Cornell University
Cooperative Extension

Agronomy Fact Sheet Series Fact Sheet 89

Reference Strips for Variable Rate Nitrogen Application

Introduction

Crop variability can be large due to within field differences of soil type, topography, drainage, and previous manure. For these reasons, a single, fixed application rate of nitrogen (N) fertilizer for an entire field can lead to over-application in some parts of the field while the crop in other parts of the same field may not get enough. Technological advances in side-dressing equipment and crop sensors now allow for variable rate application of N fertilizer. Being able to tell where more or less N is needed, and applying it at variable rates, has both economic and environmental benefits as it reduces N loss and could reduce fertilizer cost and increase overall yield. For successful implementation of on-the-go variable rate N application mid-season, N reference strips are essential. These are strips in the field that represent N availability extremes (high and low).

Here we describe the importance of various types of reference strips, and discuss their installation. Reference strips are primarily designed for use in combination with sensor technology (Greenseeker, CropCircle, OptRX, CropSpec), but they can also benefit farmers who do not use sprayer mounted crop sensors.

Importance of the Reference Strips

The use of reference strips, when implemented properly, can help prevent over-application of N fertilizer by identifying areas where plants have sufficient N or are so compromised in growth due to other reasons that further addition of N is not economical. They can also help prevent under-application of N fertilizer where soil N resources are insufficient and N addition could increase yield. Every farm field exhibits areas with a range of natural N supply capacity and this affects the ability to make N available to plants; crop sensors and variable rate application (VRA) technology, along with reference strips will allow for improved management of the variable conditions.

Types of Reference Strips

There are four types of reference strips: N-rich, zero-N, ramp calibration, and virtual. Additional reference strips may be added in large fields that show high variability.

The *N-rich strip* is where a large amount of N was applied at planting, to ensure no N deficiency mid-season when side-dress N decisions need to be made (Figure 1).

The N-rich strips are installed before, at, or directly after planting (ideally within 3 days of planting) to give sufficient time for plants to respond to the N application before it is time to side-dress N. A strip of at least 100 feet long per representative area is typically sufficient. *Avoid installing N-rich strips in the headlands, wet areas or any other problematic areas* in the field as readings will reflect conditions other than N availability. Avoid installing N-rich strips in the same spot every year as well. Typically it is sufficient to apply twice the N recommended, up to 300 lbs N/acre, in the N-rich strip.

The readings of the N-rich strips are used as a base to determine the maximum yield potential of the specific field for that year. This information is needed to calibrate the algorithm, used to prescribe the N rate according to local specifications at the time of application.

Figure 1. An N-rich strip in a corn field in Northern New York at the V7 growth stage (7 leaves with visible collar).

A *zero-N strip* is a strip in the field where no N fertilizer is applied at planting and where readings will reflect soil N supply capacity from past manure applications, rotation credits, and soil organic matter. It provides the yield potential if no further N fertilizer addition was done. It is recommended for use in conjunction with the N-rich strip.

The *RAMP calibration strip* is a pass in the field with varying levels of N (at least 5 different rates; at least 40 feet long per rate) applied in addition to the normal starter N application. The main difference in the interpretation between the RAMP and N-rich+zero-N reference strips is that the RAMP strip can give an estimation of the best rate of N to apply when no sensors are used. A RAMP strip may, for example, include 0, 50, 100, 150, and 200 pounds of N per acre. If the corn in the 100, 150, and 200 lbs N/acre sections of the strip look similar and the corn that received 0 and 50 lbs/acre is smaller and less green, the optimum rate is about 100 pounds of N per acre.

Virtual reference strips are "statistical reference strips" that are created from collected data, and not an actual physical N-rich strip in the field. In this approach the "virtual N-rich reading" is created by averaging the readings from the areas of the field that seem greenest and most vigorous while the "virtual zero-N" values are readings from the worst looking areas. The advantage of this type of reference strip is that it does not require any actual strip implementation in the field. However, its use is not recommended in variable fields because the readings do not account for the actual response of plants to fertilizer. "Virtual readings" are more likely to reflect field variability in topography, texture, compaction, organic matter, etc., rather than variability in N supply and availability.

Using Reference Strips with Sensors

The reference strips are primarily designed to be used with crop sensor technology to calibrate the variable rate applicator for a specific field and timing of application. When used with sensors, the strips should be wide enough to cover all sensors mounted on the equipment. A scan of the N-rich strip(s) provides the maximum readings that can be achieved in the specific field at the time of scanning, versus a minimum reading for the zero-N strip(s). Both readings are needed to make the best estimate for determining maximum and minimum expected yield. The best time to scan is between V6 and V8 (plant growth stages; Figure 2), identified by counting the number of leaves with visible collars (the discolored zone at the base of a leaf blade).

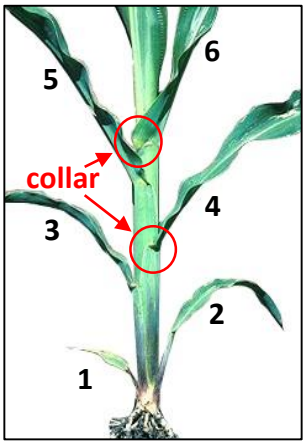

Figure 2. Corn at V6 growth stage with 6 visible collared leaves.

Using Reference Strips without Sensors

Reference strips can be useful even if crop sensors are not available. If there are no visible differences between the N-rich and the zero-N reference strips, no N fertilizer addition is needed. On the other hand, if the plants in the N-rich area look much more advanced and healthier, it is clear that the available N is not sufficient for the crop to reach its full yield potential and side-dress N is advised. Finally, the RAMP calibration strips can be used to guide N rate decisions with or without sensor use.

Summary

Reference strips are essential to obtain accurate, on-the-go, variable rate N prescriptions. Implementation of N-rich and zero-N strips or RAMP strips in each management zone in a field is recommended.

Additional Resources

- Nitrogen Rich Strips. Oklahoma State University Cooperative Extension Publication E-1022. www.nue.okstate.edu/Index_Publications/Nstrip%20brochure.pdf.
- The how, what, when, and where of applying nitrogen rich strips. Youtube video by Oklahoma State University. https://www.youtube.com/watch?v=kJ3DSwWYgE8.

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

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