# Evaluation of Two Ground-Based Active Crop Canopy Sensors in Maize: Growth Stage, Row Spacing, and Sensor Movement Speed

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Precision agriculture research has been directed toward enhancing the efficiency of N inputs by quantifying in-field variability. Remotely sensed indices such as normalized difference vegetation index (NDVI) can determine in-field N variability in maize (*Zea mays* L.). One method of determining NDVI is through the use of ground-based active crop canopy sensors. Several crop canopy sensors determine NDVI, however, climatic and management variables may affect NDVI readings. Our objectives were to compare two ground-based active crop canopy sensors (Crop Circle amber and GreenSeeker red) across plant growth stage, wind, crop row spacing, sensor movement speed, and N fertilizer rate under greenhouse conditions. Results show that wind had no effect on the NDVI readings of either sensor. Nitrogen rate and growth stage did affect the NDVI of both sensors with NDVI values generally increasing with increased N rate and advancing growth stage. For both sensors the V8 NDVI $r^2$ with N rate were lower than those observed at V10 and V12. However, the GreenSeeker (red sensor) had much lower $r^2$ values at V8 than the Crop Circle (amber sensor). Sensor speed had an effect on red sensor NDVI values while the amber sensor was not affected by sensor movement speed. The amber and red sensors distinguish plant N status and growth stage differences in maize in a greenhouse environment. However, the red sensor had more variability in NDVI readings and was affected by movement speed. The amber sensor shows no such limitations and therefore performed best under greenhouse conditions.

**Abbreviations:** CV, coefficient of variation; GDVI, green difference vegetation index; GNDVI, green normalized difference vegetation index; LAI, leaf area index; NIR, near infrared light wavelength; NDVI, normalized difference vegetation index; VIS, visible light wavelength.

A significant amount of precision agriculture research has been directed toward enhancing the efficiency of inputs such as N by quantifying in-field variability. Several methods of quantifying and managing variability have shown potential for enhancing grain yield (Fleming et al., 2004; Khosla et al., 2008, 2002; Khosla and Alley, 1999), N-use efficiency (Raun et al., 2002), and economic return (Koch et al., 2004). Most methods use some form of remote sensing to quantify in-field variability. Numerous studies have shown that remotely sensed imagery can provide valuable information about variability in maize (*Zea Mays* L.). Shanahan et al. (2001) found that green normalized vegetation index (GNDVI) acquired from an airborne platform during midgrain filling could be used to depict spatial variability in fields to estimate maize yield for potential use in site specific management. Sripada et al. (2005) found that green difference vegetation index (GDVI) acquired with aerial imagery could be used to predict the in-season economic optimum N rate. Scharf and Lory (2002) demonstrated the usefulness of airborne photographs for predicting N side-dress need in maize based on plant color. While useful, airborne or satellite remotely sensed imagery has limitations including cost, weather conditions, and the timeliness in which imagery can be acquired. One way these limitations can be overcome is through the use of remote sensing devices that

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