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BEST MANAGEMENT PRACTICES

CHAPTER 20

Corn Nitrogen Timing

Christopher Graham (Christopher.Graham@sdstate.edu) and Anthony Bly (Anthony.Bly@sdstate.edu)

To optimize uptake of nitrogen (N) fertilizer efficiency and to minimize the adverse impact of N on the environment, we recommend that N be applied at the right time, in the right form, at the right place, and in the right amount. This chapter specifically addresses applying N at the right time. A corn plant takes up a large percentage of its N between the V6 (~10 inch tall) and R1 (silking) growth stages. During this period, newer hybrids require as much as 8 lbs/day to maintain maximum production. When N is applied earlier than it is needed by the plant, it can be lost through a variety of mechansims including leaching and denitrification.

Table 20.1 Advantages and disadvantages of various fertilizer timing.

N Timing	Advantage	Disadvantage
Fall	Equipment is available.	N loss off-field can be through several mechanisms.
	Weather permitting, time is typically not a constraint.	Applied prior to crop demand. Often has lower efficiency than spring and split applications.
Preplant spring	Reduced N losses relative to fall.	If excessive spring rainfall, N loss off-field can still be significant.
At planting pop-up and starter fertilizer	Applied with or near the seed.	Salts and ammonium/ammonia in the fertilizer can inhibit germination.
	For pop-up use, only low rates required.	Applied prior to crop demand.
Topdressed, applied to standing crop after emergence and when corn is < 6 inches	Reduces losses relative to fall or preplant spring.	Volatilization losses may be high when surface broadcast.
		Rainfall required to move N into the soil when surface broadcast.
		Leaching/denitrification losses may be high following spring rainfalls, but inhibitors may help.
Sidedressed, applied when corn is <12 inches tall	Applied when plant needs N.	Accounts for early spring rainfall, however, rainfall is required to move the N into the soil.
	Accounts for rainfall.	Can be delayed by excessive rainfall conditions.
	Improved N efficiency.	Time demands due to weed control requirements.
Combination of starter + sidedressed (Split)	Accounts for rainfall, can have high efficiency.	Time required to apply the sidedressed N.

The advantages and disadvantages associated with N fertilizer timing in corn production are summarized in Table 20.1. Corn producers need to consider weather, N fertilizer source, placement, and cultural practices such as tillage, pest, weed, and disease pressure. The ultimate goal of an N fertilization program is to supply N when it is most needed. While economic and logistic factors make fall N applications more convenient, the practice has risks that may not be worth the trade-offs. In years with a wet spring a significant amount of N may be lost, making spring and split N applications preferable. This chapter provides management guidelines for fall, spring, and split N applications.

N Fertilizer Options

With the high cost of N fertilizer and an awarenes of adverse effects of N on the environment, there is an increased interest in adopting techniques that improve N fertilizer efficiency. Recent research has strengthened the case that in humid or irrigated environments, a split application is more effective at meeting corn N demands than a single application applied either in the fall or early spring. However, in rainfed corn production systems, delaying the N application increases the risk that surface-applied N will not be incorporated and available for uptake from crop roots. When this happens, the yield loss can also be substantial.

Fall Broadcast Applications of Urea

Broadcast-applied urea is most susceptible to environmental loss through volatilization. It is not recommended to fall apply N before the soil cools to less than 50°F or to sandy soil. Moreover, research from Montana found that application to snow-covered soil still maintained fairly high volatilization rates, particularly during periods of snowmelt. Additionally, application to soil with high pH, generally above 7.5, increases volatilization. Ammonia volatilization is reduced by incorporating the urea granual into the soil either by cultivation or rainfall.

Starter and Pop-up Fertilizers

Pop-up fertilizers are placed with the seed at planting, whereas starter fertilizer is applied near the seed. Salts contained within the fertilizer can reduce seed germination. For pop-up fertilizers, avoid the use of urea. For corn production in South Dakota, di-ammonium phosphate (DAP) or mono-ammonium phosphate (MAP) are recomended as a pop-up fertilizer. Both of these products contain a small amount of N. Generally, the K_2O + N rate applied with the seed should not exceed 10 lbs/acre, however this rate is dependent on row spacing and soil texture. A calculator to determine pop-up fertilizer rates is available from the International Plant Nutrition Institute, ipni.net/article/IPNI-3268.

Starter fertilizer is generally placed 2 inches to the side and 2 inches below the seed. By separating the fertilizer and seed, the risk of salt injury is reduced. However, this risk is not eliminated and it is recommended to apply less than 70 lbs of N + K_2O if the band is within 2 inches of the seed.

Split-N Applications

In a split-N application system, N is applied at multiple times during the season. It can be applied in the fall, with the seed as a starter, in a band next to the seed (2 inches deep by 2 inches to the side of the seed row), or between the rows as a sidedressed application. One of the greatest strengths with the split-N approach is that it allows the grower to account for early season N losses and changes in the grain yield potential. When a preseason nitrogen test shows adequate soil N, a producer may benefit economically by reducing preplant or starter N rates.

Research in South Dakota indicates that splitting N applications between preplant and V6 can increase corn grain yield over fall application of N. However, the amount of N to apply at V6 is dependent on the amount of nitrate-N contained in the soil. The pre-sidedress nitrate test (PSNT) is one tool that can be used to estimate the sidedress N application rate. For PSNT, randomly collect 16 to 24 soil cores from the surface 12 inches when the plants are between V3 to V5 (Magdoff et al., 1984). Sample collection and handling should follow good sampling protocols. Determine the N rate based on the NO_3-N concentration (Table 20.2).

Table 20.2 Relationship between the amount of in-season soil test N in the surface 12 inches and the sidedressed N rate. (*Modified from Blackmer et al., 1991; Reitsma et al., 2008*)

In-season soil test NO_3-N	Sidedressed N
ppm	lbs N/acre
0-10	80-120
11-15	50-90
16-20	30-60
21-25	0-40
> 25	0

One of the problems with applying N at the V6 growth stage is that rainfall is needed to move the fertilizer into the soil where it can be absorbed by the roots. This problem can be avoided by injecting the N into the soil. However, if the in-season N application is delayed due to high rainfall or logistical issues, recent research from Missouri suggests that "rescue N" applications can be applied as late as tasseling. However, growers must take precautions to minimize leaf burn.

Summary of N Timing

Nitrogen is typically lost through volatilization, leaching and/or denitrification. A single, fall application of N represents a gamble on whether N will be available in late June and early July when it is most needed by the crop. There are cases where it has been found acceptable (Bundy, 1986; Vetsch and Randall, 2004). However, fall applications on sandy soils are not recommended, and it is not recommended on other soils until temperatures decrease below 50°F.

The potential losses from early-applied N and the yield advantage from in-season application are well-defined. After accounting for N in the soil, a broader set of recommendations would include N application through a combination of applying some N (30-50 lbs/acre) early in the growing season, with the remainder being applied in the mid-vegetative stages. Protecting the N with urease and nitrification inhibitors can also prolong the time period when N is safe from loss. Where possible, adding N through irrigation water is an effective approach.

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