NITROGEN FOR CORN: TIMING, RATE, SOURCE, LOSS

Peter Scharf [1/]

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.

ADVANCES IN NITROGEN MANAGEMENT

Peter Scharf [1/]

NVision Ag uses the color of your crop, measured from above (Fig. 1), to determine the level of N stress and how much N to apply. We supply this information in the form of a rate control file (Fig. 2). Just plug it in and drive, knowing that sound research backs the rates that you are putting out.

Fig. 1. 2017 corn field with 50 lb N/acre pre-plant.

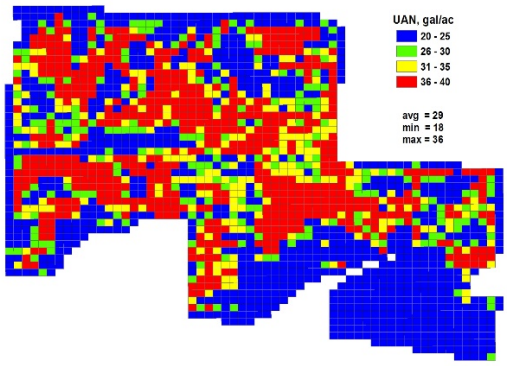

Fig. 1. Visual of UAN rate control file based on image in Figure 1. Customer set minimum rate at 20 gal/acre and maximum rate at 40 gal/acre.

This can work for you whether you are making a planned in-season N application, or have applied all your N pre-plant but are concerned whether it is still there.

In the case of potential N loss, we give you a map of estimated yield loss, along with total yield loss and dollar loss for the field, due to N deficiency. You have real numbers to decide whether it makes sense to invest in rescue N.

Every year is different. Every field is different. Some years, most of your pre-plant N is lost, along with N that was in the soil before you fertilized. Other years, the soil contributes a great deal of N and you could get by with less. Some fields do well despite excessive rain, but others suffer severe N deficiency.

Advances in nitrogen management must address this dynamic nature of nitrogen in soils. What should you do this year that you didn't do last year? Or what should you NOT do this year that you did last year?

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Nearly every answer to this question is driven by how the weather is different this year than last year. Advances in nitrogen management rely on correct responses to what the weather is doing this year.

You don't know what the weather is doing until the season unfolds in front of you. If your N programs is done before you plant, the only potential adjustment is to apply more (rescue N) in years when your pre-plant was lost.

Planning an in-season N application opens doors. Adjustments both up and down in rate become possible. And easy.

Likely you will pay more for fertilizer in-season than pre-plant. And if you feel that you must have pre-plant N, this may mean an extra trip across the field. These extra expenses have to be made up by either increasing yield or cutting back on tons. Or both. In wet years, my research at the University of Missouri has often shown higher yield with less N when applied sidedress or topdress.

FLEXIBLE NITROGEN MANAGEMENT

Peter Scharf [1/]

Let's start with what happened in 2017. Lots of rain in Wisconsin April through June. Wet all along, and especially the last half of June in southern Wisconsin.

Did this cause nitrogen loss? Yes.

Was it huge? No.

Looking through August satellite images from Wisconsin, I see some fields with definite N deficiency where I would predict serious yield loss (Figure 1). But most fields looked fine or at least pretty good.

Figure 1. Planet Labs July 28 satellite image of two fields in southeastern Wisconsin. Nitrogen deficiency appears to be limiting yield in most parts of the eastern field.

Based on some phone calls that I made in June, it sounds like a fair amount of N was applied with high-clearance applicators this year. That may be part of why the corn looked pretty good even though it rained a lot. If so, that's a great example of flexible N management.

With N solution and urea, which dominate in Wisconsin, N goes down fast. There is probably not much conflict between N application and planting. But if it's the right day to plant, planting should take priority, regardless of where N application stands. Get the N applied later. Waiting to plant is far more likely to reduce profitability than waiting to fertilize. That's another great example of flexible N management.

I hear worry about early-season N stress. This is one reason why some farmers insist on finishing N application before starting to plant. I have lots of experience with later N application on N-stressed corn, and only rarely (2 of 90) has early N stress (lack of preplant N) caused a yield reduction. In those 2 cases, the first N application was when the corn was thigh-high. In many other cases when the first application

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was made to thigh-high corn, yields were the same as or better than with preplant N in the same field. This is for corn grain. I haven't done experiments with corn silage, but what I've read suggests that early N is more important for silage.

One concern with early-season N stress is reduced row number on the corn ears. In 2017, we counted rows in plots that had not received any N over 11 years of continuous no-till corn. Yields in the zero-N plot were 135 bushels below the best treatment, but only 0.3 rows below. If that level of N stress only reduces row number by 0.3, you're not likely to see row reductions in any of your fields, even with no pre-plant N.

With increasing availability of high-clearance N applicators has come programs that emphasize split N application. The lower pre-plant N rate gives the opportunity to flex down (for example in extreme drought, I know some Missouri farmers who did this in 2012). And the machine can easily let you flex up on total N if you know that some of your preplant N was lost.

Flexibility with N means getting your priorities right and adjusting to the weather as it comes. It means being prepared with a range of options that can work. Not every field has to be managed the same way, and not every year has to be managed the same way.