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

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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 ha^{-1}, 134 ha^{-1}, 179 ha^{-1}, and 224 ha^{-1} were 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 been 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

Location and Treatments

- 15 dryland sites were selected in 2011 on cooperator fields in North Dakota.
- Six nitrogen treatments: 0-N check (control), 45 kg N/ha, 90kg N/ha, 135kg/ha N/ha, 179kg N/ha, and 224kg N/ha applied as ammonium nitrate granules within 1-5 days of planting.
- Experimental design: Randomized complete block design with four replications.
- Plot size: 6 x 3 meter
- Soil was sampled to 61cm depth for residual nitrate-N preplanting.
- P and K applied, if sampled found deficient.

Crop History & Soil Texture

- The previous crop, tillage history, and surface-subsurface soil texture were considered in grouping sites for N response after harvest and during the growing season.

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:

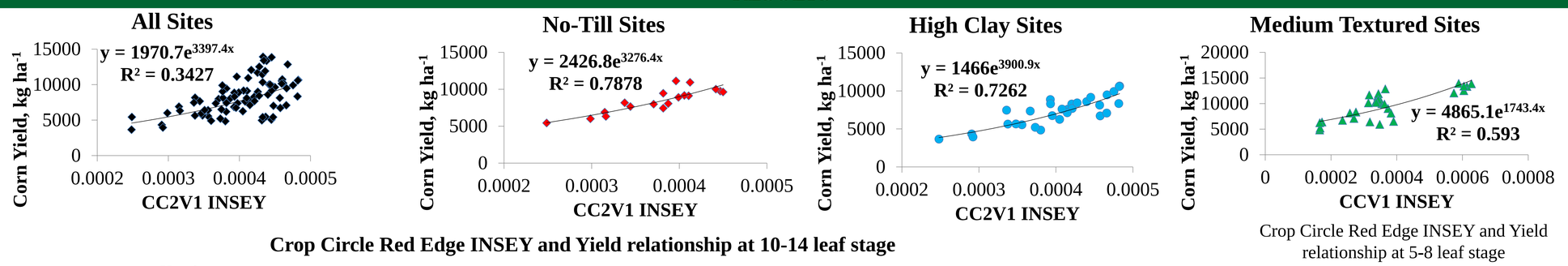
  NDVI= NIR – VIS/NIR+VIS ➡ 774 – 656/ 774 + 656
- Crop Circle-470 emit three bands visible, red edge, and near infrared so two wavelength ratio were as below:

  NDVI= NIR – VIS/NIR+VIS ➡ 760 – 670/ 760 + 670

  and

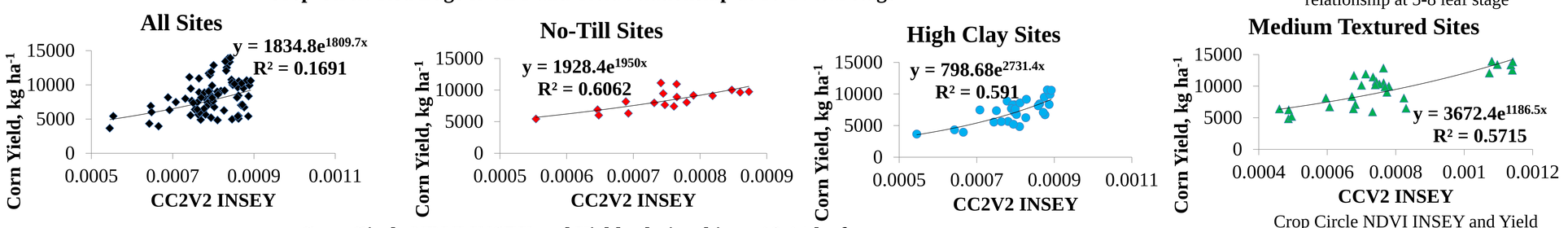
  NDVI= NIR – RED EDGE/NIR+RED EDGE ➡ 760 – 730/ 760 + 730
- Approximately 45 samples /row of each plot of NDVI were taken with both the sensors. The NDVI values were averaged for each plot as well as for each treatment.
- Both sensors, Crop Circle-470 and Greenseeker were used at 5-8 leaf stage and about 10 days to 14 days later over the top, whereas bottom readings were recorded only at 10-14 leaf stage.

RESULTS



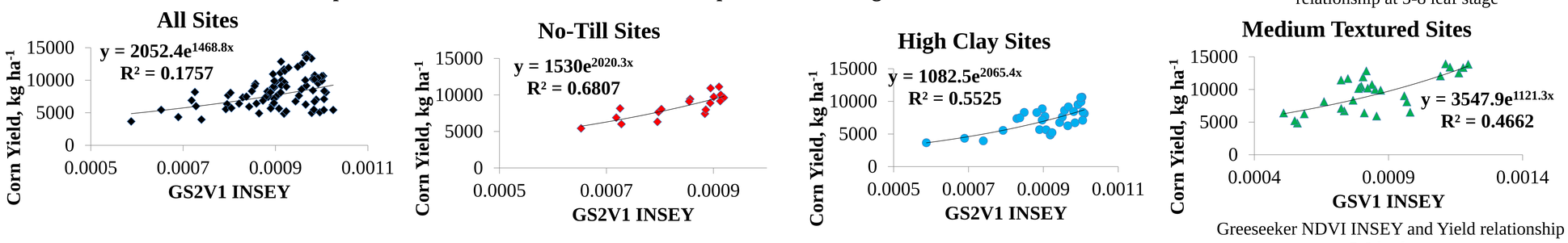
Crop Circle Red Edge INSEY and Yield relationship at 10-14 leaf stage

Crop Circle Red Edge INSEY and Yield relationship at 5-8 leaf stage



Crop Circle NDVI INSEY and Yield relationship at 10-14 leaf stage

Crop Circle NDVI INSEY and Yield relationship at 5-8 leaf stage



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

Greeseeker NDVI INSEY and Yield relationship at 5-8 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.

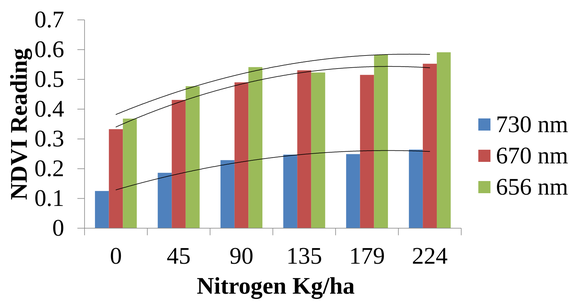


Fig. 1 NDVI readings at 5-8 leaf stage

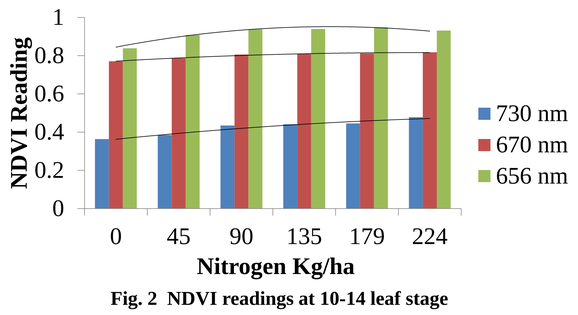
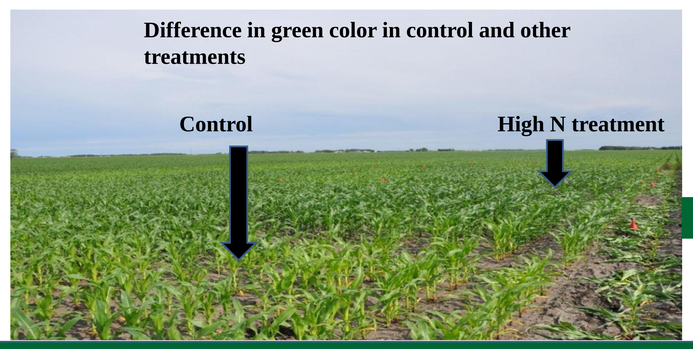


Fig. 2 NDVI readings at 10-14 leaf stage



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.
- V12 leaf stage was found better in predicting yield.
- The R^2 was weak on those locations, where Nitrogen response was less.

REFERENCES

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