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INFLUENCE OF CADMIUM-SULPHUR INTERACTION ON GROWTH AND NUTRIENT CONCENTRATION OF WHEAT (*TRITICUM AESTIVUM* L.) IN ARIDISOLS

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ABSTRACT

Investigations carried out in screen house to study the influence of 0, 20, 40, 60, 80 and 120 μg S/g soil; and 0, 5, 10, 20, 40 and 80 μg Cd/g soil on growth and nutrient concentration of wheat was investigated in screen house. Cadmium application repressed and S improved wheat dry matter yield. The depressing effect of Cd on shoot dry matter yield was alleviated by S application. Addition of Cd decreased P, K, Cu, Mn and Zn concentration and enhanced Fe content in wheat shoot. Sulphur application markedly improved P,K, Mn, Cu and Fe concentration but decreased Zn concentration.

INTRODUCTION

Environmental pollution with Cd in plants and soil is a matter of great concern. The industrial effluents, certain agricultural chemicals and municipal wastes are important sources of Cd emission into the atmosphere. Excess Cd influences the availability of Zn, Cu, Mn, Fe (Cataldo et al. 1983) and K (Keek 1978). Supplementation with essential plant nutrients on the other hand may modify the effect of Cd on plant growth and nutrient concentration. Such studies are lacking in the literature. Keeping in view the importance of Cd as a toxic element and that of S as an essential plant nutrient, the present investigation was conducted to study the influence of Cd and S on growth and nutrient concentration of wheat shoot.

MATERIAL AND METHODS

A loamy sand soil (Typic Ustipsamment) of pH 8.0, EC 0.26 dSm^{-1}, O.C. 0.18%, available P 6μg/g and DTPA extractable Cd in non detectable amount was used for screen house investigations, The sun dried soil was filled in clay pots @ 4 kg/pot. Treatments consisted of 0, 20, 40, 60, 80 and 120 μg S/g soil and 0, 5, 10, 20, 40 and 80, μ Cd/g soil and their combinations as $(NH_4)_2SO_4$ and $CdCl_2$ respectively. Each treatment was replicated thrice and randomised completely. A basal dose of 100 μg N/g, 50 μg P/g, 50 μg K/g and 5μg Zn/g soil was added in solution form and mixed thoroughly with the soil. A second dose of 50 μg N/g soil was given after 30 days of sowing. Ten seeds of wheat variety WH-147 were sown in each pot, which were later on thinned to six and grown for 65 days. After harvesting, drying and grinding the plant samples were digested in a diacid mixture of HNO_3 : $HClO_4$ (5:1). Phosphorus and potassium in plant samples were determined by standard procedures Zinc, Cu, Mn, Cd and Fe were estimated with the Atomic Absorption Spectrophotometer (GBC 902). Available Cd was estimated in DTPA soil extract (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

Shoot yield

Application of Cd decreased the dry matter yield of wheat shoot from 5.4 g/pot in control to 730 mg/pot at 80 μg Cd/g soil in the absence of applied S (Fig. 1).

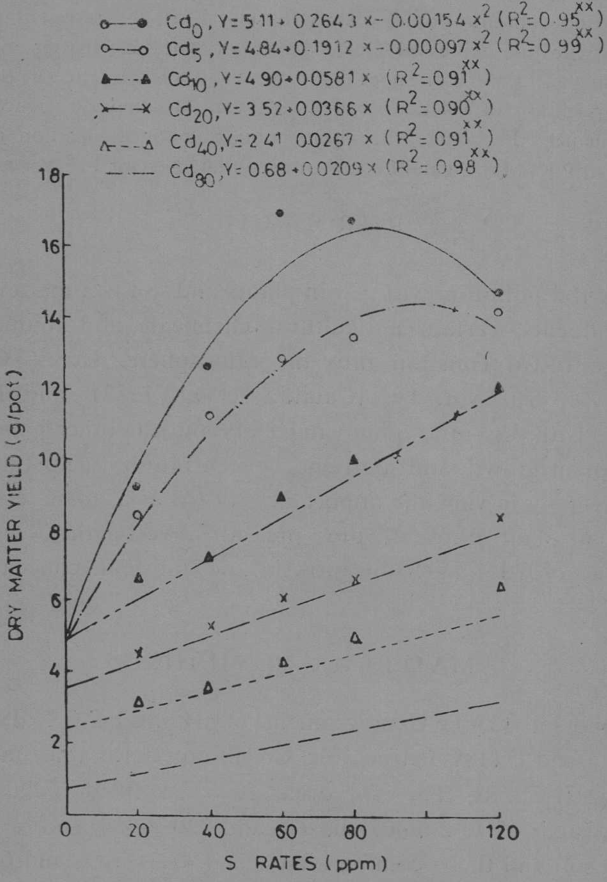

FIG.1-DRY MATTER YIELD OF WHEAT AS INFLUENCED BY Cd AND S APPLICATION

The reduction at 5 μg Cd/g was marginal. Application of 60 and 120 μg S/g soil resulted in 214 and 172 per cent increase in yield respectively, when compared with that of 0-sulphur. The shoot yield increased significantly upto 60 μg S/g soil, yield declined at 80 and 120 μg S/g soil. In the absence of S application treatments with 5 and 20 μg Cd/g soil suppressed the yield by 15 and 46 per cent, respectively. The magnitude of yield reduction due to Cd application was diluted by S at 20 μg S/g soil. The reduction in shoot yield due to Cd application (Gupta et al. 1988) is attributed to the phytotoxic effect of Cd (Haghiri 1973). With Cd application roots are damaged severely.

Phosphorus concentration

In the absence of added Cd, application of 20, 40, 60 and 120 μg S/g soil enhanced tissue P concentration by 3.3, 7.5, 11.3 31.4 and 70.7 per cent respectively over and above that with no S application (Table 1). A significant increase in P concentration of wheat shoot due to S application might be due to enhanced availability of P resulting from the exchange reaction and reduction in rhizosphere pH. Our results are in agreement with the findings of Virmani and Gulati (1971) and Nuttal (1985) albeit with other crops.

Table 1 Effect of Cd and S on P, K, Zn, Cu, Mn and Fe concentration of wheat shoot

S applied μg/g	Cd applied μg/g						
	0	5	10	20	40	80	mean
			Phosphorus Per cent				
0	0.24	0.20	0.17	0.15	0.14	0.12	0.17
20	0.24	0.21	0.18	0.16	0.15	0.13	0.18
40	0.25	0.23	4.19	0.17	0.16	0.14	0.19
60	0.26	0.24	0.21	0.17	0.17	0.15	0.20
80	0.31	0.29	0.26	0.24	0.22	0.18	0.25
120	0.40	0.37	0.34	0.32	0.30	0.24	0.33
mean	0.23	0.25	0.22	0.20	0.19	0.16	
			Potassium Per cent				
0	1.77	1.67	1.62	1.54	1.51	1.49	1.60
20	1.83	1.73	1.66	1.58	1.55	1.53	1.64
40	1.87	1.85	1.71	1.62	1.60	1.58	1.71
60	2.00	1.94	1.80	1.70	1.68	1.63	1.80
80	2.18	2.14	2.02	1.97	1.86	1.69	1.98
120	2.52	2.25	2.18	2.10	1.96	1.82	2.14
mean	2.03	1.93	1.83	1.75	1.69	1.62	—

C.D. 5%	P	K
Cd and S level Mean	0.003	0.02
Cd X S	0.007	0.06

The concentration of P in wheat shoot decreased due to Cd treatment. This antagonistic effect of Cd on P absorption was perhaps arising from the formation of insoluble $Cd_3(PO_4)_2$ either in the soil or in the root cells. Possibly formation of $Cd_3(PO_4)_2$ restricted the translocation of P to the wheat tops (Lin et al. 1975).

Potassium concentration

Application of S both in the presence as well as in absence of Cd enhanced K concentration in wheat shoot (Table 1). The increased concentration of K by S application is attributed to greater absorption of K as a consequence of S (Aulakh and Pasricha 1978). Application of Cd resulted in significant reduction of K concentration (Keek 1978).

Table 2. Influence of Cd and S application on concentration of Zn,Cu, Mn and Fe (μg/g) in wheat shoot

S applied μg/g	Cd applied, μg/g						
	0	5	10	20	40	80	mean
				Zinc			
0	46.8	48.8	43.0	36.7	34.8	32.3	40.4
20	45.3	46.7	41.3	35.2	32.7	29.8	38.5
40	43.0	45.3	39.7	33.2	30.3	27.8	36.6
60	41.0	43.3	36.6	31.0	27.3	24.3	33.8
80	38.7	39.3	33.7	28.7	24.3	21.8	31.1
120	34.7	37.3	31.0	26.3	22.3	20·7	28.7
mean	41.6	43.4	37.5	31.8	28.6	22.6	—
				Iron			
0	100	108	113	119	139	160	122
20	115	122	130	138	148	191	141
40	136	142	160	168	183	203	165
60	149	165	172	181	200	223	182
80	159	174	183	196	205	232	191
120	163	187	197	204	213	241	201
mean	137	150	159	168	180	208	—
				Manganese			
0	33.3	37.3	34.7	30.7	24.0	20.0	29.9
20	39.7	44.3	40.7	38.2	29.2	26.3	36.4
40	43.0	46.7	44.3	41.8	31.2	28.0	39.4
60	45.2	48.0	45.3	43.0	34.2	30.8	41.1
80	48.3	52.3	47.8	45.0	38.2	33.3	44.2
120	52.2	55.0	49.2	46.7	39.5	36.3	46.5
mean	43.6	47.3	43.7	40.8	32.7	29.1	—
				Copper			
0	9.5	8.5	8.1	6.9	6.0	5.8	7.4
20	9.8	8.6	8.3	6.9	6.2	6.0	7.6
40	10.1	8.7	8.5	7.3	6.5	6.3	7.9
60	10.3	9.1	8.9	8.1	7.0	6.6	8.3
80	10.8	9.8	9.1	8.5	7.6	7.0	8.8
120	11.5	10.2	9.2	8.8	7.9	7.6	9.2
mean	10.7	9.1	8.7	7.8	6.8	6.5	—

C.D. 5%	Zn	Fe	Mn	Cu
Cd & S levels	0.4	3	0.5	0.18
Cd x S mean	1.0	7	1.2	NS

Zinc, Copper, Manganese, and Iron concentration

Application of S resulted in a significant increase in Mn, Cu and Fe concentration in wheat shoot (Table 2) which is attributed to enhanced availability of these nutrients caused by the acidifying effect of $(NH_4)_2 SO_4$ used in this study as a source of S. Gupta and Mehta(1980) made identical observation in berseem. Zinc concentration decreased as a result of S application which is ascribed to dilution effect caused by enhanced plant growth, besides; increased absorption of P due to P-Zn antagonism.

Application of 5 μg Cd/g soil enhanced Zn and Mn concentration in wheat shoot but higher rates of applied Cd alleviated Zn, Cu aud Mn content which could be attributed to ionic competition between Cd and these ions suggesting a common transport site or process (Cataldo et al. 1983). The depressing effect of Cd on Zn, Cu and Mn has also been reported by Gupta et.al. (1988) and Mahler et al. (1982). The interaction effect of Cd x S on Zn, Cu and Mn was also significant. Cadmium resulted in a significant increase in Fe concentration and severity of Chlorosis which resembled with Fe deficiency enhanced with increasing rates of Cd. Application of Cd perhaps hampered Fe metabolism and depressed Chlorophyll formation (Borges and Wollum 1981).

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