Smart Ag Research

In-Field Evaluation of Variable Rate (VR) Crop Inputs Using Satellite Imagery to Generate Prescription Maps

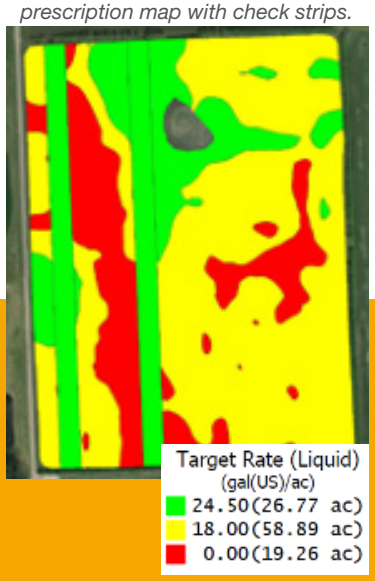
During the 2020 and 2021 growing seasons, Olds College used satellite imagery to build two fungicide and one desiccant VR prescriptions. The assessment included accuracy verification of prescription representation of the field, identification of requirements for VR applications, and studying the effects of the VR application along with associated financial benefits/implications.

The goal of each trial was to determine how a VR application can affect the cost of production and operational requirements. Specific to each trial, the team analyzed differences between the VR applied areas and the check zone in regards to plant growth, pest pressures, yield, and harvested product quality.

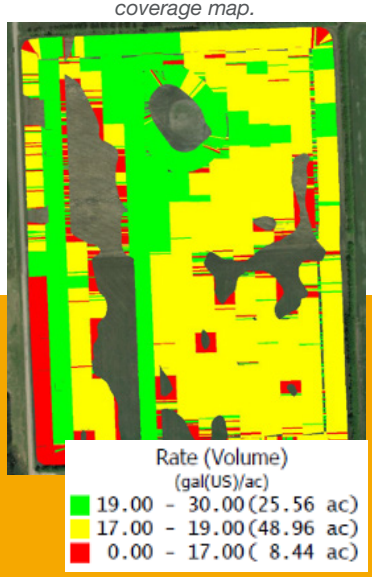
Objectives

- Complete a simple cost benefit analysis of flat rate to VR pesticide applications.
- Define additional requirements and benefits as a result of VR implementation.
- Identify observed differences between the VR applied areas and the flat rate checks.

Field 15/16 desiccation prescription map with check strips.



Field 15/16 desiccant coverage map.



Study details

- Prior to the growing season, zone maps for each trial field were created and verified with multiple data sources, including satellite imagery from Sentinel 2 and high-resolution UAV imagery.
  - Scouting locations were identified by selecting areas likely to be a representative average of the field.
- VR capable application equipment was selected.
- Prescription maps were developed.
  - Fungicide: One check location was selected to receive the label recommended high rate.
  - Desiccant: Two check locations were selected to receive the label recommended high rate.
- The prescription map was reviewed by researchers and accepted for use.
  - VR barley fungicide application - July 10, 2020
  - VR canola fungicide application - July 16, 2021
  - VR canola desiccant application - Sept 9, 2021
- Post application assessments were completed using ground truthing evaluations, drones, satellite imagery and equipment activity data.
  - Disease pressure for fungicide.
  - NDVI, seed moisture content and green seed count of canola for desiccant.
  - Yield comparisons were completed using combine yield data.

Get more information at www.oldscollege.ca/smartfarm.

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Results

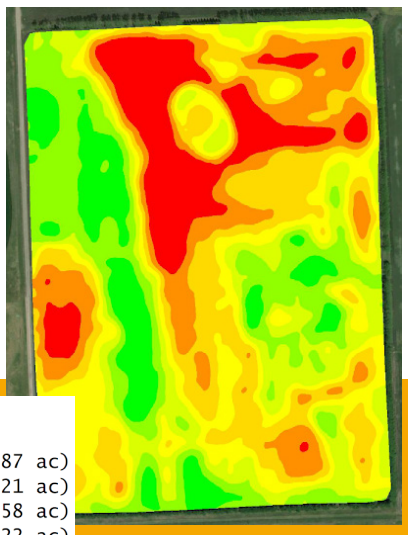
- Having subject matter experts at Olds College develop and review prescription maps was invaluable to the project.
- Levels of rate smoothing applied to the prescription maps was greater than necessary which removed minor field details from the prescription maps. These small “smoothed” areas of the field would have benefited from an increased or decreased rate of product.
- A VR fungicide application on the whole field (159 acres) in comparison to a full flat rate application would have decreased total chemical usage from 78 liters to 41.9 liters (saving $13.22/acre) with no significant impact on disease pressure for the 2021 growing season.
  - Due to the drought conditions in 2021, the level of disease infection within the field was rated as very low as per the observational scouting records and petal test results.
- A VR desiccation application on the whole field (105 acres) would decrease total chemical usage from 86.7 liters to 53.3 liters (cost savings of $5.72/acre) with no significant impact on crop maturity or harvestability.
- Benefits achieved by VR pesticide applications are impacted by:
  - Overall variability of the field.
  - Level of detail built into the prescription map (level of rate smoothing applied).
  - Capabilities of equipment used with respect to rate controllers and sectional control.
  - Cost of the prescribed product for the VR application.
  - Allowable application rate range according to the pesticide product label.
  - Number of target rates within the map.
- Factors influencing the effectiveness of VR application include:
  - Functionality of equipment with respect to rate controllers and sectional control.
  - Recommended product and label rate(s).
  - Number of target application rates specified in the prescription.
- Variances in expected product use and actual product use were observed due to rate controller abilities and transition zones.
- NDVI change detection of pre-desiccant application to post-harvest illustrated a significant inverse relationship of plant regrowth to desiccant application rate for the 2021 growing season. The inverse correlation indicates that a desiccant application would have benefited areas that did not receive treatment.
- Development of maps for in-crop applications require reliable and frequent imagery to meet specific timing of application. Noted concern during the 2020 trial included use of cloud removal software and image source for selected date. In Canada, satellite imagery is limited. Factors (overcast days or smoke in the air) leading up to product application timing may hinder the collection of quality imagery for use in prescription development.

Fungicide Product Cost Summary: Prescribed, Flat Rate, VR Only

Fungicide Application	Cost/Acre
Prescribed VR (with checkstrip)	$19.49
Flat Rate (high)	$28.58
VR Only (full field, no check strips)	$15.36

Desiccant Rate & Acres Comparison: Prescribed, Actual

Desiccant Application	Applied Rate (ml/acre)	Prescribed Acres	Actual Acres
High Application Rate Zone	826.4	26.8	25.6
Low Application Rate Zone	607.2	58.9	57.4
No Application Zone	0	19.3	22.0
Total Acres		104.9	104.9



NDVI change detection map using Sept 3 & 23 NDVI imagery from Sentinel 2 satellite.

Future Research

- Researchers are currently defining a project to explore correlations between VR applications of fertilizer and nitrous oxide emissions.