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Effect of Zinc Application on Yield and Cadmium Content of Spinach (*Spinacea oleracea* L.) Grown in a Cadmium-polluted Soil.

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Cadmium (Cd) is a toxic heavy metal causing respiratory, photosynthetic and structural disorders in plants at relatively low concentrations. Due to geo-chemical kinship, zinc (Zn) competes with Cd for absorption sites on the root surface of plants. Antagonistic effect of Zn on uptake of Cd by radish and bushbean has been reported (Lagerwerff and Biersdorf, 1972; Wallace *et al.*, 1980), though stimulation of Cd content of soybean by Zn has also been noted by Chaney *et al.* (1976). An attempt has been made in the present investigation to study the possibility of reducing the Cd poisoning of spinach by soil application of Zn.

Surface (0-15 cm) sample of an Ustipsamment loamy sand soil (pH 8.3, electricalconductance 0.4 dS/m, organic carbon 0.5%, calcium carbonate 0.7% and DTPA-extractable Zn 0.7 ppm and Cd 0.03 ppm) was polluted with Cd at the rate of 0.5, 1.0 2.0, 4.0 and 8.0 mg Cd/kg soil. Before filling in 5 kg capacity polyethylene-lined pots, both Cd treated and untreated portions of the soil were mixed with 2.5, 5.0 and 10.0 mg Zn/kg soil. All the treatments including a control were replicated three times. A basal dose of N, P and K at the rate of 60, 13 and 62 mg/kg soil using $CO(NH_2)_2$, KH_2PO_4 and KCl respectively was given to all the pots. Spinach was grown in the pots for 70 days. Dry matter yield was recorded. Dried plant samples were digested in a di-acid mixture ($HNO_3 : HClO_4 = 4 : 1$) and Cd and Zn were determined by atomic absorption spectrophotometry.

Dry matter yield and Cd content of spinach as influenced by increasing levels of Cd and Zn in the soil is given in Table 1. Increasing levels of Cd upto 8.0 mg/kg soil could reduce significantly the dry matter yield of spinach. At the highest of level Cd and when no Zn was applied, about 40% less dry matter yield of spinach was recorded than in no-Cd control. The corresponding increase in Cd content of spinach was from 0.6 to 38.4 μg/g. The detrimental effect of Cd on dry matter yield of spinach was due to its phytotoxic nature (Bazzaz *et al.* 1974; Les *et al.* 1976). In another study, Sadana and Bijay Singh (1988) could observe only 11% reduction in the dry matter yield of maize at 10 mg Cd/kg soil. Possibly spinach is more sensitive to Cd toxicity than maize.

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Table 1 Effect of increasing levels of Zn and Cd on dry matter yield and cd content of spinach.

Zn levels (mg/kg)	Cd levels (mg/kg)					
	0	0.5	1.0	2.0	4.0	8.0
			Dry matter yield (g/5kg soil)			
0	14.2	13.9	13.5	12.9	11.0	8.5
2.5	14.6	14.5	14 3	13 9	11.8	9.8
5 0	15.4	15.5	15.2	14.8	13.2	11.8
10.0	15.6	15.5	15.6	15.4	14.7	13.5
			Cd Content (μg/g)			
0	0 6	5.2	12.4	19.6	27.6	38.4
2.5	0.5	4.2	10.2	16.4	26.1	35.8
5.0	0.5	2.8	6.9	11.5	19.2	30.8
10.0	0.4	2.0	4.4	7.4	12.8	19.2

CD (P=0.05) for yield = 2.4
CD (P=0.05) for Cd content = 9.2

Since soil under investigation was marginal in Zn, significant response of spinach to Zn application upto 10 mg Zn/kg was not observed. However, when Zn was applied to a soil polluted with Cd, a significant response of spinach to Zn could be observed. At the highest level of Cd, application of 10 mg Zn/kg soil resul ed in about 60% increase in spinach yield over no-Zn treatment. The corresponding decrease in Cd content of spinach was from 38.4 to 19.2 μg g. These results clearly indicate antagonistic effect of Zn on Cd uptake. Application of Zn to Cd-polluted soils should help reduce the Cd toxicity to plants.

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