Percolation of Soluble Constituents Under Cotton Fertilized With Municipal Sewage Sludge

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ABSTRACT

Data on the potential salts and organics leaching under cotton fertilized with municipal sewage sludge is necessary to delineate best management practices when cotton is fertilized in this manner.

INTRODUCTION

Nitrogen is the nutrient that has the greatest effect on cotton yields (Tucker and Tucker, 1968). Cotton, grown with sewage sludge additions to meet the crop's nitrogen demand, has been shown to yield cotton lint at rates comparable to cotton fertilized by conventional inorganic salts (Watson et al., 1985). The new ground water quality legislation in Arizona increases the pressure on farmers to use best management practices with regard to nitrogen fertilization. Use of sludge as a nitrogen fertilizer must be shown to leach no more nitrogen than inorganic nitrogen fertilizers, if this practice is to be accepted. The potential for leaching organic constituents that might be considered toxic must also be addressed.

METHODS

Field trials were run on a Pima clay loam soil at the Marana Agricultural Center in 1986. Treatments included: 1) inorganic fertilizer at recommended rates, N at 180 lb/A and P at 27 lb/A; 2) sewage sludge to provide N at 180 lb/A (1x); and 3) sewage sludge at 3 times the recommended rate, N at 440 lb/A (3x). Liquid sludge from the Ina Road treatment facility was injected approximately one foot into the soil. Inorganic fertilizers were surface applied and disked. Treatments were replicated in a randomized complete block design.

Ten days after the initial applications and 7-10 days after the first 5 irrigations, soil cores were removed to a depth of 5.8 feet. Composite samples (3 cores each) were taken from 4 replicate plots of each of the 3 treatments. These were divided into 4 equal depth increments.

Saturation pastes were extracted and analyzed for: pH and electrical conductivity (EC) by electroanalytical methods; Ca, Mg, Na, and K by atomic adsorption spectroscopy; Cl, SO_4, and NO_3 by ion chromatography; and total organic and inoganic C by combustion/IR analysis.

Organics in the saturation extracts were analyzed by gas chromatography as follows: purgeables by purge-and-trap with halide and conductivity detectors; acid-extractable and base-neutral extractable in methylene chloride by flame ionization and electrolytic detectors. (Methods were based on EPA Methods 624 and 625 for priority pollutant analyses of waters and wastewaters.)

RESULTS AND DISCUSSION

1. Statistically significant effects due to treatments were found for EC, Ca, Mg, and NO_3. Each of these parameters increased with sludge additions showing higher salt levels in the soil in the order: inorganic fertilizer < 1x sludge < 3x sludge.

2. Ca and EC increased in subsurface soil in all treatments throughout the experimental period. However, EC values did not exceed 2 mmhos/cm at any time or depth and thus did not indicate any danger of soil salinization.

3. Concentrations of NO_3 in the surface soil were observed to be higher and to remain high for a longer time with sludge treatments, as opposed to inorganic fertilizer. The 3x sludge treatment showed over 300 mg NO_3/L (200 mg NO_3/kg soil) in the saturation extract for at least 78 days after sludge had been applied. The 1x sludge treatment reached 540 mg NO_3/L (300 mg NO_3/kg soil) in the surface soil 20 days after the sludge application.

4. Some leaching of NO_3 probably occurred in all treatments during drainage of pre-irrigation water in May. Pre-irrigation after sludge and fertilizer are applied moves NO_3 deep into the profile. Subsequent drainage during the rooting period is believed to cause loss of NO_3 from the rooting zone.

5. In general, organic pollutants in the Ina Road digested sludge are present in quantities below detection limits if present at all. Bis(2-ethylhexyl)phthlate (a plasticizer coming from plastic plumbing) was found in the sludge (< 10 ppm) but has not been detected in the sludge-treated soil. The risk of organics percolating into groundwater from agricultural use of good-quality municipal sewage sludge is expected to be low.

ACKOWLEDGEMENTS

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