NITROGEN FOR CORN: TIMING, RATE, SOURCE, LOSS

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Nitrogen management for corn is complicated. Timing, rate, source, and placement can all have significant impacts on success.

My research findings on **N timing** have been the most surprising to me. They include:

- In the absence of excess rain, effects of N timing on corn grain yield are rare. Even quite late applications can give full yield. This probably is not true for silage corn.
- In the presence of excess rain, programs with all N applied before planting usually perform poorly. In-season N is needed to produce full yield.
- I have never seen early N stress reduce ear row number enough to worry about. In 2017, after 11 years of continuous no-till corn, the zero-N treatment was 135 bushels behind the best treatment but only 0.3 rows behind.
- Pre-plant N rarely matters. In 90 experiments comparing treatments with and without pre-plant N, there were only 2 where the treatment without preplant N lost yield. In both of these the first N was applied when the corn was thigh-high.
- Nitrous oxide emissions were cut by 60% by using all-sidedress N management.

Research findings on **N rate** have also been surprising:

- In small-plot on-farm (about 1 acre) N rate experiments, the most profitable N rate ranged from 0 to 300 (highest rate used) and was pretty evenly spread over that range.
- In field-scale research, the most profitable rate varied widely across fields, usually going all the way from 0 to 250 (highest rate used). Some fields needed much more total N than others.
- The most profitable N rate could not be predicted from yield level, soil nitrate, or soil electrical conductivity at either field scale or small-plot scale.
- Corn leaf color, measured in a variety of ways, is the only reliable way to predict the most profitable N rate that I have found. This can work for corn 1 foot tall to pre-tassel, but not earlier.

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In the absence of N loss, I have not found **N source** to have any effect on corn yield. However, different sources are susceptible to different types of loss, with different solutions.

- Anhydrous ammonia is the most resistant to loss in wet weather. A coated urea product, ESN, has in some cases also shown resistance to loss in wet weather. All other sources are about equal in their vulnerability to loss in wet weather.
- Urea is susceptible to loss as ammonia gas when surface-applied. When urea is surface-applied, it should be coated with a product containing NBPT unless it is to be tilled or irrigated in within 4 days. The exception is that we have not found profitable (on average) response to NBPT once corn height is 3 feet or greater.
- UAN solution is more vulnerable to tie-up on residue than other N sources, especially if broadcast. The small droplets stick to residue and the N is take up by microbes eating the residue. Injection in high-residue situations is the best practice for UAN. If injection can't be accomplished, dribbling is better than broadcast.

N loss has been a big deal across the Midwest over the past 10 years. A string of wet years has led to large losses of N through April, May, and June, leaving the corn crop N-deficient (Fig. 1). I saw terrible deficiencies in southern Wisconsin in 2008. A large influx of machines with high-clearance N application capabilities has helped farmers to replace lost N and regain yield potential. I have measured yield responses up to 80 bushels/acre to rescue N applied after the initial N applications were largely lost.

Figure 1. Aerial photo of N-deficient corn in northeastern Missouri, July 2015. I've taken or had taken thousands of pictures like this one across Missouri, Illinois, Iowa, and Indiana. Rescue N works to recover yield potential. In all of my research, the worse the N deficiency, the larger the yield response to rescue N.