Fertilizer Nitrogen BMPs for Corn in the Northcentral Region

By Scott Murrell

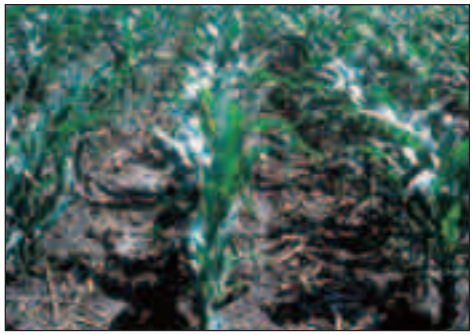
This article presents a summary of more than 30 university Extension publications in the Northcentral Region where best management practices (BMPs) are defined for nitrogen (N) use on corn. The information presented here represents BMPs common to many, and sometimes all, states in the region.

The BMPs discussed here are organized under the categories of right form, right rate, right time, and right place.

Right Form

Fall applications. Use ammoniacal or ammonium forms of N. Many consider anhydrous ammonia to be the best form to minimize loss of nitrate (NO_3^-) because it has the slowest rate of nitrification. Good chances exist that a nitrification inhibitor will provide benefits on poorly drained soils and soils with higher moisture levels near the surface when N is not applied in excess. Fall applications with a nitrification inhibitor risk not being as effective as the same rate of N applied in the spring. Use of urea is acceptable in drier climates, such as parts of western Minnesota and South Dakota, if it is incorporated soon after application on soils with lower leaching and denitrification loss potentials. A urease inhibitor may provide benefits when incorporated or 0.2 to 0.5 in. of rain does not occur within 2 to 3 days after application. Forms containing NO_3^- are not recommended.

Pre-plant or side-dress applications. On sandy soils, anhydrous ammonia performs best and forms containing NO_3^- should be avoided because of chances of leaching losses. On medium and fine textured soils, ammoniacal and ammonium forms, such as anhydrous ammonia and urea, reduce chances of NO_3^- loss. A nitrification inhibitor will usually provide benefits with pre-plant and early side-dress applications on poorly drained soils when N is not applied in excess. Fair chances exist for silt loams and coarser textured soils. A urease inhibitor can provide benefits when incorporation of urea or urea ammonium nitrate (UAN) is not possible within 2 to 3 days after application.



Right Rate

Setting realistic yield goals. For recommendations using a yield goal approach, use the average yield of the previous 5 year production levels of a given crop, then add a small percentage increase to account for a possibly higher, future attainable yield potential. Abnormally low yields should be excluded from the average.

Many states in the Northcentral Region have shifted N recommendations from a yield goal-based approach to methods that no longer consider yield levels. This change has occurred because of the lack of an observed relationship between economically optimum N rates and yield, analyzed across many site years of

data across several states. This approach averages several factors in an N recommendation model. Other states are currently retaining yield goal-based recommendations, making model parameters more explicit and changeable by the user.

Soil nitrate tests. A variety of tests are available and either account for the NO_3 already present in the soil or combine current NO_3 levels with estimates of future N mineralization. Use of the tests and interpretation of the results are state-specific.

Previous legume crops. Legumes should be credited or consideration given to the effects of legumes on corn response to applied N. Second year effects should be considered for manure and alfalfa.

Accounting for all N sources. Record location, rate, and nutrient concentration of applied manure and/or biosolids. Include N applied in other fertilizers and applied at other times during the season.

In-season assessment. Look for N deficiency symptoms. Also, a chlorophyll meter can be used if a reference strip has been left in the field. Reference strips are those where N is known to be adequate. If a need is indicated, supplemental N applications can be made. These may be side-dress or aerial applications, fertigation, or applications with high clearance equipment.

Post-season assessment. Measuring earleaf N concentrations and/or using the stalk NO_3 test can provide indications of the sufficiency of N for the crop grown. These assessments can be used to alter future management practices.

Right Time

Fall applications. Apply ammoniacal or ammonium forms of N only when soil temperatures are sustained below the critical 50 °F temperature. Do not apply N in the fall on sandy soils or soils with a higher permeability. Fall applications are not well suited to fine-textured, poorly drained soils. Fall applications run a risk of being less effective in increasing crop yields than spring applications, but work best on medium-textured, well-drained soils where N loss through leaching and denitrification is usually low.

Pre-plant or side-dress applications. Use split applications on sandy soils or fine-textured, poorly-drained soils. Side-dress applications are usually best on irrigated, sandy, low cation exchange capacity (CEC) soils. Pre-plant applications alone work best on medium and heavier textured soils except under conditions of excessive early season rainfall. Side-dress applications should be made no later than about 6 weeks after planting, or when corn is 6 to 12 in. tall.

Post side-dress applications. If a required side-dress application has been missed, an emergency rescue aerial application of urea can be used. Aerial applications of N solutions are not recommended.

Right Place

Anhydrous ammonia. Inject 6 to10 in. deep on friable, moist soil. Free ammonia can damage seedlings. Closure of the slot in the soil made by the applicator is needed to minimize volatilization loss.

Aqua ammonia and low-pressure solutions. Inject 2 to 4 in. deep on friable, moist soil. Closure of the slot in the soil made by the applicator is needed to minimize volatilization loss.

Urea and urea ammonium nitrate. Inject 4 in. deep, or surface apply and incorporate. Higher pH soils cause higher losses of N through ammonia volatilization. Higher losses can also occur if urea is surface applied on moist soils under windy conditions or following unincorporated lime applications. Post-emergence applications that are broadcast or sprayed may cause plant injury. Urea should not be applied with the seed. After emergence, UAN should be applied between rows to avoid leaf burn, preferably dribbled or sprayed in surface bands to reduce contact with the urease enzyme in both the soil and plant residue.

Ammonium and/or nitrate forms. These forms can be left on the surface, incorporated, or injected. Surface applications without incorporation should be done only where there is low risk of runoff. Surface applications of ammonium forms on calcareous soils can result in N losses through ammonia volatilization if left unincorporated.

Table 1. Maximum recommended nutrient rates of starter fertilizer to be applied in direct contact with corn seed during planting at a row spacing of 30 in. Urea, UAN, and ammonium thiosulfate are not recommended for placement with the seed.

State	Max. rate of $N+K_2O$, lb/A	Notes
Iowa	10 5	Soils with adequate moisture, not sandy. Sandy and/or dry soils.
Illinois	13-16	Rate range is for normal moisture conditions. In excessively dry spring conditions, these rates may be too high.
Indiana	8 5	Soils with CEC > 8 Soils with CEC < 7
Minnesota	12-16	Information calculated from data in Table 5 (in the reference) for the 10 gal/A rate, assuming 11.2, 10.3, and 11.65 lb/gal densities for 7-21-7, 4-10-10, and 10-34-0, respectively. Rates are based on adequate moisture. If soils are dry at planting, some seed damage can occur at these rates.
South Dakota	10 5	Medium and finer textured soils with adequate moisture. For dry and/or sandy soils.
Wisconsin	10	For sources other than urea.

Banding during planting (starter). Some N applied with or near the seed at planting provides a small supply of strategically-placed N early in the season. This can be especially important when the primary N application is banded between the rows. Plant root growth early in the season may not be extensive enough to reach this banded N, increasing the reliance on the N applied near the seed during planting. Placement in direct contact with seed limits the rates of N that can be applied (**Table 1**). It also carries higher risk of salt damage than placement a small distance from the seed, such as 2 in. to the side and 2 in. below (2x2).

Band applications other than starter. Fertilizer N applied in bands can be applied mid-row as far apart as every other row.

Summary

The BMPs provided here for N use on corn represent general approaches used by many states in the Northcentral Region. Recommendations may vary for specific locations where more specialized BMPs exist.

For more detailed information and references pertaining to the BMPs described here, visit the Northcentral Region website at **>www.ppi-ppic.org/northcentral<**. The website also has a similar summary of BMPs outlined for phosphorus and potassium in corn production in the Northcentral Region. BC

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PKalc Software Checks Nutrient Balance

"Toolbox" is a feature on the PPI/PPIC website which holds free downloadable software tools for improved nutrient management. One useful tool is called PKalc (v.1.13), a simple balance calculator which helps users determine if phosphorus (P) and potassium (K) nutrient additions are keeping up with removal by crops.

PKalc and other programs can be accessed for free at:

>www.ppi-ppic.org/toolbox< BC