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Nitrification Inhibitor in Fluid Starters Improves Corn N Uptake

Nebraska research also shows increased microbial immobilization of N.

Summary: *Efficient use of starter fertilizer N by young corn plants is dependent upon keeping N positionally available. Nitrate-N can be readily leached out of the rooting zone of permeable soils before it can be used by young plants, although it may be recovered later by older plants.*

For soils used in this study, nitrifica-tion of NH4 (ammonium), followed by leaching, lowered corn N uptake more than microbial immobilization.

A nitrification inhibitor (dicyandiamide or DCD in this study) significantly increased corn N uptake and microbial immobilization of ammonium. This is probably due to DCD maintaining more starter N in the ammonium form, which in turn maintains positional availability of starter N for young corn plants.

Under moderate leaching conditions, it may be advantageous to add a nitrification inhibitor to starters to ensure that N remains positionally available to young corn plants.

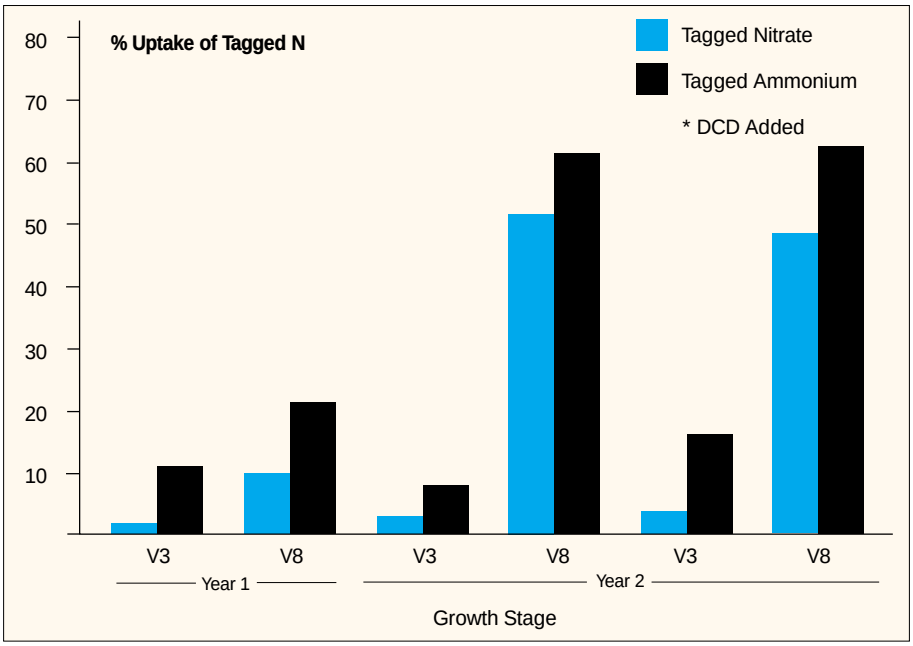

Figure 1. Percent uptake by corn of tagged N applied in a starter, Janude sandy loam and Hord silt loam, Francis, et al., Unversity of Nebraska.

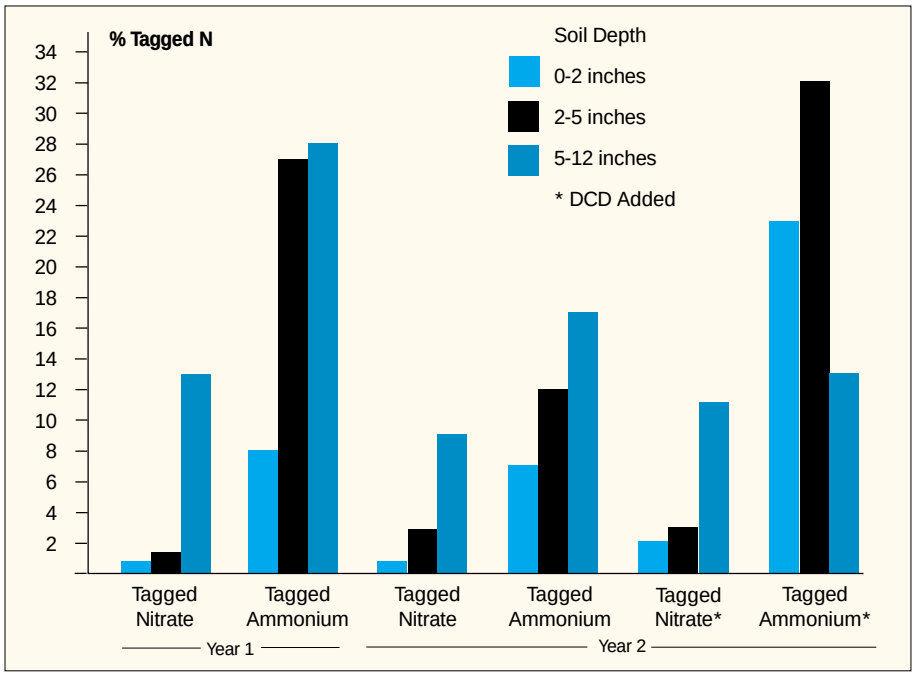

Figure 2. Percent of tagged N recovered in top 12 inches of soil at V3 sampling date, Janude sandy loam and Hord silt loam, Francis, et al., Unversity of Nebraska.

The question of which form of N (ammonium or nitrate) to supply to corn plants at specific growth stages is an interesting one.

A theoretical advantage of NH_4-N is that energy would not have to be expend-ed in reducing NO_3-N for assimilation in the developing plant. NH_4-N is also more likely to enhance uptake of P in young corn plants.

Disadvantages of NH_4-N in starters

include 1) higher susceptibility to immo-bilization by soil microorganisms, 2) greater potential for soil acidification, and 3) potential for chemical and/or clay fixation in some soils.

To identify the fate of NH_4 (ammonium) and NO_3 (nitrate) in high N starters, a study was designed to compare plant uptake and microbial immobilization of NH_4-N and NO_3-N in starter fertilizer for continuous corn, using isotopically tagged N sources.

N movement

Plant samples collected at the V3 growth stage the first year indicated a much higher apparent plant uptake of starter ammonium than nitrate (Figure 1).

One possible explanation is preferential uptake, but this was not the main cause in this case. Spring rainfall had been below normal. To ensure uniform germination and a good stand, approximately 2 inches of irrigation water was applied through a sprinkler system about five days after planting. Rain accounted for an additional 1.2 inches about four days later. Between planting and first sampling, irrigation plus rainfall totaled nearly 5 inches.

Soil analysis indicated that this moisture apparently had moved most of the $^{15}NO_3$ (tagged nitrate) out of the top 12 inches of soil by the first sampling date (Figure 2). Only one percent of starter N applied as nitrate was found as KCl extractable inorganic N above the 5-inch depth compared to approximately 20 percent for $^{15}NH_4$ (tagged ammonium) at the V3 growth stage.

Plots were located on a well drained sandy loam soil, which would suggest a low potential for denitrification. In addition, isotope enrichment at the 5- to 12-inch depth showed that tagged ammonium had also moved downward. Isotope analysis indicated that practically all of the tagged ammonium had either been nitrified or immobilized by the first sampling date, and most likely moved downward as tagged nitrate.

Increased uptake of ^{15}N (tagged N) at the VS growth stage the first year suggests that roots were beginning to intercept leached tagged N (Figure 1). Similar uptake of N at the V8 growth stage would be expected if both sources were mainly in the same form (nitrate) with similar positional availability in the expanding root zone. This indicates that N applied as nitrate did not leach much farther than that originally applied as ammonium.

First year data indicated greater micro-bial immobilization of NH_4-N, despite rapid nitrification.

Nitrification inhibitor helps

We included in the starters a nitrification inhibitor (DCD) with both tagged ammonium and tagged nitrate treatments during the second year. The objective was to find out what effect this inhibitor would have on corn N uptake. Additionally, we were interested in where starter N ended up. Would it be in the inorganic forms or immobilized by a microbial biomass?

The addition of DCD approximately doubled tagged ammonium uptake by corn at the V3 growth stage (Figure 1). Without considering other information, plant N uptake data would suggest preferential uptake of tagged ammonium versus tagged nitrate. However, excess moisture (4 inches of rainfall before emergence and over 7 inches before sampling) removed over 95 percent of tagged nitrate out of the top 5 inches of soil by the V3 growth stage (Figure 2). In comparison, just over half of the tagged ammonium without DCD was lost from the top 12 inches of soil by this date. Although all the remaining tagged NH_4-N had been converted to the nitrate form, nearly 15 percent was still available in the top 5 inches of soil.

Using the inhibitor DCD with tagged ammonium resulted in the highest proportion of tagged N still being plant available in the top 12 inches of soil four weeks after planting. Approximately three-fourths of this plant-available inorganic N was still in the top 5 inches of soil.

Large increases in tagged N uptake at the VS growth stage for all treatments in the second year indicated again that much of the starter N that had leached out of the upper 12 inches of soil was available within the crop root zone by the V8 stage. Although uptake of tagged N at V8 was much higher in the second year than the first, similar increases occurred between V3 and V8 growth stages, whether the N was applied as nitrate or ammonium. This would be expected if tagged N was mainly in the same form(nitrate) with similar positional availability between V3 and V8.

In addition to increasing plant uptake, DCD also increased tagged N uptake by the microbial biomass, probably by maintaining N in the ammonium form.

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