

Yield and nutrient uptake of rice (*Oryza sativa*) as influenced by sources and levels of phosphorus and zinc under transplanted conditions

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Received: January 1996

ABSTRACT

A field experiment conducted during rainy season of 1993 and 1994 at Varanasi indicated that highest grain yield of rice (*Oryza sativa* L.) was recorded with ammonium polyphosphate (APP) at 90 kg P_2O_5 /ha in combination with 30 kg $ZnSO_4$ /ha. Total nutrient uptake of N, P, K and Zn was positively influenced by sources and levels of phosphorus and zinc rates. Among the sources of phosphorus tested, ammonium polyphosphate (APP) followed by Urea nitric phosphate (UNP) recorded the highest grain yield and nutrient uptake than diammonium phosphate (DAP). Increasing the doses of phosphorus from 30 to 90 kg P_2O_5 /ha, application of 60 kg P_2O_5 /ha through APP in combination with 30 kg $ZnSO_4$ /ha was found to be the best for obtaining economical yield and higher nutrient uptake values of transplanted rice crop.

Key words : Nutrient uptake, Sources, Phosphorus, Zinc

Balanced nutrient is important for increasing the rice productivity. Phosphorus and Zinc show antagonism. Information pertaining to new phosphatic carriers like APP (ammonium polyphosphate) and UNP (urea nitric phosphate) in combination with zinc fertilization especially on the nutrient uptake of rice crop is meagre. Hence, the present study was undertaken to investigate the effect of sources and levels of phosphorus and Zinc on yield and nutrient uptake of transplanted rice.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 1993 and 1994 at the Institute of Agricultural Sciences, BHU, Varanasi. The soil (Entisol) contained 58.7% sand, 18.8% silt, 22.5% clay, 0.36% organic carbon, 0.60 ppm available Zn and 19.8% kg available P_2O_5 /ha with pH 7.3. The experiment was conducted in 3^3 partially confounded design with 2 replications. The treatments consisted of 3 sources of P (APP, ammonium polyphosphate granules, 12 - 56 - 0; UNP,

urea nitric phosphate granules, 19 – 19 – 0; and diammonium phosphate granules, 18 – 46 – 0), 3 levels of P (30 kg, 60 kg and 90 kg P₂O₅/ha) and 3 rates of zinc (15 kg, 30 kg and 45 kg ZnSO₄/ha) in addition to 1 control. A basal dose of 120 kg N and 60 kg each P₂O₅ and K₂O/ha was given. Nitrogen was applied in 3 splits i.e. 50% N at basal, 25% N each at 30 and 60 days after transplanting (DAT). Entire phosphorus, potash and zinc was applied as basal. ‘Sarjoo 52’ was used as a test variety by adopting a spacing of 20 cm x 10 cm.

RESULTS AND DISCUSSION

Sources of phosphorus

Grain yield during both the years, straw yield in the second year, pooled grain yield (Table 1) and total nutrient uptake of N, P, K and Zn (Table 2) showed significant variations owing to sources of phosphorus. The APP source recorded the highest grain yield

than UNP and DAP sources in both the years as well as pooled grain yield, while the straw yield was highest with UNP source which was significantly superior to APP and UNP sources in the second year only. The APP source recorded maximum total nutrient uptake (Table 2), which was significantly superior to UNP and DAP sources during both the years. In general, UNP and DAP sources were remained at par in respect total nutrient uptake values except P uptake. The higher grain yield obtained with APP source might be due to greater availability of P which is due to lesser fixation, slow hydrolysis and direct absorption (Tisdale *et al.*, 1985) and action on plant metabolism possibly through a micro nutrient element nutrition resulting from chelating properties (Rama Rao *et al.*, 1991)

Levels of phosphorus

Phosphorus levels significantly influ-

Table 1. Effect of sources and levels of phosphorus and rates of zinc on grain and straw yields and harvest index of rice

Treatment	1993			1994			Pooled Yield (q/ha)
	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	
<i>P source:</i>							
S ₁ (APP)	46.02	55.20	45.22	44.04	52.34	42.61	45.03
S ₂ (UNP)	45.33	53.47	44.83	43.15	58.83	42.44	43.34
S ₃ (DAP)	42.01	51.97	44.67	42.37	56.13	43.06	42.19
CD (P = 0.05)	3.18	NS	NS	1.51	2.33	NS	0.75
<i>P level</i>							
P ₁ (P ₃₀)	40.46	50.79	44.22	41.09	52.06	44.17	40.78
P ₂ (P ₆₀)	43.73	52.87	45.11	43.73	60.42	42.00	43.73
P ₃ (P ₉₀)	47.37	57.00	45.39	44.74	61.82	41.94	46.06
CD (P = 0.05)	3.18	2.93	NS	1.51	2.33	0.71	0.75
<i>Zn rate</i>							
Z ₁ (Z ₁₅)	41.26	51.27	44.50	41.31	54.92	43.06	41.28
Z ₂ (Z ₃₀)	44.76	54.23	45.06	44.36	58.89	43.00	44.56
Z ₃ (Z ₄₅)	45.55	55.15	45.17	43.90	60.48	42.06	44.72
CD (P = 0.05)	3.18	2.93	NS	1.51	2.33	0.71	0.75
Control	33.16	33.71	46.17	36.35	39.19	47.17	34.76
CD (P = 0.05) (control vs treated)	4.11	3.78	NS	1.95	3.01	0.92	0.96

NS, Not Significant

enced the grain, straw and pooled grain yield during both the years, harvest index in the second year and total nutrient uptake of N, P, K and Zn during both the years except P and Zn uptakes during the second year (Tables 1, 2).

There was a significant and progressive increase in grain as well as pooled yield with successive increase in P levels from 30 to 90 kg P_2O_5 /ha. Straw yield also followed the similar trend except in second year where significant increase was noticed up to 60 kg P_2O_5 /ha only. Harvest index also followed significant trend in the second year as that of grain yield where-in application of 60 kg P_2O_5 /ha significantly influenced the harvest index.

Nutrient uptake of N, K and Zn was also significantly increased with increasing levels of P from 30 to 90 kg P_2O_5 /ha during both the years except Zn uptake during the second year where significant Zn uptake was observed up

to 60 kg P_2O_5 /ha only. The P uptake was significantly improved with P application up to 60 kg P_2O_5 /ha in both the years. An adequate supply of phosphorus in the soil might have favoured the efficient use of N, P, K and Zn following higher doses of P which in turn brought about higher grain yield. The results are in accordance with those reported by Rama Rao *et al.* (1991), Raju *et al.* (1992) and Dhillon *et al.* (1993), who reported increased grain yield of rice with increased levels of phosphorus.

Rates of zinc

Application of Zn significantly exhibited variations on grain, straw and pooled grain yield and total nutrient uptake of N, P, K and Zn during both the years (Tables 1, 2). Significant increase in grain, straw and pooled yields and total nutrient uptake was observed up to 30 kg $ZnSO_4$ /ha only. There was no

Table 2. Total uptake of N, P, K and Zn (kg/ha) of rice at Harvest as influenced by sources and levels of Phosphorus at varying rates of Zinc

Treatment	Total nutrient uptake (1993)				Total nutrient uptake (1994)			
	N	P	K	Zn	N	P	K	Zn
<i>P sources:</i>								
S ₁ (APP)	86.03	38.67	141.56	0.40	86.06	38.31	146.54	0.40
S ₂ (UNP)	79.40	34.12	117.82	0.35	81.67	33.37	126.28	0.36
S ₃ (DAP)	73.88	25.00	114.08	0.32	76.20	25.28	123.63	0.34
CD (P = 0.05)	7.24	6.39	15.42	0.03	4.97	5.63	13.91	0.03
<i>P level</i>								
P ₁ (P ₃₀)	65.58	24.04	90.25	0.30	66.60	22.38	92.81	0.30
P ₂ (P ₆₀)	78.06	4.82	121.30	0.37	82.36	36.27	137.06	0.39
P ₃ (P ₉₀)	95.67	38.92	161.84	0.40	94.97	38.27	166.49	0.40
CD (P = 0.05)	7.24	6.39	15.42	0.03	4.97	5.63	13.91	0.03
<i>Zn rate</i>								
Z ₁ (Z ₁₅)	71.05	28.14	100.54	0.31	72.90	26.94	108.06	0.32
Z ₂ (Z ₃₀)	84.41	35.42	137.57	0.38	86.11	35.60	145.27	0.38
Z ₃ (Z ₄₅)	83.85	34.21	135.28	0.38	84.93	34.41	143.12	0.38
CD (P = 0.05)	7.24	6.39	15.42	0.03	4.97	5.63	13.91	0.03
Control	29.96	10.88	42.53	0.14	32.11	11.83	43.23	0.15
CD (P = 0.05) (Control vs treated)	8.99	8.07	20.01	0.04	6.75	7.11	17.60	0.04

Table 3. Interaction effect of levels of Phosphorus and zinc on pooled grain yield (q/ha) of rice

P levels (kg P ₂ O ₅ /ha)	Rates of zinc (kg ZnSO ₄ /ha)		
	Z ₁₅	Z ₃₀	Z ₄₅
P ₃₀	39.38	40.49	42.45
P ₆₀	40.97	45.37	44.85
P ₉₀	43.50	47.81	46.86
CD (P = 0.05)		1.30	

nutrition of the test crop. The present results coincide with the findings of Saravanan and Ramanathan (1988), Paramasivam *et al.* (1992) and Dhillon *et al.* (1993).

Interactions

Among the interactions, levels of P x Zn on pooled grain yield, total K uptake and Zn

Table 4. Interaction effect of levels of phosphorus and zinc on total nutrient uptake of potassium and zinc during 1993 and 1994

P (kg P ₂ O ₅ /ha)	1993			1994		
	Z ₁₅	Z ₃₀	Z ₄₅	Z ₁₅	Z ₃₀	Z ₄₅
	<i>K uptake (kg/ha)</i>					
P ₃₀	70.9	97.5	102.4	73.3	99.2	106.3
P ₆₀	98.6	130.1	135.2	107.1	153.8	150.3
P ₉₀	132.1	185.2	168.2	143.8	182.9	172.8
CD (P = 0.05)		26.4			24.3	
	<i>Zn uptake (kg/ha)</i>					
P ₃₀	0.22	0.31	0.34	0.23	0.31	0.35
P ₆₀	0.33	0.39	0.39	0.35	0.43	0.41
P ₉₀	0.37	0.43	0.41	0.37	0.42	0.40
CD (P = 0.05)		0.06			0.05	

Table 5. Interaction effect of sources and levels of phosphorus on zinc uptake (kg/ha) during 1993

P (kg P ₂ O ₅ /ha)	P source		
	APP	UNP	DAP
P ₃₀	0.32	0.30	0.26
P ₆₀	0.42	0.6	0.33
P ₉₀	0.44	0.39	0.36
CD (P = 0.05)		0.06	

beneficial effect of 45 kg ZnSO₄/ha in both the years. The harvest index (HI) was significantly influenced by Zn application during the second year. Application of 30 kg ZnSO₄/ha recorded highest HI (43%). Balanced supply of zinc up to 30 kg ZnSO₄/ha in the soil might have favoured the efficient use of N, P, K and Zn by the rice crop. Further, the increased grain yield up to 30 kg ZnSO₄/ha over ZnSO₄/ha application might also be due to balanced

uptake during both the years and source x levels of P on total Zn uptake during first year were only found to be significant.

The pooled grain yield was significantly increased by the application of 90 kg P₂O₅/ha in combination with 30 kg ZnSO₄/ha than the remaining P x Zn treatment combinations (Table 3).

Among P x Zn levels during both the years, total K uptake was significantly increased with increasing levels of P at each level of Zn application, whereas at each level of P, significant increase in K uptake was observed up to 30 kg ZnSO₄/ha only (Table 4).

The total Zn uptake was significantly increased with increasing levels of P up to 60 kg P₂O₅/ha only at all the 3 levels of Zn application. Similarly, at each level of P, Zn uptake was increased significantly up to 30 kg ZnSO₄/ha only.

During first year, source x levels of P significantly increased the total Zn uptake up to 60 kg P_2O_5 /ha only irrespective of the source. APP source was found to be significantly superior to remaining source of P (UNP and DAP) and it significantly improved the total Zn uptake at all the 3 levels of P, when compared with UNP and DAP sources (Table 5).

Thus, the present investigation envisages that though the application of 90 kg P_2O_5 /ha recorded maximum grain yield, phosphorus application @ 60 kg P_2O_5 /ha through APP source in combination with 30 kg $ZnSO_4$ /ha was the best for obtaining economical yield and higher nutrient uptake values of transplanted rice crop.

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