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Effect of Nitrogen, Phosphorus and Potassium Application on the Availability of Nutrients to Rice

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The influence of three levels in each of N (0, 50 and 100 kg/ha), P_2O_5 (0, 40 and 80 kg/ha) and K_2O (0, 30 and 60 kg/ha) fertilization on the availability of N, P, K, Ca Mg, Fe and Mn to rice was studied in a pot experiment. Increasing the levels of N resulted in consistently higher yield and increased uptake of N, P, K; Ca, Mg, Mn and Fe by the crop. Addition of P increased the yield and uptake of P, K, Ca, Mg by both grain and straw, N by grain and Mn by straw significantly. Application of K increased the grain yield and uptake of P and K significantly.

Application of fertilizer nutrientt generally leads to increased absorption of all the nutrients due to higher dry matter production. This study was undertaken to investigate the effect of N, P and K fertilization on the availability of nutrients to rice.

MATERIAL AND METHODS

A pot experiment was conducted at R.B.S. College, Bichpuri, Agra on rice (Saket-4) during *Kharif* season of 1976-77. The soil of the experimental pot represents a typical Indo-Gangetic alluvium and is characterized by a sandy loam texture, alkaline reaction; low organic matter content and an immature stage of development. The contents of N and P were low and moderate respectively. The soil was medium in respect of available K. The amounts of available Fe and Mn in soil were 20.0 and 4.8 ppm respectively. The experiment comprising three levels of nitrogen: 0, 50, 100 kg/ha (N_0, N_1 and N_2), three levels of P_2O_5 : 0, 40, 80 kg/ha (P_0, P_1 and P_2) and three levels of K_2O : 0, 30, 60 kg/ha (K_0, K_1 and K_2) was conducted in a factorial randomized block design with two replications. The sources of N, P and K were ammonium sulphate, single superphosphate and muriate of potash respectively. Normal cultural practices were followed for the crop. Deionized water was used for irrigation. At harvest, yield of grain and straw were recorded.

Composite samples of plants were drawn from pots at harvesting. After drying and grinding, the plant samples were analysed for N, P, K, Ca, Mg, Fe and Mn. Estimation of N in plant meterial was done by the colorimetric procedure outlined by Snell and Snell (1955). P by the method of Chapman and Pratt, (1961), K with flame photometer, Ca and Mg as per the method described by Richards (1954) and Fe and Mn by the method outlined by Johnson and Ulrich (1959).

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RESULTS AND DISCUSSION

Crop yield : The grain yield increased with increased N application (Table I). Application of 50 and 100 kg N/ha resulted in 31.6 and 53.9 per cent greater grain yield than control. Straw yield was also enhanced considerably by N fertilization. Such a response to N application is attributed to low N content of the soil and relatively high N requirement of the crop.

TABLE I. Grain and straw yields of rice (Saket-4)

Treatments	Grain yield (g/pot)	Straw yield (g/pot)
Levels of N		
N_0	8.49	19.67
N_1	11.17	26.65
N_2	13.07	33.48
C.D. (P = 0.05)	0.456	1.312
Levels of P		
P_0	10.11	24.38
P_1	10.90	27.02
P_2	11.72	28.39
C.D. (P = 0.05)	0.456	1.312
Levels of K		
K_0	10.50	25.75
K_1	10.91	26.72
K_2	11.33	27.06
C.D. (P = 0.05)	0.456	N.S.

N.S. = Not significant

The crop showed significant response to P application. Increase in yield of grain and straw due to application of 40 and 80 kg P_2O_5/ha over no P was of the order of 7.8 and 15.9, and 11.0 and 16.4 per cent in grain and straw respectively. The soil used was medium in P and hence showed response to P addition.

Grain yield increased significantly with the addition of 60 kg K_2O/ha. Straw yield also increased with the application of 30 or 60 kg K_2O/ha.

Nutrient uptake

Nitrogen : The application of increasing doses of N significantly increased its uptake by the crop (Table II). This significant rise in the uptake of N by rice was the combined effect of higher yield and increased absorption. Sharma and Ghosh (1977) also reported similar results.

Application of P increased the uptake of N significantly over control. Thandapani and Sakharam Rao (1974) reported that P application favourably influenced the uptake of N by rice. N uptake was also accentuated by the application of K. Singh *et al.* (1976) observed increased uptake of N with K application.

Phosphorus : Uptake of P increased significantly with increasing N levels as a result of higher yield and increased absorption. P application also brought about an increased uptake of P. The total uptake of P was markedly affected due to various levels of K. A higher dose of K application affected the uptake of P to a greater extent over the lower doses of K. Singh *et al.* (1976) also observed an increased uptake of p by the application of K.

TABLE II. N, P and K uptake by rice (mg/pot)

Treatments	N		P		K	
	Grain	Straw	Grain	Straw	Grain	Straw
Levels of N						
N_0	100·77	60.00	27.96	22.06	19.18	89.48
N_1	145.88	110.26	37.75	31.06	28.14	132.42
N_2	189.99	165.24	45.44	40.61	35.41	185.14
C.D. ($P = 0.05$)	7.36	49.15	1.74	2.15	1.07	7.93
Levels of P						
P_0	136.28	105.62	32.00	24.66	25.37	128.49
P_1	145.07	109.19	36.14	31.58	27.14	134.57
P_2	148.37	104.88	43.00	38.84	29.06	138.84
C.D. ($P = 0.05$)	7.36	N.S.	1.74	2.15	1.07	7.93
Levels of K						
K_0	140.38	104.76	34.78	28.88	25.62	121.01
K_1	143.46	107.73	36.78	31.07	27.62	134.40
K_2	146.49	107.23	39.26	33.79	28.89	144.47
C.D. ($P = 0.05$)	N.S.	N.S.	1.74	2.15	1.07	7.93

TABLE III. Ca, Mg, Fe and Mn uptake by rice (mg/pot)

Treatments	Ca		Mg		Fe		Mn	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Levels of N								
N_0	13.49	42.08	5.68	34.81	0.25	9.65	0.63	3.40
N_1	18.65	64.48	7.78	55.15	0.35	15.09	0.88	4.66
N_2	22.87	89.05	9.84	78.00	0.43	18.41	1.11	5.97
C.D. ($P = 0.05$)	0.03	12.03	0.012	11.51	0.03	3.30	0.044	0.25
Levels of P								
P_0	16.47	59.47	6.70	47.53	0.33	13.01	0.86	4.39
P_1	18.20	67.01	7.51	55.66	0.34	14.16	0.85	4.72
P_2	19.92	70.09	8.23	61.32	0.35	14.51	0.86	4.96
C.D. ($P = 0.05$)	0.03	N.S.	0.012	11.51	N.S.	N.S.	N.S.	0.25
Levels of K								
K_0	18.32	66.94	7.75	56.38	0.35	13.74	0.87	4.62
K_1	18.11	63.59	7.78	54.77	0.34	13.96	0.86	4.68
K_2	18.21	60.60	7.71	51.94	0.35	13.93	0.86	4.65
C.D. ($P = 0.05$)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Potassium : K uptake was increased significantly by N fertilization. This significant increase in K uptake was brought about by greater dry matter production and higher absorption of K by rice. If available K in soil is not limiting, as was in the present study, fertilizer N has often been found to promote the K intake in cereals. These results are in close confirmity with the observations of Sharma and Ghosh (1977).

Addition of P proved beneficial for K uptake and a consistent increase in K uptake was observed upto 80 kg P_2O_5/ha application. The uptake of K was increased significantly with the application of K. Singh *et al.* (1976) also reported similar results.

Calcium and Magnesium : Application of N increased the absorption of Ca and Mg by plants. Both the levels of N application increased the Ca and Mg uptake (Table III). Uptake of Ca and Mg was also enhanced by the application of P. Generally application of K did not produce any beneficial effect on the absorption of Ca and Mg by rice. In some cases, a reduction in Ca and Mg uptake was noted but this reduction was statistically non-significant. This might be due to the antagonistic effect of K on Ca and Mg.

Iron and Manganese : Increasing the rate of N fertilization enhanced Fe and Mn uptake. Higher yield and increased absorption of Fe and Mn might have been responsible for this effect. Venkateswarlu (1964) showed that N application induced increased uptake of Mn by rice and ammonium sulphate caused more increase in Mn content than did urea, obviously due to additional beneficial effects accruing from sulphur. Enyi (1966) also recorded a favourable effect of N application on the absorption of Mn by rice.

Uptake of Fe was not affected significantly with the application of P, although a slight increase in the values of Fe uptake was noted. Mn uptake increased due to P application. The beneficial action of superphosphate might be through chemical reaction of soil Mn with monocalcium phosphate (Lindsay and Stephenson, 1959). The results of the present investigation indicate that application of K had no significant effect on the uptake of Fe and Mn.

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