COMPONENTS OF A VARIABLE-RATE NITROGEN RECOMMENDATION

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Variable-rate nitrogen management (VRN) is a fairly hot topic right now. The outcome of VRN promises improved efficiencies, economics, yields, and environmental sustainability. As the scientific community learns more about the crop's response to fertilizer nitrogen and the soil's ability to provide nitrogen, the complexity of providing VRN recommendations, which both maximize profitability and minimize environmental risk, becomes more evident.

The components of nitrogen fertilizer recommendations are the same whether it is for a field flat rate or a variable-rate map. The basis for all N recommendations can be traced back to the Stanford equation (Stanford, 1973). At first glance, the Stanford equation is very basic and fairly elegant with only three variables in the equation.

$$N_{Fert} = (N_{Crop} - N_{Soil}) / e_{\mathrm{fert}}$$

Historically, this was accomplished on a field level through yield goal estimates and soil test nitrate values. The generalized conversions such as 1.2 lb N/bu of corn and 2.0 lb N/bu of winter wheat took account for N_{Crop} and e_{fert} to simplify the process.

N_{Crop}

The basis for N_{Crop} is grain yield × grain N concentration. As grain N is fairly consistent, the goal of VRN methods is to identify grain yield. This is achieved through yield monitor data, remote sensing and crop models.

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N_{Soil}

The N provided by, or in some cases removed by, the soil is dynamic and often weather dependent. Kindred et al. (2014) documented the amount of N supplied by the soil varied spatially by 107, 67, and 54 lb/ac across three studies. Much of the soil N concentration is controlled by organic matter (OM). For every 1% OM in the top 6 inches of the soil profile, there is approximately 1,000 lb N/ac.

e_{fert}

Historically, the efficiency at which N fertilizer is utilized was integrated into N recommendations and not provided as an input option, e.g., the general conversion factor for corn of 1.2 lb N/bu. Nitrogen concentration in corn grain ranges from 1.23 to 1.46% with an average of 1.31% (Heckman et al., 2003) or 0.73 lb N/bu. Therefore, the 1.2-lb value is assuming a 60% fertilizer use efficiency. More recently, recommendations have been to incorporate application method or timing factors in attempt to account for efficiencies.

Summary

While a VRN strategy that works across all regions, landscapes, and cropping systems has yet to be developed, the process of nitrogen management has greatly improved and is evolving almost daily. Those methods that are capable of determining the three inputs of the Stanford equation while incorporating regional specificity will capture the greatest level of accuracy and precision. Ferguson et al. (2002) suggested that improved recommendation algorithms may often need to be combined with methods (such as remote sensing) to detect crop N status at early, critical growth stages followed by carefully timed, spatially adjusted supplemental fertilization to achieve optimum N use efficiency. As information and data are gathered and incorporated and data-processing systems improve in both capacity and speed, the likelihood of significantly increasing nitrogen use efficiency for the benefit of the society and industry improves. The goal of all practitioners is to improve upon the efficiencies and economics of the system, and this should be kept in mind as new techniques and methods are evaluated. This improvement can be as small as a few percentages