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Studies on Yield and Nutrient Uptake of *Kharif* Rice as Influenced by Different Levels of Nitrogen and Phosphorus

P V Ramesh Babu, Ch Pulla Rao, G Subbaiah, Y Ashoka Rani, V Srinivasa Rao and R Veeraraghavaiah

Department of Agronomy, Agricultural College, Bapatla 522 101, Andhra Pradesh

ABSTRACT

A field experiment was conducted for two consecutive years (2008-2009 and 2009-2010) on sandy clay loam soil of Agricultural college farm, Bapatla to study the yield and nutrient uptake of *kharif* rice (cv BPT. 5204) as influenced by different levels of nitrogen and phosphorus. The twelve treatments consisted of four nitrogen levels i.e. 80 kg N ha^{-1}, 120 kg N ha^{-1}, 240 kg N ha^{-1}, green manuring @5 t ha^{-1} and three phosphorus levels i.e. 0, 30 and 60 kg P_2O_5 ha^{-1}. Application of 240 kg N ha^{-1} in combination with 60 kg P_2O_5 ha^{-1} significantly increased the grain yield, straw yield and nitrogen and phosphorus uptake as well as NPK status of soil after harvest of rice over other levels of nitrogen and phosphorus. However, it was on a par with that of application of 240 kg N in combination with 30 kg P_2O_5 ha^{-1}, but P status of soil was significantly influenced by N and P interaction during both the years of the study.

Key words : Available soil NPK status, *Kharif* rice, N and P uptake, Yield.

Rice is one of the most important staple food crops for about 50 per cent of world's population that live in Asia. More than 90 per cent of rice is produced and consumed in Asian countries. In India it is grown in an area of 41.8 m. ha with an annual production of 89.09 m.t and productivity of 2125 kg ha^{-1} during 2009-10. (Ministry of Agriculture, Govt. of India). Among several agronomic management practices that affect the productivity of rice, fertilizer application is very important, especially nitrogen and phosphorus which plays an important role in growth and development of rice crop. Keeping this in view, an effort has been made to know the more productive and profitable fertilizer levels of nitrogen and phosphorus to maintain ecological sustainability and economic soundness through adoption of best nutrient management practices.

MATERIAL AND METHODS

A field study was conducted on sandy clay loam soil of the Agricultural College Farm, Bapatla, during *kharif* during first and second years. The experimental field having a pH of 8.2, low in available nitrogen (176 kg ha^{-1}), high in phosphorus (39 kg ha^{-1}) and high in available potassium (551 kg ha^{-1}). A total rainfall of 13.5 mm and 37.6 mm was received during first and second years, respectively. The treatments comprised of twelve treatments with four levels of nitrogen (Green manure @ 5 t ha^{-1}, 80 kg N ha^{-1}, 120 kg N ha^{-1} and 240 kg N ha^{-1}) and three levels of phosphorus (0, 30 and 60 kg P_2O_5 ha^{-1}). The trial was laid out in randomized block design with factorial concept and replicated thrice. The test variety, BPT -5204 was sown with spacing of 25 cm X 15 cm. The data on five randomly selected plants in each plot and the data collected for experiment was analysed statistically and subjected to analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Treatments exerted a significant influence on grain yield and straw yield (Table .1) of rice and their interaction (Table.2 and 3) during both the years of study. Application of green manuring incorporation of *dhaincha* recorded significantly lower yields of rice than the lowest level of nitrogen (80 kg N ha^{-1}) tried during both the years. In general, there was a progressive and significant increase in grain yield and straw yield with each increment in nitrogen level from 80 kg to 240 kg N ha^{-1} during both the years of the study except 80 kg and 120 kg N ha^{-1} during first year of the study which remained at a par.

Table 1. Yield and nutrient uptake in *kharif* rice as influenced by different levels of nitrogen and phosphorus and their interaction.

Treatments	2008-09						2009-10					
	Yield (Kg ha^{-1})		N uptake (Kg ha^{-1})		P uptake (Kg ha^{-1})		Yield (Kg ha^{-1})		N uptake (Kg ha^{-1})		P uptake (Kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen levels (kg ha^{-1})												
GM 5 t ha^{-1}	3253	4218	36.1	17.8	16.8	9.4	3435	4465	37.7	19.1	24.1	10.1
80	3726	4689	41.0	19.8	18.8	10.5	3980	5007	43.7	21.3	26.7	11.2
120	4204	5137	50.4	28.7	21.2	11.5	4577	5608	54..9	31.3	30.8	12.6
240	5197	6145	83.1	38.1	26.3	13.7	5453	6506	87.2	39.7	36.0	14.6
SEm±	181	179	1.18	0.52	0.69	0.75	176	197	1.35	0.85	1.13	0.92
CD (0.05)	533	526	3.4	1.5	2.0	2.2	517	578	3.9	2.5	3.3	2.7
P levels (kg P_2O_5 ha^{-1})												
0	3518	4382	45.4	22.9	14.1	8.7	3675	4590	47.4	23.9	14.7	9.22
30	4273	5288	54.6	27.0	25.6	12.0	4509	5585	57.6	28.6	27.0	12.8
60	4494	5472	57.9	28.4	27.0	13.1	4902	6015	62.6	31.1	29.4	14.4
SEm±	157	155	1.02	0.45	0.60	0.65	152	171	1.17	0.73	0.98	0.80
CD (0.05)	461	455	3.0	1.3	1.7	1.9	447	501	3.4	2.1	2.8	2.3
Interaction												
SEm±	315	310	2.04	0.91	1.21	1.85	305	342	2.34	1.47	1.96	1.60
CD (0.05)	923	911	NS	NS	NS	NS	895	1002	NS	NS	NS	NS

GM: Green manuring @ 5 t ha^{-1}

Table 2. Interaction effect of different levels of nitrogen and phosphorus on grain yield (kg ha^{-1}) of *kharif* rice

Treatments	2008-09				2009-10			
	P level (kg $P_2O_5 ha^{-1}$)				P level (kg $P_2O_5 ha^{-1}$)			
	0	30	60	Mean	0	30	60	Mean
Green manuring @ 5 t ha^{-1}	2212	3741	3807	3253	2396	3893	4018	3435
80 kg N ha^{-1}	3349	3837	3992	3726	3439	4045	4458	3980
120 kg N ha^{-1}	3837	4242	4534	4204	3984	4605	5143	4577
240 kg N ha^{-1}	4674	5273	5645	5197	4881	5494	5986	5453
Mean	3518	4273	4494		3675	4509	4902	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	181	533	13.3		176	517	12.2	
P	157	461			152	447		
N X P	315	923			305	895		

Table. 3. Interaction effect of different levels of nitrogen and phosphorus on straw yield (kg ha^{-1}) of *kharif* rice

Treatments	2008-09				2009-10			
	P level (kg $P_2O_5 ha^{-1}$)				P level (kg $P_2O_5 ha^{-1}$)			
	0	30	60	Mean	0	30	60	Mean
Green manuring @ 5 t ha^{-1}	2882	4858	4915	4218	3137	5073	5187	4465
80 kg N ha^{-1}	4283	4841	4945	4689	4398	5102	5522	5007
120 kg N ha^{-1}	4727	5192	5492	5137	4913	5640	6271	5608
240 kg N ha^{-1}	5637	6263	6536	6145	5913	6526	7080	6506
Mean	4382	5288	5472		4590	5585	6015	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	179	526	10.6		197	578	10.9	
P	155	455			171	501		
N X P	310	911			342	1002		

The highest grain and straw yields were recorded with application of nitrogen @ 240 kg ha^{-1} could be attributed to increase in photosynthesis as nitrogen is the constituent of chlorophyll, which in turn, might have resulted in accumulation of photosynthates in vegetative portion of plants and ultimately enhanced the plant growth and grain yield. Thus, the increase in grain yield was cumulative effect of improvement of all the yield attributing characters due to increased nitrogen application as reported by several researchers like Kumar *et al.* (2008) and Meena *et al.* (2011).

Among different levels of phosphorus tried, the highest grain yield and straw yield of rice was recorded with highest level i.e. 60 kg P_2O_5 ha^{-1}, which was closely followed by 30 kg P_2O_5 ha^{-1}

Table. 4. Available N, P and K after harvest of *kharif* rice as influenced by different levels of nitrogen and phosphorus and their interaction.

Treatments	2008-09			2009-10		
	N (Kg ha^{-1})	P (Kg ha^{-1})	K (Kg ha^{-1})	N (Kg ha^{-1})	P (Kg ha^{-1})	K (Kg ha^{-1})
Nitrogen levels (kg ha^{-1})						
GM 5 t ha^{-1}	153.1	33.9	493.3	150.0	27.2	516.4
80	195.1	28.5	457.1	191.0	21.4	463.2
120	216.8	23.5	427.4	209.7	17.9	407.6
240	294.7	16.9	381.7	289.0	9.3	320.2
SEm±	5.46	0.80	3.95	6.07	0.78	6.23
CD (0.05)	16.0	2.3	11.6	17.8	2.3	18.2
P levels (kg P_2O_5 ha^{-1})						
0	225.3	14.5	458.3	223.3	8.0	463.2
30	212.1	23.4	436.3	207.5	13.5	418.5
60	207.4	39.2	425.1	200.0	35.3	393.8
SEm±	4.73	0.69	3.42	5.26	0.68	5.40
CD (0.05)	13.8	2.0	10.0	15.4	2.0	15.8
Interaction						
SEm±	9.46	1.39	6.85	10.52	1.36	10.80
CD (0.05)	NS	4.1	NS	NS	4.0	NS

GM: Green manuring @ 5 t ha^{-1}

Table. 5. Interaction effect of different levels of nitrogen and phosphorus on available phosphorus status (kg ha^{-1}) in soil after harvest of *kharif* rice

Treatments	2008-09				2009-10			
	P level (kg P_2O_5ha^{-1})				P level (kg P_2O_5ha^{-1})			
	0	30	60	Mean	0	30	60	Mean
Green manuring @ 5 t ha^{-1}	15.9	35.4	50.3	33.9	6.3	25.8	49.4	27.2
80 kg N ha^{-1}	16.1	25.4	44.1	28.5	11.9	16.1	36.3	21.4
120 kg N ha^{-1}	13.3	20.6	36.6	23.5	9.3	9.5	34.9	17.9
240 kg N ha^{-1}	12.7	12.3	26.1	16.9	4.5	2.9	20.6	9.3
Mean	14.5	23.4	39.2		8.0	13.5	35.3	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	0.80	2.3	9.4		0.78	2.3	12.4	
P	0.69	2.0			0.68	2.0		
N X P	1.39	4.1			1.36	4.0		

and both these two treatments proved significantly superior to control but remained at par with each other. Among the interactions the highest grain yield and straw of rice recorded with the 240 kg N in combinations with 60 kg P_2O_5 ha^{-1} or 30 kg P_2O_5 ha^{-1} during both the years of study. These two treatments almost proved significantly superior to rest of the treatment combinations.

The uptake of nitrogen and phosphorus (Table 1) significantly increased with increased levels of N from 80 to 240 kg N ha^{-1} and increase in phosphorus levels from 0 to 60 kg P_2O_5 ha^{-1}, but not their interaction during both the years of study. Across the treatments, green manuring recorded lowest N uptake at each stage of the crop in both the years of study. Nitrogen application from 80 to 240 kg ha^{-1} significantly and progressively increased the nitrogen uptake in grain and straw at harvest of crop during both the years.

Highest nitrogen and phosphorus uptake by grain and straw of rice was observed with application of highest levels of nitrogen and phosphorus i.e. 240 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}. This might be due to increased availability and adequate supply of nitrogen and phosphorus in the soil favoured the efficient use of major and minor nutrient elements. The response of rice crop subjected to different levels of nitrogen and phosphorus was similar to those reported earlier and was fully in agreement with the general response obtained else where by various researchers such as Raju *et al*. (1992) and Dhillon *et al*. (1993) etc.

The status of available soil N, P and K (Table.4) under nitrogen levels was higher with the 240 kg N ha^{-1} application than remaining levels of nitrogen and green manuring during both the years of study. Similarly, the status of available N, P and K under 60 kg P_2O_5 ha^{-1} was higher than the remaining levels of phosphorus application (30 kg P_2O_5 ha^{-1} and Control) in the both the years. The phosphorus application from 0 to 60 kg P_2O_5 ha^{-1} significantly influenced the N, P and K status of soil (table .5). Of all the treatments, the status of available N, P and K in soil was significantly higher in the plots which received 240 kg N and 60 kg P_2O_5 ha^{-1} than the remaining treatment combinations during both the years. Similar increase in residual status of soil N, P and K due to application of N and P levels were also reported by Sathesh Kumar *et al.*(2007).

It can be concluded from the present investigation that application of 240 kg N ha^{-1} in combination with 60 kg P_2O_5 ha^{-1} recorded highest yield of rice, nutrient uptake as well as available N, P and K in soil, which was on a par with 240 kg N ha^{-1} in combination with 30 kg P_2O_5 ha^{-1}. Hence a saving of 30 kg P_2O_5 ha^{-1} can be possible by application of 240 kg N ha^{-1} in combination with 30 kg P_2O_5 ha^{-1} rather than going for 240 kg N ha^{-1} in combination with 60 kg P_2O_5 ha^{-1}.

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