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Response to fertilizer nutrients on cultivators' field in rice-wheat system in Uttarakhand

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Abstract

An "on-farm" experiment was carried out in *Tarai* and *Bhabhar* area of Uttarakhand to study the response to N P K application in rice-wheat cropping sequence for the two consecutive years i.e. 2006-2007 and 2007-2008. Results of the study revealed that recommended dose of NPK resulted in significantly higher grain yield of rice and wheat, thus higher system yield over rest of the treatments. Recommended N, NP and NK were also found superior over the control. The response i.e. kg grain per kg of nutrient applied was higher in case of phosphorus and potassium than in case of nitrogen.

Key words: Response, fertilizer nutrients, wheat, rice.

Introduction

Uttarakhand is a newly created hilly state of India. Besides the hills, some area of the state lies in *Tarai* (low elevation plains near foot hills) and *Bhabhar* (foot of Shiwalik hills dominant with huge deposits of boulders). Majority of the farmers in this state are small (28.7 % having less than 1.0 ha land holding) and marginal (26.2 % having land holding 1-2 ha). So majority of the farmers follow traditional and subsistence farming and have low risk bearing capacity (Anon. 2008). In Uttarakhand 55 % of the cropped area is rainfed. Rice-wheat is the major crop rotation of the state. In this state rice and wheat are grown on 2.73 and 3.91 lakh hectare constituting about 36 and 50 per cent of the total cropped area, respectively with the production of these crops as 5.33 and 8.01 lakh tons, respectively, thus productivity works out to be is 1.95 and 2.05 t/ha (Anon. 2008).

During the year 2006-07, a total of 1.08 lakh tones of nitrogenous, 0.25 lakh tones of phosphoric and 0.09 lakh tones potassic fertilizers were used in the state of Uttarakhand (Anon. 2008). It clearly shows the inadequate and imbalanced fertilizer use, which is the major constraint in achieving the higher production level. Keeping in view the above mentioned facts, studies on response of rice-wheat cropping sequence to N P K application was undertaken under "on-farm" conditions.

Material and Methods

An "on-farm" investigation was carried out in 18 villages of 6 blocks in districts of Pauri and Dehradun namely Pauri, Khirsu, Dugadda in Pauri and Kalsi, Vikasnagar, Doiwala in Dehradun continuously for two years during 2006-07 and 2007-08. Five treatments comprising of control ($N_0P_0K_0$), recommended N ($N_{150}P_0K_0$), recommended N and P ($N_{150}P_{60}K_0$), recommended N and K ($N_{150}P_0K_{40}$) and recommended N, P and K ($N_{150}P_{60}K_{40}$) were evaluated in randomized block design considering every location (18) as a replication. Transplanting of rice was done in second fortnight of July, while sowing of wheat was done in November every year. Recommended package of practices was followed for the rest of the management practices for rice and wheat crops in the sequence.

Composite soil samples from 0 to 15 cm depth from each location were analysed by standard methods before sowing of the crop and after the each cropping sequence to determine the soil status in respect of soil pH, available N, P, K, organic carbon and electrical conductivity. The alluvial soils of the experimental sites were sandy loam in texture with pH of 6.1 to 7.7. The annual precipitation of the test sites varied from 500 to 2000 mm. Response of crops to the applied nutrients was calculated as per the formula given below.

$$\text{Response (per kg of nutrient)} = \frac{\text{Yield of fertilized plot - Yield of control plot}}{\text{Applied nutrient}}$$

Results and Discussion

The data on initial soil status of the experimental sites have been reported in Table1. The soils were sandy loam in texture with pH 6.1 to 7.7, available nitrogen 184 to 277 kg/ha, available phosphorus 9.6 to 17.8 kg/ha, potassium

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140 to 187 kg/ha, organic carbon 0.68 to 0.87 per cent, electrical conductivity 0.72 to 1.18 dS/m. The soils were also analysed after the completion of each cropping cycle during both the years for the available nitrogen, phosphorus, potassium, organic carbon, soil pH and electrical conductivity and data are presented in Table 2.

Results revealed that application of different nutrients did not cause significant variation in available N, P and K content as well as pH and electrical conductivity of soil during both the years. However, organic carbon content was significantly influenced by different nutrient application. Application of all the three macro nutrients increased organic carbon content of soil during both the years, but the difference from N P during 2006-07 and N K during 2007-08 was not significant.

Grain yield

Both rice and wheat exhibited consistent and significant response to all the three nutrients during both the years (Table 3). Rice as well as wheat grain yield was significantly highest when all the three nutrients were applied to both the crops during both the years, followed by application of N P, N K and N alone. Significantly lowest yield was recorded in control plots. The soils of experimental field were low to medium in available N P K content (Table 2). Therefore, the nutrient deficiencies are alleviated by the application of nutrients, thus enhance the crop yields. Further balanced application of nutrients have reported to be essential for sustained productivity (Prasad *et al.*, 2002, Rinwa *et al.*, 2003 and Sharma *et al.*, 2007).

Response over the control

On an average, increase in grain yield (rice + wheat) due to application of recommended dose of N P K was 107 percent over control (Table 3). Application of NP, NK and N increased rice + wheat yield by 81, 67, and 41 per cent, respectively over the control.

Table 1. Soil fertility status before sowing of the crops (18 locations)

Parameters	2006-07			2007-08		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Available N	277	188	233	226	184	205
Available P	17.0	9.6	13.3	17.8	10.4	14.1
Available K	187	152	170	184	140	162
Organic carbon (%)	0.87	0.68	0.78	0.83	0.68	0.76
pH	7.7	7.3	7.5	7.6	6.1	6.9
Electrical conductivity (dS/m)	1.20	0.90	1.05	1.18	0.72	0.95

Table 2. Soil fertility status after the cropping sequences (18 locations)

Treatment	Available N		Available P		Available K		Organic Carbon		pH		Electrical conductivity	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
$N_0P_0K_0$	226.1	205.8	14.1	15.19	190.3	157.7	0.711	0.706	7.55	6.84	1.602	0.961
$N_{150}P_0K_0$	207.4	222.9	13.2	13.52	189.1	155.2	0.766	0.700	7.54	6.81	1.065	1.047
$N_{150}P_{60}K_0$	216.3	223.1	11.8	15.10	188.5	166.0	0.828	0.789	7.63	6.90	1.096	0.922
$N_{150}P_0K_{40}$	214.2	216.6	13.2	15.58	178.7	161.4	0.771	0.771	7.56	6.63	1.066	0.917
$N_{150}P_{60}K_{40}$	222.2	211.0	14.4	13.55	192.6	163.4	0.820	0.816	7.57	6.96	1.077	0.972
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.026	0.026	NS	NS	NS	NS
CV (%)	12.0	11.1	24.3	15.8	14.6	8.3	5.0	5.0	1.9	7.2	11.2	15.8

Table 3. Grain yield of rice and wheat as influenced by fertilizer application

Treatments	Yield (kg/ha)						Total system yield (kg/ha) (rice + wheat)		
	Rice			Wheat			2006-07	2007-08	Mean
	2006-07	2007-08	Mean	2006-07	2007-08	Mean			
$N_0P_0K_0$	2210	2150	2180	2116	2416	2266	4326	4566	4446
$N_{150}P_0K_0$	3119	3180	3150	2958	3238	3098	6087	3418	6253
$N_{150}P_{60}K_0$	4117	4094	4106	3826	4055	3941	7943	8149	8046
$N_{150}P_0K_{40}$	3773	3800	3787	3458	3859	3659	7231	7659	7445
$N_{150}P_{60}K_{40}$	4603	4713	4658	4433	4656	4545	9036	9369	9203
CD (P=0.05)	278	194	-	294	220	-	-	-	-

Response of crops to the applied nutrients

Response of rice and wheat in terms of kg grain per kg of nutrient applied was worked out in respect of each nutrient for the component crops in rice-wheat cropping sequence. The data have been reported in Table 4. In case of rice, among the three nutrients, highest mean response was observed with phosphorus during the first year (16.5 kg grain/ kg P_2O_5 applied). During the second year it was potassium which gave the highest mean response (16.6 kg/ kg K_2O applied). The response to nitrogen was, in general, lower than to phosphorus and potassium during both the years.

Table 4. Response of rice and wheat (kg grain per kg of nutrients) to the applied nutrients

Crop		Response (kg grain per kg nutrient applied)					
		2006-07			2007-08		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
Rice	Maximum	10.6	23.3	17.9	12.2	22.6	23.3
	Minimum	3.6	9.7	8.7	3.8	8.4	9.8
	Mean	7.0	16.5	13.3	8.0	15.5	16.6
Wheat	Maximum	9.7	22.6	26.8	9.7	32.1	36.0
	Minimum	1.2	4.3	7.7	2.0	5.2	2.8
	Mean	5.5	13.5	17.3	5.9	18.7	19.4

In wheat highest mean response was observed with potassium during both the years (17.3 and 19.4 kg/kg applied K_2O during 2006-07 and 2007-08, respectively). In wheat also response to nitrogen was lower than to phosphorus and potassium during both the years. The lowest response to nitrogen might be due to the fact that this nutrient was not as critically lower in soil as P and K. Also, the response to N was lower in the absence of P and K application. Whereas, response to P and K was higher in the presence of N_{150}. This due to synergism of NP or NK the effects are more pronounal.

The findings of the present investigation envisaged the positive effect and impact of combined application of all the basic nutrients i.e. nitrogen, phosphorus and potassium at recommended doses to the component crops in enhancing their yield and thus the total productivity of irrigated rice-wheat cropping sequence in the districts of Dehradun and Pauri in the state of Uttarakhand.

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