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EFFECT OF LONG-TERM FERTILIZER APPLICATION ON SOIL FERTILITY AND PRODUCTIVITY OF RICE UNDER RICE-WHEAT CROPPING SYSTEM

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Abstract

A field experiment was carried out at CRS Masodha, Faizabad during *kharif* season of 2012-13 to evaluate the long-term effect of NPK fertilizers on productivity of rice and nutrients availability. The results showed that grain yield, yield attributing characters and nutrients uptake increased with the increasing levels of N, P and K (N_{120} P_{80} K_{40}). The minimum values were observed at control (unfertilized), which were at par to nitrogen alone (N_{120}) and N_{120} K_{40} treatment. Nitrogen responded only in presence of phosphorus and vise-versa, while potassium responded along with nitrogen and phosphorus both. The regular application of nitrogen fertilizer (80 and 120 kg/ha) reduced the soil pH but maintain soil available N over a span of 36 years. The regular application of phospatic fertilizer (single super phosphate) @ 80 kg P_2O_5/ha increased soil available P by about 3 fold from its initial level in 36 years. A significant increase in available K was also found by regular application of potassium (40 kg K_2O/ha) over the years. It was concluded that balanced application of N P and K fertilizers is necessary for obtaining higher yields and to maintain soil fertility in long run.

Key words : Long term fertilization, productivity, rice-wheat cropping system and soil fertility.

Introdution

In India, rice-wheat rotation is dominant cropping system across the Indo-Gangetic plains. Approximately 10.5 m ha area under this cropping system contributes 25% of total food grain of country. Indiscriminate use of high analysis chemical fertilizers results in the deficiency of nutrients other than the applied and disturbs the natural equilibrium of nutrient elements in soils (Kumar and Yadav, 2005). The impact of nitrogen in producing cereals is registering a declining tendency due to deficiency of other plant nutrients. Hence, an experiment was carried out to evaluate the long-term influence of chemical fertilizers on nutrients availability and productivity of rice under rice-wheat system.

Materials and Methods

The present study was carried out during *Kharif* 2012-13 in a long-term fertilizer experiment on rice-wheat system which was started in 1977-78 at C.R.S. Masodha, Faizabad at the same site superimposing the same layout. The climate of the experimental site is sub humid subtropical with an average annual rainfall 1100 mm. The soil was classified taxonomically as typical Ustochrept.

The soil was silt loam in texture with pH-7.7, organic carbon 0.45% and available NPK-130, 10 and 113 kg/ha, respectively. Ten fertilizer combinations (Table -2) were evaluated for this study. The N, P and K were applied through urea, single super phosphate and muriate of potash, respectively. Single super phosphate also provided 12percent S in addition to P. In rice, zinc was applied uniformly in all the treatments @ 25kg ZnSo4/ha since 1992 onwards. Each year, rice and wheat crops were raised under irrigated conditions following the recommended agronomic practices.

Results and Discussion

The maximum number of panicles/m^2, number of grains/panicle, test weight and grain yield (Table 1) were recorded in balanced nutrients (N_{120} P_{80} K_{40}) treatment which were significantly higher than to the imbalanced (N_{120}, $N_{120}K_{40}$) or sub optimal (N_{40} P_{40} K_{40}, N_{40} P_{80} K_{40}) treatments. The lowest values of yield attributes and yield were recorded in the control (N_0 P_0 K_0). Application of

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phosphorus along with nitrogen or nitrogen and potassium both significantly increased the yield and yield attributes due to better growth under balanced application of N, P and K fertilizers. The highest grain yield (40.2 q/ha) was also recorded in balanced nutrients treatments (N_{120} P_{80} K_{40}), which was significantly higher to imbalanced (N_{120}, $N_{120}K_{40}$) and sub optimal ($N_{40}P_{40}K_{40}$, $N_{40}P_{80}K_{40}$, $N_{80}P_{40}K_{40}$) treatments. Application of 80 kg P_2O_5/ha over 120kg N and 40kg K_2O/ha increased the yield of rice by 21.3 q/ha while application of 40 kg K_2O/ha increased the grain yield by 3.13 q/ha only over 120 kg N and 80 kg P_2O_5/ha.

The soil analysis data (Table 2) showed that the regular application of 120 kg N/ha/crop through urea resulted significant reduction in soil pH (0.86-0.97 unit) in 36 years of cropping. Intensive and regular use of nitrogen fertilizers reduced the pH of soil (Zejiang*et al*., 2011). In a span of 36 years the soil organic carbon increased by 20-30% in the treatments receiving all the

Table 1 : Effect of different fertilizer treatments on yield and yield attributing characters of rice during 36th cycle of rice-wheat system.

Treatment	Number of panicles /m²	Number of grains/ panicle	1000 grain weight (g)	Grain yield (q/ha)
Control	190	76	20.1	9.53
$N_{40}P_{40}K_{40}$	218	96	22.8	20.47
$N_{40}P_{80}K_{40}$	226	98	22.8	22.95
$N_{80}P_{40}K_{40}$	234	102	22.7	28.57
$N_{80}P_{80}K_{40}$	241	105	23.2	33.43
N_{120}	206	84	21.7	17.80
$N_{120}K_{40}$	212	87	22.0	18.90
$N_{120}P_{40}K_{40}$	238	104	23.1	34.53
$N_{120}P_{80}$	246	108	23.2	37.07
$N_{120}P_{80}K_{40}$	254	110	24.1	40.20
CD (P=0.05)	14.6	8.5	1.94	2.59

Table 2 : Effect of different fertilizer treatments on soil properties after rice during 36th cycle of rice-wheat system.

Treatment	Soil pH (1:2.5)	Organic carbon (%)	Available Nutrients (kg/ha)		
			N	P	K
Control	7.20	0.37	79.4	8.4	93
$N_{40}P_{40}K_{40}$	6.97	0.46	96.4	21.7	167
$N_{40}P_{80}K_{40}$	6.93	0.48	102.8	27.3	159
$N_{80}P_{40}K_{40}$	6.88	0.49	122.6	19.4	172
$N_{80}P_{80}K_{40}$	6.86	0.52	126.0	29.4	154
N_{120}	6.73	0.43	144.3	12.8	96
$N_{120}K_{40}$	6.74	0.41	147.0	12.2	169
$N_{120}P_{40}K_{40}$	6.78	0.54	146.0	20.6	162
$N_{120}P_{80}$	6.82	0.57	151.4	26.7	86
$N_{120}P_{80}K_{40}$	6.84	0.59	149.1	28.1	157
Initial value (1977)	7.70	0.45	130.0	10.0	113
CD (P=0.05%)	0.09	0.03	8.1	3.3	14.1

three nutrients (NPK) continuously while it declined 4-8% in imbalanced treatments (omitting P or P and K both) and 17% in unfertilized (N_o $P_o$$K_o$) treatment as compared with its initial value (0.45%). The increase in organic carbon depends on the annual turn-over of root residues, root exudates and stubbles (Sharma *et al.*, 2003). The regular application of 120 kg N/ha/crop enhanced soil available N by 11-16% from its initial level (130 kg N/ha) over 36 years of cropping. The regular application of phosphatic fertilizer @ 40 and 80 kg P_2O_5/ha/crop raised the available soil P by approximately 2 and 3 fold of its initial level (10 kg P/ha) in a span of 36 years. Kumaraswamy*et al*. (1998) reported that applied P, which is left in soil after harvest can significantly contribute to the pool of available P. The omission of potassic fertilizer depleted soil available K by 15-24% while its regular application @ 40kg K_2O/ha/crop increased soil available K by 36-52% from its initial level (113 kg K/ha) in a span of 36 years. When crops are grown successively without K application, the soil available pool remains constantly under stress. Hence, the flow of K in the dynamic equilibrium system is from non-exchangeable to exchangeable form when the later is exhausted by crops to a certain threshold value (Lall *et al.*, 2007).

The study concludes that nitrogenous fertilizer should not be used without phosphatic and potassicfertilizers over the years. Nitrogen responded only in presence of phosphorus and vise-versa, while potassium responded along with nitrogen and phosphorus both. Avoiding P and K fertilizers for a long period resulted them as limiting nutrients. The balanced and higher doses of N, P and K are required to maintain soil fertility and to sustain grain yield of rice under rice-wheat system.

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