12-1992

Nitrogen Source and Application Method: Does It Matter?

Gilbert D. Miller
Utah State University

Jay C. Andersen
Utah State University

Nitrogen Source and Application Method: Does It Matter?

Water Quality
Utah State University Cooperative Extension Service

By Gilbert D. Miller and Jay C. Andersen
Department of Economics
Utah State University

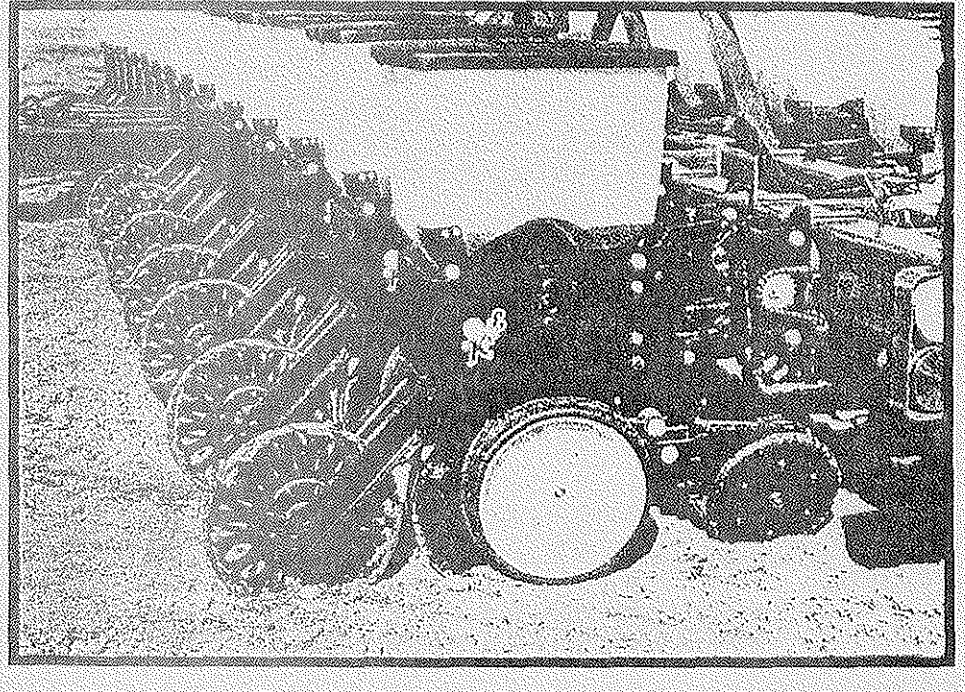
A comparison was made of the amount of nitrate leached out of the root zone and returns to management for irrigated corn silage production using three commercial nitrogen fertilizers. The three fertilizers were ammonium nitrate, anhydrous ammonia, and urea. Nitrate is soluble in the soil complex and moves with water through the soil profile. Ammonium is held in the soil complex and does not move with water in the soil. Urea is soluble in water and moves with it in the soil profile. Ammonium is transformed in the soil into nitrate by microorganisms over time dependent upon soil moisture and temperature. Urea is first transformed into ammonium and then into nitrate. The transformation into ammonium is usually completed in a couple of days depending upon soil moisture and temperature.

The fertilizers were applied on three soil types, fine sandy loam, silt loam, and silty clay. Each soil type has a different water holding capacity thus a different potential for nitrate leaching.

Irrigation management has a greater effect on the amount of nitrate that is leached out of the root zone than does the type of nitrogen fertilizer applied.

A soil-crop simulation model was used to make the evaluation because there was little observed data available that was complete enough to make an economic analysis of nitrogen management practices. The simulation model was calibrated using field data from irrigation field trials. Budgets were then prepared for each simulation using cultural practices that are commonly used by Box Elder County farmers. Costs of machinery and other inputs were obtained from dealers in Box Elder and Cache counties.

Corn silage was selected as the crop for the study because of its high nitrogen requirement which results in an increased potential for nitrate leaching. A yield goal of 38 tons per acre was selected to evaluate the effects of a high yield goal on nitrate leaching and profitability (returns to management). Two hundred pounds of elemental nitrogen were applied in addition to the 41 pounds of nitrogen carried over in the soil profile to achieve the yield goal.



A 6-inch irrigation every two weeks on fine sandy loam with a single application of ammonium nitrate as the nitrogen source resulted in about 70 lbs/acre of nitrate-nitrogen being leached out of the root zone. Change the nitrogen source to anhydrous ammonia reduced the amount of nitrate-nitrogen leached to about 52 lbs/acre, while returns to management per acre increased about $16. Part of the increase in returns to management is due to the lower cost of anhydrous ammonia (a difference of about $0.02/lb of elemental nitrogen). A single application of urea reduced nitrate leaching to about 39 lbs/acre. Returns to management increased by about $4 per acre over using a single application of anhydrous ammonia.

A 4-inch irrigation every two weeks, an amount near the estimated evapotranspiration need of the crop, reduced the amount of nitrate-nitrogen leached per acre to about 3 lbs/acre using ammonium nitrate as the nitrogen source. This reduction is much greater than the reduction resulting from changing nitrogen sources. Using anhydrous ammonia or urea resulted in a about 2 lbs/acre of nitrate-nitrogen being leached out of the root zone. Returns to management were also higher, with the highest returns from using urea.

The study showed that split application of nitrogen fertilizer did help reduce nitrate leaching and improve returns to management when over-irrigation occurred. When irrigation applications were managed to more closely match plant needs there was little benefit in split applications of nitrogen fertilizers.

Adding nitrogen fertilizer to irrigation water (fertigation) when irrigation was by sprinkler systems was shown to reduce the amount of nitrate leaching and be cost effective for those farmers who use sprinkler systems. Less total nitrogen can be applied to achieve the same yield by using plant tissue and soil nitrogen testing. Thus reducing fertilizer costs and the potential rate of nitrate leaching.

Management pracitices that control excessive nitrate leaching tend to have higher profits than those that do not.

Soil type affects the movement of water through the soil profile thus the movement of nitrate. As discussed above six 6-inch irrigations on fine sandy loam with ammonium nitrate as the nitrogen source resulted in about 70 lbs/acre of nitrate-nitrogen being leached out of the root zone. The same management on silt loam resulted in about 29 lbs/acre of nitrate-nitrogen leaching out of the root zone. The silty clay had no nitrate leach out of the root zone.

Summary

Irrigation management has a greater effect on the amount of nitrate that is leached out of the root zone than does the type of nitrogen fertilizer applied. Applying nitrogen forms that are immobile in the soil complex is most beneficial when over-irrigation occurs early in the growing season before the transformation to nitrate has taken place. Coarser textured soils respond the most to using immobile forms of nitrogen fertilizers. Fine texture soils show little response to nitrogen form. Since all nitrogen forms are transformed into nitrate at some point, all nitrogen forms should be managed as though they were nitrate. Management practices that control excessive nitrate leaching tend to have higher profits than those that do not. Farmers who spend greater effort in managing irrigation and nitrogen applications for their particular soil and crop characteristics will be rewarded with higher returns to management than those who do not.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert L. Gilliland, Vice President and Director, Extension Service, Utah State University.
(12/92)