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Quantifying Corn N Deficiency and Application Rate with Active Canopy Sensors

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Quantifying Corn N Deficiency and Application Rate with Active Canopy Sensors

Abstract
Precision agriculture technologies are an integral part of many operations in Iowa corn production. Active canopy sensors have been developed as a tool to determine plant N stress deficiency and provide on-the-go decisions for implementing variable rate N application. The objectives of this study were to assess N deficiency stress levels at the mid-vegetative corn growth stages with active canopy sensors, calibrate active sensors and associated canopy indices, and develop N rate algorithms that can be used to determine variable rate N fertilization.

Keywords
active canopy sensors, N fertilizer, corn

Disciplines
Agronomy and Crop Sciences
Introduction

Precision agriculture technologies are an integral part of many operations in Iowa corn production. Active canopy sensors have been developed as a tool to determine plant N stress deficiency and provide on-the-go decisions for implementing variable rate N application.

The objectives of this study were to assess N deficiency stress levels at the mid-vegetative corn growth stages with active canopy sensors, calibrate active sensors and associated canopy indices, and develop N rate algorithms that can be used to determine variable rate N fertilization.

Materials and Methods

 Nitrogen rate small plot trials were conducted from 2006-2008 at 62 site-years representing predominant Iowa soil types, diverse growing conditions, and varying levels of N response.

 Nitrogen fertilizer rates (0-240 lb N/acre) were applied at or shortly after planting. Each trial site was monitored with three active canopy sensors (Holland Scientific Crop Circle ACS-210 and NTech GreenSeeker Green Model 506 and Red Model 505). Sensing was conducted between the V10-12 growth stages. Each single sensor unit collected readings on-the-go while positioned at a 90° plane angle, above the corn inter-row, 2-3 ft. above the canopy. Corn row spacing for all sites was 30 in. Sensor indices were normalized by dividing the sensor index value by the index value from the highest N rate at each site.

 The economic optimum N rate (EONR) was calculated for each site from a fitted regression model of yield response to N (10:1 N fertilizer-to-corn price ratio). The N rate differential from EONR (dEONR) for each site was calculated by subtracting the EONR from the applied N rate. The model parameters for N rate algorithms were calculated using a quadratic plateau (QP) regression model of the relative canopy index and dEONR across all sites. The quadratic solution for QP regression models was used to provide the prescribed N application rate algorithms.

Results

Table 1 shows the relative canopy index calibration models and equation parameters for each active sensor. Results differed somewhat between sensors, for instance, the rNDVI had a better calibration fit from the CC-210 than the GS-505 and 506. Also, GreenSeeker sensors had greater variation in the relationship between sensor index values and dEONR compared to the Crop Circle. Each of the relative canopy indices had a similar value at zero dEONR (0.99-1.00). The join point values were similar for the rSRI and rCHL (39 to 57 lb N/acre), but lower for the rNDVI index (-13 to 27 lb N/acre).

Solving the quadratic portion of the QP calibration model produces N rate algorithms that can be used to prescribe N application rates (Fig. 1). The accelerated decrease in N rate per unit of relative index value, along with the variation in canopy index measurements, results in greater potential for N application error at slight N deficiencies.

Prescribed N rate variance across deficient dEONR is shown in Fig. 2. The range of N application which has the least amount of calculated variability is between 50 to 150 lb N/acre. As dEONR reaches zero, sensing corn N deficiency becomes increasingly difficult.

Summary

Active canopy sensors can measure N stress during the mid-vegetative corn growth period. Calibrated QP regression models related relative sensor indices to corn N deficiencies across diverse growing conditions. The quadratic solution of the index calibration models developed in this study provide N rate algorithms capable of directing variable in-season N rate application in Iowa and other similar corn production areas.

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