Effect of Phosphorus and Zinc on yield and their uptake by rice

V. Sarkunan* and A.K. Misra

Central Rice Research Institute, Cuttack-753006, Orissa, India

ABSTRACT

A pot experiment was conducted to study the interaction effects of four levels of P (0,25,50 and 100 mg kg^{1} soil) and five levels of Zn (0, 5, 10, 15 and 25 mg kg^{-1} soil) on rice in an Inceptisol. The available P content was very low in the soil and it was moderately deficient in Zn. Rice plants which did not receive P showed symptoms of P deficiency characterized by narrow short leaves with dark green colour. Significant increase in grain and straw yields was noted upto 10 mg Zn kg^{-1} soil addition while yield increase occurred at all levels of added P. The interaction revealed that Zn uptake increased only upto 10 mg Zn kg^{-1} over all the levels of P and it decreased thereafter. A decrease in P uptake was noted at higher levels of Zn addition. Zinc-P interaction showed as antagonistic effect in terms of decline in yield and uptake of both the nutrients at the highest levels of their additions.

Key words: *Phosphorus, Zn , interaction, rice yield, uptake*

There are several reports on both synergistic and antagonistic effect of Zn and P interaction in soil as well as in plant. Tandon (1987) reviewed the work of Zn X P interaction and concluded that the antagonism between them is observed when both are deficient. Biswas and Prasad (1991) from a Zn X P interaction study in the sandy loam soil of Bihar reported an increase in rice yield by about 30 and 20 per cent due to the application of 80 kg P_2O_5 and 25 kg $ZnSO_4$ ha^{-1} respectively, while the yield increased by 73 per cent when both Zn and P were applied together. The present investigation was undertaken to study the effect of P and Zn on yield and their uptake by rice in a highly P deficient soil.

A pot experiment was conducted under flooded condition using a sandy loam soil (Inceptisol), which had pH 5.2, organic C 4.6 g kg^{-1}, Olsen's P 2.4 mg kg^{-1} soil and DTPA Zn 0.7 mg kg^{-1} soil. Porcelain pots containing 3 kg of processed soil was kept flooded for a week. The treatments consisting of four levels of P (0.25, 50, 100 mg kg^{-1}) and five levels of Zn (0,5,10,15 and 25 mg kg^{-1} soil) as KH_2PO_4 and $ZnSO_4$. $7H_2O$ respectively were applied through solution. The treatments were arranged in a factorial combination with three replications. All the pots received uniform basal dose of 0.5 g N kg^{-1}soil as urea. At tillering and panicle initiation stages 150 and 100 mg N kg^{-1} soil respectively were top-dressed. Potassium was adjusted to 124 mg kg^{-1} soil with KCl. Twenty-five day old seedling of the rice variety IR 36 was transplanted in each pot and grown till maturity. After harvesting, the straw and grain were separated, dried and weighed. The grain and straw samples were digested in diacid (HNO_3 + $HClO_4$) mixture and analyzed for Zn by atomic absorption spectrophotometer and P by spectrophotometer (Jackson, 1973).

Significant increase in grain and straw yields were recorded upto 10 mg Zn kg^{-1} soil level, while yield increase occurred at all levels of added P (Table 1). The interaction effect was also significant. In the absence of added P, Zn did not enhance either grain or straw yield. On the other hand, irrespective of Zn addition both grain and straw yields increased significantly with each increment of P. The significant response to P might be due to the fact that the soil used in the study was highly deficient in available P. Further, rice plants that did not receive P were stunted in growth with limited number of tillers. These plants also showed typical P deficiency symptoms characterized by narrow short leaves with dark green colour. As the DTPA-Zn content in the soil was close to the critical limit, only a marginal response to Zn was observed. In a similar

Table 1. Effect of zinc and phosphorus on grain and straw yields (g pot^{-1}) of rice

Levels of Zn (mg kg^{-1} soil)	Grain levels of P (mg kg^{-1} soil)					Straw levels of P (mg kg^{-1} soil)				
	0	25	50	100	Mean	0	25	50	100	Mean
0	2.3	17.1	26.6	29.9	19.2	5.4	15.1	20.2	20.2	15.3
5	2.6	18.2	28.4	31.4	20.1	6.3	16.8	21.4	22.8	16.8
10	2.9	22.5	29.0	32.7	21.8	6.8	21.4	22.1	23.4	18.4
15	3.1	20.8	25.6	29.6	19.8	6.8	15.8	22.0	23.1	16.9
25	2.4	18.0	24.2	29.9	18.6	7.0	15.1	19.4	22.7	16.1
Mean	2.7	19.3	27.0	30.6		6.4	16.9	21.0	22.5	
CD (P=0.05)	Zn=1.4; P=1.3; Zn x P = 2.8					Zn = 1.5; P=1.4; Zn X P = 3.0				

Table 2. Effect of zinc and phosphorus on grain and straw yields (g pot^{-1}) of rice

Levels of Zn (mg kg^{-1} soil)	Zn uptake levels of P (mg kg^{-1} soil)					P uptake levels of P (mg kg^{-1} soil)				
	0	25	50	100	Mean	0	25	50	100	Mean
0	0.38	1.20	1.73	1.73	1.26	1.40	13.82	32.57	44.68	23.12
5	0.48	1.39	1.84	1.97	1.42	2.00	16.18	36.23	47.79	25.55
10	0.55	1.78	2.17	2.15	1.66	2.47	17.95	36.05	45.40	25.47
15	0.60	1.36	1.99	1.81	1.44	2.51	17.57	32.75	42.18	23.75
25	0.64	1.22	1.63	1.86	1.33	2.58	15.82	30.40	41.18	22.49
Mean	0.53	1.39	1.87	1.91		2.19	16.27	33.60	44.25	
CD (P=0.05)	Zn=0.17; P=0.10; Zn x P = 0.27					Zn = 2.00; P=1.79; Zn X P = 2.70				

study, Verma and Tripathy (1986) and Ahmed *et al.* (1989) also reported a beneficial effect of Zn upto 10 mg kg^{-1} soil when combined with P addition in rice.

Zinc uptake showed a significant rise upto 10 mg Zn kg^{-1} level while P uptake increased concomitantly with P addition (Table 2). Phosphorus addition also significantly influenced the total Zn uptake. The interaction revealed that the uptake of Zn increased only upto 10 mg kg^{-1} over the P treatment. Phosphorus uptake although increased upto 10 mg Zn kg^{-1} level, a decrease in P uptake was noted at higher levels of Zn, irrespective of P levels barring control. In the present study, the antagonistic effect of Zn X P interaction in terms of decline in yield as well as the uptake of both the nutrients was evident at the highest levels of their addition. Gangwar et al. (1974) from a field experiment on rice opined that higher levels of P application might tend to make the plant to accumulate lesser quantity of Zn. Several workers (Kulkarni and Chavan, 1985; Duraiswamy *et al.* 1986) have also reported P-Zn antagonism.

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