Effects of Sewage Sludge on Heavy Metals in Cotton Seed

A. D. Day, B. B. Taylor, I. L. Pepper, M. M. Minnich

ABSTRACT

In 1987, seed samples from three cotton fields in Avra Valley, Arizona, grown with liquid sewage sludge and inorganic nitrogen fertilizer, were analyzed for five heavy metals. Concentrations of cadmium, copper, lead, nickel, and zinc were similar in cotton seeds fertilized with either sewage sludge or inorganic nitrogen fertilizer. The levels of all five metals were well below the allowable EPA limits.

INTRODUCTION

The application of liquid sewage sludge on agricultural lands is used in many metropolitan societies as a cost-effective and environmentally-safe method of disposal. Sewage sludge contains considerable amounts of major and minor plant nutrients, essential for plant growth. Several studies have shown that plant growth and yields from crops grown with sewage sludge were comparable to the plant growth and yields from crops grown with commercial fertilizers.

The continuous use of sewage sludge as a fertilizer may be limited due to the presence of toxic heavy metals. The extent of sludge-born metal accumulation in soils and the possible contamination of the human food chain through plant uptake is dependent on the source of the sludge and its application rates. The objective of this study was to determine the concentration of five hazardous heavy metals in the seed from cotton grown with liquid sewage sludge.

MATERIALS AND METHODS

Portions of Fields JK-20, JK-34, and JK-38, Avra Valley, Arizona, were reserved for liquid sewage sludge research in 1986. Anaerobically digested liquid sewage sludge, from the Pima County Wastewater Treatment Plant, was applied using the disk method in JK-20 and the injection method in JK-34 and JK-38. Inorganic nitrogen (N) fertilizer was applied using surface application. The following fertilizer treatments were used:

1. 170 lb/acre N for JK-20 and 180 lb/acre N for JK-34 and JK-38, from inorganic sources.
2. Plant-available N from sewage sludge in amounts equal to the N from the inorganic sources.

Land preparation included plowing, disking, and listing to form 40-inch planting beds. Stoneville 506 cotton was planted in dry soil at 18 lb/acre. All other agronomic practices were those normally used for cotton in the Avra Valley area.Prior to defoliation, four 2-row plots were selected at random in each fertilizer treatment for data collection and analyses. Cotton seed samples, from each replication, were analyzed for five hazardous heavy metals (cadmium, copper, lead, nickel, and zinc) concentrations at the A & L Eastern Agricultural Laboratories, Inc., Richmond, Virginia.

RESULTS AND DISCUSSION

Analyses for the concentrations of heavy metals (Table 1) indicated that cadmium was less than 0.5 parts per million (ppm); lead and nickel were less than 5 ppm; copper ranged from 8 to 10 ppm; and zinc ranged from 32 to 41 ppm in all fields fertilized with sewage sludge and inorganic N. The heavy metal concentrations in the seed, especially those for cadmium, lead, and nickel, were below the allowable EPA safe limits. Seeds from cotton fertilized with sewage sludge showed a slight increase in zinc concentration. The foregoing observation was similar to results obtained from barley and wheat seeds in previous studies.

The very low concentration of heavy metals in cotton seed produced with liquid sewage sludge makes this by-product from the cotton industry safe for livestock feed.

ACKNOWLEDGEMENTS

Financial support for this research project was provided by the Pima County Wastewater Management Department, Tucson, Arizona.

Table 1. Heavy metal concentration in Stoneville 506 cotton seed grown with two fertilizer treatments in Fields JK-20, Jk-34 and JK-38, Avra Valley, Arizona in 1986

Field location	Fertilizer treatment	Heavy metal concentration (ppm)				
		Cadmium	Copper	Lead	Nickel	Zinc
JK-20	1	<0.5	9	<5	<5	32
	2	<0.5	10	<5	<5	40
JK-34	1	<0.5	10	<5	<5	32
	2	<0.5	10	<5	<5	41
JK-38	1	<0.5	8	<5	<5	33
	2	<0.5	10	<5	<5	36

Fertilizer treatment.

1. 170 lbs/acre nitrogen (N) for JK-20 and 180 lbs/acre N for JK-34 and JK-38, from inorganic sources.
2. 170 lbs/acre plant-available N for JK-20 and 180 lbs/acre plant-available N for JK-34 and JK-38, from sewage sludge.