Improving In-Season Corn Nitrogen Dressing Using Canopy Sensing in Manitoba

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Objective

To determine (1) if standardizing spectral reflectance indices using a high reflectance reference area provided a stronger relationship to grain corn yield than the unstandardized sensor data (2) if standardized spectral reflectance indices captured in early vegetative growth could estimate in-season N dressing of grain corn.

Background

Canopy sensing is affected by and light conditions (intensity of light and the influence of spectral signature from surrounding objects) which are not uniform throughout the field (Singh et al. 2019). The novel approach of standardizing light conditions between measurement dates for both active (GreenSeeker and CropCircle) and passive (UAV MicaSense muli-spectral) sensors was taken.

Figure 1. Corn reflectance being measured by the GreenSeeker® (back) and the CropCircle™ (front).

Figure 2. The MicaSense Red Edge 5-channel camera mounted on UAV platform (DJI Matrice 100) flying over the corn plot at Haywood in 2019.

Active Optical Sensor

- Has own light source that emits light pulses and measures the intensity of light reflected back (Fig 1).

Passive Optical Sensor

- Uses a light source by sensing the amount of radiation reflected wavelengths (Fig 2). (Cao et al., 2015; Franzen et al., 2019)

Vegetation Index (VI)

$$\text{NDVI} = \frac{(NIR - Red)}{(NIR + Red)} \quad \text{NDRE} = \frac{(NIR - Red\_Edge)}{(NIR + Red\_Edge)}$$

Standardization

NDREs= Current plot (NDRE) + (1- Highest plot NDRE on day of sensing)

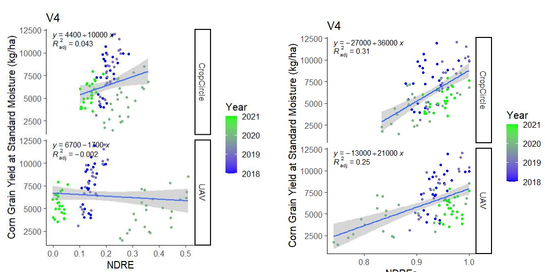
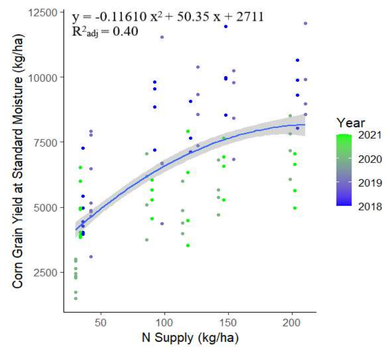


Figure 3. Linear regression predicting corn grain yield at V4 using NDRE (Left) and $NDRE_S$ (Right).

Nitrogen Dressing Estimates

Step 1. Establish a reference area (non-limiting, High-N) and test area.

Step 2. Determine corn grain yield at Maximum return to Nitrogen (MRTN).



High Price Ratio: MRTN is 177 kg ha^{-1} Yield at MRTN is 7,986 kg ha^{-1}

Figure 4. Corn grain yield response to N supply for pre-plant urea addition across study years.

Step 3. Calculate Fertilizer Grain Use Efficiency

$$\text{FGUE} = \frac{\left(\frac{N\ in\ high\ N\ x\ dry\ yield}{100}\right) - \left(\frac{N\ control\ x\ dry\ control\ yield}{100}\right)}{N\ rate}$$

Step 4. Calculate In-Season N dressing

Calculations	Equation	Results
Yield difference	MRTN-Current yield	3486 kg/ha
% N in Grain	1.30% N x kg/ha	45 kg/ha
% FGUE	/0.3 N in Grain	151 kg of N per ha

N rate to reach MRTN yield goal of 7,986 kg/ha

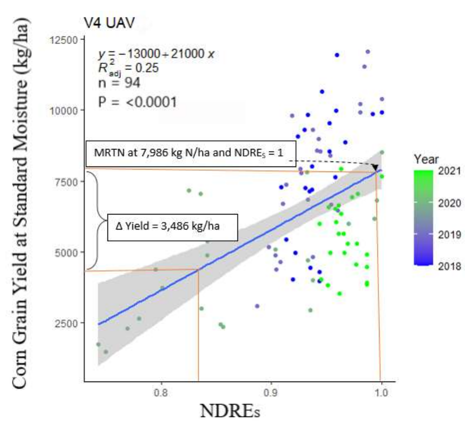
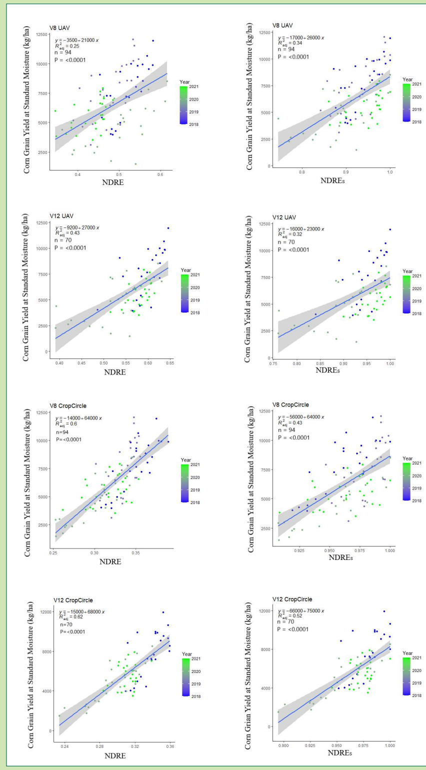


Figure 5. Estimating N requirement from canopy spectral reflectance

Results



Summary

- $NDRE_S$ and $NDVI_s$ improved corn grain yield estimation at early growth stages
- Standardization improved grain yield predictions at V8 for the passive sensor using RE.
- Our study has provided options to use canopy sensors to help make N fertilizer application decisions and predict end of season corn yield for corn growers in Manitoba.
- Standardizing NDRE values shows promise for both active and passive sensors to be used to capture differences in metrological conditions and make utilizing multiple site years possible.

Acknowledgment

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Reference

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