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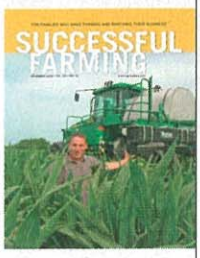
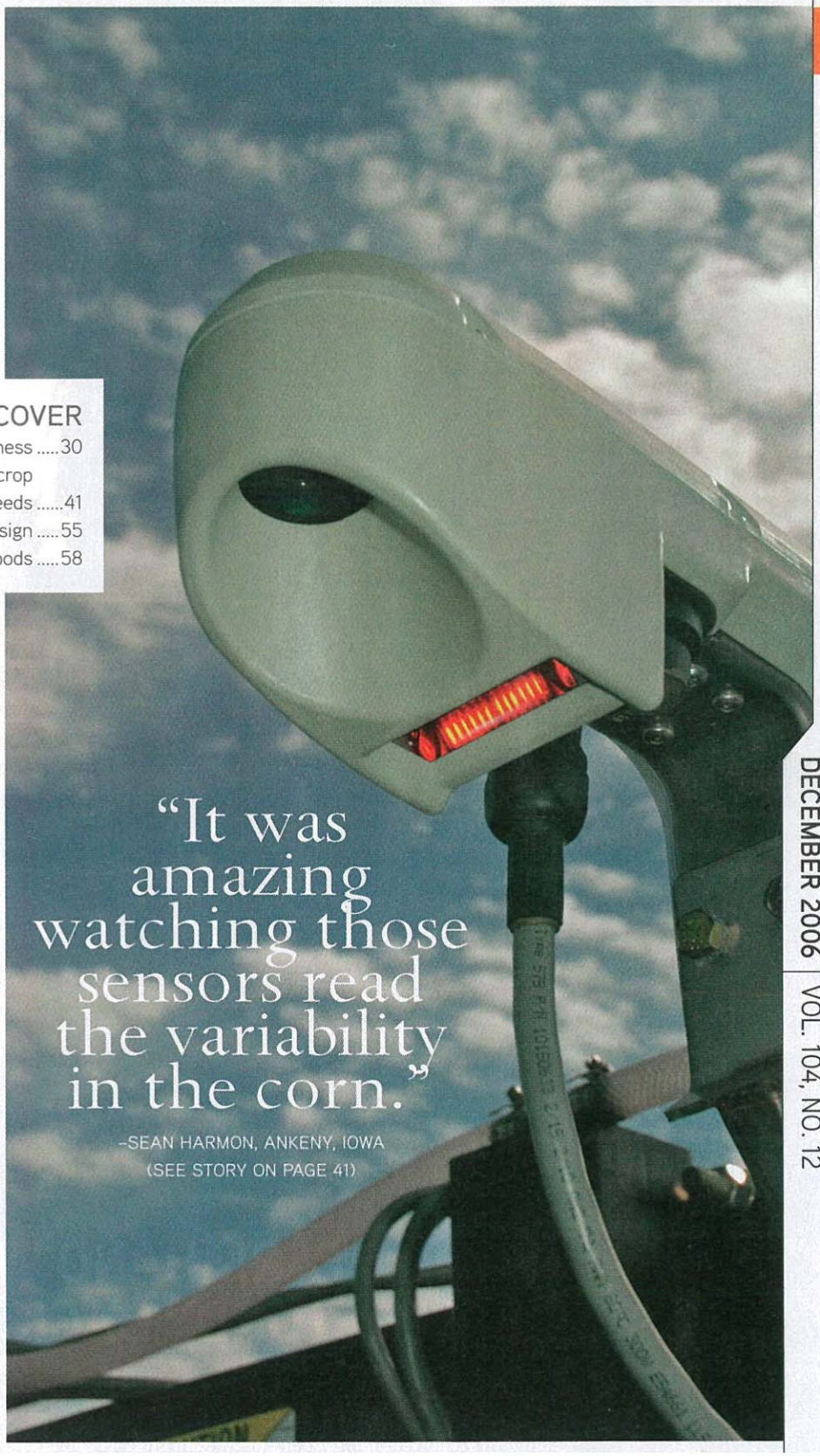


ON THE COVER
Sean Harmon farms with his dad, David, and brother, Mike, near Ankeny, Iowa. Sean started experimenting with nitrogen sensors last fall. He plans to use them a lot more for the 2007 crop. Photograph: Rich Fee

FROM THE COVER

IN EVERY ISSUE



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N sensors shine through

Reflected light gauges plant health and nitrogen needs

By Rich Fee, Crops and Soils Editor

and Larry Reichenberger

This is a composite photo of a GreenSeeker sensor. The light being emitted from diodes in the rectangular window was photographed in the dark and combined with the main photo.

When nitrogen (N) was relatively cheap and water quality wasn't a big issue, many of us applied high rates of N before planting to make sure the crop never ran short.

Ironically, putting a high rate of N on early in the season is an important part of a new approach to N management. The twist with this new system is you will only put a high rate of N on a representative area of each field. Then you will use N sensors to compare that N-rich strip to the rest of the field. The sensors let the crop tell you when it has enough N to meet its yield potential and when it doesn't.

Using light reflected off the crop, the sensors compare the color of the crop in the N-rich strip to the color of the crop in the rest of the field.

Choosing the right N rate before the crop is even planted is ▸▸

N sensors shine through

more a matter of luck than science. It's like predicting the weather, with a slew of other factors thrown in.

N sensors promise a way to gauge crop status midway through the season. For corn, that means after spring and early summer N losses, and also after the soil has had a chance to release N for the crop.

The sensors also provide a means for measuring – and managing – the variability across a field. Oklahoma State University (OSU) researchers did a lot of the development work on the GreenSeeker N sensor, and they have done a lot of research on small-scale variability in fields. As an example of that variability, they cite "distinct differences in yield potential" between two small areas in a field that are less than 3 feet apart. Those differences exist even though the two areas have been tilled and fertilized the same for over 30 years.

Photograph: Rich Fee

Sean Harmon started experimenting with nitrogen sensors last season. He plans to use them a lot more for the 2007 crop.

VARIABLE N RATES

When the sensors are mounted on an N-injection rig or sprayer and tied into a rate controller, you can simultaneously apply N at variable rates as you cross the field.

"The use of real-time sensing to drive variable-rate application reduces the management time constraint to site-specific management," says Jess Lowenberg-DeBoer, a Purdue University ag economist. "In effect, management becomes automated."

Robert Mullen, an Ohio State University Extension specialist who has worked with N sensors for several years, says, "Current nitrogen recommendations assume four things: One, yield potential doesn't vary year after year. Two, the yield level the soil will support without supplemental nitrogen is negligible. Three, preplant nitrogen will be available throughout the growing season. And four, soil uniformity produces similar yield results across the field.

"Growers know that none of these assumptions are entirely accurate," he adds. "And they can potentially be avoided using optical sensors."

Peter Scharf, a University of Missouri nutrient management specialist, has been working with sensors to vary application rates on 12- to 15-inch-tall corn. "The idea is to cut back in smart places," he says. "This technology allows us to diagnose how much fertilizer is needed better than we could with previous methods."

Several land-grant universities are developing algorithms to use with N sensors in their states. An algorithm is a procedure or formula for solving problems.

DOLLARS AHEAD

Using an N sensor paid off last season for Miami, Oklahoma, wheat grower Brent Rendel.

"We put N-enhanced strips in each of our 39 wheat fields using three nitrogen rates," he says. "Then, a handheld GreenSeeker sensor was used to determine how much topdress N was needed to bring the entire field up to the lowest-rate strip that was sufficient in nitrogen. This resulted in a savings of $14.59 per acre over applying our standard topdress rate of 75 pounds per acre."

Assuming a urea price of $325 per ton, Rendel figures this approach saved more than $24,000 on his 1,665 acres. "Installing the strips takes some time, but we think it's well worth it," he says.

SURPRISING VARIABILITY

When farmers first started using yield monitors, they were often amazed at how much variability there was across fields that looked uniform. Sean Harmon had a similar experience last summer when he used GreenSeeker N sensors to sidedress N.

"It was amazing watching those sensors read the variability in the corn," he says. "Looking at it with your eyes, you'd say the plants all looked the same. But driving across it, those sensors saw a difference."

Harmon farms with his dad, David, and brother, Mike, near Ankeny, Iowa, and also near Ft. Dodge. The Harmons and Ankeny farmer Bruce Johnson and his uncle, Allen Johnson, teamed up to buy the GreenSeeker system and a 12-row Yetter toolbar with injection coulters. Both operations have John Deere applicators upon which to mount the toolbar.

"We bought it to better manage

nitrogen," says Sean Harmon. "We've been putting most of our nitrogen on in the fall. But then we cross our fingers and hope it will be there the next growing season."

The Harmons' experience with the system was limited this year because they didn't buy it until after their corn was up and long after most of their N was on. Because of a 5½-inch rain at Ft. Dodge right after planting, corn there definitely benefitted from sidedressing, but the rates weren't tied to an N-rich reference strip.

This fall, they were planning to limit fall anhydrous to 60 or 70 pounds on about 300 acres, then come back next summer with the GreenSeeker and put on whatever it calls for. They'll put 225 pounds, well above their normal rate, in the N-rich reference strip.

Photograph: Rich Fee

Ted Mayfield (right) is COO of NTech, which makes GreenSeeker nitrogen sensors. He was on hand when Bruce Johnson (left) was getting started with the system last spring.

LOOKING FOR TROUBLE

Harmon plans to put the sensors on his spray boom and map other fields when he sprays in late May or June. "Then I can look at the maps and see if there are problem areas."

The Johnsons also had most of their N on before they bought the N-sensing system. Consequently, Bruce Johnson is looking ahead to next year more than he is looking back. He plans to cut rates some, install N-rich reference strips, and map while spraying. "Then we will compare those reference strips to the rest of the field to determine if anything else is needed," he says.

"I think the way this tool is going to make us money is not by the number of acres we put under it, but by giving us the confidence to cut rates because we'll be certain that we are at optimum rates," Johnson says.

Over the past three years, a group of Missouri farmers and custom applicators, along with a team of researchers from the University of Missouri and the USDA-ARS, have put N sensors to the test.

"We're working in farmers' fields using both the GreenSeeker and the Crop Circle sensors," says Harlan Palm, University of Missouri agronomist. "Both units have performed well, and we're confident this technology will eventually be a significant tool to help farmers both economically and environmentally."

In 2004, Missouri results from seven fields showed that applying a variable rate using the sensors saved N in five cases – cutting up to 90 pounds per acre in one field that had recently been in pasture. More N was applied in two cases – adding up to 34 pounds per acre. Four locations had lower yields with variable-rate N, while three saw a yield increase. As a result, three producers lost money (up to $17.50 per acre), while four producers made money (up to $33 per acre). ▸▸

Photograph: University of Missouri

An 80-foot applicator from MFA Co-op in Mexico, Missouri, applied liquid N based on readings from two N sensors. Another dealer applied dry urea with a spreader truck.

N sensors shine through

"On the average, the fertilizer savings were offset by the loss in yield with a nitrogen price of 30¢ per pound. But, with a nitrogen price of 42¢ per pound, the variable-rate approach would have saved an average of about $13 per acre," says Palm.

"The best chance of success for this technology appears to be where there's a lot of in-the-field variability, such as in river bottoms where soil types change dramatically," he says. "Man-made variability from manure application is another example."

In 2005, drought damaged all but one of the Missouri research plots, and 2006 data is still being analyzed.

Photograph: University of Missouri

Bruce Wilson has varied sidedress NH_3 application rates in corn for two years. N sensors on both sides of his tractor analyze corn needs and adjust the rate accordingly.

EARNING THEIR KEEP

"The learning curve has been slow, but we think nitrogen sensors have a place," says Higginsville, Missouri, farmer Gary Riekhof. He used two of the sensors in front of his 16-row liquid sidedress applicator.

"It worked well, but like most farmers we're nervous about needing to apply nitrogen in a relatively narrow window of time," he says.

Producers in the project are sharing sensor heads. Mexico, Missouri, farmer Bruce Wilson used them on his 12-row NH_3 sidedress applicator for two years in plots.

"The sensors actually applied more nitrogen than we would have used, but that was good because that also raised the yield," he says. "We're already varying fertilizer rates in management zones developed from electrical conductivity and yield maps, so we think we were pretty efficient with nitrogen."

Wilson adds that the sensor technology is appealing because it gives a real-time indication of N needs. "Our decisions with the management zones are based on history, but the sensors account for everything right until the time we pull into the field to apply the nitrogen," he says.

Next year, farmers in Missouri will be encouraged to give N sensors a try by a new cost-sharing program from the USDA-NRCS. As part of the state's EQIP program, producers can receive up to $20 per acre a year for three years to offset the cost of adopting crop canopy-sensing technology.

Photograph: Larry Reichenberger

OSU agronomist Bill Raun (right) has worked with farmer Tom Denker (left) to test the use of nitrogen-rich strips.

CATCHING ON

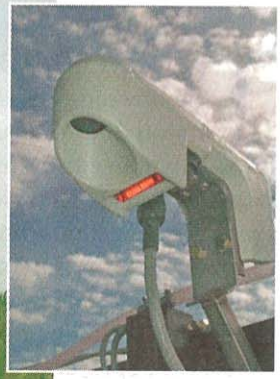
In Oklahoma, farmers like Brent Rendel are learning that N sensors don't have to be mounted on a sprayer to be a benefit. Working with crop consultants and county agents, they're adopting various N-rich strip management strategies that use handheld GreenSeeker sensors. The sensors make in-season assessments of production potential and adjust N rates using OSU's sensor-based N rate calculator (www.nue.okstate.edu). Presentations from recent N sensor meetings are also at that site.

OSU agronomist Bill Raun has helped develop the N-rich strip approach, along with a more refined ramped approach that fine-tunes N rate selection even more. "It has really caught on this season," he says. "There are thousands of fields across Oklahoma and Kansas where farmers, consultants, and ag agents are installing nitrogen strips." ■

Active sensors shine light on crops' midseason nitrogen needs

By Rich Fee, Crops and Soils Editor

GreenSeeker



Photographs: Rich Fee

Ted Mayfield explains how the GreenSeeker sensor works. Red and NIR light emitted from diodes in the rectangular window are reflected off the corn and measured by a photodiode in the round opening.

The GreenSeeker sensor technology was developed by NTech (formerly known as Patchen) and Oklahoma State University researchers in 2001 and 2002. NTech sold the first handheld sensors to wheat producers in 2002 and corn growers in 2004. Sensors for fertilizer applicators came later.

The GreenSeeker sensor is termed an active sensor because it generates its own light source rather than relying on ambient light. The sensor uses light-emitting diodes (LED) to generate red and near-infrared (NIR) light. The light generated is reflected off the crop and measured by a photodiode located at the front of the sensor head (see photos).

CROP TELLS YOU ITS NITROGEN NEEDS

Red light is absorbed by plant chlorophyll during photosynthesis. Healthy plants absorb more red light and reflect larger amounts of NIR than unhealthy plants. The red light and NIR light readings from a crop, when compared to a nitrogen-rich calibration strip in the same field, are used to gauge the crop's yield potential and nitrogen needs.

Growers using the system apply a reduced rate of nitrogen (N) early, then topdress or sidedress based on what the GreenSeeker reveals about the crop during the growing season.

Two versions of the GreenSeeker system were available this year. Several wheat growers in Oklahoma used a handheld version in conjunction with N-rich calibration strips to determine the best flat rates of N for topdressing on each field.

Meanwhile, corn growers in the Midwest and wheat producers in the Dakotas and Canada were using GreenSeeker RT200 systems on nitrogen application rigs to simultaneously gauge the crops' N needs and to apply the amount of N the system called for.

The handheld system costs $2,900 (without a PDA). The RT200 system, which includes six sensors, mounting brackets, a color computer, and software, costs $22,500. It is usually used with injection rigs or 60- to 90-foot-wide sprayers.

Ted Mayfield, chief operating officer of NTech, estimates that RT200 systems were used on about 10,000 acres of wheat and 10,000 acres of corn this year. ■

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