

## EFFECT OF ZINC NITROGEN AND PHOSPHORUS ON THE YIELD AND UPTAKE OF ZINC BY WHEAT IN LOAMY SAND SOIL

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### ABSTRACT

In a field experiment, effect of zinc fertilization (0, 2.5, 5.0, 7.5, 10.0, and 12.5 kg Zn ha<sup>-1</sup>) was studied at two levels of nitrogen (60 and 120 kg N ha<sup>-1</sup>) and three levels of phosphorus (0, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) on the yield and uptake of zinc by wheat (Cv. Kalyan Sona) in an alkaline loamy sand soil having low contents of available nitrogen, phosphorus and zinc. A positive significant interaction of N, P and Zn on the grain and straw yield of wheat was observed. The optimum dose of N, P<sub>2</sub>O<sub>5</sub> and Zn was found to be 120, 60 and 10 kg ha<sup>-1</sup>, respectively. Zinc uptake by wheat crop increased with an increase in the levels of applied N, P and Zn.

### INTRODUCTION

In soils containing low or marginal supply of available zinc, application of nitrogen and phosphorus fertilizers have been reported to aggravate zinc deficiency problem (Randhawa and Nayyar 1982; Tisdale et al. 1985). Sandy soils, which occur extensively in arid and semi-arid tract of Rajasthan, are invariably low in N and P availability whereas, zinc supply is either low or marginal (Lal 1989). In the sandy soils of Jobner tract, in a pearl millet-wheat cropping system, continuous application of N, P and K fertilizers resulted in severe zinc deficiency (Lal 1989). Since, no information was available on this aspect, it was thought worthwhile to investigate response of wheat crop to zinc fertilization in a coarse textured soil of Rajasthan at different levels of nitrogen and phosphorus to work out its zinc requirement.

### MATERIAL AND METHODS

A field experiment was conducted in an alkaline (pH 8.0) loamy sand soil of Agronomy Farm, S. K. N. College of Agriculture, Jobner (Rajasthan) during the Rabi season of 1982-83. The experimental soil contained 0.16% organic carbon,

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16.2 kg ha<sup>-1</sup> available P<sub>2</sub>O<sub>5</sub>, 140.5 kg K<sub>2</sub>O ha<sup>-1</sup> and 0.42, 0.65, 5.5 and 9.1 ppm of DTPA extractable Zn, Cu, Fe, and Mn, respectively.

In a split plot design experiment, the main plot treatments consisted of two levels of nitrogen (60 and 120 kg N ha<sup>-1</sup>) and three levels of phosphorus (0, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and sub-plot treatments were six levels of zinc (0, 2.5, 5.0, 7.5, 10.0 and 12.5 kg ha<sup>-1</sup>). The 60 kg K<sub>2</sub>O ha<sup>-1</sup> was applied as a basal dose. Wheat crop (Cv. Kalyan Sona) was grown to maturity and grain and straw yield recorded after harvest of the crop. Grain and straw samples were washed successively with tap water and to lots of glass distilled water and dried at 70°C. Dried samples were ground in a stainless steel grinder. The powdered grain and straw samples were digested in a diacid mixture (4 : 1, HNO<sub>3</sub> and HClO<sub>4</sub>) and in the digest zinc content was estimated on Atomic Absorption Spectrophotometer.

### RESULTS AND DISCUSSION

Average grain and straw yield of wheat consistently increased with the increase in the levels of applied N and P but with Zn the increase was observed only up to 5 kg Zn ha<sup>-1</sup> which is at par with 7.5 kg Zn ha<sup>-1</sup> and thereafter a significant decrease was observed (Table 1). The average increase in the grain yield under 5 kg Zn ha<sup>-1</sup> treatment is 13.6% over zero kg Zn ha<sup>-1</sup>. Positive significant effect of applied N, P and Zn on the wheat yield is attributed to low supply of these nutrients in the experimental soil. The adverse effect of higher dose of Zn might be due to imbalance of zinc with iron nutrition of crop as the experimental soil was marginal in available Fe.

Interactive effect of N, P and Zn was found to be significant and produced a maximum yield of 38.02 and 61.63 q ha<sup>-1</sup> of grain and straw of wheat under the treatment 120, 60 and 10 kg ha<sup>-1</sup> of N, P<sub>2</sub>O<sub>5</sub> and Zn, respectively as compared to 28.52 and 46.22 q ha<sup>-1</sup> under 120, 60 and 0 kg ha<sup>-1</sup> of N, P<sub>2</sub>O<sub>5</sub> and Zn. This is attributed to balanced fertilization with respect to all the three growth limiting plant nutrients in this sandy soil. A consistent increase in the uptake of Zn by wheat crop with the increase in the levels of applied zinc amply substantiates this fact.

Zinc requirement of wheat crop increased with the increase in N and P on account of stimulation of plant growth resulting in higher uptake of Zn. At 60 kg N ha<sup>-1</sup>, application of 2.5 and 5.0 kg Zn ha<sup>-1</sup> was found to be sufficient at 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, respectively, which increased to 7.5 and 10 kg Zn ha<sup>-1</sup> under 120 kg N ha<sup>-1</sup> at the same levels of phosphorus. Thus, 10 kg Zn ha<sup>-1</sup> was found to be the optimum dose at 120 and 60 kg ha<sup>-1</sup> of N and P. The higher rate of zinc required could be ascribed to very low level of DTPA - Zn in the experimental soil. The experimental soil contained DTPA extractable Zn which is much below critical limit

Table 1. Effect of nitrogen, phosphorus and zinc on the grain, straw yield and zinc uptake by wheat

Zn (kg ha <sup>-1</sup> )	60 kg N ha <sup>-1</sup> (N <sub>1</sub> )			120 kg N ha <sup>-1</sup> (N <sub>2</sub> )			Average for Zn
	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )			P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )			
	0 (P <sub>0</sub> )	40 (P <sub>1</sub> )	60 (P <sub>2</sub> )	0 (P <sub>0</sub> )	40 (P <sub>1</sub> )	60 (P <sub>2</sub> )	
0.0	17.9	19.8	20.5	24.1	26.6	28.5	22.9
2.5	18.8	20.9	21.7	26.6	28.8	31.4	24.7
5.0	18.1	21.9	23.7	26.9	31.4	34.0	26.0
7.5	17.2	19.4	24.5	26.5	33.7	36.7	26.3
10.0	16.0	17.2	22.8	25.6	31.4	38.0	25.1
12.5	14.6	16.4	21.7	23.7	29.1	36.4	23.7
Average							
CD 5%							
	Grain yield (q ha <sup>-1</sup> )						
	N 19.6, N <sub>2</sub> -30.0, P <sub>0</sub> -21.3, P <sub>1</sub> -24.7, P <sub>2</sub> -28.3						
	N 0.3; P-0.4; Zn-0.4;						
	Straw yield (q ha <sup>-1</sup> )						
0.0	29.6	32.1	32.8	38.6	44.0	46.2	37.2
2.5	31.1	33.9	34.7	42.6	47.5	50.9	40.1
5.0	30.0	35.6	37.9	43.2	52.0	55.1	42.3
7.5	28.4	31.4	30.2	42.6	55.6	59.5	42.8
10.0	26.5	27.8	36.5	41.0	51.9	61.6	40.9
12.5	24.2	26.6	34.7	38.0	48.1	59.0	38.4
Average							
CD 5%							
	Zinc uptake (g ha <sup>-1</sup> )						
	N <sub>1</sub> -31.8; N <sub>2</sub> -48.7; P <sub>0</sub> -34.6; P <sub>1</sub> -40.5; P <sub>2</sub> -45.7						
	N 0.5; P-0.6; Zn-0.7						
0.0	109.9	95.4	83.9	113.8	124.8	108.7	109.4
2.5	129.4	118.4	106.7	161.7	153.6	140.0	134.9
5.0	140.2	142.3	138.8	180.7	191.1	192.2	164.2
7.5	152.3	140.7	163.4	199.4	224.6	226.1	184.4
10.0	125.7	143.5	166.7	206.5	231.3	266.3	190.0
12.5	149.7	146.1	175.8	200.8	229.2	271.1	195.4
Average							
CD 5%							
	: N <sub>1</sub> 134.9; N <sub>2</sub> -188.3; P <sub>0</sub> -157.5; P <sub>1</sub> -161.8; P <sub>2</sub> -170.1						
	: N 3.1; P-3.9; Zn-4.9						

of 0.5 ppm suggested by various investigators (Brown et al. 1971 and Lindsay and Norvell 1978). The low content of available Zn in the experimental soil appears to be due to its high pH (8.0), low organic matter content and coarse texture which are conducive to deficiency of zinc for crop growth as these factors affect both intensity and quantity parameters of availability of Zn in soil.

Zinc deficiency is more common in the pH range of 6.0 to 8.0 (Tisdale et al. 1985). Zinc is absorbed by the plants as  $Zn^{2+}$ . For each unit increase in pH a hundred-fold decrease in the solubility of zinc has been reported by these authors which is due to formation of insoluble compounds such as  $Zn(OH)_2$  and  $ZnCO_3$ . Fixation of Zn by soil constituents including clay minerals of Al, Fe and Mg also increases markedly with the increase in pH. In very sandy soils organic matter may represent both the immediate reserve of many plant nutrients in addition of N and the factor determining concentration of many of the nutrient ions in solution through its solubilization and chelation effect.

The present study, although of preliminary nature, reveals that in sandy soils, the nutrient element Zn is likely to act as limiting factor in controlling response of wheat and other crops to N and P fertilization and a balanced application of all the three nutrients would be a key to success in boosting crop production in such soils.

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