The Influence of Sewage Sludge on Nitrogen Availability, Crop Growth, and Yield at Marana, 1988

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INTRODUCTION

Most metropolitan areas must grapple with the problem of how to discard sewage sludge produced by sewage treatment plants. Sewage sludge has been used effectively in crop production as a source of plant nutrients, particularly nitrogen. Liquid sewage sludge from Tucson is currently being applied on agricultural land near Marana.

Previous work has shown that yields were similar when barley, cotton, and wheat were fertilized with inorganic fertilizer and an equivalent amount of plant available nitrogen from Tucson sewage sludge (Unger and Fuller, 1985; Watson et al., 1985; Day et al., 1988). However, information is not avalilable on the plant availablity of nitrogen from sewage sludge compared to inorganic fertilizer throughout the growing season.

The primary objective of this study was to determine the plant availability of nitrogen from sewage sludge compared to inorganic fertilizer as indicated by cotton petiole testing. A secondary objective was to continue to monitor the effect of sewage sludge on crop growth and yield in the third year of a 5-year study.

MATERIALS AND METHODS

The effect of sewage sludge on cotton was studied on a Pima clay loam at the Marana Agricultural Center during the 1988 growing season. The following treatments were applied before planting: 1) Recommended inorganic fertilizer: 180 and 27 lbs/a N and P, respectively, 2) 1X sewage sludge: an amount to provide the recommended plant available nitrogen (180 lbs N/a) for cotton, 3) 1X inorganic fertilizer: an amount equal to the nutrient content of the sludge: 180, 55, and 6.6 lbs/a N, P, and K, respectively, and 4) 3X sewage sludge.

Anaerobically-digested liquid sewage sludge was obtained from the Pima County Treatment Plant at Ina Road and injected into the soil to a depth of 8 to 12 inches. The 3X sludge rate was applied in three passes with approximately 2 weeks between applications to allow the soil to dry. The inorganic fertilizer treatments were applied as follows: 1) N and P were sprayed onto the soil as UN32 and 10-34-0 solutions and 2) K was applied in granular form as potassium sulfate.

Pima cotton cultivar S-6 and upland cotton cultivar DPL-41 were planted on 29 April in 2 separate experiments. The experimental design was a randomized complete block with 4 replications. The plots were 20 feet wide and 565 feet long. Herbicides, insecticides, irrigations, and defoliants were applied as required to maintain optimum yields.

The number of plants in 60 feet of row were counted on 4 June. Petioles were sampled on a weekly basis from 24 June to 14 September. Nitrate-N in the petioles was extracted with aluminum sulfate and analyzed using a nitrate electrode. Plant height was recorded on 24 October. A defoliant was applied on 29 October and 11 November. The upland cotton was machine picked on 16 November and the Pima on 23 November. Two rows were picked per plot.

RESULTS AND DISCUSSION

Petiole Nitrate - Nitrogen availablity to the crop as indicated by petiole nitrate concentration is presented in Figs. 1 and 2 for Pima and upland cotton, respectively. For pima cotton, petiole concentration was greatest for the 3X sludge rate, and the 1X sludge rate was greater than the inorganic fertilizer treatments throughout most of the season. For upland cotton, petiole nitrate concentration was also greatest for the 3X sludge treatment at certain sampling times, particularly later in the season. The 1X sludge treatment was similar to the inorganic fertilizer treatments for upland cotton, in most cases, in contrast to the results for pima cotton.

The petiole analyses suggest that the treatments used in this study may have resulted in excessive nitrogen availability to the plant early in the season, desirable levels later in the season, but never deficient levels of nitrogen. Slow release of nitrogen from the sludge by microbial decomposition may play a relatively minor role in the nitrogen availablity to the plant since approximately 70% of the nitrogen in the sludge is quickly available and differences in petiole nitrate between equivalent rates of sludge and inorganic fertilizer were detected early in the season.

Plant Growth and Yield - The influence of sludge and inorganic fertilizer on plant growth and yield is presented in Table 1. Pima cotton plants were shorter in height when fertilized with the recommended amount of inorganic fertilizer compared to the other treatments. However, cotton growth was slower in the 3X sludge rate than the other treatments early in the season according to visual observation. No differences in plant stand or yield were detected.

Table 1. Plant growth and yield as affected by sewage sludge and inorganic fertilizer treatments.

Treatment	Plant stand	Plant height	Total yield	Lint yield	Seed yield	Gin turnout
	pl/ft2	inches	----------lb/a----------			---%---
			Pima			
Recommended fertilizer	2.09	58	2540	849	1690	33.5
1X sludge	2.10	65	2900	946	1650	32.7
1X fertilizer	2.00	62	2510	840	1670	33.5
3X sludge	2.10	64	2470	820	1650	33.2
FLSD (5%)	NS	4.4	NS	NS	NS	NS
			Upland			
Recommended fertilizer	3.05	35	4080	--	--	--
1X sludge	3.03	37	4260	--	--	--
1X fertilizer	2.87	38	4590	--	--	--
3X sludge	2.36	40	4247	--	--	--
FLSD (5%)	NS	NS	NS	--	--	--

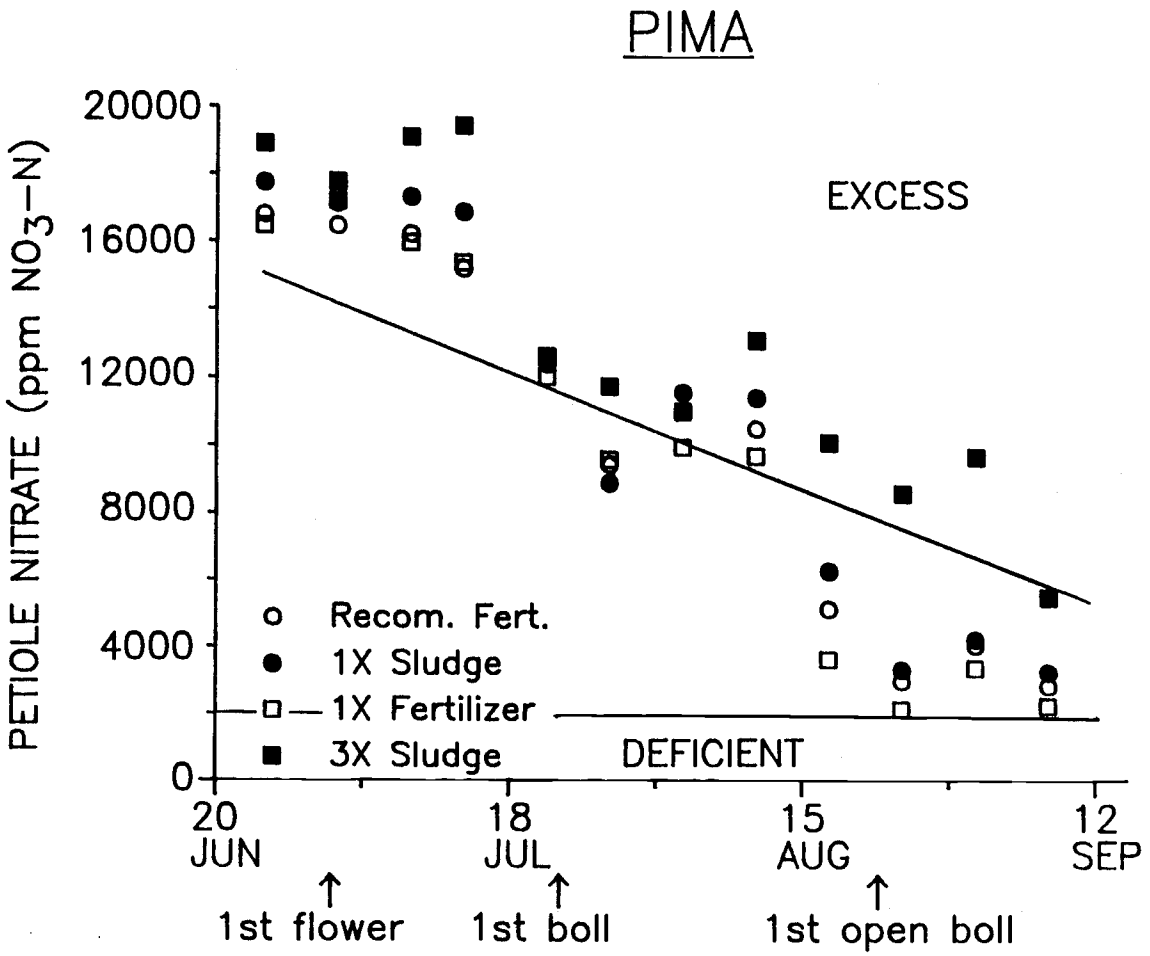

Fig. 1. Petiole nitrate concentration of Pima cotton as influenced by sewage sludge and inorganic fertilizer.

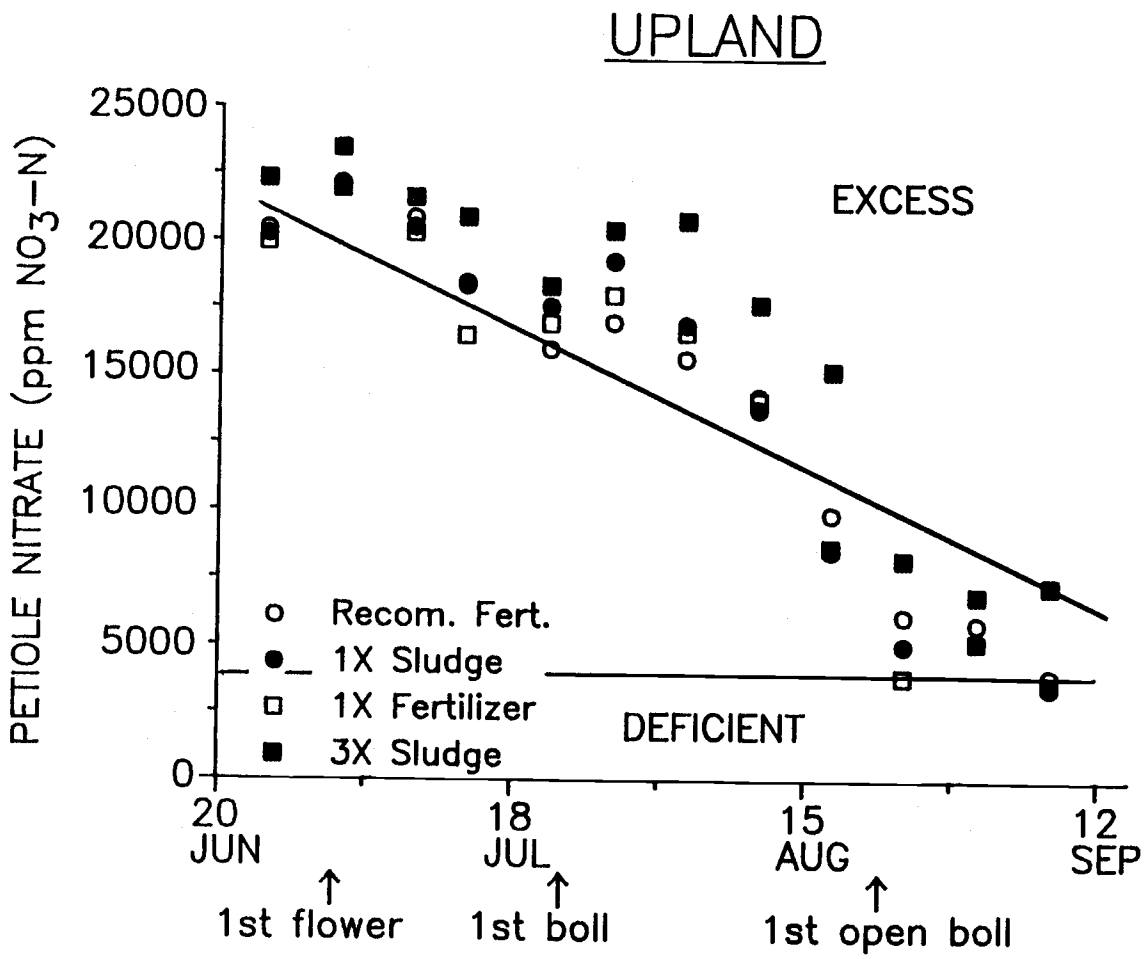

Fig. 2. Petiole nitrate concentration of upland cotton as influenced by sewage sludge and inorganic fertilizer.

In conclusion, sewage sludge and inorganic fertilizer appear to be equally effective as sources of nitrogen, although more nitrate may accummulate in the petioles with sewage sludge and result in excessive availability of nitrogen to the crop.

REFERENCES

Day, A. D., M. J. Ottman, B. B. Taylor, I. L. Pepper, and R. S. Swingle. 1988. Liquid sewage sludge as fertilizer for wheat. Bio Cycle. 29(10):60-61.

Unger, M., and W. H. Fuller. 1985. Optimum utilization of sewage sludge of low and high metal content for grain production on arid lands. Plant Soil. 88:321-332.

Watson, J. E., I. L. Pepper, M. Unger, and W. H. Fuller. 1985. Yields and leaf elemental composition of cotton grown on sludge-amended soil. J. Environ. Qual. 14:174-177.