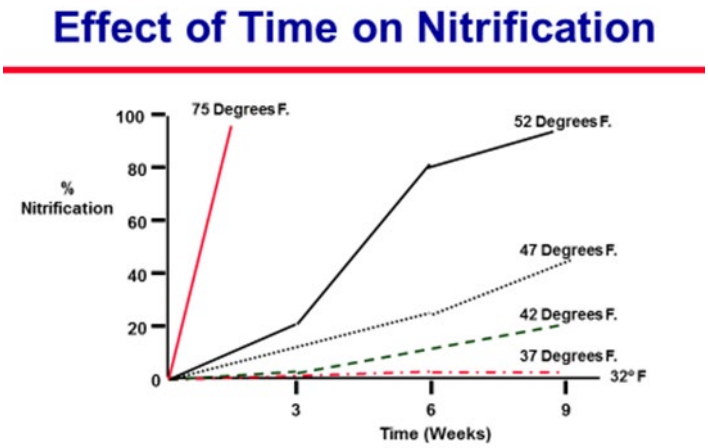
Fall Nitrogen Considerations

Nitrogen management is a complex process involving a variety of agronomic and economic factors. Because of the complexity of addressing these factors, current N management practices generally results in low nitrogen use efficiency (NUE) by the corn crop (< 50% NUE), which leads to N leaching into groundwater or subsurface tile lines. Although spring and in-season applications tend to be the most efficient use of applied N, fall N application allows for more efficient allocation of time, labor, and equipment than in the spring. As fall N application time approaches, steps can be taken to help increase NUE, reducing N lost to ground and surface waters, and maximizing the economic return on applied N.

1. When can application of anhydrous ammonia begin?

If anhydrous ammonia is to be fall applied, delay applications until soil temperatures at a 4-inch depth are consistently below 50°F. Even after this soil temperature is reached, anhydrous ammonia shouldn't be applied to fields with a high leaching potential, such as coarse textured, sandy soils. How soon we reach 50°F varies by geographic location, but in general soil temperatures in Iowa reach 50°F in late October or early November. Temperatures below 50°F minimize the potential for nitrification, which results in the conversion of ammonium-N to nitrate-N, prior to soil freeze-up. As long as nitrogen remains in the ammonium form (NH4) it is not subject to loss due to either leaching or denitrification. Since soil bacteria carry out nitrification, low soil temperature controls the speed of nitrification as illustrated in the figure to the right. Nitrification inhibitors can help to slow this conversion process, helping to keep more N in the ammonium form for a longer period of time.



Source: Frederick & Broadbent, 1966

2. When should fall manure be applied, and should a nitrification inhibitor be included in the application?

For logistical reasons, fall manure application typically begins much earlier in the fall than anhydrous ammonia application. Because of the high ammonium content of manure, its application should be treated similar to anhydrous ammonia application. When possible, manure application should be delayed until later in the fall when soil temperatures reach 50°F. Including a nitrification inhibitor can help to slow the conversion of ammonium to nitrate in the soil. A 4-year study from southern Minnesota was recently published, in which the authors evaluated early (1st week of October) vs late (1st week of November) manure applications with and without a nitrification inhibitor. Soil samples were collected before planting each spring. The data shows:

Soil samples (0 to 12" depth) summarizing a 4-year study conducted in southern Minnesota evaluating fall manure application timing with and without a nitrification inhibitor.

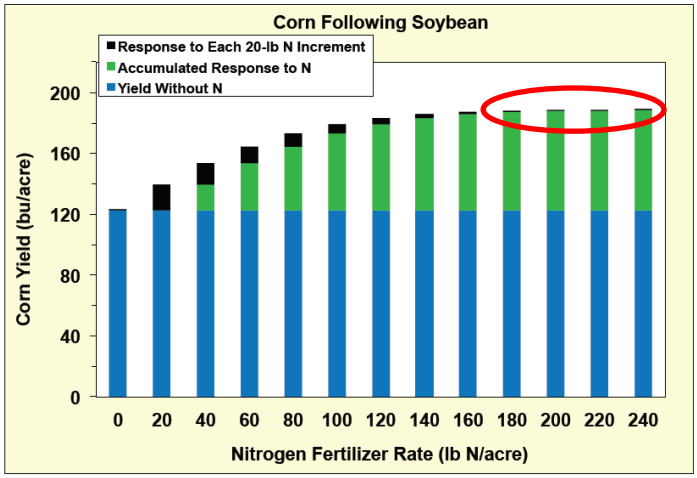
	Application Timing			
	1st week of October		1st week of November	
Treatment	Ammonium (ppm)	Nitrate (ppm)	Ammonium (ppm)	Nitrate (ppm)
Manure	13	17	27	25
Manure + Nitrification Inhibitor	43	12	47	11

Vetsch et al. 2017. Agron. J. 109:2358-2370

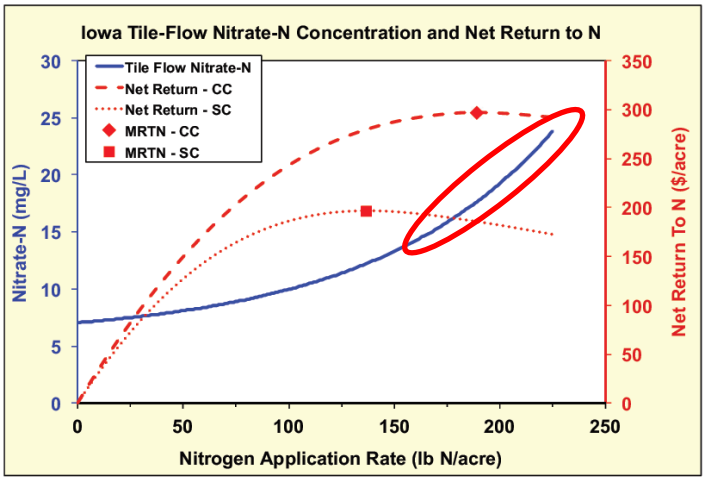
- Delaying application until later in the fall increased the amount of N retained in the ammonium form in the spring
- Including the nitrification inhibitor in both early and late applications helped retain a higher amount of N in the ammonium form through the winter, and available in the root zone for crop uptake the next season

3. Can N rates be increased to compensate for lost N, rather than include a nitrification inhibitor?

Although this can be done, the figure below (left) shows that N applied above the optimal rate has little to no yield response. Adding a nitrification inhibitor to N applied at the optimal rate helps to stabilize N, keeping it in the root zone over the winter and available for crop uptake next season, and leads to a higher yield response to applied N. Additionally, when N is applied in excess of the optimal rate, nitrate-N in tile flow increases (figure below, right). N rates in excess of the optimal rate lead to more of the applied N being leached so it can't be taken up by the crop next season. Higher rates of N don't necessarily lead to more N being utilized by the crop, but can lead to increases in N being lost to the environment.



Sawyer, J.E. April 2017. ISU Extension publication CROP 3073



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Summary Points

- Fall anhydrous ammonia applications should be delayed until 4-inch soil temperatures are consistently below 50°F
- Delaying applications of fall manure and including a nitrification inhibitor can help reduce N losses
- Including a nitrification inhibitor with fall N applications can increase N availability for crop uptake the next season and reduce the amount of N lost to the environment
- N rates in excess of the optimal rate have been shown to have little to no yield response, and lead to increased nitrate-N in tile flow water