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Control of Nitrate Leaching with Winter Annual Cover Crops

Daniel McCracken

Public attention and Federal legislation have focused recently on the contamination of groundwater by nitrate. Seeking to establish standards for safe drinking water, the Federal Government has set the maximum concentration for nitrate (as nitrogen) at 10 parts per million. In large areas of the Great Plains, this value is now commonly exceeded in well water. The limited data from Kentucky appear to indicate that excessive nitrate concentrations are not as widespread in Kentucky water supplies as they are in the water of states more heavily involved in grain production and more dependent on shallow wells for supply. One of the more compelling arguments for controlling nitrate leaching to groundwater is raised by concern over public health in rural America. Nitrate in drinking water poses a threat primarily to infants, though, at very high concentrations, the health of adults and livestock may also be adversely affected.

Nitrate leaching and groundwater contamination can be considerable from cropland that is adequately fertilized for profitable crop production. Non-leguminous summer grains, the chief among them corn in Kentucky, typically receive large applications of N fertilizer at or near planting. If rainfall is high or irrigation heavy during the window between N fertilization and the onset of rapid corn growth (usually 4 to 6 weeks after planting), significant nitrate leaching may occur. Delaying N application to more nearly coincide with rapid corn growth helps control nitrate leaching at this time, and offers the opportunity to reduce N rates. Later in the season, when the crop is growing rapidly, N uptake by corn and corn’s demand for moisture are high, and little, if any, leaching out of the rooting zone occurs in most years on most soils. The greatest potential for nitrate leaching typically exists after corn harvest. Since well-fertilized corn usually takes up 50% or less of applied N fertilizer, much N remains in the soil at harvest which may be susceptible to leaching as nitrate over the fall, winter and early spring under Kentucky’s climate.

When land is left unvegetated, for even a portion of the year, it begins to “leak” dissolved nutrients out of the rooting zone at higher rates, provided also that rainfall or irrigation is sufficient to permit the flow of water through the soil. Forests and grasslands usually leak little nitrate, in part, because they are vegetated year-round. One approach to the management of nitrate leaching in grain production systems is to use cover crops during otherwise fallow winter periods. Vegetation provided by cover crops limits nitrate leaching by drawing on soil moisture, so reducing the volume of water available for leaching, and by scavenging nitrate from the soil.
Hairy vetch and rye are winter annuals well-adapted for growth in Kentucky as cover crops. Both provide a heavy mulch in most years, which aids in soil and water conservation. But in other ways they differ. Hairy vetch, since it is a legume, can supply N to crops which follow it. Rye, because it establishes a more complete ground cover before the onset of winter dormancy, more effectively reduces soil loss during the fall and winter. Hairy vetch and rye also differ in the ability to limit nitrate leaching.

Studies underway since 1986 at the Agronomy Research Farm at Lexington show that rye is far superior to hairy vetch in controlling nitrate leaching in a no-till corn production system (Table 1). While dry matter production and the reduction in leachate volume by the two cover crops were similar, rye nearly eliminated nitrate leaching, and vetch reduced it only by half.

Table 1. Cover crop reduction of leachate volume and nitrate leached between corn harvest and planting of the next corn crop. Average of 2 years data.

<table>
<thead>
<tr>
<th>Cover crop</th>
<th>Dry matter production (tons/acre)</th>
<th>Leachate volume</th>
<th>Nitrate leached</th>
</tr>
</thead>
<tbody>
<tr>
<td>no cover</td>
<td>----</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>vetch</td>
<td>1.5</td>
<td>71</td>
<td>54</td>
</tr>
<tr>
<td>rye</td>
<td>1.2</td>
<td>76</td>
<td>2</td>
</tr>
</tbody>
</table>

The use of a cover crop as a management tool depends on how well it fits a producer's particular needs. If control of nitrate leaching is a priority, winter annual cereals, such as rye, appear much better suited to the task than winter annual legumes, such as hairy vetch. Other attributes of cover crops, including their effectiveness in erosion control, their ability to supply N to crops which follow, and the extent to which they deplete soil moisture, should also be considered when incorporating cover crops into management strategies which sustain profitable crop production and, at the same time, protect soil and water resources.

Extension Soils Specialist