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Effect of Different Levels of Nitrogen and Phosphorus on Growth and Yield of *Kharif* Rice (*Oryza sativa* l.)

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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 during *kharif* to study the effect of different levels of nitrogen and phosphorus on rice (cv BPT. 5204). 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 plant height, tiller number, drymatter accumulation, productive tillers, number of filled grains, test weight, grain yield and straw yield 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} during both the years of the study.

Key words : Growth, *Kharif* rice, Yield attributes and Yield

Agriculture in India is largely rice based and grown in an area of 41.8 m. ha with annual production of 89.09 m.t and productivity of 2125 kg ha^{-1} during 2009-10. (Ministry of Agriculture, Govt. of India). The demand of rice in India is increasing with increase in population and is expected to be 140 m.t by 2025 (Pandey *et al*,. 2008). Due to rise in input costs, high competition in international market for rice and problems of managing food grain stocks in India, rapid degradation of rice ecologies due to imbalanced use of fertilizers and improper water management practices adopted, it has put a tremendous pressure on the rice growers to make rice farming economically viable and ecologically sustainable. Keeping this in view, an effort has been made to know the more productive and profitable fertilizer levels 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* 2008-09 and 2009-10. 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 2008-09 and 2009-10, 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 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.

RESULTS AND DISCUSSION

The plant height, tiller number, drymatter accumulation, yield attributes and yield significantly influenced by different levels of nitrogen and phosphorus during both the years of study (Table. 1, 2, 3, 4, 5, 6 and 7).

In general, the higher growth, yield attributes and yields were recorded during the second year (2009-10) of the study than that of first year (2008-09). All the growth characters, yield attributes and yields were significantly influenced by levels of nitrogen and phosphorus and their interactions during both the years, except plant height at maturity, tiller number at 60 days after transplanting (DAT) and test weight. During both the years of study, the green manuring *insitu* with *dhiancha* (N_1) recorded significantly lowest plant height of rice than the lowest level of nitrogen (80 kg N ha^{-1}) tested , but it was at a par with 80 kg N ha^{-1} during both the years of study. In general there was a progressive and significant increase in plant height with each increment in nitrogen level from 80

Table 1. Growth parameters of *kharif* rice as influenced by different levels of nitrogen and phosphorus and their interaction.

Treatments	2008-09			2009-10		
	Plant height (cm) at maturity	Tillers at 60 DAT (No m^{-2})	Drymatter accumulation at maturity (kg ha^{-1})	Plant height (cm) at maturity	Tillers at 60 DAT (No m^{-2})	Drymatter accumulation at maturity (kg ha^{-1})
Nitrogen levels (kg ha^{-1})						
GM 5 t ha^{-1}	70.8	231	7266	87.8	243	7728
80	71.3	279	8403	89.2	298	8940
120	71.4	330	9444	90.2	338	10312
240	73.3	399	11682	91.3	407	12257
SEm±	1.19	3.15	233	1.14	4.09	279
CD (0.05)	3.5	9.0	684	3.3	12.0	818
P levels (P_2O_5 kg ha^{-1})						
0	70.8	373	7913	87.0	435	8292
30	71.9	439	9606	90.2	466	10109
60	72.5	466	10079	91.7	504	11027
SEm±	1.03	2.72	202	0.99	3.54	241
CD (0.05)	2.1	8.0	592	2.9	10.3	708
Interaction						
SEm±	2.07	5.45	400	1.98	7.09	483
CD (0.05)	NS	NS	1185	NS	NS	1417

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

Table 2. Interaction effect of different nitrogen and phosphorus levels on drymatter accumulation (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 with dhaincha @ 5 t ha^{-1}	5199	8679	8841	7266	5673	8978	9250	7728
80 kg N ha^{-1}	7659	8750	8986	8403	7852	9243	9998	8940
120 kg N ha^{-1}	8612	9529	10192	9444	8924	10328	11686	10312
240 kg N ha^{-1}	10426	11893	12728	11682	10967	12335	13469	12257
Mean	7913	9606	10079		8292	10109	11027	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	233	684	7.5		279	818	8.4	
P	202	592			241	708		
N X P	400	1185			483	1417		

Table 3. Yield attributes and yield of *kharif* rice as influenced by different levels of nitrogen and phosphorus and their interaction.

Treatments	2008-09					2009-10				
	Yield attributes			Yield (Kg ha^{-1})		Yield attributes			Yield (Kg ha^{-1})	
	Productive tillers (No. m^{-2})	Filled grains (No panicle^{-1})	Test weight (g 1000 grains^{-1})	Grain	Straw	Productive tillers (No. m^{-2})	Filled grains (No panicle^{-1})	Test weight (g 1000 grains^{-1})	Grain	Straw
Nitrogen levels (kg ha^{-1})										
GM 5 t ha^{-1}	208	115	14.0	3253	4218	217	119	14.1	3435	4465
80	253	138	14.2	3726	4689	239	134	14.4	3980	5007
120	301	133	14.9	4204	5137	304	140	14.9	4577	5608
240	373	147	15.5	5197	6145	376	151	15.4	5453	6506
SEm±	3.50	3.32	0.21	181	179	3.62	2.93	0.14	176	197
CD (0.05)	10	9	0.5	533	526	10	8	0.4	517	578
P levels (P_2O_5 kg ha^{-1})										
0	243	119	14.4	3518	4382	252	125	14.2	3675	4590
30	284	134	14.6	4273	5288	292	138	14.8	4509	5585
60	324	140	14.8	4494	5472	309	145	15.1	4902	6015
SEm±	3.02	2.83	0.12	157	155	3.14	2.53	0.12	152	171
CD (0.05)	9.0	8.4	0.4	461	455	9	7	0.3	447	501
Interaction										
SEm±	6.12	5.72	0.32	315	310	6.32	5.1	0.25	305	342
CD (0.05)	18	16	NS	923	911	18	15	NS	895	1002

Table 4. Interaction effect of different levels of nitrogen and phosphorus on number of productive tillers m^{-2} 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}	169	210	245	208	175	224	252	217
80 kg N ha^{-1}	212	252	296	253	231	263	224	239
120 kg N ha^{-1}	259	304	342	301	262	309	342	304
240 kg N ha^{-1}	332	372	416	373	339	372	418	376
Mean	243	284	324		252	292	309	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	3.5	10.4	3.7		3.6	10.7	3.8	
P	3.0	9.0			3.1	9.3		
N X P	6.1	18.1			6.3	18.6		

kg to 240 kg N ha^{-1} in both the years, However, there was no significant difference in plant height (Table.1) in between two consecutive treatments among all the treatments of nitrogen and phosphorus levels during both years of the study. The increased level of nitrogen might have resulted in easy and greater availability of nitrogen to crop plants, which might have increased the plant height due to more cell division and cell elongation. These findings are inconformity with findings of Samarthalameena *et al*, (2003) and Prasad Rao *et al.* (2011).

Among different levels of phosphorus tested, the higher plant height of rice was observed with highest level of phosphorus tried (60 kg P_2O_5 ha^{-1}) and proved significantly superior to control (Po) but remained at a par with 30 kg P_2O_5 ha^{-1} which was also at par with control (Po). This trend was observed in both the years of the study. However, the interaction between nitrogen and phosphorus levels was found to be non significant during both the years of experimentation. Similar trend was also observed in respect of tillers and test weight as that of plant height

The highest drymatter accumulation (Table. 1 and 2) was also with 240 kg N ha^{-1} and found significantly superior to remaining nitrogen levels, which also differed significantly with each level of nitrogen increment. However, green manuring recorded the lowest drymatter accumulation. The similar trend of response was also observed in respect of phosphorus application as that was noticed incase of nitrogen application. There was a progressive and significant increase in drymatter accumulation with increasing levels of phosphorus from 0 to 60 kg P_2O_5 ha^{-1} during in the both the years. However, where in the application of phosphorus 30 and 60 kg P_2O_5 ha^{-1} during first year of study which remained statistically at a par. The highest drymatter accumulation observed with 240 kg N ha^{-1} might be due to increased nitrogen availability which is responsible for profused tillering and plant height and hence, the higher drymatter accumulated. The similar results were also reported by Stalin *et al*. (1999), Dwivedi *et al* 2006.

In general, the yield attributes, such as productive tillers m^{-2} and number of filled grains $panicle^{-1}$ (Table. 3) were significantly influenced by the different nitrogen and phosphorus levels. Number of productive tillers m^{-2} and number of filled grains $panicle^{-1}$ across the different nitrogen levels or phosphorus levels and their interaction (Table. 4 and 5) was found to be significantly differ during both the years of the study. The lowest productive tillers m^{-2} and number of filled grains $panicle^{-1}$ was recorded with green manuring and highest number tiller was recorded with 240 kg N ha^{-1}, while 0 (Control) and 60 kg P_2O_5 ha^{-1} treatments in respect of phosphorus levels tested during both the years. Among the interactions, phosphorus @ 0 kg P_2O_5 ha^{-1} (Control) in combination with green manuring recorded the productive tillers m^{-2} and number of filled grains $panicle^{-1}$, where as highest productive tillers m^{-2} and number of filled grains $panicle^{-1}$ was recorded with N_{240} and P_{60} in the both the years of study.

The increased number of productive tillers m^{-2} and number of filled grains $panicle^{-1}$ recorded with 240 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} could be attributed to better nutrient availability more in these treatments than the other treatments, which in turn, might have helped in faster cell division and enlargement. Further, it might be also due to more number of tillers and higher Drymatter accumulation. Similar results were also reported by Bandhyopadhyay and Puste (2002) and Prasad Rao *et al* .2011.

Grain yield and straw yield (Table. 3) of rice was significantly affected by different levels of nitrogen and phosphorus and their interaction (Table. 6 and 7) during both the years of study. During both the years, the green manuring incorporation of *dhaincha* recorded significantly lower yields of rice than the lowest level of nitrogen (80 kg N ha^{-1}) tried. In general, there was a progressive and significant increase in grain yield and straw 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.

The increase in grain yield and straw yield with application of nitrogen 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 several researchers like Kumar *et al*, (2008) and Meena *et al.*(2011).

During both the years, among different levels of phosphorus tried, the highest grain yield and straw yield of rice was recorded with highest level of phosphorus tested (60 kg P_2O_5 ha^{-1}) which was closely followed by 30 kg P_2O_5 ha^{-1} and both these two treatments proved significantly superior to control (P_o). 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

Table 5. Interaction effect of different levels of nitrogen and phosphorus on number of filled grains panicle^{-1} 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}	89	123	134	115	94	128	134	119
80 kg N ha^{-1}	123	128	134	128	128	134	142	134
120 kg N ha^{-1}	128	134	138	133	133	139	147	140
240 kg N ha^{-1}	137.0	150.0	154.0	147	145	152	157	151
Mean	119	134	140		125	138	145	
	SEm ±	CD (0.05)	CV%		SEm ±	CD (0.05)	CV%	
N	3.3	9.8	7.6		2.9	8.7	6.6	
P	2.8	8.4			2.5	7.6		
N X P	5.7	16			5.1	15		

Table 6. 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_5ha^{-1})				P level (kg P_2O_5ha^{-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 7. 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		

P_2O_5 ha^{-1} during both the years of study. These two treatments almost proved significantly superior to rest of the treatment combinations, though these two treatments remained statistically identical. Hence, the present study indicating the dependence of the phosphorus can be reduced by the application of 30 kg P_2O_5 in combination with 240 kg N ha^{-1} instead of going for highest levels of nitrogen and phosphorus i.e. 240 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}, though numerical increase in grain yield and straw yield was recorded with 240 kg N ha^{-1} in combination with 60 kg P_2O_5 ha^{-1}. The comparable performance of 60 kg P_2O_5 ha^{-1} and 30 kg P_2O_5 ha^{-1} over control might be due to more availability of phosphorus over longer period. The similar equal performance of 30 and 60 kg P_2O_5 ha^{-1} to that of control was also reported by Ghanasyam singh *et al.* (2008) and Goyal *et al* .(2009).

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 growth, yield attributes and yield of rice 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 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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