PREDICTING RELATIVE YIELD OF CORN IN INDIANA USING AN ACTIVE SENSOR

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Introduction

Fine-tuning N fertilization is important for improving the economic and environmental impact of corn production. This importance is highlighted by ever rising fertilizer prices and increased public scrutiny. Reflectance measurements using an active sensor during the growing season may be useful for determining the need for additional N. This is the second year of a multi-year study to evaluate canopy reflectance as an N management tool across a variety of Indiana soil types.

The objectives of this study were to evaluate correlations among chlorophyll meter, and Crop Circle sensor, evaluate correlation between Crop Circle readings and final grain yield, and to determine the optimum N rate for each location.

Methods

In 2006 field scale experiments (12 rows by 100-300 m long treatment plots) were established at 7 Purdue University research farms across the state of Indiana. A single hybrid was used each year, Pioneer 34A19 in 2006 and 34A20 in 2007. The two hybrids vary only in the addition of the Roundup Ready gene. All 2006 locations consisted of corn-soybean (CS) rotations. In 2007 experiments featured both CS and corn-corn (CC) rotations. Sidedress N treatments were applied at growth stage V3-V5 with urea ammonium nitrate solution (28% UAN). Sidedress N rates ranged from 0 to approximately 250 kg N/ha in 44 or 55 kg N/ha increments.

In 2007 an additional experiment was established at 3 locations to examine the effects of N stress and delayed N application. This experiment featured 3 treatments consisting of a conventional sidedress N application, N application delayed until V12, and 112 kg of N applied at planting plus a delayed application at V12. Sidedressed and delayed N application consisted of 7 N rates varying from 0 to 230 kg N/ha. Harvest of two of these experiments is complete.

Several measurements were made during the growing season with a chlorophyll meter (Minolta SPAD 502), and at a single time with a Holland Scientific ACS 210 Crop Circle. The earleaf was obtained at silking and total N determined. Chlorophyll index [(880 nm- 590 nm)/590 nm] was calculated for all canopy reflectance readings and a SPAD reading of the most recently expanded leaf was taken within 2 days of the reflectance measurements. The middle 6 rows of each field scale plot were harvested while only 2 rows were harvested from the smaller delayed N application study. Grain moisture and yield were collected using a yield monitor and/or weigh wagon. Grain yield, chlorophyll index and SPAD were all evaluated. Yield, chlorophyll index and SPAD readings were all evaluated on a relative basis-the value of each treatment divided by the value obtained with the highest N rate.

Results

Relative SPAD and relative chlorophyll index had a high correlation (R^2=0.85) across different soil types, cropping systems and growing seasons. Although both tools indirectly measure chlorophyll concentration, the relationship was not certain because the SPAD is measured on the newest expanded leaf and the Crop Circle measures the upper canopy.

Relative yield was also strongly correlated with the relative chlorophyll index at approximate growth stage V12 (R^2=0.85) This relationship takes into account 2 growing seasons, a wide range of soil types, and CC and CS rotations. By predicting relative yield we may be able to anticipate the plants' N requirements and fine-tune N recommendations late in the season and/or on the go. It is important to note that no additional N was applied after the readings were collected. Little research has been done to examine the effects of delayed N applications under rainfed conditions in the eastern Corn Belt. If we hope to employ any strategy where late applied N is used, additional data needs to be collected examining the ability of the crop to take up and utilize late applied N fertilizer.

Discussion

By locating plots throughout the state we were able to evaluate the capabilities of the sensor across many growing environments. Data was gathered from plots over 2 years from both CC and CS rotations. A variety of soil types were included and maximum yields at each location ranged from 7274 to 13232 kg/ha. Agronomic optimum N rates ranged from 177 to 261 kg/ha. The relative chlorophyll index effectively predicted relative yield over a wide variety of conditions.

Although only two of the experiments from the delayed N study have been harvested, it appears that delaying large applications of N can reduce yield. While the crop still responded to the late applied N, previous stress was too severe for full yield to be achieved. A more practical solution may be to make a sidedress application at a slightly reduced rate and use the sensor at growth stage V10-12 to ensure that the plant has an adequate amount of N. This approach could reduce N use as well as limit the chances of N deficiency and yield loss.

Conclusion

In summary the relative chlorophyll index of the upper canopy measured with a Crop Circle was closely related to relative chlorophyll meter readings on the most recently expanded leaf, and grain yield. Relative chlorophyll index accurately predicted relative yield across a diverse range of environments, soil types, and yield levels in both corn-corn and corn-soybean rotations. The delayed N experiments have shown that maintaining yield potential is especially important when using chlorophyll index to fine-tune N applications.

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