REAL-TIME CALIBRATION OF ACTIVE CROP SENSOR SYSTEM FOR MAKING IN-SEASON N APPLICATIONS

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ABSTRACT

Variable-rate in-season nitrogen (N) applications have the potential to increase N use efficiency and optimize profitability. The challenge is to calibrate the vegetation indices derived from canopy sensors or imagery to account for crop growth stage, local cultural practices, and spatial variability in plant vigor. The concept of using a high N reference area to calculate a sufficiency index for plants being considered for supplemental N application was developed for plot research with SPAD chlorophyll meters. Extending this calibration approach to field scale operations involves establishment of high N reference strips. In both cases, sufficiency index values of plants are used to calculate an in-season N application rate based on active sensor reflectance values. Many producers and commercial applicators feel the establishment and use of high N reference strips in fields will be problematic and lead to confusion and errors. A statistical approach was coupled with real-time data collection to progressively update and analyze the data base to generate a reference vegetation index value from which to calculate a sufficiency index. This automated approach to calibration of the in-season N application algorithm was tested on field strips containing randomized N rate plots. Nitrogen application rates determined by this real-time calibration approach were compared with rates based on an approach that involved scanning the strip prior to making the N applications (i.e., establish a high N crop reference value). The real-time calibrated N rates quickly locked-in on nearly the same rates as those based on pre-scanned crop data. Risk of under-application with the real-time calibration approach would be minimized by starting in a part of the field with relatively high crop vigor. The real-time approach to calibration of in-season N application algorithms provides good accuracy considerable convenience by eliminating the hassles associated with high N reference strips.

INTRODUCTION

Reluctance of commercial applicators and corn producers to endorse the concept of using a high-N strip to calibrate active crop sensors prompted consideration of other approaches. The use of starter fertilizers and some preplant

N applications is common among corn producers. The in-season N application strategy relies on enough planting-time N to supply the corn crop until the V8-V14 growth stages. Considering the natural spatial variability in fields, early season N applications are very likely to result in parts of the field with more than adequate N. Conceptually; these areas could serve as a high-N reference if they could be readily identified and quantified. Scanning one or more field transects would therefore constitute a virtual reference strip from which a sensor reference value could be extracted. The purpose of this research was to compare N application rates using the reference values derived from an high-N strip and virtual reference strip. A second goal was to evaluate a "Drive and Apply" that relies on software to progressively update the reference while driving through the field and making variable rate N applications.

MATERIALS AND METHODS

Two eight-row wide strips of sprinkler-irrigated corn each containing four replications with six pre-plant N rates (plots 15-m long) were monitored on 21 July, 2009 (V12) with two ACS-470 Crop Circle sensors. Adjacent strips either received 50 or 150 kg N at planting. The strips were scanned several days prior to testing in order to obtain and hardcode reference values into software for the Drive-and-Apply methodology. The basic form of the algorithm used to calculate the proposed N rate was: $N_{APP} = (N_{OPT} - N_{CRD}) \cdot \sqrt{(1 - SI)/\Delta SI}$ where N_{OPT} was the optimum N rate, N_{CRD} was the N applied at planting, SI was the sufficiency index of the plot in question, and ΔSI was the difference in SI values between plots receiving zero N and N_{OPT} rates.

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RESULTS AND DISCUSSION

Each field strip containing the six N-rates was scanned to determine the virtual reference value (red-edge chlorophyll vegetation index). Reference values were derived from scans of the 50 and 150 kg N/ha strips. The 95 percentile values from the collected data were used to establish the reference value. This reference value was then used in the software to calculate the *SI* as the sensors then traveled through the field as though N fertilizer was being applied. Finally, "Drive-and-Apply" software, that comparatively updated the reference value based on the hardcoded reference value and the crop status thus-far within the strip, was tested using the same algorithm to make N recommendations. Once the system had traveled ~90 m and encountered relatively high and low vigor plants, the N recommendation nearly mimicked the N rates where the strip was scanned before N application was initiated.