Rescue Nitrogen Applications to Corn

Nitrogen (N) is essential to plant growth. As a constituent of protein, it is instrumental in critical plant functions from germination to senescence. As a component of the chlorophyll molecule, N has a primary role in photosynthesis and therefore yield accumulation in crops. Unfortunately, this critical plant nutrient can be easily lost from the soil by leaching or denitrification when excessive rainfall occurs.

Wet spring conditions can delay planned N applications as well as promote losses of previously applied N. When this occurs, producers must decide if an additional N application is warranted to avoid the risk of reduced yield. Recent wet springs and resulting yield losses demonstrate the importance of making the correct decision.

Figure 1. Nitrogen loss to corn field areas in wet spring.

When determining whether or not to apply additional N, producers should evaluate how much N remains in the soil and decide if that will be enough to meet crop needs. If not, a rescue N application may be needed. Applying N late in the spring reduces the risk of further N loss and increases the likelihood of N availability when the corn crop needs it most.

Evaluating Nitrogen Loss

There are several ways to evaluate N losses after excessive rainfall events: **1)** using crop sensors, and **2)** gathering other information to make a good estimate.

Crop Sensors – Recently improved optical sensors can help assess N deficiency and the amount of N needed to optimize crop response. Mounted on N-application equipment, these sensors measure crop "greenness", which correlates with plant chlorophyll content and therefore estimates crop N status. After calibrating the sensor using a well-fertilized "reference strip" the applicator traverses the rest of the field, performing the sensing, rate calculations and application all at once. Besides these sensors, aerial imagery and chlorophyll meters are also good tools for in-season evaluation of corn N needs.

Estimating N Loss – In lieu of soil testing or crop sensing, N loss can be estimated, and this estimate used as a basis for deciding if more N should be applied. In this process the key questions to answer are: **1)** When was the N applied?, **2)** What form was used?, **3)** How much was applied?, and **4)** What were the field conditions following the application?

Figure 2. Heavy rainfall and low-lying areas are a combination that can lead to N losses by denitrification.

Greater quantities of N fertilizer are converted to nitrate as time goes by and soil temperatures increase. Knowing when the N was applied and what fertilizer was used enables the estimation of the quantity of N in the nitrate form when rainfall occurred (Table 1).

Table 1. Amount of nitrogen fertilizer in the nitrate-N form 0, 3 and 6 weeks after application. Adapted from Lee et al., 2007.

N Source	Week After Application		
	0	3	6
	% Fertilizer as Nitrate-N		
Anhydrous ammonia (NH_3)	0	20	65
NH_3 with N-Serve	0	10	50
Urea	0	50	75
UAN	25	60	80
Ammonium nitrate	50	80	90

Just because N was in the nitrate form does not mean all of it was lost. The soil temperature and duration of soil saturation are two key factors affecting denitrification. Higher soil temperatures and longer periods of soil saturation both increase denitrification losses (Table 2).

Table 2. Estimated denitrification losses as influenced by soil temperature and days of saturation (Bremner and Shaw, 1958.)

Soil Temp (°F)	Days Saturated	Nitrate-N Loss (% of total N applied)
55 - 60	5	10
	10	25
75 - 80	3	60
	5	75
	7	85
	9	95

Another way to estimate whether a rescue N application is needed is to use the Nitrogen Loss Scoresheet developed at the University of Missouri (Scharf, 2008). After estimating the amount of nitrate lost by either method above, a better decision can be made as to whether a rescue N application is needed and how much additional N is required.

Rescue N Application Methods

Options for rescue N application are limited compared to earlier season N applications. Equipment availability and N source are the two most important factors to consider, as well as risk of leaf injury and the potential for NH_3 volatilization from urea application. If a high-clearance sprayer is available, banded applications of urea ammonium nitrate (UAN) solution can be made. Make sure the sprayer is equipped with weighted hoses that drag the ground, preventing the hoses from riding up on the leaves and causing splatter and leaf burn. Banding will also help minimize urea hydrolysis and volatilization.

If choosing to broadcast the rescue N, urea is the product of choice. This is because other N sources – ammonium nitrate (NH_4NO_3) and UAN solution – cause extensive leaf burning when broadcast (Figure 3). Studies have shown that this leaf injury often results in yield loss. Urea is much safer to broadcast, usually resulting in only minimal crop injury. (Nelson et al., 2010).

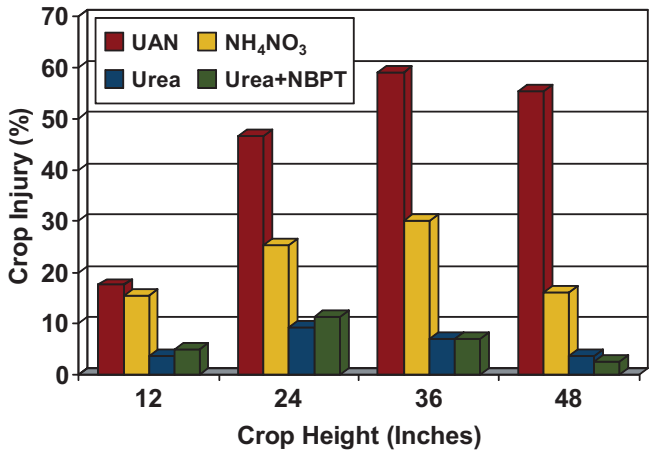

Figure 3. Corn leaf injury due to broadcast application of N fertilizers at different plant heights. (Nelson et al., 2010.)

However, urea is subject to NH_3 volatilization. The use of NBPT (N-(n-butyl) thiophosphoric triamide), a urease inhibitor, can help prevent urea hydrolysis and subsequent NH_3 volatilization. Banded applications also will help minimize N loss. Late applications of controlled-release urea are not recommended because of the delay between application and the N being released and available to the corn.

Corn Response to In-Season N Applications

Field research studies have verified the following points regarding N loss and late in-season N applications:

- Early-season N stress can result in irreversible yield loss, due in part to a reduction in the number of kernel rows per ear, which is generally determined between V5 and V8.
- Research studies conducted throughout the Corn Belt over the last 30+ years have clearly shown that rescue applications during the late vegetative stages (through tasseling) are likely to result in increased yields and economic returns.
- The greater the N deficiency and the longer it goes uncorrected, the greater the potential for yield loss. Corn is more responsive the sooner N is applied; some studies have shown that economic yield responses seldom occur after pollination.
- Under severe N deficit, some response may occur to 30-60 lb/acre N applied 3 weeks past silking (Thomison, 2010).

These points are also important regarding management of fields after a period of excessive rainfall and N loss:

- In many situations where N loss occurred, prolonged soil saturation and/or ponding likely lowered corn yield potential. As a result, full N rates may no longer be needed.
- N losses are likely not uniform throughout the field (e.g., denitrification is greatest in low-lying areas). In such cases, apply N only where needed to avoid unnecessary costs and potential future losses of excess N.
- When use of ground equipment is prevented by wet field conditions, **aerial application of urea** is still an option. Use of a urease inhibitor can help prevent urea hydrolysis and subsequent NH_3 volatilization.
- To avoid severe corn tissue damage, do **not** use UAN solution, ammonium nitrate or ammonium sulfate for aerial application.
- Maintain a **backup plan** for rescue applications. This could include finding a service provider for high-clearance or aerial applications well ahead of the potential need. A quick response to N-deficiency stress will help minimize yield loss.

References

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