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RESPONSES OF BUSH BEAN PLANTS TO TIN
APPLIED TO SOIL AND TO SOLUTION CULTURE

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Abstract

Tin as SnCl_2 was applied to bush bean plants (Phaseolus vulgaris L. var. Improved Tendergreen) grown in Yolo loam (pH 6) and Hacienda loam (calcareous) soils at rates of up to 500 ppm of dry weight of soil. Yields were slightly decreased at the highest application rate. Tin concentrations in leaves and stems as determined by emission spectrography were around 1 ppm with leaves greater than stems. The presence of the chelating agent, DTPA (diethylene triamine pentaacetic acid), had no influence on yields. It seemed to increase Sn contents very slightly with the Hacienda soil. In the noncalcareous soil Sn resulted in decreased Fe and increased Pb in leaves. Bush beans were grown in solution culture with 0, 10^{-6} , 10^{-5} , 10^{-4} , and 10^{-3} M levels of SnCl_2 with and without CaCO_3 . Without CaCO_3 the 10^{-3} M Sn was very toxic. Leaf and stem levels of Sn were increased only slightly by the Sn applications. Most of the accumulated Sn remained in roots.

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Introduction

Cohen (1) reported that small amounts of Sn stimulated root growth in sunflower when grown in solution culture, but that levels around 10^{-4} M or higher were toxic to corn, peas, and sunflower. After reviewing the literature, Wallihan (10) concluded that there is no real evidence that Sn improved growth of plants and that Sn was not detrimental to plants when grown in soil. Milliman (5) suggested that plants do not accumulate Sn. Several workers (1, 3, 4, 6, 7, 8) reported that Sn in soil is insoluble and not readily available to plants. The purpose of the present study was to determine if Sn at various concentrations were available to plants grown in solution culture and if any responses to Sn could be detected. It was also desired to determine if the chelating agent DTPA (diethylene triamine pentaacetic acid) could mobilize Sn in soil and cause transport of it into plants as it does for several other metals (2).

Materials and Methods

Bush bean plants (Phaseolus vulgaris L. var. Improved Tendergreen) were grown for 17 days in a glasshouse with Yolo loam (pH 6) and Hacienda loam (calcareous) (pH 7.5) soils with SnCl_2 applied at rates of 0, 5, 25, 50, or 500 ppm Sn of dry weight of soil. The Na salt of DTPA equivalent to 5 ppm Fe on the dry weight of soil basis but without Fe (1:1 chelate) was used with one set of plants. Nitrogen as NH_4NO_3 at 100 ppm N of dry weight of soil was applied to all plants. Stems and leaves were removed, washed in distilled-deionized water, dried, weighed, and prepared for analysis by emission spectrography (9). There were four replicates for each treatment.

Bush beans were grown for 26 days in solution culture with 0, 10^{-6} , 10^{-5} , 10^{-4} , or 10^{-3} M SnCl_2 . One set received CaCO_3 and one did not. Leaves, stems, and roots were separated. Shoots were washed in $1/10$ N HCl and roots

for 1 hr in 10^{-2} M CaCl_2 , then in distilled-deionized water, dried, weighed, and prepared for analysis. There were four replicates for each treatment.

Results and Discussion

Yields of bush beans grown in soil were decreased slightly by the highest application rate (Table 1). Tin concentrations in the shoots were very low with leaves higher than that of stems. The Sn applications had very little effect on plant contents of Sn. Very slight increases only were noted for some of the treatments. DTPA seemed to increase slightly the Sn concentrations of plants grown in Hacienda soil, but DTPA had no influence on Sn concentrations in the Yolo soil. The high level of Sn seemed to depress the Fe concentrations of the plants grown in Yolo loam without the DTPA. Sn also resulted in increased concentrations of Pb in shoots, but the DTPA did not.

The 10^{-3} M concentration of SnCl_2 decreased yields of plants grown in nutrient solution without CaCO_3 . Most of the Sn remained in roots and very small quantities were found in leaves and stems. In general, the higher application rates of Sn resulted in slight increases of it in the plants. This tends to confirm earlier reports that Sn is very unavailable to plants, and not readily mobile in them. The CaCO_3 in the nutrient solution prevented the toxicity due to 10^{-3} M SnCl_2 .

References

1. Cohen, B. B. 1940 Some effects of stannous sulphate and stannic chloride on several herbaceous plants. *Plant Physiol.* 15:755-760.
2. Essington, E., H. Nishita, and A. Wallace 1963 Effect of chelating agents on the uptake of Y^{91} , Ru^{106} , Ce^{144} , and Pm^{147} , by beans grown in calcareous soil. *Soil Sci.* 95(5):331-337.
3. Harbaugh, J. W. 1950 Biogeochemical investigations in the Tri-State district. *Econ. Geol.* 45:548-567.
4. Laycock, D. H. 1954 The mineral constituents of some Nyasaland tea leaves and tea soils. *J. Sci. Food Agr.* 5:266-269.
5. Millman, A. P. 1957 Biogeochemical investigations in areas of copper-tin mineralization in southwest England. *Geochim. Cosmochim. Acta* 12:85-93.
6. Mitchell, R. L. 1954 Trace elements in some constituent species of moorland grazing. *Jour. Brit. Grassland Soc.* 9:301-311.
7. Prince, A. L. 1957a Influence of soil types on the mineral composition of corn tissues, as determined spectrographically. *Soil Sci.* 83:399-405.
8. Prince, A. L. 1957b Trace-element delivering capacity of ten New Jersey soil types, as measured by spectrographic analyses of soils and mature corn leaves. *Soil Sci.* 84:413-418.
9. Wallace, A. and Collaborators 1971 Mineral element analyses of plants by means of an emission spectrograph, p. 1-4. In A. Wallace, editor and publisher, *Regulation of the Micronutrient Status of Plants by Chelating Agents and Other Factors*, Los Angeles, Ca USA.
10. Wallihan, E. F. 1966 Tin, p. 476-477. In Homer D. Chapman, editor, *Diagnostic Criteria for Plants and Soils*, University of California, Agricultural Sciences, Berkeley, Ca. USA.

Table 1. Effect of SnCl_2 applications to bush bean plants grown in soil (dry weight basis).

Soil	Sn in soil	Yield plant	Leaf Sn	Stem Sn	Leaf Fe	Stem Fe
	ppm	mg	ppm	ppm	ppm	ppm
+DTPA						
Yolo	0*	428	0.9	0.2	205	71
	5	439	1.4	0.7	262	84
	25	375	0.9	0.2	236	78
	50	420	1.1	0.5	233	76
	500*	371	1.3	0.4	140	46
-DTPA						
Yolo	0*	382	1.2	0.6	75	33
	5	429	1.3	0.9	95	33
	25	435	1.3	0.8	105	42
	50	370	1.4	0.6	94	31
	500*	297	1.2	0.4	92	46
+DTPA						
Hacienda	0	353	0.4	0.4	81	21
	5	302	0.8	0.6	64	15
	25	300	1.4	0.9	56	16
	50	299	1.5	1.0	61	19
	500	236	1.4	1.2	53	22
-DTPA						
Hacienda	0	288	0.4	0.4	55	26
	5	271	0.6	0.5	52	18
	25	313	0.5	0.3	46	14
	50	271	0.9	0.4	63	22
	500	282	0.8	0.6	47	18
LSD .05		116	0.4	0.3	49	21
LSD .01		153	0.6	0.4	64	28

* Pb concentrations of leaves of plants of these treatments were 3.4, 9.6, 3.5, and 8.5 respectively (LSD .05 = 4.2) indicating that Sn resulted in increased uptake of Pb.

Table 2. Yields and Sn contents of plant parts of plants grown in nutrient solution with different levels of SnCl_2 .

SnCl_2	Yield	Sn in	Sn in	Sn in
<u>M</u>	mg/plant	leaves	stems	roots
		ppm of dry weight		
		without CaCO_3		
0	2314	1.3	0.5	2.7
10^{-6}	2223	1.6	1.1	49.1
10^{-5}	2723	2.0	1.8	>300
10^{-4}	2910	2.6	3.8	>300
10^{-3}	450	5.0	8.9	>300
		with CaCO_3		
0	3538	2.6	1.5	3.1
10^{-6}	3062	1.4	0.5	26.9
10^{-5}	3104	0.5	0.5	229
10^{-4}	3099	0.5	1.3	>300
10^{-3}	3328	2.2	3.2	>300
LSD .05	630	1.3	0.6	
LSD .01	833	1.7	0.8	