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Absorption of Selenium from Coal Fly Ash-Amended Soil by *Astragalus racemosus*

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Plants normally growing on soils in the Northeastern United States contain about 0.05 ppm of selenium on a dry weight basis. It has been shown that plants growing on soils amended with coal fly ash (FURR et al. 1976, 1978a) or on fly ash alone (FURR et al. 1978b, De Jong et al. 1977, STOEWSAND et al. 1978) absorbed notably higher concentrations of selenium. It is well known that certain plant species of the genus Astragalus which grow over a wide area of the Western United States accumulate very high concentrations of the element. Fly ash and some of these western soils contain selenium in the same concentration range. It was of interest therefore to study the availability of this toxic element in fly ash to a selenium accumulator plant. In the work reported, one of the well known Astragalus selenium accumulator species was grown to maturity in pots of soil amended with coal fly ash and then analyzed for total selenium.

EXPERIMENTAL

Several hundred pounds of the dry, freshly produced fly ash was obtained from Milliken Station, a coal-burning electric power-generating plant located in Lansing, New York, about 20 miles north of Ithaca on the eastern shore of Cayuga Lake. This power plant produces about 500 tons of fly ash daily. The soil was a Honeoye silt loam (fine-loamy, mixed, mesic glossoboric hapludalfs), 4.8% organic matter and with an exchange capacity of 16 milliequivalents per 100 grams sampled near Ithaca, New York. The soil was air-dried, sifted through a 2-mm screen and mixed by quartering. The total concentration of selenium in fly ash and soil was, respectively, 7.5 and 0.3 ppm, dry weight. The growth media treatments consisted of soil alone (control), the soil containing 25 or 50 weight per cent of fly ash and fly ash alone. The fly ash was thoroughly incorporated into the soil using a cement mixer. The pH's of the resulting medias were: soil alone, 7.4; 25% fly ash, 7.2; 50% fly ash, 7.1; fly ash alone, 6.5. Each treatment was replicated 4 times.

Astragalus racemosus was grown to maturity in the various media contained in 8-liter plastic pots with one plant per pot. This species of Astragalus is a well known selenium accumulator plant (ROSENFELD and BEATH 1964). Each plant was fertilized daily with 1000 ml of Hoaglands solution prepared from reagent-grade potassium nitrate and potassium dihydrogenphosphate (HOAGland and ARNON 1950). About two weeks after flowering the entire

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upper portion of the plant was harvested and rinsed with distilled water to remove adhering dust. Each treatment replicate was individually air-dried, milled, mixed and analyzed for total selenium by the method of OLSON (1969).

RESULTS AND DISCUSSION

The concentration of selenium (ppm, dry weight) in the plants is plotted as a function of the percentage of fly ash in the soil (see Figure 1). It is evident that selenium absorption by the

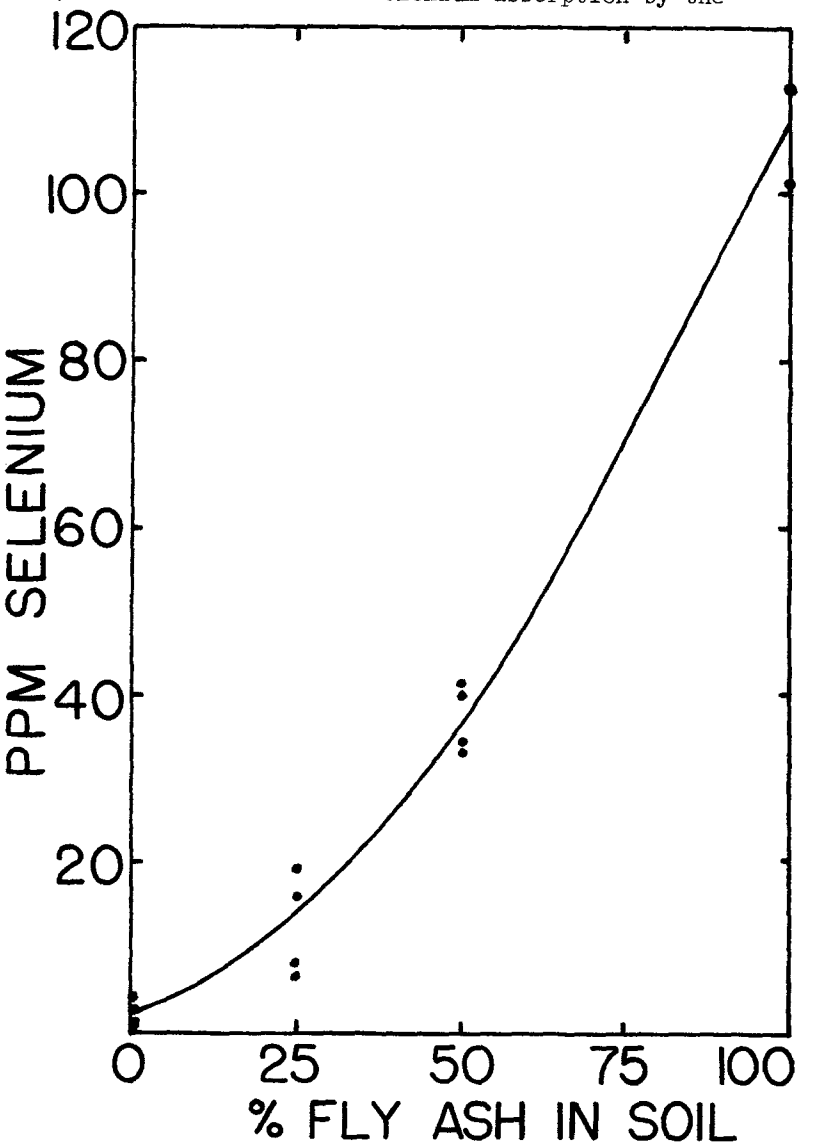

Figure 1. Concentration (ppm dry wt) of selenium in Astragalus racemosus grown on potted soil amended with increasing percentages of coal fly ash.

plants was high and dependent on the percentage of fly ash in the soil. In an earlier pot experiment (FURR et al. 1976) it was shown that several vegetable crops and millet similarly absorbed selenium from soil amended with 5 or 10% fly ash in proportion to the fly ash content of the soil but the total concentration of selenium absorbed by the crops was far lower (less than 1 ppm) than with Astragalus racemosus. Interestingly, white sweet clover (Melilotus alba), a deep rooted crop, found growing on a bed of fly ash 15 to 22 meters in depth was found to contain 66 ppm of selenium, dry weight (FURR et al., 1978b).

Two of the plants growing on the 100% fly ash exhibited a pronounced yellowing and stunted growth pattern and therefore were not sampled. It was difficult to properly water the plants growing on fly ash alone since the material tended to form channels through which added solution drained away.

The data indicate that selenium may be concentrated by a known accumulator plant such as Astragalus racemosus when grown on coal fly ash or fly ash-amended soil. The concentration of selenium in this plant species may reach several thousand ppm when grown in sand culture containing a soluble selenium salt solution (ROSENFELD and BEATH 1964). Absorption of selenium may therefore be limited by the concentration and form of the element in fly ash, the quantity of fly ash in the growth medium and presence of other ions which may antagonize selenium absorption or cause phytotoxicity.

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