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Irrigation Management To Control Nitrate Leaching: What Is In It For The Framer?

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Irrigation Management To Control Nitrate Leaching: What Is In It For The Farmer?

Water Quality

Utah State University Cooperative Extension Service

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Irrigation is important to Utah agriculture. Approximately one million acres of farmland is under irrigation in Utah. This is the most productive farmland in the State, because plant growth is less limited by water availability. When water is not limiting plant growth, more nitrogen is required by the plants to reach their productive potential. A high rate of nitrogen application not only enhances plant growth, but also may increase the amount of nitrate that is leached out of the root zone. When this happens, the nitrate is no longer available for the plants to use. The direct economic effect of nitrate leaching is the cost of the nitrate that was leached before it was used by the crop.

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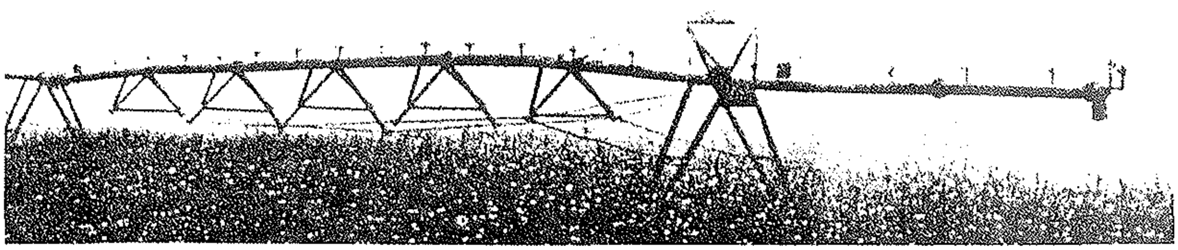
Besides the loss of an input before it is used in production, nitrate leaching out of the root zone and into groundwater may be associated with the following when ingested: (1) methemoglobinemia (blue baby), which is a reduction in the oxygen carrying capacity of the blood in people and other mammals; (2) cardiovascular collapse and shock in horses; (3) possibility of stomach cancer. Eutrophication can occur when nitrate bearing groundwater reaches surface water through wells or springs.

Managing irrigation application is an important tool in controlling the amount of nitrate that leaches out of the root zone. This has been demonstrated by irrigation and soil scientists. What has not been demonstrated is the economic benefits and costs associated with improving irrigation practices. Some of these benefits and costs will be examined here. Because there was little data available that was complete enough to do an economic analysis of irrigation practices it was necessary to use a soil-crop simulation model that had been calibrated using field data from irrigation experiments. Budgets were then prepared for each simulation using standard cultural practices used by farmers in Box Elder County. The cost of machinery and other inputs were obtained from dealers in Box Elder and Cache counties.

Corn silage was selected as the crop to study because of its high nitrogen requirement which results in 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. Two hundred pounds of elemental nitrogen were applied as ammonium nitrate in addition to the 41 pounds of nitrogen already in the soil, to achieve the yield goal.

Soil characteristics were important in determining the amount of nitrate that leaches out of the root zone. Six 6-inch irrigation spaced at two week intervals applied to a fine sandy loam, a silt loam, and a



silty clay had profoundly different amounts of nitrate that leached out of the root zone. The fine sandy loam which has a high infiltration rate and a low water holding capacity (less than a foot in a five and a half foot profile) leached approximately 70 pounds per acre of nitrate-nitrogen out of the root zone, while about 29 pounds per acre leached on the silt loam with a water holding capacity of about 19 inches in the five and a half foot profile. No nitrate leached out of the root zone on the silty clay that has a water holding capacity of almost two feet in the five and a half foot profile. This clearly illustrates that the amount of nitrate leached is related to the water holding capacity of the soil. To avoid excessive leaching the farmer needs to know how much water the soil profile will hold and how much water can be applied before leaching occurs.

The six 6-inch irrigations described above applied about 12 inches more water than was necessary for the evapotranspiration (ET) needs of the crop. Reducing the number of irrigations to four and applying them by estimated ET after the first irrigation resulted in a reduction of nitrate leached on fine sandy loam of about six pounds of nitrate-nitrogen per acre. Net returns to management fell by about $10 per acre. On silt loam the amount of nitrate-nitrogen leached was essentially zero, while net returns increased by approximately $24 per acre. On fine sandy loam using 6-inch irrigations the amount of nitrate leached was reduced only by reducing returns to management. On silt loam using 6-inch irrigations, by estimated ET, both the returns to management and the amount of nitrate that leached out of the root zone improved.

Changing to six 4-inch irrigations (which applied the estimated ET requirement of approximately 24 inches of water) resulted in a small increase in returns to management on fine sandy loam and the amount of nitrate-nitrogen leached was reduced to about three pounds per acre. It was estimated that the labor required to apply 4-inch irrigations would be twice that needed to apply 6-inch irrigations, thus doubling the labor cost for each application. The value of the residual nitrogen in the soil that was not leached out of the root zone adds to the benefit of applying 4-inch irrigations on fine sandy loam.

On the fine sandy loam it was necessary to apply 2-inch irrigations by estimated ET to reduce the amount of nitrate-nitrogen leached to zero. Two-inch applications require a change in irrigation technology, a change from furrow irrigation to sprinkler irrigation. Center pivots are required to irrigate corn with sprinklers. The technological change is costly in terms of returns to management. Returns to management was reduced by about $50 per acre compared to the returns to management using 4-inch irrigations. Because of the more uniform application of irrigation water using center pivots there is likely going to be less variability in yield and nitrate leaching thus the cost stated may be more than may be the case under field conditions.

As can be seen from the above discussion, each soil type behaves differently. Each soil requires its own irrigation management method to maximize return to management and control the amount of nitrate that leaches out of the root zone. Each farmer must know the soils they work with to manage their resources wisely. Applying irrigation water by estimated ET taking into account the water infiltration and water holding capacity of the soil will increase returns to management and limit the amount of nitrate that leaches out of the root zone.

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