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RESPONSE OF ONION, *T. Aus* AND *T. Aman* RICE TO NPKS FERTILIZERS IN THE HIGH GANGES RIVER FLOODPLAIN SOIL

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ABSTRACT

An experiment was conducted at farmer's field of Kushtia sadar MLT site under AEZ 11 during three consecutive years at 2001-2004 to find out the rate of nutrients (NPKS) for Onion (Taherpuri), *T. aus* (IR-50) and T. *aman* rice (BR-11) to NPKS on the yield under AEZ11. Four different levels of NPKS were assigned in RCB design with 4 replications. Average of three years study reveals that a considerable response of Onion, *T. aus* and *T. aman* rice to NPKS was observed. However, the response to P, K and S was more distinct in comparison to N. Similarly, the response was more evident in Onion compared with *T. aus* and *T. aman* rice. Yield of Onion increased up to the application of 120, 43, 120 and 20 kg/ha of N, P, K and S, respectively. Yield of *T. aus* and *T. aman* rice increased up to the application of 70, 18, 34 and 10 kg/ha of N, P, K and S, respectively. From the regression analysis it was found that the relationship was almost quadratic in nature. The application of 115-40-118-18 kg NPKS/ha for Onion, 63-19-29-9 kg NPKS/ha for *T. aus* rice and 65-17-33-9 kg NPKS/ha for *T. aman* rice was the most economically optimum fertilizer dose in the High Ganges River Floodplain Soil under AEZ 11.

Key words : Onion, *T. aus*, *T. aman*, NPKS fertilizer

INTRODUCTION

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, The use of fertilizers should be economized.

Intensive use of high yielding varieties of the crops has led to a sharp increase in removal of plant nutrients from soil. In 1996, 421-71-457-44 million tons of NPKS, 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). Fertilizers have been responsible for nearly 50% yield increase registered in the recent years (Islam and Haque 1998).

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The major cropping patterns in Bangladesh agriculture are mostly rice based (Haque 1998). Onion - *T. aus* - *T. aman* rice cropping pattern is the dominant cropping pattern in medium high land area of Kushtia region under the High Ganges River Floodplain (AEZ 11). 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 *et al.,* 1998). Fertilizer recommendation for crops in a cropping pattern of a particular AEZ needs to change after a certain period of time. Application of imbalance fertilizer to individual crop is commonly found among the farmers of Kushtia region which 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 agricultural production to an economically level. Hence, the present study was carried out to determine an economically optimal dose of fertilizer nutrients for Onion - *T. aus* - *T. aman* rice cropping pattern at Kustia under AEZ11.

MATERIALS AND METHODS

The experiment was conducted at farmer's field of Multilocation testing (MLT) site Kushtia sadar under Kushtia district (AEZ-ll and land type-MHL) during 2001-2004 with Onion - *T. aus* - *T. aman* cropping system. The soil was silt loom having pH 8.1, initial Soil organic matter 1.88%. total N 0.15%, exchangeable K 0.69 meq/l00g soil, Olsen's P 3.98 ppm, available S 30 ppm, available Zn 0.82 ppm and available B 0.36 ppm. The experimental plot of onion 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, 60, 120 and 180), P (0, 22, 43 and 65), K (0, 60, 120 and 180) and S (0, 10, 20 and 30) for Onion, *T. aus* and *T. aman* rice was tested based on the soil analysis. Onion (var. Taherpuri) seed was sown on 02 November and harvested on 6 April. Forty days old seedlings of *T. aus* (var. IR-20) rice were transplanted on 25 May with a spacing of 25cm × 15cm and harvested on 05 August. Forty days old seedlings of *T. aman* rice (var. BR-22) were transplanted on 18 August with a spacing of 20cm × 15cm and were harvested on 12 December. Fertilizer doses were calculated according to original soil status of the experimental plots using Fertilizer Recommendation Guide 1997. In case of Onion, 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, K, 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 DAT, at maximum tillering stage and before panicle initiation stage. Data on yield and yield attributes were recorded and analyzed statistically by Duncans 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 onion

Effect of different levels of NPKS on the yield of Onion is shown in Table 1. Bulb yield influenced significantly due to the different rates of nutrients. Bulb yield of onion were increased progressively with the increasing rate of NPK and S up to 120, 43, 120 and 20 kg ha^{-1}, respectively, and then declined. The highest bulb yield (12.47 t/ha) was obtained with T_3 ($N_{120}P_{43}K_{120}S_{20}$ kg ha^{-1}) treatment and lowest (6.8 t/ha) was from the T_{14} (native fertility) treatment which was same as to average of three years result. Similar result was also observed by Ali and Haque (1994). Application of 120 kg N/ha, 43 kg P/ha, 120 kg K/ha and 20 kg S/ha individually performed the highest yield of onion (Table 2). Addition of nitrogen increased bulb yield 36, 68 and 60% by 60, 120 and 180 kg N ha^{-1} respectively over the N-control. The effect of nitrogen was more pronounced as compared to that of P, K, and S. Bulb yield increased progressively with the increasing rates of P up to 43 kg ha^{-1} and thereafter decreased. Gupta and Gaffar (1990) found the highest yield of onion bulb (16.6 t/ha) by the application of 54 kgP/ha. However, the yield difference between the highest and the lowest yielding treatment was 22%. Fruit yield of onion also increased progressively with added K fertilizer up to 120 kg ha^{-1}. Ahmed *et al.,* (1987) observed the yield performance of Taherpuri onion variety at Rajbari was 8.42 t/ha with 65 kg K/ha. Further increase in K fertilizer tended to depress the bulb yield. The yield difference between the highest and the lowest yielding treatment was 36%. Sulphur increased bulb yield significantly up to 20 kg ha^{-1} and thereafter decreased. Balasubramonium *et al.*, (1979) studied that the added S had positive effect in increasing the yield of onion but a reduction in yield with very high dose of S was also observed.Application of 205 kg S ha^{-1} had 54% higher yield than the control (without S).

Effect of NPKS on T. aus rice

Effect of different levels of NPKS on the yield of *T. aus* 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 and nutrients. Grain yield increased slowly up to the application of 70, 18, 34 and 10 kg NPKS ha^{-1} respectively, and then tended to decline. The highest grain yield (3.83 t/ha) was obtained with T_3 ($N_{70}P_{18}K_{34}S_{10}$ kg ha^{-1}) treatment and lowest (2.32 t/ha) was from the T_{14} (native fertility) treatment which was same as to average of three years result.

The highest yield was obtained with 70 kgN/ha, which was also identical with 105 and 35 kgN/ha during 2003-04. But in 2001-02 and 2002-03, it was identical with 105 kgN/ha. About 51% yield increased with 70 kg N/ha over control and it was 35 and 23% for 105 and 35 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.

Table 1. Effects of different fertilizer treatments on the yield of onion - *T. aus* - *T. aman* cropping pattern

Treatments N-P-K-S Kg/ha	Onion				*T. aus*				*T. aman*			
	Bulb yield (t/ha)				Grain yield (t/ha)				Grain yield (t/ha)			
	2001-02	2002-03	2003-04	Mean	2001-02	2002-03	2003-04	Mean	2001-02	2002-03	2003-04	Mean
T_1 =0-43-120-20	7.2	7.0	8.0	7.4	2.39	2.96	3.00	2.78	3.24	3.18	3.25	3.24
T_2 = 60-43-120-20	8.4	10.2	12.2	10.27	2.99	3.24	4.05	3.44	4.10	4.05	4.35	4.18
T_3 = 120-43-120-20	11.4	12.9	13.5	12.47	3.51	3.80	4.18	3.83	4.80	4.75	4.66	4.73
T_4 = 180-43-120-20	10.5	12.5	12.8	11.92	3.44	3.71	4.10	3.75	4.52	4.45	4.47	4.48
T_5 = 120-0-120-20	8.6	10.8	11.5	10.15	2.47	2.99	2.95	2.80	3.16	3.21	3.75	3.37
T_6 = 120-22-120-20	9.2	11.9	12.8	11.67	3.10	3.38	3.72	3.40	4.10	4.15	4.25	4.18
T_7 = 120-65-120-20	10.4	12.3	13.0	12.00	3.25	3.62	4.16	3.67	4.45	4.55	4.50	4.50
T_8 = 120-43-0-20	8.6	8.7	10.2	9.16	2.81	2.8	3.05	2.90	3.21	3.29	3.25	3.25
T_9 = 120-43-60-20	10.2	11.6	11.8	11.00	3.20	3.37	3.78	3.45	4.11	4.16	4.08	4.12
T_{10} = 120-43-180-20	10.9	11.9	12.0	11.59	3.33	3.65	4.03	3.67	4.40	4.52	4.37	4.43
T_{11} = 120-43-120-0	8.6	10.3	10.0	9.38	2.90	2.92	3.16	2.96	3.0	3.18	3.13	3.10
T_{12} = 120-43-120-10	9.5	11.2	12.3	11.00	3.30	3.33	3.57	3.40	4.12	4.22	4.15	4.16
T_{13} = 120-43-120-30	10.0	11.3	12.7	11.38	3.40	3.64	3.95	3.66	4.51	4.38	4.48	4.46
T_{14} = Native fertility	6.8	6.1	7.3	6.7	2.17	2.34	2.45	2.32	2.19	2.44	2.62	2.42
LSD value (0.005)	0.01	0.05	0.01	-	0.02	0.07	0.04	-	0.01	0.03	0.08	-
CV (%)	8.52	11.31	9.90	-	14.65	10.63	14.99	-	10.54	12.54	10.72	-

Response to phosphorus was also observed and yield increased linearly with the increase of phosphorus. The highest yield was obtained with 18 kg/ha, which was identical with 27 and 9 kg P/ha during 2001-02 and 2002-03. But in 2003-04, it was identical with 27 kgP/ha. Average of three years data showed that yield increased by 56% over control up to application of 7 kg P/ha. However, about 31 and 21% yield increased with 27 and 9 kg P/ha over control. It might be due to very low status of phosphorus in the soil and *T. aus* rice responded positively in yield increment at a higher dose of P. Abedin *et al. (*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. The response to K was not very sharp. The highest yield was obtained with 34 kg/ha, which was identical with 51 and 17 kg K/ha during the 3 years and about 32% yield increased with 34 kg K/ha over control and it was 26 and 16% for 51 and 17 kg K/ha. A considerable response to added S was observed. The highest yield was obtained with 10 kgS/ha, which was identical with 15 and 5 kg S/ha during 2001-02 and 2002-03. But in 2003-04, it was identical with 15 kgS/ha and about 29% yield increased with 10 kgK/ha over control and it was 20 and 14% for 15 and 5 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.

Table 2. Single effect of N, P, K and S on yield (Average 3 years) of onion, *T. aus* and *T. aman*

Onion			*T. aus*			*T. aman* rice		
Nutrient level (kg/ha)	Bulb yield (t/ha)	% yield increase over control	Nutrient level (kg/ha)	Grain yield (t/ha)	% yield increase over control	Nutrient level (kg/ha)	Grain yield (t/ha)	% yield increase over control
	N			**N**			**N**	
0	7.4	-	0	2.78	-	0	3.24	-
60	10.27	36	35	3.44	23	35	4.18	23
120	12.47	68	70	3.83	51	70	4.73	43
180	11.92	60	105	3.75	35	105	4.48	38
	P			**P**			**P**	
0	10.15	-	0	2.80		0	3.37	-
22	11.67	14	9	3.40	21	9	4.18	24
43	12.47	22	18	3.83	56	18	4.73	40
65	12.00	18	27	3.67	31	27	4.50	33
	K			**K**			**K**	
0	9.16	-	0	2.90		0	3.25	-
60	11.00	20	17	3.45	16	17	4.12	26
120	12.47	36	34	3.83	32	34	4.73	45
180	11.59	26	51	3.67	26	51	4.43	36
	S			**S**			**S**	
0	9.30	-	0	2.96	-	0	3.10	
10	11.00	16	5	3.40	14	5	4.16	24
20	12.47	54	10	3.83	29	10	4.73	42
30	11.38	22	15	3.66	23	15	4.46	33

Effect of NPKS on T. aman rice

Grain yield influenced significantly due to different rates of nutrients (Table 1). All the nutrients showed some response towards the yield. However, the response to NPKS was not very sharp. The highest grain yield (4.73 t/ha) was obtained with T_3 ($N_{70}P_{18}K_{34}S_{10}$ kg ha^{-1}) treatment and lowest (2.42 t/ha) was from the T_{14} (native fertility) treatment which was same as to average of three years result.

Grain yield increased sharply up to 35 kg N ha^{-1} and after that the trend was increasing but rate was slow and yield increased up to 70 kg N ha^{-1} and then tended to decline (Table 2). About 43 % yield increased with 70 kg N/ha over control and it was 38 and 23% for 105 and 35 kg N/ha, respectively. Similarly, P, K and S also showed response

towards the yield. The highest yield was obtained with 18, 34 and 10 kg PKS/ha, respectively which was identical with all treatments except control during the 3 years and about 40, 45 and 42% yield increased with 18, 34 and 10 kg PKS/ha, respectively over control.

Regression analysis

Regression analysis of Onion, *T. aus* and *T. aman* rice yields on average of 3 years was done to fit the quadratic functions for estimating the optimum levels of each nutrient over the different levels of NPKS/ha (Figs. 1, 2 and 3). Dobermann *et al. (*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 the yield decreased. Fig. 1 shows that yield of Onion increased with increasing level of fertilizer nutrients to a certain limit and then decreased with further increase in nutrient levels. But the increment of yield was prominent in case of N and the highest yield (12.47 t/ha) was obtained from 86 kg/ha. P has distinct effect on the yield. The highest grain yield (12.47 t/ha) was obtained from 43 kg P/ha. Application of 20 kg/ha of S produced the highest yield (12.47 t/ha). From the regression equations for Onion (Table 3), the agronomic optimum levels of NPKS/ha were estimated as 120-43-120-20 and the economic optimum fertilizer doses were 115-40-118-18 kg/ha for obtaining maximum yield of 10.44, 11.00, 12.43 and 11.20 t/ha, respectively. Fig. 2 and 3 show that yield of *T. aus* and *T. aman* rice increased with increasing level of fertilizer nutrients to a certain level and then decreased with further increase in nutrient levels. But the yield increment was prominent in case of N and the highest yield (3.83 t/ha and 4.73) was obtained from 70 kgN/ha. Similar trend was observed with P, K and S. From the regression equation for *T. aus* and *T. aman* rice (Table 4 and 5), the agronomic optimum levels of NPKS/ha were estimated as 70-18-34-10 kg/ha and the economically optimum fertilizer doses were 63-19-29-9 kg NPKS/ha of *T. aus* and 65-17-33-9 of *T. aman* rice for maximum yield of 2.98, 3.01, 3.34 and 3.22 t/ha and 4.19, 4.27, 4.63 and 4.49 t/ha, respectively. The economic optimal doses were less than the optimal agronomic dose that was economically viable at Kushtia during the experimentation years.

Table 3. Response function of onion yield to N, P, K and S fertilizers

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 7.296 + 0.0696x - 0.0002x^2$	0.99	120	115	10.44
P	$Y = 10.12 + 0.0977x - 0.0011x^2$	0.99	43	40	11.00
K	$Y = 9.061 + 0.0486x - 0.0002 x^2$	0.97	120	118	12.43
S	$Y = 9.1835 + 0.2863x - 0.007x^2$	0.95	20	18	11.20

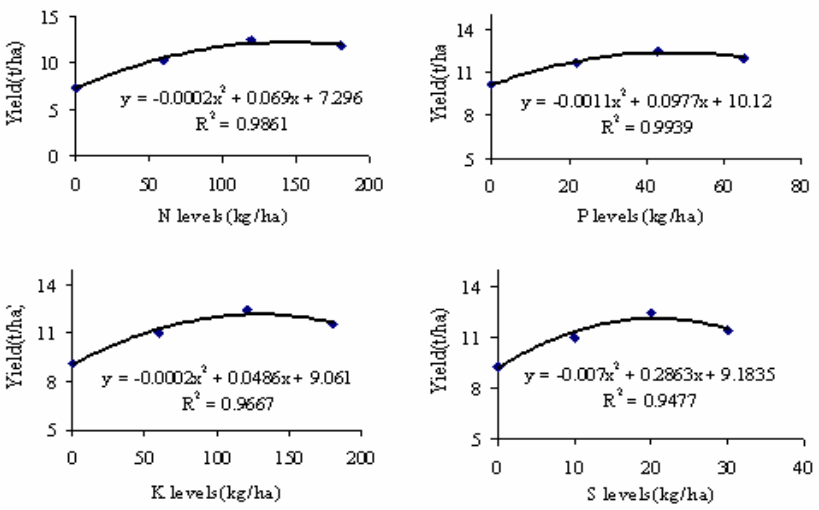

Fig. 1. Response of Onion to N, P, K and S at Kushtia

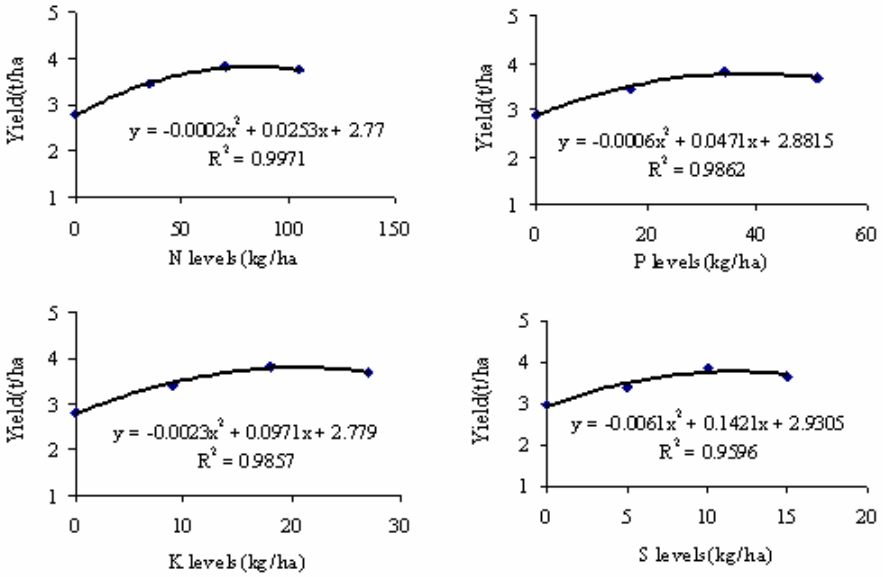

Fig.2. Response of T. *aus* to N, P, K and S at Kushtia

Table 4. Response function of *T. aus* rice yield to N, P, K and S fertilizers

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 2.77 + 0.0253x - 0.0002x^2$	0.99	70	63	2.98
P	$Y = 2.8815 + 0.0471x - 0.0006x^2$	0.99	18	19	3.01
K	$Y = 2.779 + 0.0971x - 0.002x^2$	0.98	34	29	3.34
S	$Y = 2.9305 + 0.1421x - 0.0061x^2$	0.96	10	9	3.22

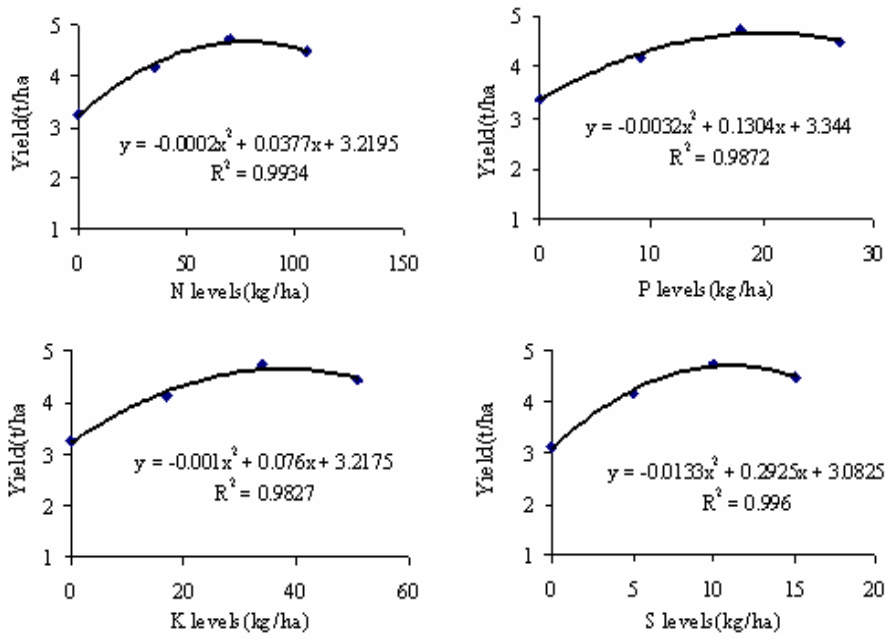

Fig.3. Response of T. *aman* to N, P, K and S at Kushtia

Table 5. Response function of *T. aman* rice yield to N, P, K and S fertilizers

Nutrients	Regression equation	R^2	Optimum rates of nutrient (kg/ha)		Maximum yield (t/ha) at optimum level of nutrient
			Agronomic	Economic	
N	$Y = 3.2195 + 0.0377x - 0.0002x^2$	0.99	70	65	4.19
P	$Y = 3.344 + 0.1304x - 0.0032x^2$	0.99	18	17	4.27
K	$Y = 3.2175 + 0.076x - 0.001x^2$	0.98	34	33	4.63
S	$Y = 3.0825 + 0.2925x - 0.0133x^2$	0.99	10	9	4.49

The cumulative result indicated that fertilizer dose that maximized yield of Onion was 120-43-120-20 kg NPKS/ha, *T. aus* rice was 70-18-34-10 kg NPKS/ha and 70-18-34-10 kg NPKS/ha for *T. aman* rice while 115-40-118-18 kg NPKS/ha was profitable for Onion, 63-19-29-9 kg NPKS/ha for *T. aus* and 65-17-33-9 kg NPKS/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, 115-40-118-18 kg NPKS/ha for Onion, 63-19-29-9 kg NPKS/ha for *T. aus* and 65-17-33-9 kg NPKS/ha for *T. aman* rice could be proposed for recommendation in high Ganges river floodplain area under AEZ 11.

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Appendix Table 1. The price of inputs and the price of outputs at Kushtia sadar

Price of fertilizers	Price of rice and straw
Urea = 6.00 Tk./kg	Onion = 20.00 Tk./kg
TSP = 15.00 Tk./kg	Rice grain = 7.00 Tk./kg
MP = 9.00 Tk./kg	Rice straw = 0.50 Tk./kg
Gypsum = 3.00 Tk./kg	
Cowdung = 0.40 Tk./kg	