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FERTILIZER MANAGEMENT FOR WHEAT CROP IN THE HIMALAYAN PIEDMONT SOIL

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Abstract

An experiment was conducted at the farmers' fields in the Himalayan Piedmont soil to evaluate the soil test based (STB) fertilizer dose on wheat crop practicing in the rice – wheat cropping sequence during the Rabi season 2002-2003. Three fertilizer treatments: (i) no fertilizer (control), (ii) local farmers' fertilizer management practice (FP) and (iii) soil test based fertilizer dose (STB) were tested in 10 farmers' fields. The soils of the test fields were acidic and light textured. Results showed that the control plot produced a mean yield of 1.54 t/ha, which increased to 3.96 t/ha with FP and 4.98 t/ha with STB fertilizer dose. The STB fertilizer dose also increased the nitrogen, P, K and S uptake by wheat. Wheat yield showed a strong linear relationship with N, P, K, and S uptake. Partial factor productivity (PFP) of fertilizer (sum of N, P, K and S) was 25.2 kg/kg in FP and that in STB was 24.6 kg/kg. Slightly lower PFP in STB than that of FP may be attributed to the higher dose of N and K in the former. However, the significant yield increase in STB compared with FP encouraged farmers to practice STB fertilizer application for wheat cultivation.

Keywords: Soil test based fertilizer dose, wheat crop, Himalayan Piedmont soil.

Introduction

The rice-wheat system occupies about 0.80 million ha in Bangladesh. With the introduction of modern varieties of wheat and rice, the application of inorganic fertilizer became inevitable to supplement soil nutrient supply for the high yielding crops. But farmers in Bangladesh apply fertilizer according to their best knowledge of soil fertility in the field. Moreover, cropping intensity has been increased with the increasing irrigation facility and soil became exhausted, as there is not sufficient fallow period to rejuvenate its nutrient supplying capacity. Most soils of Bangladesh have low organic matter content, usually less than 2% (BARC, 1997). After the green revolution and due to intensive cropping, the soil C and N status in Bangladesh has decreased considerably (Ali *et al*., 1997). Soil organic matter in continuous rice-rice system tends to increase (Cassman *et al*. 1995), but degradation of soil organic matter and subsequently reduced nutrient supplying capacity is a great concern particularly in rice- wheat system (Yadav *et al*., 2000).

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Wheat is the second cereal crop in Bangladesh. It is grown in a vast area of northwestern part of Bangladesh. Light textured soils of this area have low exchangeable K and farmers use low amounts of K fertilizer. There are many causes of low K use in farmer's fields, such as the effect of K in vegetative crop growth is not clearly demonstrated, K fertilizers are more costly than urea, and sometimes it is not available in the local market. Intensive cropping and use of modern rice varieties for high yield caused heavy depletion of K and other nutrients in soils, particularly in the absence of K application (Tiwari, 1985). A study on response of wheat to K in Northwestern part of Bangladesh showed that in medium and low K content soils grain yield increased significantly up to 60 kg/ha and 90 kg/ha of the applied K level, respectively (Saha *et al*. 2001). At present, a soil test based fertilizer application method (STB) was suggested (BARC, 1997). Application of fertilizer following STB would benefit the farmers, but demonstrations of the results under farmers' conditions are not frequent. The present investigation was aimed to evaluate the soil test based fertilizer application method on wheat under farmers' field conditions and to introduce this method among the farmers.

Materials and Method

The experiment was conducted in Rabi season of 2002-2003 at ten farmers' fields of different villages under Birganj Upazilla of Dinajpur district, Bangladesh (Table 1). The soil of the experimental field is sandy loam in texture. The soils of the test fields were acidic (pH 4.25 – 4.83), low in organic carbon (0.5 –1.06 %), total N 0.04 – 0.09 %, available P 8 – 20 mg/kg, exchangeable K 0.08 – 0.15 cmol/kg, available S 14 – 34 mg/kg and Zn 2.3 – 4.1 mg/kg (Table 1). Farmers' fertilizer dose for wheat was 80 kg N, 19 kg P, 43 kg K and 15 kg S/ha, respectively. The STB fertilizer dose consisted of 113 – 139 kg N, 7 – 27 kg P, 46 – 81 kg K and 0 – 8 kg S and 0 kg Zn/ha, respectively, depending upon the soil test results (Table 2). Three treatments were tested: (i) No fertilizer (control), (ii) farmers' fertilization practices (FP) and (iii) soil test based chemical fertilizer (STB). There was no replication within the sites.

Wheat was line sown at 15 cm apart from line to line in the 1st week of December 2002. The seed rate was 140 kg/ha. The experiment was laid out in RCB design with 10 replications (considering 10 farmers as replications). The test-cropping pattern was Wheat (Variety- Shotabdi) – Fallow – T. Aman rice (Wet season). Appropriate cultural and management practices including plant protection measures were followed. At maturity straw yields of wheat was recorded from 1 m^2 area and the grain yield was recorded from 5 m^2 area at the centre of each plot and adjusted at 14% moisture content. Initial soil and plant samples were analyzed using standard analytical procedures (Black, 1965; Jackson, 1962; Page *et al.,* 1982 and Yoshida et al, 1972). The obtained data were statistically analyzed using IRRISTAT version 4.1 (IRRI, 1998).

Table 1. Initial soil properties of 10 farmer's field of different villages under Birganj Upazila, Dinajpur, 2002-03.

Farmer's name	Village name	Soil texture	Soil pH	% OC	Total N (%)	Avai. P (mg/ kg)	Exch. K (cmol/ kg)	Avai. S (mg/ kg)	Avai. Zn (mg/ kg)
Md. Mosharaf Hossain	Nokha Para	Sandy Loam	4.50	1.06	0.09	14	0.09	18	4.1
Md. Osman Gani	Bhabki	Sandy Loam	4.54	0.70	0.06	16	0.13	28	3.8
Md. Shabul Islam	Chaulia	Sandy Loam	4.42	1.06	0.09	8	0.10	26	3.4
Md. Rezoanur Rahman	Boalia	Sandy Loam	4.78	0.63	0.05	11	0.09	27	4.1
Sree Rajendra Nath	Damai Ketra	Sandy Loam	4.65	0.79	0.07	18	0.10	14	3.2
Md. Abul Hossain	Jagdal	Sandy Loam	4.83	0.64	0.06	16	0.13	19	2.3
Md. Toshir Uddin	Uttar Paltapur	Sandy Loam	4.25	0.98	0.09	16	0.08	30	2.5
Md. Shofiqul Islam	Dakhin Paltapur	Sandy Loam	4.70	0.50	0.04	14	0.12	32	2.5
Sree Madhab Chandra	Moricha	Sandy Loam	4.80	1.02	0.09	16	0.09	34	2.5
Md. Anisur Rahman	Krishna Nagar	Sandy Loam	4.62	0.95	0.08	20	0.15	22	2.6

Results and Discussion

The control plot yielded from 0.83 to 2.24 t/ha (mean 1.54 t/ha). Farmer's fertilizer dose yielded from 2.29 to 4.79 t/ha (mean 3.96 t/ha) with the application of fertilizer according to their best knowledge of soil fertility management. The wheat yield increased to 4.14 – 5.63 t/ha (mean 4.99 t/ha) receiving STB fertilizer dose. The increase in wheat yield in STB compared to the FP might be attributed to the increased dose of N and K. In some cases the STB dose of P was lower than FP dose, and the STB dose of S was always lower than FP dose. In many cases, no S was required according to STB dose, while most farmers applied 15 kg S/ha. The N dose in FP was 80 kg/ha, but the N dose for STB varied from 113 to 139 kg/ha.

The wheat fields required 7 – 27 kg P/ha, while farmers applied a flat dose of 19 kg P/ha. The P dose in the STB was lower than the FP except in two cases. In case of K, the STB treatment received 46 – 81 kg K/ha compared to the flat dose of 43 kg/ha in the FP. Six farmers' fields out of 10 required no S application according to STB, the rest required 1.5 – 8.0 kg S/ha, while the farmers applied 15 kg S/ha. The STB fertilizer application not only increased wheat yield but saved P and S application in many fields (Table 3).

Table 2. Fertilizer dose (kg/ha) for wheat at 10 farmers' fields of different villages under Birganj upazila, Dinajpur, 2002-03.

SL No	Village name	Treatment	Fertilizer dose (kg/ha)				
			N	P	K	S	Zn
1	Nokha Para	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	113	17	76	6	0
2	Bhabki	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	128	13	56	0	0
3	Chaulia	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	113	27	71	0	0
4	Boalia	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	113	22	76	0	0
5	Damai Ketra	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	123	10	71	8	0
6	Jagdal	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	128	7	56	4	0
7	Uttar Paltapur	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	113	13	81	0	0
8	Dakhin Paltapur	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	139	17	61	0	0
9	Moricha	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	113	7	76	0	0
10	Krishna Nagar	Cont.	0	0	0	0	0
		FP	80	19	43	15	0
		STB	118	7	46	1.5	0

Table 3. Yield and nutrient uptake of wheat in farmers' fields (average of 10 farmers) at Birganj, Dinajpur, 2002-03.

Fertilizer treatment	Yield (t/ha)		Nutrient uptake (kg/ha)			
	Grain± SE	Straw	Nitrogen	Phosphorus	Potassium	Sulfur
Control	1.54 ± 0.15	2.14 ±0.18	31.14 ±2.77	5.46 ± 0.57	22.96 ± 1.90	3.72 ±0.30
FP	3.96 ± 0.26	5.30 ±0.13	86.85±6.91	14.34±1.04	65.24±2.33	10.53±0.48
STB	4.98 ± 0.15	6.15 ±0.14	119.0±5.31	18.01±0.72	94.10±3.45	15.15±0.93
$LSD_{0.05}$	0.56	0.43	15.32	2.34	7.67	1.82

The application of fertilizer increased N, P, K, and S uptake (kg/ha) (Table 3). The N, P, K, and S uptake showed linear relationship with the grain yield of wheat (Fig. 1).

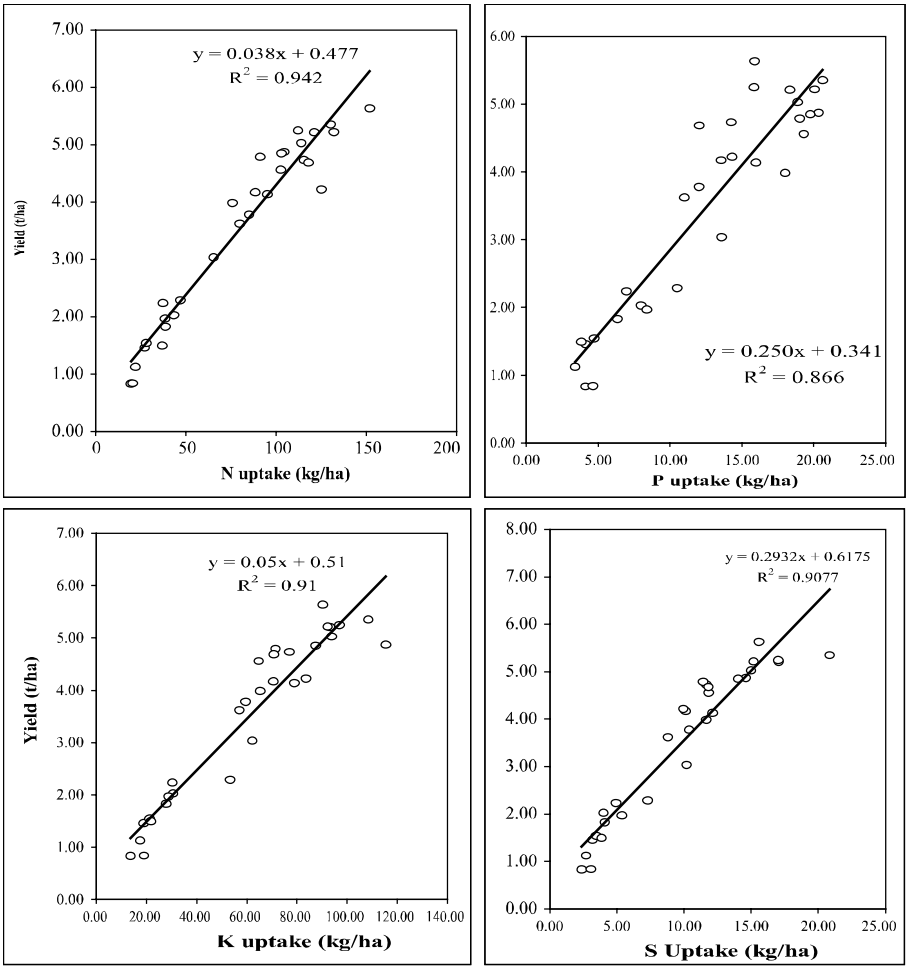

Fig. 1. Relationship between nutrient uptake and grain yield of wheat.

The relationship between N uptake and wheat yield was explained by the linear relationship $Y = 0.477 + 0.038X$ ($R^2 = 0.942$), where Y = grain yield (t/ha) and X is N uptake (kg/ha). The uptake of P and wheat yield was also explained by the linear relationship $Y = 0.341 + 0.250X$ ($R^2 = 0.866$), where Y = grain yield (t/ha) and X is P uptake (kg/ha). Similar trend was also observed in case of K and S uptake and the wheat yield where the linear relationship of K and S was $Y = 0.51 + 0.05X$ ($R^2 = 0.91$) and $Y = 0.6175 + 0.2932X$ ($R^2 = 0.9077$), respectively.

Conclusion

Soil test based fertilizer application increased wheat yield by 25.7% compared to farmers' conventional fertilizer management. The STB fertilizer dose may be applicable to the neighbouring farmers whose farm soils are of similar characteristics.

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