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YIELD RESPONSE OF MUNGBEAN, T. AUS AND T. AMAN RICE TO NPK FERTILIZERS IN GANGES TIDAL FLOODPLAIN

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ABSTRACT

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The experiment was conducted at farmers' field of Farming System Research and Development (FSRD) site, Lebukhali under Patuakhali district during 1999-2000, 2000-2001 and 2001-2002 to determine the response and to find out the optimum rate of nutrients (NPK) for Mungbean-T.-aus-T.-aman cropping pattern under AEZ-13. Different three levels of NPK with control were assigned in RCB design with 5 dispersed replications. Average of three years study reveals that a considerable response of T. aus and T. aman rice to N, P and K was observed. The response was more evident in T. aus and T. aman rice compared to Mungbean. The results indicated that fertilizer nutrient dose that maximized yield of Mungbean, T. aus and T. aman rice were 12-15-6 kg/ha, 78-24-15 kg/ha and 48-13-13 kg/ha NPK, respectively while 11-10-6 kg/ha NPK was profitable for Mungbean, 70-19-14 kg/ha NPK for T. aus rice and 45-11-13 kg/ha NPK for T. aman rice in respect of yield and economics.

Key words: Cropping pattern, yield, fertilizer

INTRODUCTION

The major cropping pattern in Bangladesh agriculture mostly consists of rice based cereal crops (Hoque, 1998). In Patuakhali district about 25% of non-saline cultivated land is occupied by Mungbean-T. aus-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 and potassium 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 in 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 it may 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 Mungbean-T aus-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 1999-2000, 2000-2001 and 2001-2002. The land type was medium high land with pH 6.24. The initial soil nutrient status of the experimental plot was total nitrogen 0.16%, P, S and Zn level 7.55, 57.92 and 3.80 µg g^{-1} soil, respectively and K level 0.30 meq $100g^{-1}$ soil. Soil organic matter was 1.62% (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 BARI mung-2 for Mungbean, BRRI dhan-27 for T. aus rice and local improved variety (Sada mota) for T. aman rice. Four different levels of N, P and K (Table 1) for Mungbean, T. aus and T. aman were tested on the basis of soil analysis. The experiment was initiated with Mungbean. Mungbean was sown on 01-04 February in a continuous row keeping line to line 30 cm apart and was harvested on 18-22 April. Thirty days old seedling of T. aus rice was transplanted on 26-30 April with a spacing of 25 cm × 15 cm and was harvested on 13-17 August. Same aged seedling of T. aman rice was transplanted on 21-25 August with same spacing as T. aus rice and was harvested on 25-31 December. Fertilizer doses were calculated according to initial soil status of the experimental plots using Fertilizer Recommendation Guide 1997 (FRG, 1997b). All fertilizers were applied as basal in Mungbean. In case of T. aus and T. aman rice entire quantity of P and K 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 days after transplanting (DAT), at maximum tillering stage and before panicle initiation stage. The source of N, P and K were urea, TSP and MP, respectively. Cymbush was applied to control the Thrips of Mungbean. No other disease or pest was reported in any of the three crops. Data on yield and yield attributes were recorded and analyzed statistically. Regression analysis was done and optimum and economic dose of fertilizer nutrients 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 Mungbean-T. aus-T. aman cropping pattern

Level	Nutrient (kg/ha) for mungbean			Level	Nutrient (kg/ha) for T. aus			Level	Nutrient (kg/ha) for T. aman		
	N	P	K		N	P	K		N	P	K
1	0	0	0	1	0	0	0	1	0	0	0
2	10	14	5	2	55	18	14	2	40	14	14
3	20	21	10	3	75	21	18	3	55	18	18
4	30	28	15	4	90	25	21	4	65	21	21

RESULTS AND DISCUSSION

Effect of NPK on Mungbean

Effect of different levels of NPK on the yield of Mungbean is shown in Table 2. Seed yield did not influenced to a greater extent due to application of different rates of nutrients. However the trend was not same over the three experimental years. Higher rate of nutrients increase higher biomass yield and reduce seed yield considerably in Mungbean (Singh *et. al.*, 1981). A medium to fertile soil can easily produce a satisfactory seed yield of Mungbean without application of any fertilizer. Seed yield increased up to 10 kg N/ha and yield decreased less or beyond that level, even 30 kg N/ha decreased yield to a negative direction as compared to no nitrogen application in all the three consecutive years. In case of phosphorous yield increased up to 10 kg P/ha and then yield declined in 1999-2000. But in the next two years yield increased up to 20 kg P/ha and then yield declined. Identical yield increased over control was observed due to application of 14 and 21 kg P/ha. The highest yield increased over control (5.91%) was observed when 5 kg K/ha was applied and the rate of increment of yield was decreased with the further increase of K and it was negative as compared to control when 15 kg K/ha was applied.

Table 2. Yield of Mungbean as affected by different levels of nutrients

Nutrient levels (kg/ha)	Seed yield (kg/ha)			Mean (kg/ha)	% Yield increased over control
	1999-2000	2000-2001	2001-2002		
N level					
0	798	824	830	817	-
10	882	850	857	863	5.63
20	830	837	814	827	1.22
30	796	772	790	786	-3.79
P level					
0	748	790	781	773	-
14	837	818	805	820	6.08
21	830	837	814	827	6.99
28	764	793	792	783	1.29
K level					
0	817	780	839	812	-
5	881	847	852	860	5.91
10	830	837	814	827	1.85
15	801	782	805	796	-1.97

Effect of NPK on T. aus rice

Effect of different levels of NPK on the yield of T. aus rice is shown in Table 3. Grain yield influenced significantly due to application of different rates of nutrients. The trend was more or less similar over the three years. Grain yield increased considerably up to 75 kg N/ha and then decreased with the increase of nitrogen application. Average of three years data showed that application of 75 kg N/ha increased grain yield 39.25% over control and beyond this level it decreased considerably (29.19% over control). Tanka (1986) reported that excess nitrogen gave higher dry weight around heading simultaneously becomes low, causing a yield decline due to reduced ripening percentage. Fertilization with phosphorous at the rate of 18, 21 and 25 kg/ha also differ producing grain yield. Almost similar trend was observed over the years. Average of three years data showed that yield increased by 21.50% over control up to application of 21 kg P/ha. However identical yield increased over control (18.35 and 19.84%) was observed when 18 kg and 25 kg P/ha, respectively was applied. Response of T. aus rice to potassium was observed to some limited extent. It was less than nitrogen and phosphorous. Highest grain yield over control (12.40%) was observed when 18 kg K/ha was applied and the rate of increment decreased with the further increase of K. More or less similar trend was observed over the years. Initial status of K in the experimental soil was optimum, therefore, response to added K was not very distinct. Singh *et. al.* (1985) did not found significant response due to potassium alone and combination with phosphorous due to high available status of potassium in the experimental soil.

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

Nutrient levels (kg/ha)	Grain yield (kg/ha)			Mean (kg/ha)	% Yield increased over control
	1999-2000	2000-2001	2001-2002		
N level					
0	3020	3077	3058	3052	-
55	3892	3844	3856	3864	26.61
75	4223	4257	4270	4250	39.25
90	3932	3969	3940	3947	29.32
P level					
0	3471	3075	3516	3498	-
18	4146	4160	4114	4140	18.35
21	4223	4257	4270	4250	21.50
25	4185	4203	4188	4192	19.84
K level					
0	3740	3776	3825	3781	-
14	4147	4130	4172	4148	9.71
18	4223	4257	4270	4250	12.40
21	4082	4089	4063	4083	7.99

Effect of NPK on T. aman rice

Effect of different levels of NPK on the yield of T. aman rice is shown in Table 4. Grain yield influenced significantly due to application of different rates of nutrients. The highest yield was obtained with 75 kg n/ha and yield deceased less or beyond this limit. Similar trend was observed over the years. Grain yield increased over control was 34.42% when 75 kg N/ha was applied and the increment was 28.01 and 25.00% over control with application of 55 and 90 kg/ha N, respectively. Response of phosphorous to T. aman rice was less than that of nitrogen. Grain yield of T. aman rice do not differ significantly with 18 and 21 kg/ha P. However, the highest average yield (4200 kg/ha) was obtained from 18 kg P/ha and yield increment was 21.74% 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 14 kg K/ha produced 12.02% higher yield over control and it was very much closer with that of 18 kg K/ha application. Zaman *et. al.* (2007) observed identical yield increment in T. aman rice when applied 15 and 20 kg P/ha. It might be due to optimum initial K status of the experimental field.

Table 4. Yield of T. aman as affected by different levels of nutrients

Nutrient levels (kg/ha)	Grain yield (kg/ha)			Mean (kg/ha)	% Yield increased over control
	1999-2000	2000-2001	2001-2002		
N level					
0	3022	3078	3068	3056	-
40	3895	3934	3907	3912	28.01
55	4115	4135	4074	4108	34.42
65	3850	3794	3816	3820	25.00
P level					
0	3438	3466	3446	3450	-
14	4195	4215	4190	4200	21.74
18	4115	4135	4074	4108	19.07
21	3876	3882	3912	3890	12.75
K level					
0	3704	3708	3718	3710	-
14	4134	4164	4170	4156	12.02
18	4115	4135	4074	4108	10.73
21	3993	4015	3988	3992	7.60

Regression analysis

Regression analysis of Mungbean, T. aus 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, 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. The large and significant R^2 value in case of P in T. aus and NPK in 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 Mungbean increased with increasing level of nutrients to a certain limit and then decreased with further increase of nutrient level. But the increment of yield was prominent in case of N and the highest seed yield (852 kg/ha) was obtained from 12 kg N/ha. P has distinct effect on the seed yield and the highest seed yield (827 kg/ha) was obtained from 15 kg P/ha. Application of 6 kg K/ha produced the highest seed yield (849 kg/ha) and further application of K yield began to decrease. The reason might be optimum K status in soil (Appendix table 1). From the regression equation of Mungbean (Table 5) the agronomically optimum levels of NPK/ha were estimated as 12-15-6 and the economically optimum nutrient dose were 11-10-6 kg/ha for maximum yield of 852, 821 and 849 kg/ha, respectively. Figure 2 shows that yield of T. aus 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 (4062 kg/ha) was obtained from 78 kg/ha. Similar trend was observed with P and K. From the regression equation of T. aus rice (Table 5) agronomically optimum levels of NPK/ha were estimated as 78-24-15 kg/ha and the economically optimum fertilizer nutrient dose was 70-19-14 kg/ha NPK for maximum yield of 4052, 4184 and 4191 kg/ha, respectively. Similarly from the regression equation (Table 5) fertilizer nutrients doses for T. aman rice were calculated. Agronomically optimum level of NPK/ha for T. aman rice were estimated as 48-13-13 kg/ha and the economically optimum fertilizer nutrient dose was 45-11-13 kg/ha NPK for maximum yield of 4002, 4202 and 4163 kg/ha, respectively. The economically optimal doses were less than the optimal agronomic doses that was economically viable for Patuakhali region during them experimentation years.

Table 5. Response function of Mungbean, T. aus and T. aman rice to N, P and K for seed/grain yield (average of 3 years)

Nutrient	Regression equation	R^2	Optimum rates of nutrient (kg/ha)	Maximum yield (kg/ha) at optimum levels of nutrients
Mungbean				
N	$y = -0.2175x^2 + 5.235x + 820.85$	0.9019	11	852
P	$y = -0.2421x^2 + 7.2922x + 771.91$	0.939	10	821
K	$y = -0.79x^2 + 10.23x + 816.15$	0.8457	6	849
T. aus rice				
N	$y = -0.1688x^2 + 26.267x + 3040.5$	0.9285	70	4052
P	$y = -1.2846x^2 + 60.604x + 3496.7$	0.9905	19	4184
K	$y = -1.8867x^2 + 55.936x + 3777.9$	0.9259	14	4191
T. aman rice				
N	$y = -0.418x^2 + 39.997x + 3048.9$	0.9625	45	4002
P	$y = -4.7058x^2 + 120.25x + 3449.2$	0.9984	11	4202
K	$y = -2.6549x^2 + 69.412x + 3709.6$	0.9989	13	4163

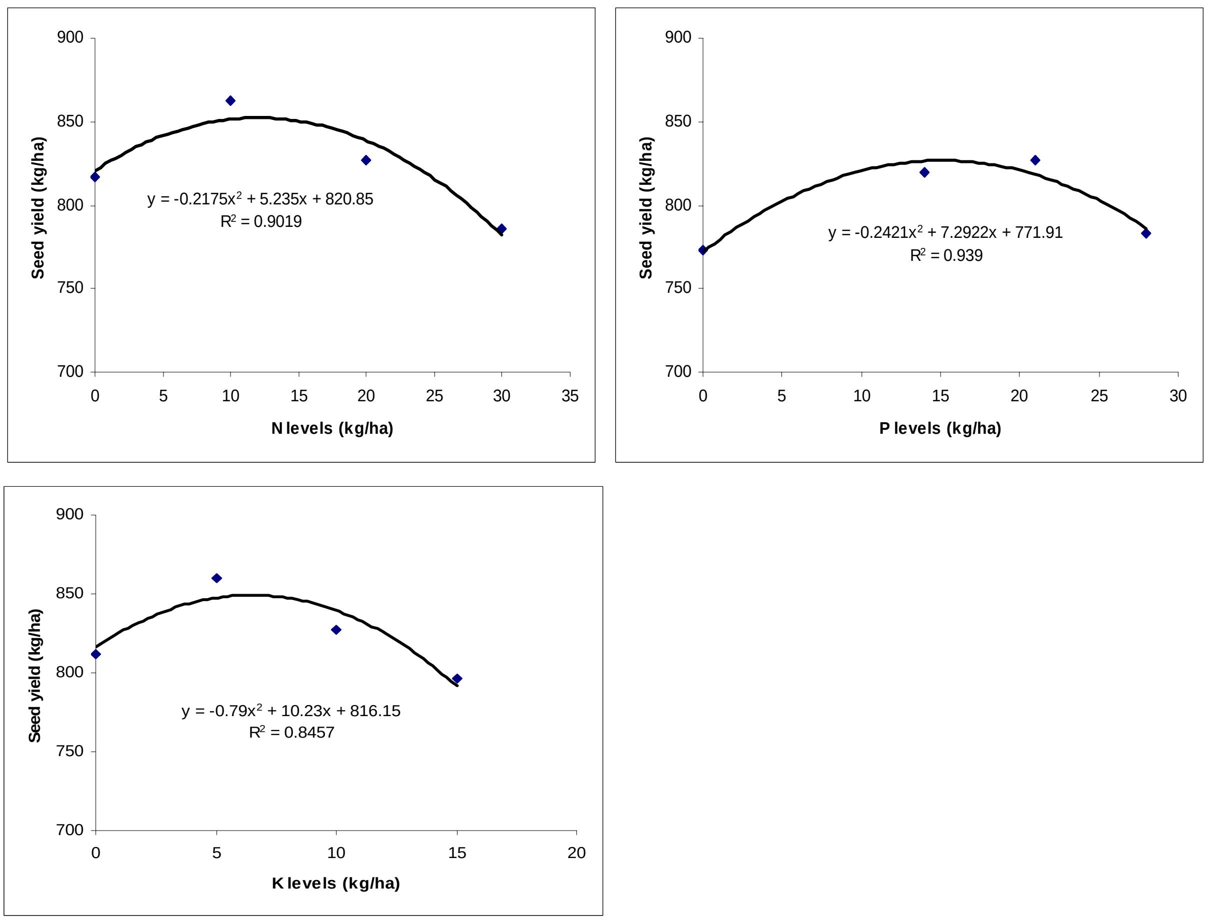

Figure 1. Response of Mungbean to N, P and K at Lebukhali, Patuakhali

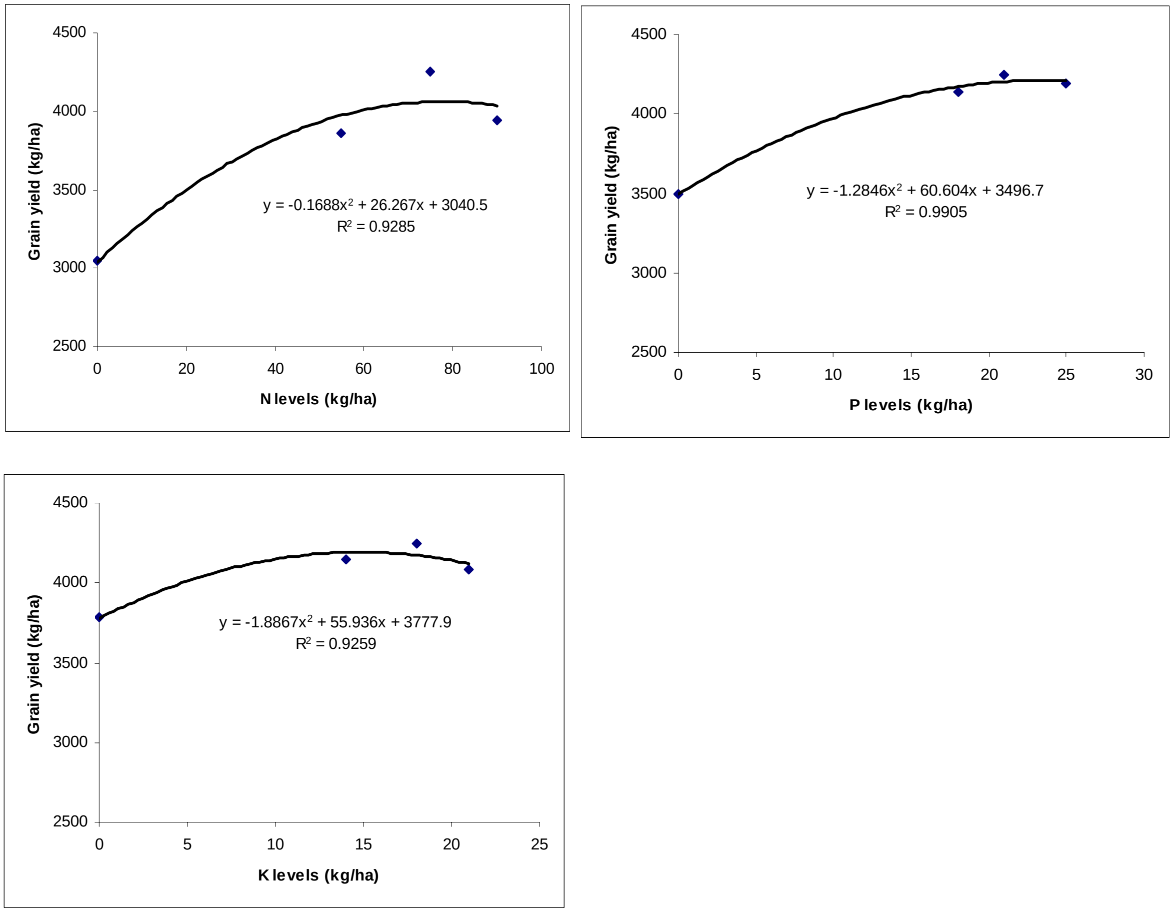

Figure 2. Response of T. aus rice to N, P and K at Lebukhali, Patuakhali

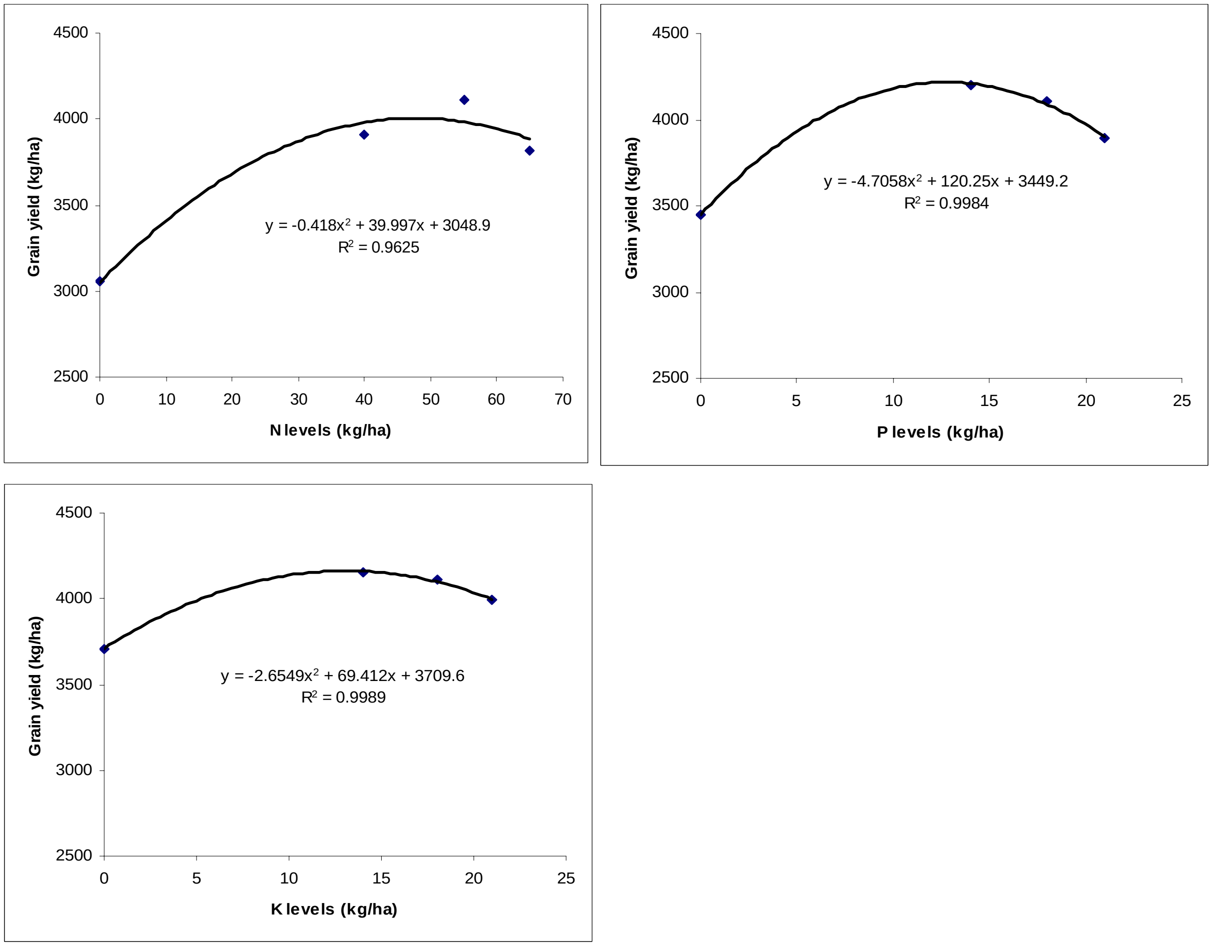

Figure 3. Response of T. aman rice to N, P and K at Lebukhali, Patuakhali

The cumulative results indicated that fertilizer nutrient dose that maximized yield of Mungbean, T. aus and T. aman rice were 12-15-6 kg/ha, 78-24-15 kg/ha and 48-13-13 kg/ha NPK, respectively while 11-10-6 kg/ha NPK was profitable for Mungbean, 70-19-14 kg/ha NPK for T. aus rice and 45-11-13 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, 11-10-6 kg/ha NPK for Mungbean, 70-19-14 kg/ha NPK for T. aus rice and 45-11-13 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	6.24	Slightly acid
Organic matter (%)	1.62	Low
Total N (%)	0.16	Low
Available P (µg g^{-1} soil)	7.55	Low
K (meq $100g^{-1}$ soil)	0.30	Optimum
S (µg g^{-1} soil)	57.92	Very high
Zn (µg g^{-1} soil)	3.80	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	Mungbean : 30 Tk/kg
TSP : 15.00 Tk/kg	T. aus rice : 6 Tk/kg
MP : 10.00 Tk/kg	T. aman rice :6 Tk/kg
Mungbean seed : 55 Tk/kg	
T. aus seed : 10 Tk/kg	
T. aman seed : 10 Tk/kg	