Comparison of two commercial active optical sensors regarding their relationship between early-season sensor readings and final corn (Zea mays, L.) yield

Lakesh Sharma and Dave Franzen
Department of Soil Science, North Dakota State University, Fargo, ND

ABSTRACT

Ground-based active-optical (GBAO) crop sensors have been shown useful in predicting corn (Zea mays, L.) yield early in the growing season. Our objective was to compare the relationship between sensor readings and the ‘in-season estimate of yield’ (INSEY) from both the Greenseeker sensor and the Crop Circle sensor. The experimental design was a randomized complete block with four replications and six N rate (ammonium nitrate) treatments; control, 45 kg ha\(^{-1}\), 90 kg ha\(^{-1}\), 134 ha\(^{-1}\), 179 kg ha\(^{-1}\), and 224 kg ha\(^{-1}\) applied preplant within 1-5 days of planting. The GBAO sensors were used at 5-8 leaf stage, and about 10-14 days later. The Crop Circle sensor averaged an R\(^2\) of about 0.78. The Greenseeker relationship averaged about 0.52. There was a particularly improved relationship between sensor reading and INSEY by the Crop Circle sensor at the 10-14 leaf stage.

INTRODUCTION

• Nitrogen use efficiency (NUE) for world cereal production is averaging 33% (Raun and Johnson, 1999).

• Ground-based active-optical (GBAO) crop sensors have shown useful in predicting corn yield early in the growing season.

• GBAO sensors emit a coded light of specific wavelengths onto crop foliage. This light is reflected back and measured by the device.

• GBAO sensors allow the prediction of crop response to N, particularly if a non-N-limiting reference strip is established in the field earlier in the season.

OBJECTIVES

1. Compare Greenseeker with Crop Circle for in-season yield estimation.
2. Evaluate the strength or weaknesses of over-the-top readings compared to beneath-canopy readings in corn.

MATERIALS AND METHODS

Sensor Readings

• Greenseeker (N-Tech Industries, distributed through Trimble) and Holland Scientific Crop Circle Sensor-470 were used for the study.

• Greenseeker emits two bands visible and near infrared as below:

\[ \text{NDVI} = \text{NIR} - \text{VIS/NIR+VIS} \]

\[774 - 656 + 774 + 656\]

• Crop Circle-470 emit three bands visible, red edge, and near infrared so two wavelength ratio were as below:

\[ \text{NDVI} = \text{NIR} - \text{VIS/NIR+VIS} \]

\[760 - 670/760 + 670\]

\[\text{NDVI} = \text{RED EDGE/NIR+RED EDGE} \]

\[760 - 730/760 + 730\]

• Approximately 45 samples /row of each plot of NDVI were taken with both the sensors. The NDVI values were averaged for each plot as well as for each treatment.

• Both sensors, Crop Circle-470 and Greenseeker were used at 5-8 leaf stage and about 10 days to 14 days later over the top, whereas bottom readings were recorded only at 10-14 leaf stage.

RESULTS

Greenseeker NDVI INSEY and Yield relationship at 10-14 leaf stage

- Yield and INSEY R\(^2\) from all sites was at least doubled in both sensors when sites were divided into categories of soil texture and tillage.

- In locations where the corn yield response to N was small, the R\(^2\) of the sensor readings from both instruments at both growth stages were small. Where response to N was large, the relationships between sensor reading and INSEY were large.

- R\(^2\) was found maximized with the Crop Circle using the Red Edge wavelength. It happens because NDVI ‘saturates’ and reaches maximum values quickly. (Fig.1 and Fig.2). (Gitelson et al., 1996; Myneni et al., 1997).

- Yield and INSEY relationships were generally higher at the10-14 leaf stage except in medium textured soils, where relationships at both growth stages were similar with both sensors.

- Relationships were generally weaker with both sensors when corn was sensed under the canopy as compared to over the top.

SUMMARY

• Soil categories help to increase the R\(^2\) relationship between yield and INSEY.

• Over the top readings have better results than bottom with both the sensors.

• NDVI from red and near infrared gave poor results between yield and INSEY as compared to Red Edge under dry land.

• Crop circle was found better as compared to Greenseeker.

• VI2 leaf stage was found better in predicting yield.

• The R\(^2\) was weak on those locations, where Nitrogen response was less.

REFERENCES


ACKNOWLEDGEMENTS

Thanks to the North Dakota Corn Council, IPNI and Pioneer Hi-Bred International for their support of this project.