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NITRIFICATION INHIBITORS

W. W. Frye

Nitrogen often limits the production of nonlegume crops because of inefficiency of N fertilizers. In some cases, more than half the fertilizer N may be lost from the soil. Therefore, it is important to use it as efficiently as possible. One way in which N fertilizer efficiency may be improved is by slowing the nitrification process in the soil.

The Nitrification Process and Its Effects

Nitrification is a biological process in the soil in which Nitrosomonas bacteria change ammonium-N to nitrite-N; then Nitrobacter bacteria change nitrite to nitrate-N. These organisms are called nitrifying bacteria, or simply, nitrifiers. Nitrate is subject to being lost by leaching and denitrification; ammonium is not. Thus, with conditions under which there is a high risk of N loss, it may be beneficial to maintain a portion of the N in ammonium form until the peak N demand by crops. Certain chemicals, called nitrification inhibitors, can be used for that purpose. Benefits from their use are due to keeping more N as ammonium in the soil for a longer time.

Nitrification Inhibitors

Nitrification inhibitors slow the first step of the nitrification process--the transformation of ammonium to nitrite. This occurs when activity of the Nitrosomonas bacteria is selectively inhibited.

While many chemicals are known to inhibit nitrification, only a few have been patented and approved for use in crop production. One which has been approved is nitrapyrin, manufactured under the trade name, N-Serve, by Dow Chemical U.S.A. Much research has been conducted on N-Serve nationwide, as well as in Kentucky. N-Serve 24E, an emulsifiable liquid, is labeled for use with anhydrous ammonia and with N solutions. Additionally, N-Serve 24 is labeled in Kentucky for use by direct application to dry ammonium sulfate and urea fertilizers for surface application for no-tillage corn.

Results with N-Serve

Research results with N-Serve have been variable and sometimes inconsistent. However, rather consistent responses have been obtained in Kentucky with the use of N-Serve

for no-tillage corn grown on soils which tend to remain wet until late spring. In these studies, N-Serve was sprayed directly onto dry N fertilizer which was immediately broadcast onto the soil surface either at planting or two weeks before.

Yields of grain were increased significantly by the use of N-Serve with yield-limiting rates of N fertilizer (75 or 80 lbs/acre N) in all years at all locations except 2 of 5 years at Princeton. There was little or no response to N-Serve with higher rates of N at any locations.

Yield responses to the use of N-Serve on conventional tillage corn in Kentucky have been generally lower and less consistent than with no-tillage corn. Results from several locations showed some positive and some negative responses. This was probably due to: (1) less N lost by leaching and denitrification and (2) more N mineralized from soil organic matter with conventional tillage than no-tillage.

Conditions Favorable for Use of Nitrification Inhibitors

Whether or not the N conserved by the use of a nitrification inhibitor will give a crop-yield response is determined by one or more of the following factors: (1) amount of fertilizer N applied, (2) time of fertilizer N application, (3) soil conditions, and (4) climatic conditions.

A yield response to the use of a nitrification inhibitor is more likely where nitrate is lost by leaching or denitrification following application of an optimum or less than optimum rate of ammonium fertilizer. Response should not be expected if an excessive rate of N fertilizer is applied or if the optimum amount is applied and little or no N loss is likely to occur.

Response is more likely when ammonium fertilizer is applied before or at planting than when it is delayed until 4 to 6 weeks after planting.

Soil conditions under which yield increases from use of a nitrification inhibitor may be expected include wet soil due to high water table or slow permeability, very porous soil where leaching may be excessive, and soil with a high amount of easily oxidized organic matter, especially if the soil is also wet. While these conditions are likely to result in leaching and denitrification losses of N under both no-tillage and conventional tillage, their effects are usually greater under no-tillage.

If the weather is unusually dry during the spring and early summer, a response to a nitrification inhibitor may not be obtained, even if fertilizer rates and soil conditions would ordinarily favor a response, because N losses would probably be low.

Nitrification Inhibitors with Wheat

Preliminary studies in Kentucky indicate that N-Serve used with N fertilizer applied in fall or winter for wheat appears to increase efficiency of the N. Although results at this time are inconclusive, it does not seem likely that use of N-Serve with fall-applied N will replace the need for spring topdressing.