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ZINC-PHOSPHORUS INTERACTION ON GROWTH AND NUTRIENT UPTAKE BY MAIZE *(ZEA MAYS* L.)

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ABSTRACT

Field experiment on zinc-phosphorus interaction on the yield and quality of maize (*Zea mays*L.) was undertaken in kharif 1985 on silty clay loam soil. An increase in the level of zinc upto 45 kg $ZnSO_4$ ha^{-1} and phosphorus upto 30 kg P ha^{-1} have increased their available status in soil. Foliar spray of zinc at 15 kg $ZnSO_4$ ha^{-1} in conjunction with phosphorus at 30 kg P ha^{-1} gave significantly higher grain and stalk yield, nutrient uptake and quality of the maize crop. Foliar spray of zinc is superior mode of zinc fertilization.

INTRODUCTION

Despite cultivations of high yielding maize (*Zea mays* L.) genotypes and adoption of improved management practices, increase in crop yields per unit area is low. Imbalance and inadequate fertilization is one of the major constraint in achieving good yield of maize. Further, out of Zn and P, any one can decrease the availabilty of the other one (Hulagur et al. 1975). Looking to the importance of the zinc in plant nutrition, field experiment was conducted to assess the interrelationship of zinc and phosphorus in maize CV Ganga-5.

MATERIAL AND METHODS

A field experiment on maize (CV Ganga-5) was conducted in kharif, 1985. The soil of the experimental field was silty clay loam having pH 8.3, EC 0.85 dSm^{-1}, $CaCO_3$ 1.6%, organic carbon 0.6%, available phosphorus 11 kg P ha^{-1}, available potash 143 kg K ha^{-1} and available zinc 0.76 ppm.

Six levels of zinc, four as soil application (0, 15, 30 and 45 kg $ZnSO_4$ ha^{-1}) and two as foliar spray (15 and 30 kg $ZnSO_4$ ha^{-1}) in conjunction with three levels of phosphorus (0, 15 and 30 kg P ha^{-1}) were replicated thrice in a plot size of 4 x 2.5 m in a randomized block design. Under soil application zinc sulphate and phosphatic fertilizer as per the treatment were drilled separately in the soil at sowing. Zinc sulphate solution (0.5 per cent with 0.25 per cent lime neutralizer) was sprayed

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in three splits at knee height, jointing and tasseling stage i.e. at 40, 50 and 60 days of crop growth. Basal dose of 40 kg N ha^{-1} and 35 kg K ha^{-1} was given at the time of sowing. Top dressing of 40 kg N ha^{-1} was done at 40 days of crop growth.

Crop was harvested at maturity (115 days of crop growth). Grain and stalk samples were drawn from all the treatments and analysed for nitrogen, phosphorus, potassium and zinc contents. Soil samples were drawn to assess the available zinc and phosphorus status of the soil. Soil pH, organic carbon, available phosphorus and potash and content of N, P and K in plant were determined by the procedures outlined by Jackson (1967). DTPA extractable Zn in soil (Lindsay and Norvell, 1978) and plant zinc was estimated using AAS (Atomic Absorption Spectrophotometer).

RESULTS AND DISCUSSION

Soil application of zinc upto 45 kg $ZnSO_4$ ha^{-1} recorded a significant increase in its available status of the soil (Table 1). Zinc fertilization either as soil or foliar spray had no effect on the available phosphorus status of the soil. However, phosporus fertilization of the soil decreased the available zinc and increased the available phosphorus status of the soil. Increase in the available zinc as a result of Zinc fertilization and decrease as a consequence of phosphorus fertilization of the soil is an outcome of zinc-phosphorus inter-relationship (Choudhary and Totawat, 1985).

Table 1. Effect of zinc and phosphorus fertilization on their available status in the soil

Treatments	Available nutrient status	
	Zinc (mg kg^{-1})	Phosphorus (kg P ha^{-1})
Initial value	0.8	11.3
Soil application (kg $ZnSO_4$ ha^{-1})		
0	0.8	15.7
15	0.8	16.1
30	1.1	16.4
45	1.2	16.5
Foliar spray (kg Zn SO_4 ha^{-1})		
15	0.8	16.6
30	0.8	16.9
CD 5%	0.02	NS
Phosphorus (kg P ha^{-1})		
0	0.9	15.6
15	0.8	16.4
30	0.8	17.1
CD 5%	0.02	0.44

Foliar spray of zinc @ 15 kg $ZnSO_4$ ha^{-1} resulted in significantly highest grain and stalk yield of maize (Table 2). Soil application of zinc upto 45 kg $ZnSO_4$ ha^{-1} and phosphorus upto 30 kg P ha^{-1} have consistently increased both grain and stalk yields. A significant increase in yield of grain and stover of cereal crops as result of zinc fertilization in soil as well as foliar spray has also been reported by Choudhary and Totawat (1985), Maliwal et al. (1985) and Chugh et al. (1989).

Table 2. Zn-P interaction effect on grain and stalk yield of maize

Phosphorus levels kg P ha^{-1}	Zinc treatments (kg $ZnSO_4$ ha^{-1})						
	Soil application				Foliar spray		Mean
	0	15	30	45	15	30	
	GRAIN YIELD (t ha^{-1})						
0	1.4	1.7	1.9	2.2	2.3	2.2	2.0
15	1.8	1.9	2.2	2.5	3.0	3.1	2.4
30	1.8	2.1	2.4	3.1	3.3	3.4	2.6
Mean	1.7	1.9	2.2	2.6	2.9	2.9	
	Zn		P		Zn x P		
CD 5%	0.22		0.15		0.38		
	STALK YIELD (t ha^{-})						
0	3.0	2.6	3.5	2.7	4.2	5.1	3.5
15	3 1	4.4	4.6	4.6	4.5	5.1	4.4
30	3.2	4.5	5.1	5.2	6.5	6.6	5.0
Mean	3.1	3.9	4.4	4.5	5.1	5.2	

The maize crop responded to zinc fertilization though in soil the DTPA extractable zinc was 0.76 ppm indicating the soil under study is marginal in available zinc. A response to zinc application in soil having DTPA extractable Zn more than 0.65 ppm for wheat (Choudhary and Totawat 1985; Singh and Singh 1989), and critical limit of 1.4 ppm for maize and 1.6 ppm for rice have been reported by Gangwar and Chandra (1976).

Foliar spray of 15 kg $ZnSO_4$ ha^{-1} in conjunction with 30 kg p ha^{-1} in soil recorded significantly higher grain and stalk yield of maize as compared to all other soil treament combinations except 45 kg $ZnSO_4$ along with 30 kg P ha^{-1}. Thus showing a definite superiority of application of zinc as foliar spray. Phosphorus fertilization of the crop resulted into more proliferated root system and thereby increasing the growth of plant making them more responsive to the zinc applied as foliar spray (Brown et al. 1970).

Zinc and phosphorus fertilization have significantly increased the uptake of of nitrogen, phosphorus, potassium and zinc by maize (Table 3). However, such increases in nutrient uptake by zinc fertilization in soil was significant only upto 30 kg $ZnSO_4$ ha^{-1} level except uptake of nitrogen which significantly increased upto 45

Table 3. Zn-P interaction effect on nutrient uptake by maize (kg ha^{-1})

Phosphorus levels (kg P ha^{-1})	Zinc treatments (kg Zn SO_4 ha^{-1})						
	Soil application				Foliar spray		Mean
	0	15	30	45	15	30	
NITROGEN							
0	38.1	49.1	60.4	63.0	84.4	98.3	65.5
15	57.3	76.5	87.6	96.1	113.3	140.3	95.2
30	63.4	87.2	123.9	150.8	186.3	172.7	130.7
Mean	52.9	71.0	90.6	103.3	128.0	137.1	
		Zn		P		Zn x P	
CD 5%		8.8		5.4		3.5	
PHOSPHORUS							
0	12.2	11.5	14.9	12.6	14.8	18.2	14.0
15	16.3	20.0	21.6	21.2	18.0	22.5	19.9
30	18.4	23.6	25.7	26.9	24.9	25.8	24.3
Mean	15.6	18.4	20.2	20.2	19.2	22.0	
		Zn		P		Zn x P	
CD 5%		2.4		1.7		1.4	
POTASSIUM							
0	88.2	135.5	145.6	140.0	169.6	158.0	106.2
15	88.2	136.8	147.4	141.1	171.4	158.6	146.2
30	88.3	139.5	149.5	142.0	175.4	159.6	169.7
Mean	88.2	137.3	147.5	141.0	171.5	158.8	
		Zn		P		Zn x P	
CD 5%		0.06		0.03		0.18	
ZINC							
0	0.13	0.13	0.16	0.14	0.20	0.24	0.17
15	0.15	0.20	0.21	0.22	0.24	0.27	0.21
30	0.15	0.22	0.25	0.27	0.33	0.28	0.25
Mean	0.14	0.18	0.21	0.21	0.26	0.26	
		Zn		P		Zn x P	
CD 5 %		0.01		0.01		0.01	

kg $ZnSO_4$ ha^{-1} level. Foliar spray of zinc has shown superiority in improving the nutrient uptake and quality of maize. Increase in phosphorus level has significanty increased Zn uptake by maize. Zinc fertilization alone or in combination with phosphorus has significantly increased the uptake of nitrogen, potassium and zinc by maize. Significantly highest uptake of nitrogen, potassium and zinc was recorded when 15 kg $ZnSO_4$ ha^{-1} was sprayed in conjunction with soil application of 30 kg P ha^{-1}. An increased total uptake of zinc and nitrogen with increasing levels of zinc have also been reported by Patel and Patel (1988). Similarly, the highest uptake of nutrient as a consequence of foliar spray of zinc in conjunction with phosphorus have also been

reported by Choudhary and Totawat (1985) and Raj Gopal and Mehta (1971). The increased uptake of nutrient has resulted in higher maize grain yield as is evident from the significant correlation (r) between nitrogen, phosphous, potasium and zinc uptake and maize grain yield (r = 0.93, 0.68, 0.85 and 0.90 respectively).

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