Sensor-Based N Management Strategy

New optical sensing variable rate application system improves nitrogen use efficiency and increases producer returns.

Nitrogen (N) fertilizer is one of the largest seasonal, variable input costs for crop growers. N use efficiency (NUE) in cereal crop production is estimated at about 33 percent, suggesting that current N recommendations result in the majority of applied N being unaccounted for in the harvested grain.

As one answer to this problem, NTech Industries is marketing an optical sensing variable-rate application system called *GreenSeeker.* The system was researched and developed at Oklahoma State University in conjunction with NTech. Ten on-farm field trials conducted in the spring of 2002 showed promising results. Based on micro-environment (every 4.5 ft^2) yield potential and responsiveness, variably applying N increased yields an average of 5 bu/A (with 13 lbs/A less N), and increased return by $17/A.

Current Assumptions

Current N recommendations are typically determined using five-year yield averages to set an attainable yield goal, which is multiplied by an assumed N requirement for each unit (e.g., bushel) of yield expected. If the field is soil sampled, available soil test nitrate is then subtracted from the N recommendation. Using this strategy, four things are assumed: 1) yield potential does not vary much from year to year, 2) yield level the soil will support without supplemental N is negligible, 3) N applied preplant will remain available throughout the growing season, and 4) the soil is completely uniform and yield potential is similar across the field.

The assumption yield potential does not vary from year to year is a poor one—ask any producer. Yield levels can and do differ greatly from year to year. Analysis of an ongoing 31-year winter wheat experiment in Lahoma, Oklahoma, revealed the need for fertilizer N varied greatly from year to year. In only 8 of 31 years (26 percent of the time) did traditional techniques to determine N recommendation result in the correct rate of N needed to maximize yield. Some years 80 lbs/A of N was too much and in other years it was too little.

If optical sensing technology had been available over those same 31 years, cutting preplant N rates to 40 lbs/A of N and applying topdress N would have resulted in a return of $43.17/A/yr, which would have been a $10.94/A/yr increase in return (Figure 1). However, prior to the development of optical sensing techniques to accurately quantify yield potential, using a five-year average was better than the alternative (guessing).

How it Works

In order to use the GreenSeeker variable rate application system, producers are asked to cut back on preplant N rates and include a nitrogen rich strip (NRS) in the field. The NRS allows one to observe how the crop is responding to an environment rich in N. When the decision to topdress is made mid-season, senor readings are collected from the NRS and an area adjacent to the NRS that received less preplant N. If the sensor values are similar (meaning the addition of excess N is not being used by the crop), the soil is providing adequate N by mineralization of the organic fraction or high N in rainfall. Thus the need for more N is removed. If the crop is responding to the high N environment,

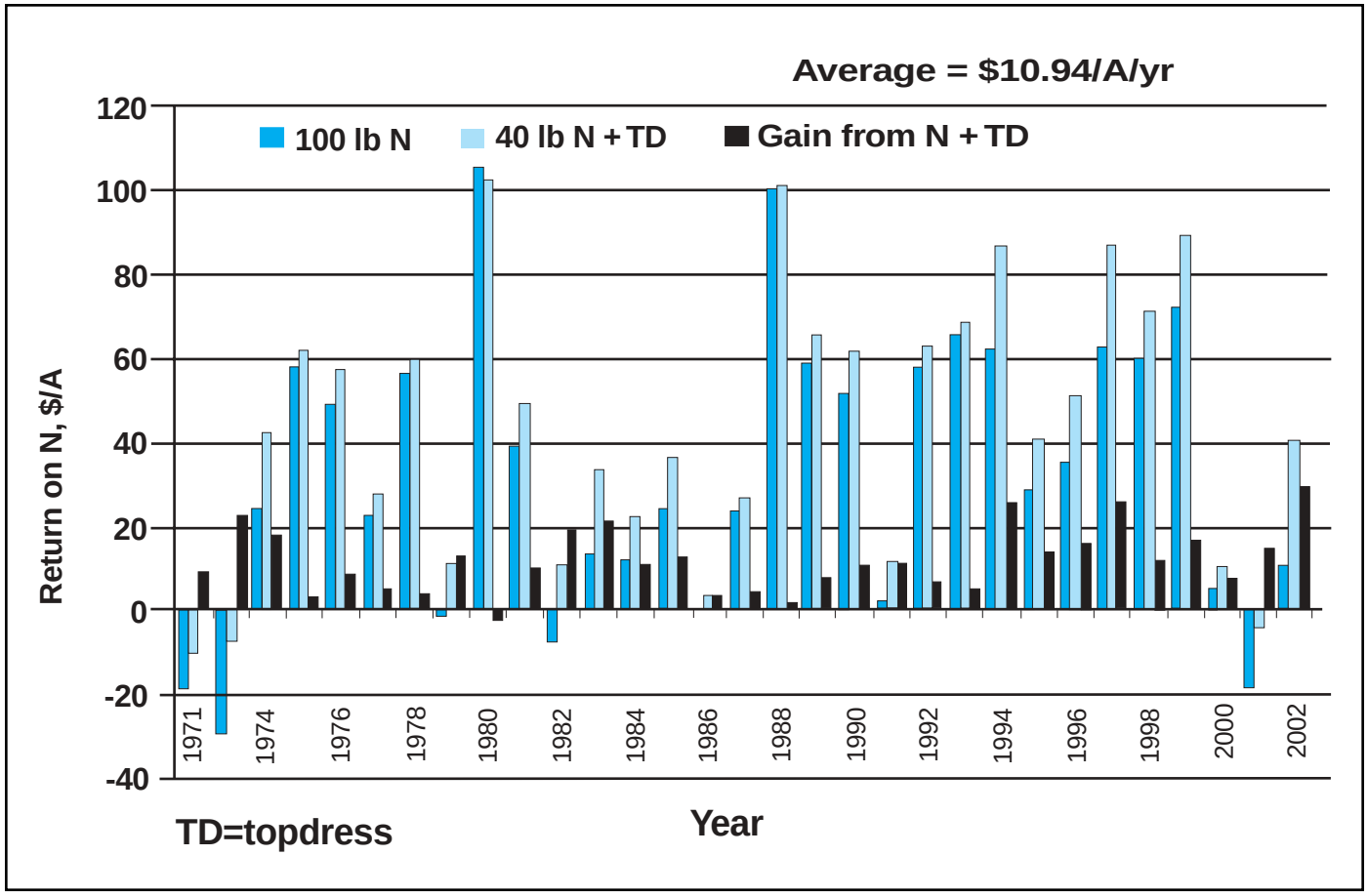

Figure 1. Return from application of 100 lbs/A of N versus 40 lbs/ A preplant and using GreenSeeker technology to apply topdress, if this technology had been available over 31 years at Lahoma, Oklahoma.

then additional N is required. Using the sensor values, a response index (RI) is calculated for that specific field environment.

When the applicator crosses a field, the boom has sensors mounted every two feet approximately 32 to 48 inches above the crop canopy. The sensors measure normalized difference vegetative index (NDVI) and project the potential yield of each 4.5 ft^2 area. Using the RI of a specific field, the system projects what the yield potential is with additional N and applies that amount of N to meet the yield potential.

Pitfalls Avoided

By using the optical sensing variable rate application system, all four previous assumptions associated with traditional N management can be avoided. Because potential yield is predicted within the growing season, not based on a 5-year average, one can identify the year-to-year variability in yield and manage N accordingly. By cutting back on preplant N rates and including an NRS within the field, N contributed by the soil is recognized and accounted for when determining the amount of supplemental N necessary to achieve maximum yield.

Splitting N applications between preplant and topdress avoids creating a large pool of N that may be subject to losses if all N is applied at once before seed is ever placed in the ground. Using a system that operates at such a fine resolution, spatial variability is addressed and each 4.5 ft^2 is treated independently to maximize fertilizer efficiency and economic return.

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