The Effects of Soil Compaction from Different Sewage Sludge Application Methods on Cotton Growth and Yield

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INTRODUCTION

Liquid sewage sludge from Tucson has typically been injected 8 to 12 inches into the soil using a modified fertilizer spreader with flotation tires (terragator). Other methods of application have been practiced, however. Sludge has been applied into shallow furrows and incorporated into the soil with a chisel plow using the terragator. Liquid sewage sludge has also been applied directly onto the soil from tanker trucks, eliminating the necessity to transfer the sludge to a holding tank before application.

The influence of sewage sludge on soil physical properties has been reported (Epstein et al., 1976; Wei et al., 1985). However, the influence of sewage sludge application methods on soil compaction and crop performance has not been clearly established. The primary objective of this study was to compare soil compaction, crop growth, and yield using different methods of sewage sludge application. A secondary objective was to compare sewage sludge and inorganic fertilizer in terms of nitrogen availability to the plant as indicated by petiole nitrate.

MATERIALS AND METHODS

A field study was initiated in 1988 at the Kai Ranch in Avra Valley on field JK-36. The following treatments were applied: 1) deep sludge injection 8 to 12 inches into the soil using a terragator with flotation tires, 2) shallow sludge injection and incorporation into the soil with a terragator fitted with a chisel plow, 3) surface sludge application using a tanker truck on a soil free of compaction, followed by disc incorporation, 4) surface sludge application using a tanker truck on truck-compacted soil, followed by disc incorporation, 5) inorganic nitrogen as UN32 applied in the first irrigation on truck compacted soil, and 6) inorganic nitrogen as UN32 applied in the first irrigation on soil free of truck compaction. Sludge was applied at a rate of approximately 1.8 tons of dry matter per acre supplying nearly 200 pounds of plant available nitrogen per acre. The plots were approximately 12 feet wide and 1200 feet long. The experimental design was a randomized complete block with four replications.

Upland cotton cultivar Stoneville 506 was planted in dry soil and irrigated on 19 May. The field was replanted on 10 June due to a poor initial stand. Petioles were sampled on a weekly basis from 1 July to 31 August. Plant height was measured near harvest. Two rows from each plot were machine-picked on 9 November. Soil strength, an indicator of soil compaction, was measured on 8 December using a tractor-mounted cone penetrometer.

RESULTS AND DISCUSSION

The influence of sludge application method on cotton petiole nitrate is presented in Table 1. Sewage sludge application method did not affect plant availability of nitrogen as indicated by petiole nitrate. However, the inorganic fertilizer treatments had lower petiole nitrate concentration than the sewage sludge treatments at the 8 July sampling date and when averaged over all sampling dates. The nitrate concentration in the petioles were close to being excessive early in the growing season, but were never at a deficient level for any treatment. We were not able to detect any differences in plant height or yield due to sludge application method (Table 2). The usefullness of this yield data was limited due to late planting and stand establishment problems.

The effect of sludge application methods on soil compaction was measured using a soil penetrometer. The results of the tests have not been fully summarized at the present time. However, preliminary indications are that soil compaction from the terragator was negligible, but the use of tanker trucks may result in considerable soil compaction.

REFERENCES

Epstein, E., J. M. Taylor, and R. L. Chaney. 1976. Effects of Sewage Sludge and Sludge Compost Applied to Soil on Some Soil Physical and Chemical Properties. J. Environ. Qual. 5:422-426.

Wei, Q. F., B. Lowery, and A. F. Peterson. 1985. Effect of Sludge Application on Physical Properties of a Silty Clay Loam Soil. J. Environ. Qual. 14:178-180.

Table 1. Petiole nitrate concentration as influenced by sludge application method.

	Treatment						
Sampling date*	Sludge, deep inject.	Sludge, shallow inject.	Sludge, truck, no traf.	Sludge, truck, traffic	Fert., traffic	Fert., no traf.	LSD .05
	----------ppm nitrate-N----------						
Jul 1	25800	25800	26400	25400	22800	24400	NS
Jul 8	26600	24900	26500	26500	21700	22300	3278
Jul 13	20900	20200	20600	23400	19900	18300	NS
Jul 21	16100	15500	17200	17400	15200	14700	NS
Jul 27	15900	14300	14800	15600	14300	13000	NS
Aug 3	16200	16200	15900	15900	14700	14300	NS
Aug 10	15800	15100	16000	16400	14600	12800	NS
Aug 17	10600	8790	9280	10600	9160	7300	NS
Aug 24	7910	8110	7590	8580	6370	6490	NS
Aug 31	3790	3380	3140	4000	2080	1900	NS
Mean	16000	15200	15700	16400	14100	13500	1780

* First flower = Jul 13; First boll = Aug 3; First open boll = Aug 24.

Table 2. Plant height and yield as affected by sludge application method.

Treatment	Plant height	Seed cotton yield
	inches	lbs/a
Sludge, deep injection	43.0	2420
Sludge, shallow injection	41.8	1590
Sludge, truck, no traffic	41.8	1790
Sludge, truck, traffic	42.2	1930
Fertilizer, traffic	43.2	2030
Fertilizer, no traffic	41.2	2210
FLSD (5%)	NS	NS