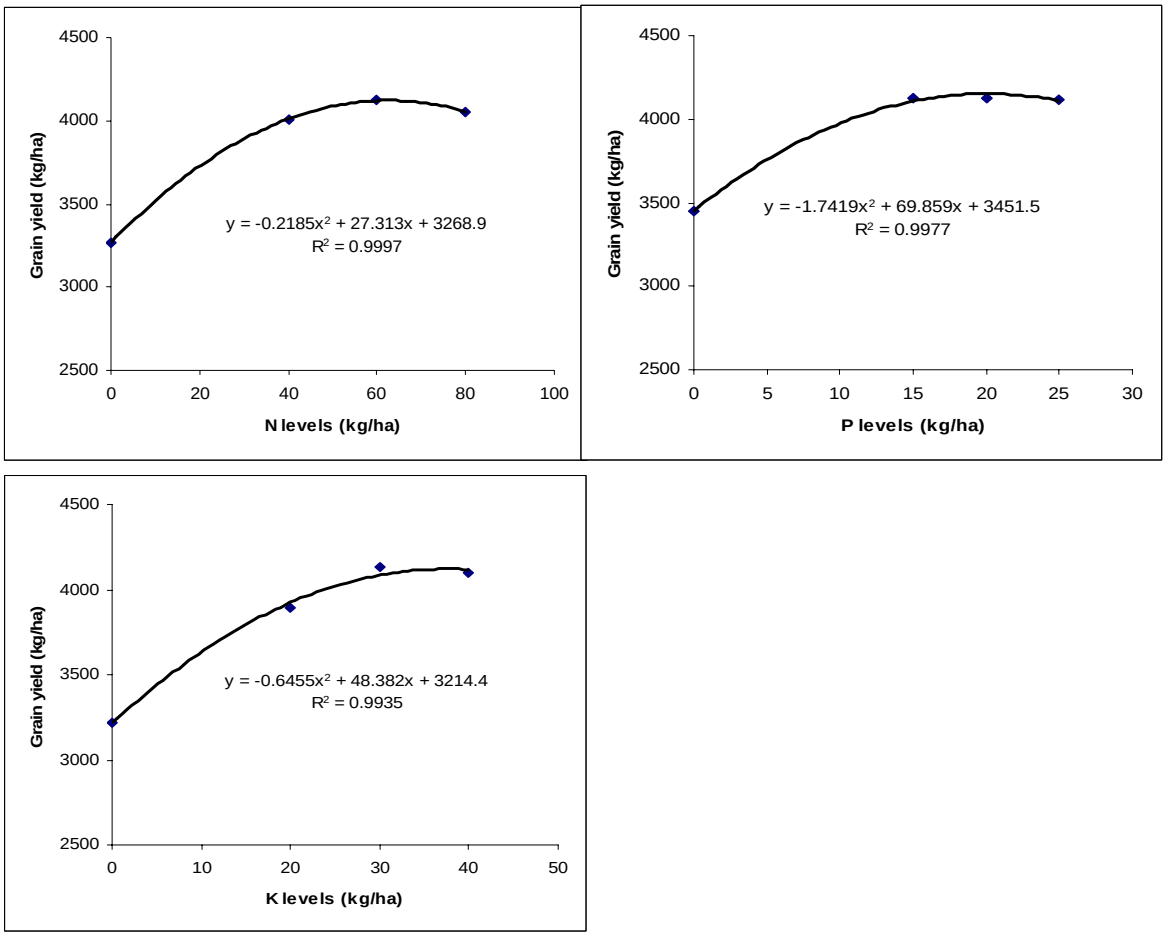

Figure 2. Response of T. aman rice to N, P and K at Lebukhali, Patuakhali

CONCLUSION

The cumulative results indicated that fertilizer nutrient dose that maximized yield of Chili and T. aman rice were 119-97-92 kg/ha and 63-20-37 kg/ha NPK, respectively while 117-93-89 kg/ha NPK was profitable for Chili and 60-19-36 kg/ha NPK for T. aman rice in respect of yield and economics. The present recommended doses were relatively lower but judicious that ensures higher yield than that of farmers' traditional practices and it will be helpful to improve soil health for sustainable higher yield. So, 117-93-89 kg/ha NPK for Chili and 60-19-36 kg/ha NPK for T. aman rice could be proposed for recommendation for Patuakhali in Ganges Tidal Floodplain area (AEZ-13).

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Appendix 1. Initial soil nutrient status of the experimental plots

Nutrient	Soil test value	Interpretation
pH	5.3	Slightly acid
Organic matter (%)	1.44	Low
Total N (%)	0.08	Very Low
Available P (µg g^{-1} soil)	4.4	Very Low
K (meq $100g^{-1}$ soil)	0.28	Optimum
S (µg g^{-1} soil)	33.46	High
Zn (µg g^{-1} soil)	3.69	Very high

Appendix 2. The price of inputs and the price of outputs at Patuakhali

Price of inputs	Price of rice and straw
Urea : 7.00 Tk/kg	Chili (dry capsule): 50.00 Tk/kg
TSP : 15.00 Tk/kg	T. aman rice :7.00 Tk/kg
MP : 10.00 Tk/kg	
Chili seed : 20.00Tk/10 g	
T. aman seed : 10 Tk/kg	