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DETERMINATION OF NUTRIENTS FOR POTATO -T. AUS -T. AMAN RICE CROPPING PATTERN UNDER SURMA KUSHIARA FLOOD PLAIN IN AEZ-20

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Abstract

The experiment was carried out in the Surma Kushiyara Floodplain soil at the farmer's field of Farming System Research and Development (FSRD) site, Jalalpur, under South Surma Upazilla of Sylhet district in the medium high land under agro-ecological zone (AEZ)-20 for the three consecutive years 2013-2016 to determine economic dose of organic and inorganic fertilizers for Potato-T. aus -T. aman rice cropping pattern. The experiment was composed of four treatments *viz.* T_1: Soil test based (STB) fertilizer dose for high yield goal (HYG), T_2: T_1+ CD 5 t ha^{-1}, T_3: T_1 along with CD 5 t ha^{-1} in IPNS approach and T_4: Farmers practices for potato-T. aus -T. aman rice cropping pattern maintained in a randomized complete block design with six dispersed replications. The varieties for potato, T. aus and T. aman rice were Diamont, BRRI dhan48 and Binadhan-7, respectively. The results showed that the tuber yield of potato, grain yields of T.aus and of T. aman rice were significantly influenced by the different treatments. The increase yield of tuber 6.11t ha^{-1} (33.30 %), grain of T. aus 0.42 (10.24%) and T. aman 0.54 (15.52%) rice was obtained from T_2 over control (T_4) and also higher compared to other treatments. The treatment STB fertilizer for HYG + 5 t ha^{-1} of CD also showed 25.03% higher T. aman rice equivalent yield (22.53 t ha^{-1}) compared to farmers practice (T_4) treatment. The monetary values for the whole cropping pattern showed that the highest benefit cost ratio (2.03), gross return (Tk. 4,61,865 ha^{-1}) and gross margin (Tk.2,33,735 ha^{-1}) were obtained from STB fertilizer for HYG + 5 t ha^{-1} of CD. The treatment IPNS based on fertilizer management with cowdung for HYG had no significant effect on the yield of first and succeeding crops. So, considering crop productivity and economic return, soil test based fertilizer for high yield goal with 5 t ha^{-1} cowdung could be recommended for the Potato - T. aus - T. aman rice cropping pattern for AEZ-20 of Sylhet region.

Introduction

Fertilizer is one of the most important factors to increase the productivity of crops (Anon., 1997). In Bangladesh, fertilizers are generally recommended for each crop without considering the residual effect of fertilizers applied to the previous crops. Nitrogenous fertilizers have very little residual effect on the subsequent crops as it is lost through leaching, volatilization, de-nitrification, etc. But the fertilizers like phosphate, potash, zinc, and sulphur have considerable residual effect on the following crops. Higher cropping intensity, introduction of high yielding crop varieties, improper cropping sequence and faulty management practices led to a sharp depletion of soil fertility. Fallow - T. aus - T. aman rice is one of the dominant cropping

patterns in this region under rainfed condition in medium highland to lowland areas of Surma-Kushyara Floodplain (Kaisar *et al.*, 2007).

Potato is a promising crop, which can be cultivated in fallow land of this area. At present, the potato is being cultivated by farmers and it becoming a commercial crop in this area. To enhance potato production, practice of potato-rice based improved pattern can be an economically viable and improved cropping pattern instead of existing Fallow-T. aus-T. aman rice cropping pattern for utilization of fallow land in Sylhet region (Nazrul *et al.*, 2013). However, this improved pattern has been developed but the farmers are not aware of suitable fertilizer doses for this pattern. The development of appropriate nutrient management technologies for different cropping pattern is the most important and should be the immediate goal of soil fertility research. The present study was undertaken to find out a cropping pattern based fertilizer recommendation and to determine the economically profitable dose of fertilizer for Potato- T. aus-T. aman rice cropping pattern under Surma-Kushyara Floodplain soil.

Materials and Methods

The experiment was carried out in the Surma-Kushiyara Floodplain soil at the farmer's field of Farming System Research and Development (FSRD) site, Jalalpur, under South Surma Upazilla of Sylhet district in the medium high land under AEZ-20 for the three consecutive years 2013-2016 to determine economic combined dose of organic and inorganic fertilizers for Potato-T. aus -T. aman cropping pattern. The varieties for potato, T. aus and T. aman rice were Diamont, BRRI dhan48, and Binadhan-7, respectively. The fertilizer treatments used in the experiment was based on Fertilizer Recommendation Guide (FRG, 2012). Soil samples were collected from farmers' field and analyzed at SRDI laboratory, Sylhet for chemical analysis. The chemical properties of the soil are presented in Table 1. Four different fertilizer packages viz. T_1: Soil test based (STB) fertilizer dose for high yield goal (HYG), T_2: T_1+ CD 5 t ha^{-1}, T_3: T_1 along with CD 5 t ha^{-1} in IPNS approach and T_4: Farmers practices (average of 25 farmer's data) were tested. In all the crops N, P, K, S, and Zn were applied through urea, triple super phosphate, murite of potash, gypsum, and zinc sulphate, respectively.

The experiment was laid out in a randomized complete block design with six dispersed replications. The unit plot size was 10 m 4 m for the whole cropping pattern. On basis of soil analysis, fertilizer doses were estimated with the help of soil analysis value as per treatment. The estimated fertilizer doses for Potato, T. aus and T. aman rice were presented in the Table 2. Almost all the nutrients were low to very low except Zinc (medium) and Boron (low).

Table 1. Soil analysis values of different samples collected from farmers fields

Replications	pH	OM	Total	K	P	S	Zn	B
		(%)	N (%)	meq/100g soil		Micro gram/g soil		
1	5.40	1.56	0.07	0.11	2.46	10.80	1.24	0.33
2	4.50	1.07	0.05	0.12	12.53	12.31	1.11	0.51
3	5.53	0.98	0.06	0.16	11.32	8.31	1.00	0.56
4	5.51	1.26	0.06	0.11	11.99	8.31	1.15	0.54
5	4.70	1.21	0.07	0.14	9.87	11.52	1.08	0.62
6	5.48	1.27	0.06	0.13	8.59	9.14	1.22	0.48
Average	-	1.23	0.06	0.13	9.46	10.07	1.13	0.51
	SA	L	VL	L	L	L	M	OP

SA: Strongly acidic, L: Low, VL: Very low, OP: Optimum, M: Medium

Table 2. Treatment-wise fertilizer doses for crops under Potato - T. aus - T. aman rice cropping pattern at FSRD site, Jalalpur, Sylhet

Treatments	Potato						T. aus				T. aman			
	N	P	K	S	Zn	CD	N	P	K	S	N	P	K	S
	Kg ha^{-1}													
T_1: STB Fertilizer for HYG	151	29	66	14	0.5	0	76	11	27	7	91	11	36	9
T_2: T_1+CD 5tha^{-1}	151	29	66	14	0.5	5000	76	11	27	7	91	11	36	9
T_3: $T_1$with 5tha^{-1} CD in IPNS	126	22	55	14	0.5	5000	76	11	27	7	91	11	36	9
T_4: Farmers practice (FP)	180	50	70	25	2.0	0	110	20	40	15	60	15	30	0

Note: CD: Cowdung, HYG: High yield goal, IPNS: Integrated nutrient system. Farmers practices (FP) as control.

The potato (*Solanum tuberosum* L.) tubers were sown from 20-25 November in three consecutive years. Seeds (Tubers) were sown at the rate of 1.5 t ha^{-1} and spacing was 60 cm *x* 25 cm. Entire amount of cowdung, TSP, MoP, gypsum, and zinc sulphate and one half amount of urea was applied at final land preparation and remaining one-half urea was top dressed at 30-35 days after seeding (DAS) before earthing up. Two irrigations were done at 20-25 and 45-50 DAS. The fungicides, Indofil and Secure were applied at 35 and 45 DAS, respectively for late blight control. The tuber of potato was harvested from 25-27 February in three consecutive years.

After potato harvest, the second crop T. aus rice *(Oryza sativa)* was transplanted on the same plot from 15-20 April. Twenty-five-days old seedlings were used with spacing was 20 cm x 15 cm. Half of N, the full dose of other fertilizers were applied during final land preparation. The rest of N-fertilizer was top dressed at 35 days after transplanting (DAT). Once weeding was done at 30 DAT. The insecticide Dursban 20 EC was applied for rice bug control. The crop was harvested from 25-28 July at full maturity. Third crop T. aman rice was transplanted from 25-30 July. Twenty days old seedlings were used with spacing was 20 cm × 15 cm. Except N-fertilizer the full dose of other fertilizers were applied during final land preparation. N-fertilizer was top dressed in two equal splits at 30 and 45 DAT. Dimecron insecticide was applied for controlling rice stem borer. The crop was harvested from 05-10 November at full maturity. Data on tuber of potato and grain yield rice were recorded from 6m^2 area. Collected data were analyzed statistically and the means were separated by LSD at 5% level (Gomez and Gomez, 1984). The cost and return analysis were done considering the prices of nutrients, products and additional costs only following the method suggested by Perrin *et al.* (1979).

Results and Discussion

Tuber yield of potato

Tuber yield of potato responded significantly to different fertilizer treatment packages (Table 3). On an average, tuber yield of potato ranged from 18.35 to 24.46 t ha^{-1}. The highest tuber yield (24.46 t ha^{-1}), was obtained in T_2 and significantly higher than all other treatments. The lowest tuber yield (18.35 t ha^{-1}) was recorded in FP as control (T_4) treatment.

The increase yield of tuber 6.11t ha^{-1} (33.30 % increases) was obtained from T_2 over control (T_4), which was also higher compared to other treatments. On the contrary, the treatment packages incorporated with cowdung (T_2 and T_3) performed better and provided higher yield of potato tuber compared to other treatments. It might be the beneficial effects of cowdung as organic matter which improves microclimates of underground soil, increase water holding capacity and other micronutrients availability. The results are corroborated with the findings of Ahmed *et al.,* (2012) reported that the tuber yield and yield attributes of potato were increased with the increasing of cowdung up to 15 t ha^{-1} thereafter declined. Organic manures viz., cowdug helps to improve soil texture, structure, soil aeration and water holding capacity. It also supplies different plant nutrient elements especially Zn, B, S and Mg, which is not only increase the yield but also improve the qualities like size, dry matter and nutrient content of potato (Taya *et al.,* 1994).

Grain yield performance of Transplanted aus (T. aus) rice

There was a significant and positive effect of different treatments of fertilizers packages on grain yield of T. aus rice (Table 4) over three consecutive years. The highest grain yield (4.52 t ha^{-1}) was recorded in T_2 (T_1 + CD 5 t ha^{-1}), which was statistically different from all other treatments. The lowest grain yield (4.10 t ha^{-1}) was recorded in control (T_4) treatment, which was also significantly different with all other treatments. The grain yield was 0.42 t ha^{-1} i.e., 10.24 % increase in T_2 treatment over farmers practices (T_4). It also appeared that the treatment T_2 which contained higher amount of fertilizer nutrients gave higher yield compared to others treatments including FP. It might be due to residual effect of chemical fertilizers and cowdung applied to the previous crop (potato). It revealed that application of cowdung has little effect on the yield of first succeeding crops. The average grain yield of rice varied from 4.10 to 4.52 t ha^{-1} in the experimentation.

Grain yield performance of Transplanted aman (T. aman) rice

The grain yield of T. aman rice was significantly affected due to the different treatments (Table 5). The grain yield varied from 3.48 to 4.02 t ha^{-1} (Table 5). On an average the highest grain yield (4.02 t ha^{-1}) was recorded from T_2 (STB fertilizer dose for HYG + CD 5 t ha^{-1}) which was significantly different with all other treatments. The lowest grain yield (3.48 t ha^{-1}) was observed in (T_4) as control. The results indicated that STB fertilizer dose for HYG + 5 t ha^{-1} of CD (T_2) gave higher grain yield (0.54 t ha^{-1}) of T. aman rice, which was 15.52 % increased over FP. Jha *et al.* (2004) also reported that chemical fertilizers + CD produced significantly higher grain yield compared with the application of inorganic fertilizer alone.

Rice equivalent yield

As comparing the treatments effect, yields of potato tuber and T. aus rice was converted into T. aman rice equivalent yield on the basis of prevailing market price of individual crops. The highest rice equivalent yield was recorded from STB fertilizer dose for HYG + CD 5 t ha^{-1} (T_2) due to the highest yield of potato, T. aus and T. aman rice crops. The treatment comprises of T_1 and T_1 with 5 tha^{-1} CD in IPNS treatments failed to show higher rice equivalent yield than STB fertilizer dose for HYG + CD 5 t ha^{-1} (T_2). Farmer's practice showed lowest rice equivalent yield due to lower yields of all three crops (Table 6). The highest percent of REY (25.03 %) was obtained from T_2 (T_1+ CD 5 t ha^{-1}) over farmers practices (T_4) treatment.

Agro-economic performance

Cost and return analysis of different treatments on Potato - T. aus - T. aman rice cropping patterns during 2013-16 have been presented in Table 7.

Table 3. Effects of different treatments on the tuber yields of potato under Potato – T. aus -T. aman rice cropping pattern at FRD site, Jalalpur, during 2013-16.

Treatments	Tuber yield (t ha^{-1}) of potato				Yield increase over FP	
	2013-14	2014-15	2015-16	Pooled	(t ha^{-1})	(%)
T_1: STB Fertilizer for HYG	22.13	18.42	20.11	20.22	1.87	10.19
T_2: T_1+CD 5tha^{-1}	25.79	24.10	23.49	24.46	6.11	33.30
T_3: T_1 with 5tha^{-1} CD in IPNS	23.52	20.58	20.90	21.67	3.32	18.09
T_4: Farmers practice (FP)	19.34	17.25	18.47	18.35	-	-
LSD $_{(0.05)}$	1.64	1.77	1.28	1.56	-	-
CV (%)	3.62	4.40	3.09	3.70	-	-

Table 4. Effects of different treatments on the grain yields of T. aus rice under Potato-T. aus-T. aman rice cropping pattern at FRD site, Jalalpur, during 2013-16

Treatments	Grain yield (t ha^{-1}) of T. aus rice				Yield increase over FP	
	2013-14	2014-15	2015-16	Pooled	(t ha^{-1})	(%)
T_1: STB Fertilizer for HYG	4.61	4.18	4.01	4.27	0.17	4.15
T_2: T_1+CD 5tha^{-1}	4.85	4.43	4.27	4.52	0.42	10.24
T_3: T_1 with 5tha^{-1} CD in IPNS	4.96	4.04	3.93	4.31	0.21	5.12
T_4: Farmers practice	4.61	3.98	3.72	4.10	-	-
LSD $_{(0.05)}$	0.36	0.15	0.16	0.22	-	-
CV (%)	4.67	1.81	2.57	3.02	-	-

Table 5. Effects of different treatments on the grain yields of T. aman rice under Potato-T. aus-T. aman rice cropping pattern at FRD site, Jalalpur, during 2013-16

Treatments	Grain yield (t ha^{-1}) of T. aman rice				Yield increase over FP	
	2013-14	2014-15	2015-16	Pooled	(t ha-1)	(%)
T_1: STB Fertilizer for HYG	3.55	3.75	3.82	3.71	0.23	6.61
T_2: T_1+CD 5 tha^{-1}	3.85	3.94	4.28	4.02	0.54	15.52
T_3: T_1 with 5tha^{-1} CD in IPNS	3.57	3.91	3.95	3.81	0.33	9.48
T_4: Farmers practice	3.21	3.70	3.53	3.48	-	-
LSD $_{(0.05)}$	0.33	0.14	0.25	0.24	-	-
CV (%)	4.62	1.77	3.28	3.22	-	-

The highest gross return (Tk.4,61,865 ha^{-1}) was obtained from T_2 (T_1 + CD 5tha^{-1}) which was about 10% higher than T_3, 16% than T_1, 25% than farmer's practice. Among the fertilizer treatment, the lowest gross return was recorded from farmer's practice. The highest gross

margin (Tk. 2, 33,735 ha^{-1}) and benefit cost ratio (2.03) was also obtained from T_2 followed by Tk. 1,93,710 ha^{-1} obtained from T_3 (T_1 with 5tha^{-1} CD in IPNS) treatment. The treatment T_4 (FP) produced the lowest gross margin (Tk. 1, 44,173 ha^{-1}) and BCR (1.64) over control treatment. The treatment T_1 and T_3 failed to show higher benefit than T_2 due to lower yield of all crops.

Table 6. T. aman rice equivalent yield of different treatments under Potato-T. aus-T. aman rice cropping pattern at FRD site, Jalalpur, during 2013-16 (Average).

Treatments	Rice Equivalent Yield (t ha^{-1})		T. aman yield (t ha^{-1})	Total T. aman REY (t ha^{-1})	% increase REY over FP
	Potato	T. aus			
T_1: STB Fertilizer for HYG	11.83	3.83	3.71	19.37	7.49
T_2: T_1+CD 5tha^{-1}	14.32	4.19	4.02	22.53	25.03
T_3: $T_1$with 5tha^{-1} CD in IPNS	12.68	3.99	3.81	20.48	13.65
T_4: Farmers practice	10.74	3.80	3.48	18.02	-

Table 7. Cost and return analysis of different fertilizer packages in Potato-T. aus-T. aman rice cropping pattern at FRD site, Jalalpur, during 2013-16.

Treatments	Gross return (Tk. ha^{-1})	Total variable cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})	Benefit cost ratio (BCR)
T_1: STB Fertilizer for HYG	397085	220630	176455	1.79
T_2: T_1+CD 5tha^{-1}	461865	228130	233735	2.03
T_3: $T_1$with 5tha^{-1} CD in IPNS	419840	226130	193710	1.85
T_4: Farmers practice	369410	225237	144173	1.64

Price of inputs (Tk. kg^{-1}): Rice-40.00; potato = 30.00; urea= 16.00; TSP-22.00; MoP = 15.00; Gypsum=10.00; Zinc sulphate = 55.00; Cowdung =1.50.
Ploughing cost = Tk. 10 $decimal^{-1}$; labour cost = Tk. 300 $man^{-1}day^{-1}$.
Price of outputs (Tk. ka^{-1}): Potato = 12.00; T. aus rice = 19.00; T. aman rice=20.50.

Conclusion

From the above study, it may be concluded that the STB fertilizer dose for HYG + CD 5 t ha^{-1} (T_2) was found agronomically viable and economically profitable under Potato-T. aus-T. aman rice cropping pattern at Agro-Ecological Zone -20 of Sylhet region. So, considering crop productivity and economic return; STB fertilizer nutrients for HYG + CD 5 t ha^{-1} (T_2) could be recommended for the Potato - T. aus - T. aman rice cropping pattern under Surma-Kushayara Floodplain soil.

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