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Nitrification inhibitors. Once NH_4^+ is nitrified to nitrate (NO_3^-), N is susceptible to loss by denitrification or leaching. Nitrification inhibitors such as dicyandiamide (DCD) or nitrapyrin (known by its trade name N-Serve) can retard this conversion, reducing loss potential. When properly applied, inhibitors can significantly affect crop yields. In one experiment, 42% of the applied ammonia remained in the NH_4^+ form through the early part of the growing season when the inhibitor was used, in contrast with only 4% when the inhibitor was not used. However, the benefit from using an inhibitor varies with soil condition, time of year, type of soil, geographic location, rate of N application, and prevailing weather conditions between N application and crop uptake. Yield increases of 10 to 30 bushels per acre are possible by using an inhibitor in years with excessive rainfall, but there is often no advantage when soil conditions are not conducive to leaching or denitrification.

Nitrification inhibitors are most often used with fall applications to help protect against N loss. In general, poorly or imperfectly drained soils that easily become water saturated and coarse-textured (sandy) soils with high potential for leaching probably benefit the most from nitrification inhibitors. Moderately well–drained soils that undergo frequent periods of 3 or more days of flooding in the spring also benefit. Although they are not commonly done, when springs are very wet and on nearly all types of soil from which N losses frequently occur, especially on sandy and poorly drained soils, spring preplant applications may benefit from the use of an inhibitor. Application of inhibitors is generally not recommended for sidedress applications. Soils typically do not stay saturated with water very long during the growing season after sidedress application, and only a few weeks elapse between sidedressing and rapid plant uptake, so there is little benefit to preventing conversion to nitrate. The longer the period between N application and absorption by the crop, the greater the probability that nitrification inhibitors will contribute to higher yields. However, the length of time that fall-applied inhibitors remain effective in the soil also depends partly on soil temperature. On a Drummer silty clay loam soil, an inhibitor application when soil temperature is 55 °F can keep close to 50% of the applied ammonia in NH_4^+ form for about 5 months. When soil temperature is 70 °F, the soil may retain the same amount for only 2 months.

Time of application and geographic location must be considered along with soil type when determining whether to use a nitrification inhibitor. Using inhibitors can significantly improve the efficiency of fall-applied N on the loam, silt loam, and silty clay loam soils of central and northern Illinois in years when the soil is very wet in the spring. At the same time, inhibitors do not adequately reduce the rate of nitrification in the low-organic-matter soils of southern Illinois when N is applied in the fall for the following year’s corn. The lower organic matter content and the warmer temperatures of southern Illinois soils, both in late fall and early spring, cause the inhibitor to degrade too rapidly. Furthermore, applying an inhibitor on sandy soils in the fall does not adequately reduce N loss because the potential for leaching is too high. Fall applications of N with inhibitors thus are not recommended for sandy soils or for soils low in organic-matter content, especially south of Illinois Route 16.

Nitrification inhibitors should be viewed as management tools to reduce N loss. Nitrification inhibitors are most likely to increase yields when N is applied at or below the optimal rate. When N is applied at a rate greater than that required for optimal yields, benefits from an inhibitor are unlikely, even when moisture in the soil is excessive. Finally, it is not safe to assume that the use of a nitrification inhibitor will make it possible to reduce N rates below the MRTN rate, because those rates were developed from fields where no significant amount of N was lost.

Fall applications.

Because of concerns over environmental degradation and reductions in economic return on N brought on by higher fertilizer prices, fall applications should be done only in soils and regions with low N-loss potential. Fall N applications should not be done in soils that are sandy, organic, or very poorly drained or that have excessive drainage, or where soils rarely freeze or temperatures decline very slowly from 50 °F to freezing. Nitrogen, other than that included incidentally with the phosphorus application, should not be fall-applied for corn on any soil south of a line that approximates Illinois Route 16, or the terminal moraine of the last glacier. Soil maps may be used to determine where within this boundary area fall N can be safely applied. Most of the incidental N in phosphorus fertilizers should not be expected to be available the next spring. However, the amount of N in a typical P application is small, and so its loss would rarely translate into a significant yield loss. When applied properly, fall N on wheat is acceptable.

Fall N applications are often preferred because they are more economical to farmers and the fertilizer industry. Fall applications often lower the cost of fertilization by reducing transportation and storage expenses and by requiring less storage and application equipment. They also provide logistical advantages, such as saving time in the spring to allow for early planting, better distribution of labor and equipment, and generally better soil conditions in the fall to protect soils from compaction during fertilizer application.

In places where fall application is environmentally acceptable, farmers should apply N in forms that do not contain nitrate. The preferred source for fall application is anhydrous ammonia, because it nitrifies more slowly than other forms. Manure and poultry litter can also be applied in the fall as long as they are incorporated in the soil and the guidelines are followed on soil temperature and soil conditions as described for fall application of inorganic N fertilizers. Urea-containing fertilizers, even when incorporated, are not as effective as fall-applied anhydrous ammonia or spring-applied urea.

Fall N applications should be done when daily maximum bare soil temperature at 4 inches is below 50 °F. On average, this temperature is reached after the first day of November in northern and central Illinois. However, this average date is not a satisfactory guide because of the great variability present from year to year. Current soil temperatures for different regions of Illinois are available at www.isws.illinois.edu/warm/soiltemp.asp. While these temperatures may be useful in most cases, soil temperature can vary due to many factors, including soil color, drainage, and amount of crop residue on the surface. For this reason the best method to determine soil temperature is direct measurement in the field to be fertilized. It is important to note that while the rate of nitrification is significantly reduced below the recommended 50 °F soil temperature, microbial activity continues until temperatures are below 32 °F. The 50 °F temperature for fall application is a realistic guideline for farmers. Applying N earlier risks too much loss. Waiting until later risks wet or frozen fields, which would prevent application and fall tillage.

In Illinois, most of the N applied in late fall or very early spring is converted to NO_3^- by corn-planting time because of nitrification during the long periods when soil temperatures are between freezing and the mid-40s. In consideration of the date at which NO_3^- is formed and the conditions that prevail thereafter, the difference in susceptibility to denitrification and leaching loss between late fall and early spring applications of NH_4^+ sources is probably small. Both are, however, more susceptible to loss than is N applied at planting time or as a sidedress application.

Large amounts of residue generated from corn or other crops can create challenges for planting and field operations in the spring. There is also concern that the high ratio of carbon to nitrogen in the residue means a high potential for tying up N and making it unavailable for the following crop when it needs it. A common question has been whether application of N, such as UAN, on the residue would help with the breakdown of corn stalks. Research has shown no benefit in fall application of N to increase microbial decomposition of corn residue or to improve N availability for the next crop. Typically, low temperature or dry residue, and not N availability, is the main limiting factor for microbial decomposition of residue in the fall.