GreenSeeker® trials take On-Farm Network™ nitrogen studies to a new level

Interest is growing in variable rate application of nitrogen (N) fertilizer for corn. Varying fertilizer rates spatially within fields seems intuitive and could result in an increase in yield along with a possible reduction in total N use.

While this sounds good, there's a big piece of the puzzle missing: we're still not certain of how to vary the rate in a way that properly feeds the crop and is better than an a uniform application across the field.

Pre-season estimates of nitrogen fertilizer application rates for corn based on differences in soils and prior yields have been shown to be unreliable. While yield potential and soil differences are important, many other factors such as rainfall and nitrate leaching affect N loss and availability.

Recent technology that can predict spatial differences in N management seems to work best by waiting to apply N until the crop has started to grow.

Waiting until harvest gives us the best information about differences in the field. At that point, though, it's too late to correct the stress. So what is needed is a system that allows us to incorporate the impacts of winter and spring weather and still be able to recognize crop needs and apply corrective amounts of fertilizer while the crop can still respond to it.

Waiting until the crop has started to grow and then monitoring it could be a practical solution. Once the crop is growing, N stress is easily seen in growth rate and color. N-stressed plants have less chlorophyll, which is a green pigment that allows the plant to capture the sunlight and convert it to yield. More chlorophyll means plants can capture more light. That also means there will be less light reflected from the leaves.

Light reflectance can be measured from satellites, aircraft, or ground-based sensors.

The ISA On-Farm Network™ has a great deal of experience using aerial imagery for evaluating different management practices for corn and soybeans, for guided corn stalk nitrate sampling, and detecting causes of plant stress and variability in yields and yield response.

During a group meeting of On-Farm Network participants in Jefferson last year, growers expressed interest in evaluating the GreenSeeker sensor technology. The GreenSeeker (N-Tech, CA) is an active type of sensor developed originally at Oklahoma State University for use in determining N needs of winter wheat. It was later adapted for prescribing variable N rates for corn.

The sensor emits light toward plants in near infrared (NIR) and red bands, and measures the amount of these two light bands that is reflected from the plants. Using a ratio of the reflected red and NIR light, the sensor calculates the Normalized Difference Vegetation Index (NDVI). The NDVI value is a measure of both the degree of plant greenness and the amount of plant biomass.

There are a couple of strategies for using such a technology. One is to apply a fraction of what you think you need for the crop, and then use the sensor to detect where additional N is needed in-season. A second strategy is to react to excessive rainfall conditions, which can result in above-average N stress, and see where additional N may be needed.

To field test this system in the On-Farm Network, we set out test strips with different scenarios. For the system to work:

- You must be able to detect the N stress at the time needed to correct it.
- You must be able to predict how much N is needed.
- You must be able to apply the N where needed.
- The plant must be able to get the N applied.

To address the first two points, strips with high and low N rates were placed in each field.

To address the third and fourth point, we used a Hagie ap-

Table 1

Management information and time of preplant and in-season fertilizer applications

Trial ID	Rotation	Time	N form	Rainfall March-May	Time of in-season applications: Reference	Variable
				----- in. -----		
ST2007014A	Soybean	Preplant	UAN	11.5	6-Jun	6-Jul
ST2007048C	Soybean	Fall	NH3+NS[1]	10.8	11-Jun	6-Jul
ST2007058A	Soybean	SD	UAN	12.9	7-Jun	29-Jun
ST2007059A	Soybean	Fall	Swine Manure	12.1	7-Jun	29-Jun
ST2007067A	Soybean	Preplant	UAN	11.6	5-Jun	26-Jun
ST2007275A	Corn	SD	NH3	12.6	7-Jun	5-Jul
ST2007275B	Soybean	SD	NH3	12.6	7-Jun	5-Jul

[1] N-Serve

plicator with a high clearance sidedress injector toolbar (with drop arms and a coulter to inject UAN).

The On-Farm Network GreenSeeker studies were established in seven fields in Greene and Hardin counties. Six of the fields were corn after soybeans. Each trial had three replicated treatments: control, reference (control + 50 or 75 lb. N), and variable rates (control + GreenSeeker variable rate application).

The control strips received the growers' normal preplant nitrogen application, which in two cases was well below 100 lbs. per acre. The reference strips were established by applying an additional 50 or 75 lbs. N/acre on top of the preplant or sidedressed rates applied by the growers. The variable rate strips received additional nitrogen as prescribed by the GreenSeeker technology.

All management information and application times for the reference strips, in-season variable N rates, and amount of spring rainfall are presented in Table 1. We used the Oklahoma State University algorithm when applying variable N rates. Liquid N solution was sidedressed at or before tasseling with the Hagie high clearance sidedress applicator. Aerial imagery of the fields was collected several times during the growing season as a way to monitor the crop. Six areas within each trial were selected from aerial imagery collected in late August. Stalk samples were collected from each treatment and analyzed for nitrate content to determine N-sufficiency levels.

Yield summaries (Table 2) showed that in all fields, yields were increased in strips that received extra N, both the fixed and variable N rates. The additional N was profitable in all fields except one of the corn after corn fields.

The average variable rate applied by the GreenSeeker system was 20 lbs. N/acre less than the average N rate applied to the reference strips (Table 2). The reference strips, however, yielded about 4 bu./acre higher than the strips that received variable N rates. There seemed to be a small economic benefit to applying the higher N rate across the field, using current fertilizer and grain prices.

Corn stalk nitrate test data showed that about 80% of samples from the control strips were deficient in N by the end of the season. Deficiency in the reference and variable rate strips was similar, with a slightly smaller percentage of deficient samples from the reference strips.

When analyzing aerial images of the trial fields taken in mid-July and late-August, we found high correlations between yield response to N and relative green light reflectance for some fields, but poor correlations for others. This suggests that the sensor did a very good job of identifying responsive areas in some fields but not in others.

Moisture stress, both excess and lack of water, can reduce plant growth and development and increase green reflectance early during growing seasons. This could reduce the ability of the sensor to correctly identify N stress areas.

Future trials should evaluate the performance of the sensor under differing weather conditions, specifically with less rainfall and a lower probability of yield response. This is important not only in evaluating economics under different conditions, but also in ensuring that the N applied mid-season will be taken up by the crop in drier conditions.

Fig. 1 Stalk nitrate test results from different treatments in the GreenSeeker study

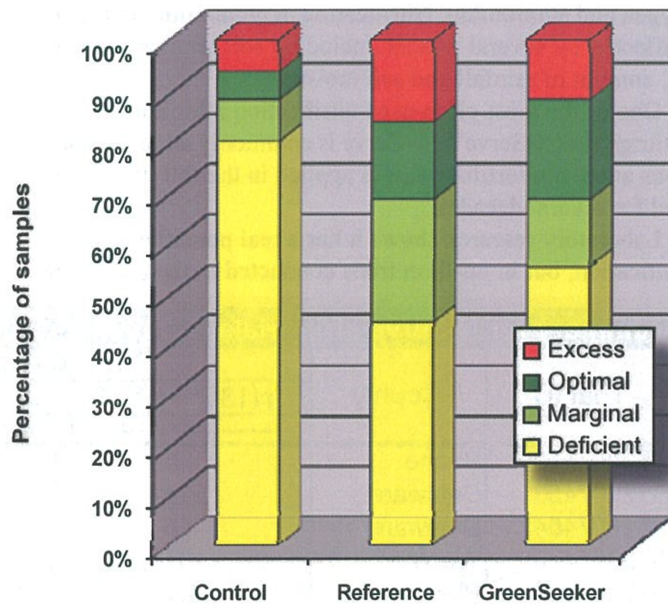

Table 2

Yield summary for the GreenSeeker trials in 2007

Trial ID	N fertilizer rate			Yield		
	Control	Reference	Variable	Control	Reference	Variable
	---- lb. N/acre ----			---- bu./acre ----		
ST2007014A	97	172	150	147	173	166
ST2007048C	135	185	164	224	228	229
ST2007058A	120	170	151	205	220	215
ST2007059A	122	172	159	181	195	189
ST2007067A	44	119	88	157	185	180
ST2007275A	100	150	137	148	152	152
ST2007275B	50	100	81	147	167	162
Average	**95**	**153**	**133**	**173**	**189**	**185**