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Fertilizer Recommendation for Potato-Boro-T.Aman Cropping Pattern in Old Himalayan Piedmont Plain Soils of North-West Bangladesh

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Abstract: Field experiments were carried out with Potato-Boro-T. aman cropping pattern at Birgonj, Dinajpur and Debigonj, Panchagarh during the consecutive years of 2011-12 to 2012-13 in the Old Himalayan Piedmont Plain Soils under agroecological zone (AEZ) 1 of North-West Bangladesh. The experiments were designed with eight treatments and laid out in randomized complete block design (RCBD) with three replications. The treatment combinations were: T_1 (100%STB), T_2 (T_1 + 25% N), T_3 (T_1 + 25% NP), T_4 (T_1 + 25% NK), T_5 (T_1 + 25% PK), T_6 (T_1 + 25% NPK), T_7 (75% of T_1) and T_8 (Control). Results indicated that application of different fertilizers significantly affected the grain yield at all of the locations. The highest yield was found in treatment T_6 (T_1 + 25% NPK). Statistically identical yield was observed in treatments T_3, T_4 and T_5 at Birgonj, Dinajpur and T_3 at Debigonj, Panchagar. All the treatment combinations gave significantly higher grain yield over the control at both of the locations. The highest straw yield was found in treatment T_6 (T_1 + 25% NPK). Statistically identical straw yield was found in T_3 and T_4 at Birgonj, Dinajpur and T_1, T_4 and T_5 at Debigonj, Panchagarh. Significantly the lowest yield was obtained in control treatment (T_8) in both of the locations. The highest total N uptake was observed in treatment T_6 and a similar trend of total N uptake was observed for P uptake in both the locations. Treatment T_6 showed the highest uptake of total K. The highest uptake of total S was observed in treatment T_6 at Birgonj, Dinajpur and T_3 at Debigonj, Panchagarh. However, the lowest total N, P, K and S uptake was observed in control treatment (T_8) at both of the locations. The partial economic analysis showed the highest MBCR of 4.57 in T_3 at Birgonj, Dinajpur and 4.75 in T_6 treatments at Debigonj, Panchagarh respectively. Fertilizer doses recommended for Potato-Boro-T.aman pattern were $N_{169}P_{31}K_{135}S_{12}Zn_2B_1$ - $N_{175}P_{10}K_{75}S_{10}Zn_1B_{0.5}$ - $N_{80}P_{7.5}K_{32}S_8$ at Birgonj, Dinajpur and $N_{188}P_{23}K_{169}S_8Zn_2B_1$ - $N_{188}P_{10}K_{94}S_8Zn_1B_{0.5}$ - $N_{84}P_{7.5}K_{40}S_6$ at Debigonj, Panchagarh.

Key words: Fertilizer, Potato-Boro-T. aman pattern, Nutrient balance

Introduction

Over few decades, population has excreted enormous pressure on the land resource base in Bangladesh for deriving necessary food, fibre and fuel. Crop intensification in agricultural land has increased remarkably along with increased irrigation replacing the traditional systems. Ali *et al*. (1997a-b) reported that the soils in Bangladesh are depleted with many of the essential nutrients, particularly because of intensive cropping along with HYV of crops having almost no return from organic recycling. It inflicted serious injury to the land qualities due to nonjudicious extraction of plant nutrients by growing crops without proper replenishment (Saheed, 1991). As a consequence of irrational land use, depletion of soil organic matter and deficiency/imbalance in plant nutrient status emerged as major problems. The amount of nutrient taken up by a crop is closely related to the total amount of biomass it produces. In general, higher the yield level higher is the amount of nutrient removed by the crop (Bhuiyan, 1993).

Present decline or stagnation of major crop yield is the cumulative effects of low organic matter content, nutrient depletion, imbalanced fertilization and poor management practices of agriculture in Bangladesh (Mia, 1994). Karim (1995) emphasized that everybody should be aware of the phenomenon of nutrient depletion/mining from the soils. Nutrient mining is one of the major causes for stagnation or decline in yield of major crops of Bangladesh. If this problem of nutrient depletion is not corrected it will cause a serious damage of the soil and to the welfare of mankind.

Relatively higher amount of fertilizers need to be used in HYV of different crop cultivation. Fageria *et al*. (1991) stated that supplying of mineral nutrients to crops in adequate amounts is one of the most important factors in achieving higher productivity. Fertilizer has now become a very costly commodity of agriculture in Bangladesh. A huge amount of foreign currency is needed to import different fertilizers in the country. It is, therefore, urgently needed to develop fertilizer management packages in such a way that it suited farmers' resource constraints for ensuring the high use efficiency of fertilizers. Abedin and Mukhopadhya (1990) reported that cropping system approach is essential for tapping up the residual effect of fertilizer nutrients to rationalize their use. Information based on soils, crops and cropping pattern, BARC prepared

Fertilizer Recommendation Guide - 2012 to adopt balanced fertilization for sustaining crop production in the country (FRG, 2012). This national Fertilizer Recommendation Guide need to be further updated and verified for different dominant cropping patterns at different AEZs. Therefore, we attempted to develop fertilizer recommendation for Potato-Boro-T. aman pattern in the Old Himalayan Piedmont Plain Soils under AEZ 1.

Materials and Methods

Description of the experimental sites

Field experiments were carried out with Potato-Boro-T. aman pattern at Birgonj, Dinajpur and Debigonj, Panchagarh during 2011-12 to 2012-13 consecutive years in the Old Himalayan Piedmont Plain Soils (AEZ 1). The climatic condition of the experimental area is sub-tropical monsoon as prevailed in the other portion of the country. The lands of the experimental areas were medium lowlands to highlands with medium to good drainage conditions. Potato-Boro- T.aman is a dominant cropping pattern although some other patterns such as Mustard-Maize-T.aman, Potato-Maize-T.aman, Wheat-Jute- T.aman, Potato-Groundnut- T.aman and Boro-Fallow- T.aman were also observed in the study areas.

Collection and analysis of initial soil samples

Initial soil samples were collected from the different experimental sites. After collecting soil sample, the unwanted materials like gravels, plant roots, leaves etc., were picked up and removed. Then the samples were air dried, well mixed and ground to pass through a 20 mesh sieve and stored in clean plastic bags for physical and chemical analysis. Soil samples were analyzed following standard methods Ali et al. (2013). The soils of the experimental plots were sandy loam in texture and moderately acidic in nature. The organic matter and total nitrogen contents varied from 1.20 to 1.74% and 0.060 to 0.087%, respectively. Available phosphorus and sulphur contents varied from 16.6 to 25.5 mg kg^{-1} and 12.0 to 21.9 mg kg^{-1} respectively. Exchangeable potassium content was 0.09 cmol kg^{-1} in both of the locations.

Collection and analysis of grain and straw samples

Grain and straw samples were collected during harvesting period. Grain and straw 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. The grain and straw samples were analyzed for the determination of N, P, K and S contents following the procedures as reported by Ali *et al*. (2013).

Details of the field experimentation

The land was well prepared before transplantation. After uniformly leveling, the experimental plots were laid out in randomized complete block design (RCBD) with three replications. The unit plots area was 5mx4m. Eight treatment combinations of fertilizers were used in the experiments. The treatment combinations were: T_1 (100%STB), T_2 (T_1 + 25% N), T_3 (T_1 + 25% NP), T_4 (T_1 + 25% NK), T_5 (T_1 + 25% PK), T_6 (T_1 + 25% NPK), T_7 (75% of T_1) and T_8 (Control). The sources of N, P, K, S and Zn were urea, TSP, MoP, gypsum and zinc oxide, respectively. Three healthy seedlings of Binadhan-7 rice of 25-30 days old were transplanted per hill in the plots. Fertilizers were applied to each plot as per treatment. The full dose of all fertilizers except urea was applied as basal to each individual plots during final land preparation. The fertilizers were incorporated into the soils. The first split (1/3) of N was applied within 10 days after transplanting. The second split (1/3) of N was applied at maximum vegetative growth stage and incorporated with the soil. The third split (1/3) of N was applied at or before P.I. stages. Pest control and other intercultural practices like irrigation, etc. were given as and when necessary. Data on yield and yield contributing characters of different crops of the cropping pattern were recorded and statistically analyzed.

Statistical analysis

The recorded data were compiled and tabulated properly. The recorded data were statistically analyzed to find out the significance of variance resulting from the experimental treatments on various plant characters. Analysis of Variance (ANOVA) was done following RCBD with the help of a computer package program MSTAT and mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and discussion

Potato

The tuber yield of potato at three different locations during Rabi season of 2011-12 and 2012-13 are shown in Table 1a to Table 1b. In 2011-12, the highest tuber yield of potato was obtained in treatment T_6 (T_1 + 25% NPK) at Debigonj, Panchagarh; which was statistically higher than all other treatments. But at Birgonj, Dinajpur the highest potato yield was recorded in treatment T_4 which was statistically identical with treatments T_2, T_3 and T_6. In 2012-13, the highest tuber yield of potato was also obtained in

treatment T_6 (T_1 + 25% NPK) at Debigonj, Panchagar which was statistically identical with T_4 treatments. At Birgonj, Dinajpur the highest potato yield was recorded in treatment T_5 which was statistically identical with treatment T_3 and T_6. Similar results have also been reported by Ashrafi *et al*. (2013).

Boro rice

Application of fertilizers using different combinations significantly affects the grain and straw yield of boro rice at different locations (Table 1a to Table 1b). In 2011-12, the highest grain yield was observed in different treatments at different locations that are in T_3 at Debigonj, Panchagarh and T_6 at Birgonj, Dinajpur. Straw yield was found highest in T_4 at Birgonj, Dinajpur and T_6 at Debigonj, Panchagarh. In 2012-13, the highest grain yield was observed in T_6 at both of the locations and the treatment T_6 is statistically identical with T_3 and T_4 at Birgonj, Dinajpur. Straw yield was found highest in T_4 at Birgonj, Dinajpur and T_6 at Debigonj, Panchagarh. In all cases, the lowest yields (grain and straw) were recorded in the control treatment (T_8). Similar results have been observed in Islam et al. (2006).

ransplanted aman rice

Results indicate that application of fertilizers at different proportion significantly affected both the grain and straw yields of T. aman rice (Table 1a to Table 1b). In 2012, the highest grain yield was found in treatment T_6 (T_1 + 25% NPK). Statistically identical grain yield was observed in treatments T_3 at Birgonj, Dinajpur. In case of straw, the highest yield was found in T_4 at Debigonj, Panchagarh and T_4 at Birgonj, Dinajpur. Statistically identical yield was found in T_1 and T_3 at Birgonj, Dinajpur; and T_6 at Debigonj, Panchagar. In 2013, the highest grain yield was found in treatment T_6 (T_1 + 25% NPK) at Debigonj, Panchagar and in T_3 (T_1 + 25% NP) at Birgonj, Dinajpur. Statistically identical yield was observed in treatments T_2, T_4, T_5 and T_6 at Birgonj, Dinajpur and T_2, T_3, T_4 and T_5 at Debigonj, Panchagarh. In case of straw, the highest yield was found in treatment T_6 (T_1+25% NPK). Statistically identical yield was found in T_2, T_3, T_4 and T_5 at Birgonj, Dinajpur and T_1, T_2, T_3, T_4 and T_5 at Debigonj, Panchagarh. Significantly the lowest yield was obtained in the control plot (T_8) in all the above cases. Ali et al. (2013) reported almost similar results for T.aman rice cultivation in the same areas.

Table 1a. Effects of fertilizers on the yield (t ha^{-1}) of Potato in Potato-Boro-T. aman pattern during 2011-12 and 2012-13 at Birgonj, Dinajpur

Treatments	2011-12					2012-13				
	Potato	Boro		T. aman		Potato	Boro		T. aman	
	Tuber	Grain	Straw	Grain	Straw	Tuber	Grain	Straw	Grain	Straw
T_1=100%(STB)	27.71c	5.59de	6.87d	4.79b	6.13ab	24.80c	5.30cd	6.40c	4.75b	5.65bc
T_2 =T_1+ 25% N	29.65ab	5.77cd	8.77ab	4.75b	5.76b	27.34b	5.90b	6.50c	5.10ab	6.20ab
T_3 =T_1 +25% NP	30.00ab	5.95c	7.50cd	5.05ab	6.02ab	27.86ab	6.05ab	6.80b	5.56a	7.06a
T_4 =T_1+25% NK	30.20a	5.39e	9.15a	4.73b	7.08a	27.16b	6.03ab	7.20a	5.15ab	6.67a
T_5 =T_1 +25% PK	28.68bc	6.57b	7.50cd	4.10c	4.46c	29.58a	5.53c	5.70d	5.20ab	6.73a
T_6 =T_1+25%NPK	29.24ab	6.95a	7.75bcd	5.47a	5.83b	28.71ab	6.40a	7.10a	5.50a	7.15a
T_7 =75% of T_1	24.46d	5.03f	8.39abc	3.63c	3.22d	20.33d	5.13d	5.40e	3.65c	5.00c
T_8= Control	14.29e	2.65g	3.77e	2.23d	2.10e	18.28e	2.70e	3.00f	2.51d	3.71d
CV (%)	2.62	2.14	7.88	7.92	7.93	4.43	3.91	1.71	6.04	8.39

STB: Potato (Granula) = $N_{135}P_{25}K_{135}S_{12}Zn_2B_1$**;** Boro (BRRIdhan-28) = $N_{140}P_{08}K_{75}S_{10}Zn_1B_{0.5}$ and T. aman (Binadhan-7) = $N_{64}P_6K_{32}S_8$

Table 1b. Effects of fertilizers on the yield (t ha^{-1}) of crops in Potato-Boro-T. aman pattern at Debigonj, Panchagarh

Treatments	2011-12					2012-13				
	Potato	Boro		T. aman		Potato	Boro		T. aman	
	Tuber	Grain	Straw	Grain	Straw	Tuber	Grain	Straw	Grain	Straw
T_1=100%(STB)	14.70d	5.90b	7.27b	4.20b	5.16c	20.64c	5.30d	6.03cd	4.10b	4.55ab
T_2 =T_1+ 25% N	18.68c	6.37ab	8.32ab	4.15b	5.55bc	20.92c	5.80c	7.10ab	4.27ab	4.64ab
T_3 =T_1 +25% NP	18.68c	7.00a	8.77ab	4.20b	5.40bc	21.31c	6.27b	7.00abc	4.38ab	4.81ab
T_4 =T_1+25% NK	17.76c	6.37ab	8.55ab	4.18b	6.98a	24.99a	5.73c	6.50bcd	4.20ab	4.94ab
T_5 =T_1 +25% PK	20.17b	6.37ab	7.50b	4.20b	5.89bc	23.83b	5.97c	6.95abc	4.18ab	4.78ab
T_6 =T_1+25%NPK	21.91a	6.87a	9.37a	4.58a	6.21ab	25.65a	6.60a	7.40a	4.75a	5.24a
T_7 =75% of T_1	12.45e	4.25c	4.80c	4.15b	5.06c	17.54d	4.90e	5.70d	3.85b	4.58b
T_8= Control	09.46f	2.00d	3.72c	2.47c	3.31d	9.49e	2.55f	3.20e	2.28c	3.44c
CV (%)	3.27	8.14	10.06	4.70	8.44	2.83	2.59	9.76	7.89	8.25

STB: Potato (Cardinal) = $N_{150}P_{18}K_{135}S_8Zn_2B_1$**;** Boro (BRRIdhan-28) = $N_{150}P_{08}K_{75}S_8Zn_1B_{0.5}$ and T. aman (Binadhan-7) = $N_{67}P_6K_{32}S_6$

Average yield (t ha^{-1}) of crops and fertilizer use economy in Potato-Boro-T. aman pattern

Average yield (tha^{-1}) of crops and results of partial budget analysis of Potato-Boro-T. aman pattern are shown in Table 2a to Table 2b. Results of partial budget analysis demonstrated the highest net benefit of Tkha^{-1} 4,42,632 in T_6 followed by Tkha^{-1} 4,31,752 and Tkha^{-1} 4,24,717 in T_3 and T_5 treatments at Birgonj, Dinajpur (Table 2a). The highest net benefit of Tkha^{-1} 3,79,267 was obtained in T_6 followed by Tkha^{-1} 3,48,382 and Tkha^{-1} 3,38,367 in T_5 and T_4 treatments at Debigonj, Panchagarh (Table 2b). The highest MBCR of 4.57 and 4.75 was obtained in T_3 at Birgonj, Dinajpur and T_6 treatment at Debigonj. Based on the most profitable treatment, the following doses of fertilizers are recommended for Potato-Boro-T.aman cropping pattern: $N_{169}P_{31}K_{135}S_{12}Zn_2B_1$ - $N_{175}P_{10}K_{75}S_{10}Zn_1B_{0.5}$ - $N_{80}P_{7.5}K_{32}S_8$ at Birgonj, Dinajpur and $N_{188}P_{23}K_{169}S_8Zn_2B_1$ - $N_{188}P_{10}K_{94}S_8Zn_1B_{0.5}$ - $N_{84}P_{7.5}K_{40}S_6$ at Debigonj, Panchagarh. Islam et al. (2006) reported almost similar trend of results for development of fertilizer recommendation for Potato-Boro-T.aman cropping pattern in the Tista Meander Floodplain Soils (AEZ 3) and Old Brahmaputra Floodplain Soils (AEZ 9).

Table 2a. Effects of fertilizers on the average yield (t ha^{-1}) of crops and fertilizer use economy in Potato-Boro-T. aman pattern at Birgonj, Dinajpur

Treatments	Average (2011-12 & 2012-13)					Gross return	Fert. cost	Net return	Marginal return	MBCR
	Potato Tuber	Boro		T. aman		Tk. ha^{-1}				
		Grain	Straw	Grain	Straw					
T_1=100%(STB)	26.26	5.44	6.09	4.77	5.89	4,27,730	35,563	3,92,167	147217	4.14
T_2 =T_1 + 25% N	28.5	5.84	7.63	4.93	5.98	4,62,160	39,388	4,22,772	177822	4.51
T_3 =T_1 + 25% NP	28.93	6.00	7.15	5.31	6.54	4,72,640	40,888	4,31,752	186802	4.57
T_4 =T_1 + 25% NK	28.68	5.71	8.18	4.94	6.88	4,61,610	42,438	4,19,172	174,222	4.11
T_5 =T_1 + 25% PK	29.13	6.05	7.43	4.65	5.60	4,64,830	40,113	4,24,717	179767	4.48
T_6 =T_1+25%NPK	28.96	6.68	7.43	5.49	6.49	4,86,070	43,438	4,42,632	197,682	4.55
T_7 = 5% of T_1	22.39	5.08	6.89	3.64	4.11	3,65,700	27,238	3,38,462	93512	3.43
T_8 = Control	16.29	2.68	3.39	2.37	2.91	2,44,950	-	2,44,950	-	-

Grain = 15 Tk. kg^{-1}; Straw = 1 Tk. kg^{-1}; Potato=10 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.

Table 2b. Effects of fertilizers on the average yield (t ha^{-1}) of crops and fertilizer use economy in Potato-Boro-T. aman pattern at Debigonj, Panchagarh

Treatments	Average (2011-12 & 2012-13)					Gross return	Fert. cost	Net return	Marginal return	MBCR
	Potato Tuber	Boro		T. aman		Tk. ha^{-1}				
		Grain	Straw	Grain	Straw					
T_1=100%(STB)	17.67	5.6	6.65	4.15	4.86	3,34,455	35,335	2,99,120	1,27,660	3.61
T_2 = T_1 + 25% N	19.80	6.09	7.71	4.21	5.09	3,65,305	39,473	3,25,970	1,54,510	3.91
T_3=T_1 + 25% NP	19.99	6.64	7.89	4.29	5.11	3,76,845	40,673	3,36,172	1,64,712	4.05
T_4=T_1 + 25%NK	21.38	6.05	7.53	4.19	5.96	3,80,890	42,523	3,38,367	1,66,907	3.93
T_5=T_1 + 25%PK	22.00	6.17	7.23	4.19	5.34	3,87,965	39,583	3,48,382	1,76,922	4.47
T_6=T_1+25%NPK	23.78	6.74	8.39	4.67	5.73	4,22,990	43,723	3,79,267	2,07,807	4.75
T_7 = 75% of T_1	14.99	4.58	5.25	4.00	4.83	2,88,678	26,993	2,61,685	90,225	3.34
T_8 = Control	9.48	2.28	3.46	2.38	3.38	1,71,460	-	1,71,460	-	-

Grain = 15 Tk. kg^{-1}; Straw = 1 Tk. kg^{-1}; Potato=10 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.

Nutrient balance in soil

Nutrient uptake by Potato-Boro-T. aman cropping pattern at different locations was influenced due to different treatments (Table 3a and Table 3b). The highest N, P and K uptake was observed in treatment T_6 at Birgonj, Dinajpur. Treatment T_6 also produced the highest N, K and S uptake at Debigonj, Panchagarh. The highest S uptake in treatment T_5 at Birgonj, Dinajpur and P uptake in T_3 at Debigonj, Panchagarh was recorded. From Table 3a and Table 3b, there observed negative balance of nutrients (N, P, K and S) in both the locations after two years cropping in the Old Himalayan Piedmont Plain Soils (AEZ 1) of this study. The negative balance of nutrients were 202 – 346 kg N, 17 – 32 kg P, 204 – 349 kg K and 2 – 21 kg S per hectare at Birgonj, Dinajpur but were 146 – 275 kg N, 17 – 24 kg P, 118 – 171 kg K and 7 – 24 kg S per hectare at Debigonj, Panchagarh. Similar trends of nutrient balance for Potato-Boro-T. aman cropping pattern in the Tista Meander Floodplain Soils (AEZ 3) and Old Brahmaputra Floodplain Soils (AEZ 9) were also reported by Islam et al. (2006).

Table 3a. Fertilization effects on nutrient balance (kg ha^{-1}) due to Potato-Boro-T. aman cropping in soil at Birgonj, Dinajpur

Nutrient added				Nutrient uptake				Nutrient balance			
N *	P	K	S	N	P	K	S	N	P	K	S
339	39	242	30	426	61	474	39	-290	-22	-232	-9
424	39	242	30	439	67	591	44	-269	-28	-349	-14
424	49	242	30	436	78	517	49	-266	-29	-275	-19
424	39	303	30	492	71	521	50	-322	-32	-218	-20
339	49	303	30	482	78	533	51	-346	-29	-230	-21
424	49	303	30	505	80	616	46	-335	-31	-313	-16
254	29	182	30	304	46	386	32	-202	-17	-204	-2
0	0	0	0	226	31	258	21	-226	-31	-258	-21

*** Assume 40% nitrogen use efficiency**

Table 3b. Fertilization effects on nutrient balance (kg ha^{-1}) due to Potato-Boro-T. aman cropping in soil at Debigonj, Panchagarh

Nutrient added				Nutrient uptake				Nutrient balance			
N *	P	K	S	N	P	K	S	N	P	K	S
367	32	242	22	363	49	399	34	-216	-17	-157	-12
459	32	242	22	405	53	413	34	-221	-21	-171	-12
459	40	242	22	414	64	400	41	-230	-24	-158	-19
459	32	303	22	378	56	452	40	-194	-24	-149	-18
367	40	303	22	383	58	421	37	-236	-18	-118	-15
459	40	303	22	459	63	474	46	-275	-23	-171	-24
275	24	181	22	319	42	343	29	-209	-18	-162	-7
0	0	0	0	146	21	193	13	-146	-21	-193	-13

*** Assume 40% nitrogen use efficiency**

Conclusion

The highest yield, nutrient uptake and net benefit found in treatment T_6 (T_1 + 25% NPK) both at Birgonj, Dinajpur and Debigonj, Panchagarh. From T_6 treatment, doses of fertilizer nutrients $N_{169}P_{31}K_{135}S_{12}Zn_2B_1$ - $N_{175}P_{10}K_{75}S_{10}Zn_1B_{0.5}$ - $N_{80}P_{7.5}K_{32}S_8$ at Birgonj, Dinajpur and $N_{188}P_{23}K_{169}S_8Zn_2B_1$ - $N_{188}P_{10}K_{94}S_8Zn_1B_{0.5}$ - $N_{84}P_{7.5}K_{40}S_6$ in kg ha^{-1} at Debigonj, Panchagarh were recommended for Potato-Boro-T.aman cropping pattern in the Old Himalayan Piedmont Plain Soils under AEZ 1 of North-West Bangladesh.

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