Nitrogen Rate Trials in Corn

Introduction

Nitrogen (N) management for corn is one of the biggest challenges faced by corn growers. Too much, and money is wasted; too little, and yield is lost. An N rate trial is the most accurate way to determine the most economic rate of N (MERN; N rate where the last pound of N costs as much as the value of the corn it produced) for a given year. With rate controllers and yield monitors, more producers are interested in and able to test and learn from their N management decisions. This factsheet describes how to design and implement an N response trial for corn, including field selection, N rates to test, layout of the trial, data collection, and analyses.

Field Selection

Field selection depends on whether the farm wants to get a broad sense for N needs or test a particular situation. After selecting what type of field management scenario is to be evaluated, find a field that is large enough to accommodate the trial and is as uniform as possible (avoid wet spots, shallow areas, shade from nearby trees, etc.). Soil organic matter and soil texture homogeneity in the trial area are important as both contribute to a soil's ability to supply its own N to the crop. Make sure to select fields that are not limiting in pH, phosphorus, potassium, or other nutrients.

Plot Layout and Design

It is recommended that N rate trials have five N rates, including a zero rate (control) and a rate high enough to exceed the expected crop responsive rate (Figure 1):

1. Zero N (control without additional N).
2. Low N (typically half of the recommended N rate).
3. Expected optimum N rate.
4. Expected optimum N rate plus 25-50 lbs N/acre.
5. Excess N rate (typically 1.5 to 2x the expected optimum N rate).

The zero N rate is needed to reflect the soil's ability to supply N on its own, whether it be through organic matter decomposition, N release from previous manure, or crop residue additions. Along with this, not all fields respond to N additions. The zero N rate addresses this because it indicates if the field responded to N additions at all. Yield data at the zero-N treatment are also essential to determine a MERN and when comparing data from different fields and years on a farm or between farms.

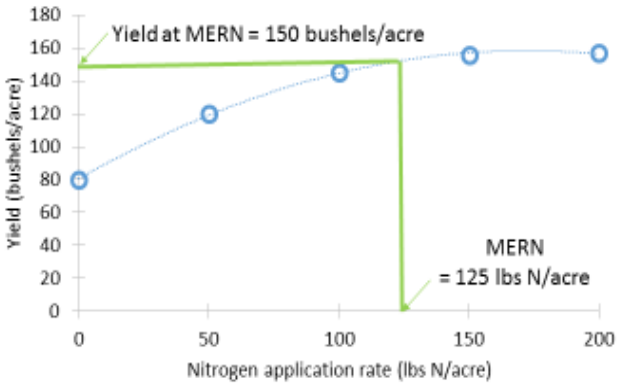
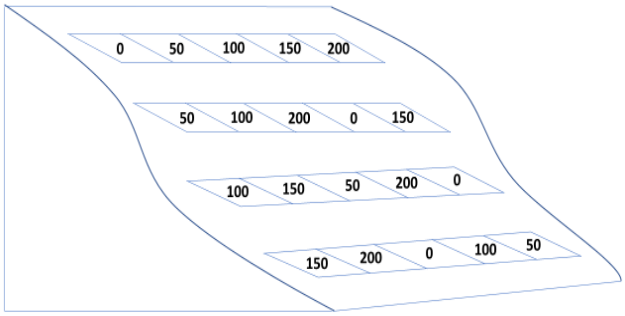


Figure 1: An N response curve with five N rates can be used to determine the most economic rate of N (MERN) and the yield at the MERN. In this example, the MERN is 125 lbs N/acre and the yield at the MERN was 150 bu/acre.

The 5 N rates need to be repeated in at least 3 sets across a field, but 4 sets (or more where possible) is recommended. Each set is called a replication or a block. Within each block, the N rates need to be assigned by chance. This is known as randomization. A simple way to randomly assign treatments in each block is to write each rate on a piece of paper, put the pieces of paper in a hat, mix them up, and pull out a paper one at a time and assign that rate to a location across the block. Figure 2 shows an example. Replications are needed to avoid drawing conclusions based on random patterns in a field. Blocks in the trial (each block has all five N rates) should be arranged in the field so that the variability of the area within a block is as small as possible, and any trends in the field (i.e. slope) are perpendicular to the layout of the blocks (Figure 2).

The size of the plots depend on the equipment used for planting, sidedressing, and harvest. The width of a plot is at least one pass

of the widest equipment used in the operation. If working with a custom applicator for manure spreading, spraying, or other operations in the field, the operator's equipment and associated technology (i.e. a flow management system or vacuum pump) also need to be accounted for.



Listed are N application rates in lbs N/acre.

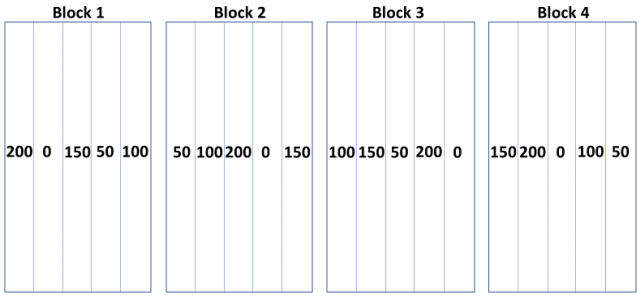


Figure 2: An N rate trial for corn on sloped land (A) and an example of randomizing treatments within blocks (B). Treatments are perpendicular to the slope. This is crucial as field variability within a block of treatments needs to be minimized to be able to draw reliable conclusions from trials.

Management and Collecting Data

It is important to plant the same variety of corn in each of the plots and keep all pest control and other field operations identical among plots. For N rate trials, measurements should, at a minimum, include yield and dry matter content for each plot. For silage, it is recommended to take forage samples to compare forage quality. In addition, for N rate trials, a corn stalk nitrate test is recommended for each plot. Avoid harvesting/sampling of border rows because these rows could be impacted by the treatment in the neighboring plots. Record anything unusual (i.e. wet spots or major weed influence) that would impact yields within the trial.

Analyze Data

Statistical analyses need to be done with the yield data to determine the MERN. Contact land-grant university faculty, a private advising company, or a cooperative extension office with statistical analyses expertise for assistance. Yield monitors can be used to collect yield data, but yield data require proper cleaning before being used in comparisons.

Learn, Share, and Repeat Elsewhere

There is individual value for the farm in conducting an on-farm N rate study, but if farm data is pulled together or shared, everyone can learn from it. This information can assist future trials on the individual, local, state, and regional level. For this reason, consider participating in the New York On-Farm Research Partnership (http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/).

Summary

On farm N trials can provide useful information that assists an operator in reducing input costs, minimizing environment losses, improving yield, and overall nutrient management. Research is a multi-year process, but all parties associated with the trial can benefit from it if designed and implemented correctly.

Additional Resources

- Making the most of your on-farm trials (G. Quensel; Ontario Ministry of Agriculture, Food and Rural Affairs). 2015. http://www.omafra.gov.on.ca/english/crops/field/news/croptalk/2015/ct-0315a5.htm.
- Determining optimum N rates for corn (J. Shanahan; Pioneer). https://www.pioneer.com/home/site/us/agronomy/library/optimum-nitrogen-rates/
- Validating N rates for corn on farm fields in southern Minnesota (G. Randall, M. Schmitt, J. Strock, and J. Lamb; University of Minnesota Extension). https://www.extension.umn.edu/ agriculture/nutrient-management/nitrogen/validating-n-rates-for-corn-on-farm-fields-in-southern-minnesota/.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

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