https://doi.org/10.29321/MAJ.10.A02686

Madras agric. J. 69 (1) : 11-16, Jan., 1982

Effect of Zinc, Copper and Phosphorus Fertilization on the Uptake of Iron, Manganese and Molybdenum by Hybrid Maize*

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The laboratory experiment was conducted using the loamy sand of Anand to Study the effect of applied Zn, Cu, and heavy doses of P on the content and uptake of Fe, Mn and Mo by Hybrid Maize (Ganga-5). Addition of Zn reduced Fe and Mn content of maize plant. Application of Cu decreased the uptake of iron, manganese and molybdenum. While P-fertilization decreased Fe, increased Mn and Mo uptake when studied exclusive of other factors.

Availability of micronutrients to crops is an intricate phenomenon. Addition of one micronutrient renders the other less available by several complex reactions that take place in the soil (Tisdale and Nelson, 1970). Of recent, Zn fertilization to maize is common owing to its high susceptibility to Zn deficiency. These nutrients possibly create imbalance in the nutrition of the crop as a whole. Herein it is attempted to study the effects Zn, Cu and P fertilization on the uptake of Fe, Mn and Mo by maize crop.

MATERIAL AND METHODS

A loamy sand soil collected from the Agronmy farm of Agricultural College, Anand, having pH 7.4; total N, 0.033%; Org. C, 0.26%; available P, Zn and Cu respectively with 7.2, 1.65 and 0.26 ppm; exchangeable K, Fe and Mn with 0.015%, 8.0 and 6.3 ppm and easily reducible Mn with 61 ppm was used for the study. Four kg portions of Processed soil were placed in polythene - lined earthen pots. The treatments consisted of (i) 3 levels of Zn (0, 5, 10 ppm) in the form of $ZnSO_4 . 7H_2O$ (ii) 3 levels of Cu (0, 5, 10 ppm) in the form of $CuSO_4 . 5H_2O$ and (iii) 3 levels of P_2O_5 (50, 100, 500 ppm) in the form of KH_2PO_4 and their 27 combinations were replicated thrice. A basal dose of N at the rate of 120 ppm in the form of $(NH_4)_2 SO_4$ was given in two equal splits, (i) Prior to sowing and (ii) 30 days after sowing.

Four maize (Ganga—5) plants in each pot were raised. Plants were harvested after 46 days, state at which plants take up maximum nutrients.

* Part of the M. Sc. (Agri.) Thesis submitted by the Senior auther to the GAU, Ahmedabad

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washed with glass-distilled water. Plant material was dried at 70°C, weighed and ground to fine powder. Content of Fe, Mn and Mo in the sample were detemined by employing colorimetric methods as outlined by Jackson (1958), willard and Greathouse (1917) and Johnson and Arkley (1954) respectively.

RESULTS AND DISCUSSION

The data in Table I indicate that the graded levels of Zn, Cu and P fertilization have decreased the Fe content whereas its uptake was increased due to increase in the yield (Hulagur. *et al.*, 1975). Though there was reduction in the content of Fe there was considerable improvement in uptake owing to increase in the yield on Zn application. The iron chlorosis in corn and millet (Brown and Tiffin, 1962) and low content of Fe in Sorghum (Mahendra Singh and Yadav, 1980) were also noticed due to Zn fertilization.

The content of Mn in maize plant was significantly reduced (Table II) due to the application of Zn, Cu and P at different levels. The lowest concentration of Mn was noticed at 5 and 10 ppm of Zn and Cu respectively. The lower content of Mn in the new flush of citrus (Labahauska *et al.*, 1963) and in sorghum (Mahendra Singh and Yadav, 1980) were attributed on account of Zn and Cu feeding respectively. With regard to uptake of Mn, there were no significant changes on feeding the plant with any of the nutrients except P which has significantly reduced Mn uptake at 500 ppm indicating the inverse relationship between P and Mn when applied with Zn. However, P-fertilization alone increased the Mn content. Similar findings were reported by Larsen (1964) and Mehta and patel (1969).

Zinc application did not affect the content and uptake of Mo where as Cu fertilization decreased both the content and uptake of Mo (Table III). The content was lowered by 18 and 51 per cent respectively at 5 and 10 ppm of Cu Such an antagonistic relationship between Cu and Mo has also been observed in wheat at Ludhiana (Anon, 1972). Bull (1951) and Mackay *et al.* (1966) opined similar antagonistic relationship between Cu fertilization and Mo uptake. Addition of P significantly increased both the content and uptake of Mo. Increase in the Mo content was 5.78 per cent and 10.27 per cent due to the increased levels of P from 50 to 100 ppm and 50 to 500 ppm respectively. Barshad (1951) suggested that the stimulating effect of the phosphate ions may lie in the formation of a complex 'Phosphomolybdate' which is absorbed more easily by the plant than molybdate anion alone.

The foregoing article enlights the effect of applied micronutrients on the uptake and content of other

minerals by maize plants and thus enabling to understand the balancing of maize nutrition for higher yields.

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TABLE I Iron content and uptake by maize under different levels of Zn, Cu and P (Mean of 3 replications)

	Cu_0			Cu_1			Cu_2			Mean Values		
	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	P	Zn	Cu
					Content (ppm)							
P_1	1254	476	461	1247	476	476	1280	476	463	731	790	714
P_2	618	752	764	590	752	726	583	743	753	698	667	703
P_3	543	778	779	552	779	758	512	776	756	689	660	701
					Uptake (mg/pot)							
P_1	18.28	8.18	7.74	18.00	7.88	7.86	19.17	9.56	8.52	11.65	10.91	12.18
P_2	8.92	12.96	14.71	8.79	13.94	14.68	8.00	14.86	15.82	12.52	13.00	12.29
P_3	6.13	14.69	18.30	6.69	17.06	15.68	4.19	17.93	18.72	13.67	13.53	12.98

		Zn	Cu	P	Zn × Cu	Zn × P	Cu × P	Zn × Cu × P
C. D. at 5% :	Content	92	NS	NS	NS	161	NS	NS
	uptake	0.62	NS	0.62	1.08	1.08	1008	NS
S. Em :	Content	33				± 58		± 100
	uptake	± 0.224				± 0.39		± 0.681

TABLE II Manganese content and uptake by maize under different levels of Zn, Cu and P (Mean of 3 replications)

	Cu_0			Cu_1			Cu_2			Mean values		
	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2
						Content (ppm)						
P_1	35.9	25.0	24.9	30.5	28.2	29.2	26.2	23.1	27.9	27.9	32.7	27.0
P_2	37.2	19.9	24.4	32.1	23.1	24.6	27.6	22.4	24.4	26.2	21.8	26.8
P_3	37.9	17.9	19.3	33.4	16.7	23.8	33.4	16.2	25.4	24.1	23.8	24.4
						Uptake (μg/pot)						
P_1	530	428	415	443	469	477	402	466	512	460	436	437
P_2	530	342	468	480	426	498	380	444	509	453	420	452
P_3	441	345	436	429	366	491	288	493	581	408	465	431

		Zn	Cu	P	Zn × Cu	Zn × P	Cu × P	Zn × Cu × P
C. D. at 5%	Content	2.13	2.13	2.13	3.71	3.71	NS	NS
	Uptake	NS	NS	37	NS	NS	64	NS
S. Em	Content		± 0.77		± 1.34		± 2.32	
			±13.7		±23.2		±41.3	

TABLE III. Molybdenum content and uptake of maize under different levels of Zn, Cu and P (Mean of 3 replications)

	Cu_0			Cu_1			Cu_2			Mean values		
	Zn_0	Zn_1	Zn_2	Zn_1	Zn_2	Zn_0	Zn_0	Zn_1	Zn_2	P	Zn	Cu
						Content (ppm)						
P_1	0.64	0.54	0.54	0.39	0.36	0.39	0.26	0.26	0.26	0.40	0.42	0.57
P_2	0.58	0.58	0.55	0.42	0.41	0.41	0.28	0.28	0.28	0.42	0.42	0.41
P_3	0.60	0.62	0.60	0.43	0.43	0.42	0.29	0.29	0.28	0.44	0.41	0.28
						Uptake (μg/pot)						
P_1	7.96	9.29	8.78	5.64	6.56	6.44	4.06	5.30	4.79	6.54	6.02	10.01
P_2	8.35	9.83	10.63	6.19	7.69	8.36	3.92	5.58	5.94	7.39	8.07	7.18
P_3	10.03	11.78	13.47	5.54	9.45	8.78	2.45	7.18	7.05	8.41	8.25	5.14

		Zn	Cu	P	Zn × Cu	Zn × P	Cu × P	Zn × Cu × P
C. D. at 5%	Content	NS	0.007	0.007	NS	NS	0.01	NS
	Uptake	0.69	0.69	0.69	NS	1.19	NS	NS
S. Em	Content		± 0.003			± 0.004	± 0.0075	
	Uptake		± 0.25			± 0.43	± 0.74	