CMCDC

2017 POTATO REPORT

Canada

MHPEC Inc.

Manitoba

Contents

Overview of the Canada-Manitoba Crop Diversification Centre

Carberry Site

The Manitoba Crop Diversification Centre (MCDC) was established in 1993 under a ten-year agreement among the Government of Canada, Government of Manitoba, and the Manitoba Horticulture Productivity Enhancement Centre Inc. (MHPEC). Subsequent agreements have continued operations of the Centre under the Canada-Manitoba Crop Diversification Centre (CMCDC).

CMCDC's mission is to facilitate the development and adoption of science-based solutions for agricultural crop production, with a focus on water management, crop diversification and environmental stewardship. Its program and outcome areas are broadly classified as:

- Partnerships and communication
- Water supply and irrigation
- Potato industry support (applied research and technology transfer)
- Environment
- Crop diversification

Canada's support is provided through the Science and Technology Branch (STB) of Agriculture and Agri-Food Canada (AAFC). At the Carberry site, presently, this includes four full-time and one seasonal staff position, summer students, support for operating costs, infrastructure support and services.

Manitoba's commitment is through Manitoba Agriculture, which provides one staff position, one staff-equivalent in part-time support from other Manitoba Agriculture provincial specialists (technology transfer) and an annual contribution toward project costs.

MHPEC Inc. is a consortium formed by the two Manitoba French-fry processors (Simplot Canada [II] Ltd. and McCain Foods [Canada] Ltd.), and Keystone Potato Producers Association (the processing potato growers' association). The MHPEC members support MHPEC through direct cash contributions, which are expended in support of the CMCDC program for supplies, staff (including seasonal, summer students and casual labour) and services.

All partners in CMCDC actively participate in the Centre management and program advisory committees.

The CMCDC site at Carberry is located at the junction of Highways #1 and #5 on a half-section (130 ha) of loam-clay loam soil, approx. 70 ha of which is irrigated. Co-location of Manitoba Agriculture's Carberry Growing Opportunities Center and Manitoba Sustainable Development water licensing staff with CMCDC staff benefits all involved in serving our agricultural clients efficiently. Much of the processing potato activities are conducted at this site and at a nearby sandy off-site. In addition, the Centre is affiliated with three provincial diversification sites in

Arborg, Roblin and Melita for purposes of planning and coordinating crop diversification activities.

Most Centre programs and projects are conducted in collaboration with other public or private agencies, including universities, AAFC Science and Technology staff, Manitoba government, private crop protection companies and consultants. Given the on-going challenge of limited resources and the need for enhanced communication among agencies, CMCDC has a unique role to play in the coordination of partnerships to ensure knowledge is discovered, interpreted and communicated effectively to producers and the agricultural industry at large.

Communication of activities and results are conducted through research reports, field tours and workshops held at each site throughout the summer, also coordinated among the various partners and clients.

CMCDC continues to strive for excellence in fulfilling its mission. The need is greater than ever to deliver high quality research and extension programs efficiently that ensure the following outcomes:

- agricultural productivity is enhanced,
- environmental resources are conserved and protected, and
- producers adopt new management practices that encourage sustainable production

CMCDC-Carberry Sites – Aerial Photos and Trial Locations

CMCDC Carberry Site 2017

1. Long-Term Phosphorus Demonstration
2. AAFC Barley Grain & Forage
3. Ducks Unlimited Winter Wheat
4. MCVET Winter Wheat & Fall Rye
5. Canterra Seeds RR Soybeans
6. MB Pulse & Soybean Growers (MPSG) AAFC Soybean Residue Study
7. MPSG CN Soybean
8. Western Canadian RR Soybeans
9. MPSG NR Edible Beans
10. Pea Variety Trial
11. Canadian Hemp Trade Alliance Hemp Variety Trial
12. FCC Flax Demo A & B
13. CHTA Hemp N-Fertility
14. Quinoa Variety Trial & Demos
15. Buckwheat
16. AAFC Soybean Moisture Trial
17. U of M Gluten Strength in Wheat Trials
18. Manitoba Corn Growers Association CN Corn Cold Nursery
19. MCGA CN Corn Yield Trial
20. Fusarium Head Blight Wheat
21. Wheat Population Trial
22. Barley Population Trial
23. Oat Population Trial
24. MCGA CN Corn Yield Trial
25. Canterra Seeds RR Corn
26. Potato Seed Age Treatment Plots
27. Gaia Consulting Trials
28. MCGA Corn Yield Trial
29. Wheat Trial
30. AAFC Field Runoff Monitoring Study
31. AAFC Bee Establishment Trial
32. AAFC Field-Scale Efficiency Monitoring Study
33. Northstar Seeds Plot
34. AAFC Cereal Disease Nursery
35. Solum Valley Biosciences Trials

Imagery from MHPEC

CMCDC Carberry Offsite 2017

1. Potato Variable vs. Uniform Rate Irrigation Study
2. Potato Seed Age Testing Plots
3. Potato Heat x Water Stress Study
4. Potato Nitrogen Previous Crop Study
5. Potato Demonstration Plots
6. Potato Moisture Monitoring Plot
7. Student Study Research Plot
8. Wheat Nitrogen Trial
9. Gaia Consulting Trials

Imagery from MHPEC

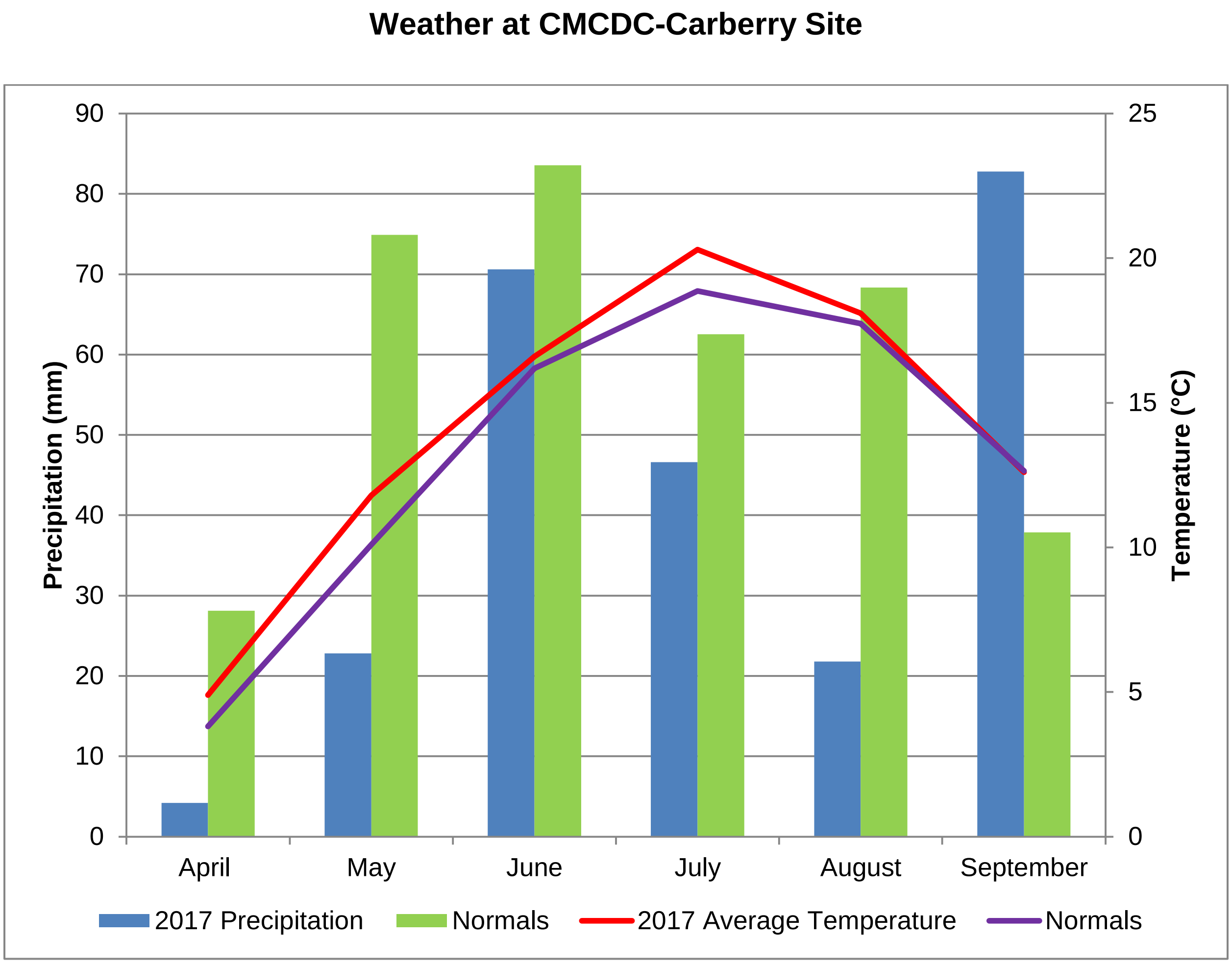

Figure 1. 2017 growing season precipitation and monthly temperatures at CMCDC-Carberry.

Staff at CMCDC Carberry 2017

Full time staff	Supporting CMCDC Partner	Position
Lindsey Andronak	AAFC	Research Technician
Brian Baron	AAFC	Site Supervisor
Zachary Frederick	MHPEC	Potato Research Agronomist
Craig Linde	Manitoba Agriculture	Diversification Specialist
Alison Nelson	AAFC	Agronomist (Winnipeg)
Sherree Strain	AAFC	Office Administrator

Seasonal/Term staff		
Eric Claeys	AAFC	Field Operations Assistant
Alan Manns	Manitoba Agriculture	Field Operations Worker
Beverley Mitchell	MHPEC/Manitoba Agriculture	Research Associate

Summer students/Casual staff		
Kailey Dahmer	MHPEC	Summer Research Assistant
Erica Ebro-Prokesz	AAFC	Summer Research Assistant
Enovwo Emebradu	AAFC	Summer Research Assistant
Olivia Gessner	AAFC	Summer Research Assistant
Ryan Groves	AAFC	Field Operations Worker
Charles Kuizon	Manitoba Agriculture	Summer Research Assistant
Darcy Manns	Manitoba Agriculture	Summer Research Assistant
Boma N-Chris	AAFC	Summer Research Assistant
Mackenzie Shamanski	MHPEC	Summer Research Assistant
Rylee White	MHPEC	Summer Research Assistant

2017 CMCDC Carberry Field Day

Our annual field day was held August 16, 2017 with over forty people in attendance, and over half the crowd representing Manitoba farms and the farm industry. We hosted a potato and irrigation program in the morning and a diversification program in the afternoon. As always, the event included a free BBQ lunch for attendees.

The Field Day is our chance to open our fields and trials up for discussion, inspection and demonstration; and to provide a platform for our collaborators and partners to reach industry representatives. Alison Nelson presented some data and results from one of our potato seed research projects and exhibited some soil moisture monitoring systems available for irrigators. Zachary Frederick presented results from his Field Variability Study. Other presenters highlighted potato research and demonstration work linked to CMCDC that is being undertaken by Manitoba Agriculture, the potato industry, University of Manitoba and Gaia Consulting Ltd.. The range of work presented at the field day highlights the various ways the CMCDC-Carberry site and staff continue to carry out and enable research and demonstration initiatives to advance the potato and irrigation industry.

In the afternoon, Craig Linde and a range of other speakers from Manitoba Agriculture, Roquette, University of Manitoba, and AAFC discussed the pea, soybean and corn research underway at Carberry.

It's great to see some strong interest in the research and demonstration efforts underway at the Centre in potato, irrigation and crop diversification. Thank you to the CMCDC staff, partners and collaborators for making the day a success!

Seed Physiological Age of Russet Burbank Potatoes

Principal Investigators:	Dr. Alison Nelson, AAFC – Carberry Manitoba Potato Research Committee
Scientific Support:	CMCDC
Progress:	Year 3 of 4
Objectives:	- Determine the impact of seeding date, harvest date and soil moisture regime of a potato seed crop, and seed storage regime on physiological seed age and subsequent field performance of a Russet Burbank processing crop. - Establish base seed performance values and physiological measures for future seed physiological age studies in Manitoba
Key 2017 Message:	- Warming seed for a number of weeks prior to planting did not impact crop yield, but did affect the tuber size profile. The warmed seed produced more tubers sized less than 6 oz. The constant storage temperature had more tubers in the 10-12 and >12 oz categories.
Contact Information:	alison.nelson@agr.gc.ca

Project Report

Growing and storage conditions of a potato seed crop are known to affect the seed physiological age, and the performance of the seed in the following production crop. The purpose of this study is to assess the effects and interactions of various potato seed crop management practices on the physiological age and subsequent performance of a processing potato crop.

Treatments are applied to non-replicated seed plots in year 1. The impact of the seed treatments are observed in the randomized, replicated test plots in year 2.

In 2015, 2016 and 2017, non-replicated plots of E3 Russet Burbank seed were planted at CMCDC-Carberry Onsite to obtain all combinations of:

Early and late planting dates (2-3 weeks apart)
Early and late termination and harvest dates (2 weeks apart)
Irrigated and dryland seed production
Constant and ramp-up storage temperature regimes

A total of 16 seed crop treatments were obtained (Table 1) – the treatments are all applied to the seed crop plots (year 1). The seed crop treatment impacts on subsequent (year 2) crop performance were tested in a randomized complete block design trial, at CMCDC-Carberry Offsite in 2016 and 2017. The test plots in year 2 are all treated the same to determine the impact of seed crop management on processing crop stand, emergence, yield and quality. A third season of seed crop treatments were also grown in 2017, with the test plots slated for 2018.

Table 1. Treatment listing for the potato seed physiological age trial. All treatments are applied in the seed crop year (year 1), with the test plots (year 2) being treated equally across all plots.

Treatment	Seed Crop Planting	Seed Crop Harvest	Seed Crop Moisture	Seed Storage Temperature
1	Early	Early	Irrigated	Constant
2	Early	Late	Irrigated	Constant
3	Early	Early	Dryland	Constant
4	Early	Late	Dryland	Constant
5	Early	Early	Irrigated	Ramp up
6	Early	Late	Irrigated	Ramp up
7	Early	Early	Dryland	Ramp up
8	Early	Late	Dryland	Ramp up
9	Late	Early	Irrigated	Constant
10	Late	Late	Irrigated	Constant
11	Late	Early	Dryland	Constant
12	Late	Late	Dryland	Constant
13	Late	Early	Irrigated	Ramp up
14	Late	Late	Irrigated	Ramp up
15	Late	Early	Dryland	Ramp up
16	Late	Late	Dryland	Ramp up

Seed Crop Treatments

The year 1 seed plot treatment details are outlined in Table 2. Planting and harvest dates differed by approximately two weeks. The tubers were dug approximately two weeks after vine kill, when field conditions were suitable for harvest. Tubers sized 3-8 oz. were stored for year 2 testing.

Table 2. Details of differences in year 1 seed crop treatment details.

Main Treatment	Treatment Details	
Planting Date	Early – before May 1	Late – mid-May
Harvest Date	Early - Terminated mid-Aug	Late - Terminated late Aug
Seed Crop Moisture	Irrigated – 4-5" added water	Rainfed – no added water
Seed Storage	Ramp up – in late March, start warming seed 0.5°C/day. Hold at 10°C until planting.	Constant – seed warmed by 0.5°C/day for approximately 1 week before planting

The length of the sprouts on the Ramp Up treatments required all seed pieces to be de-sprouted during handling, cutting and seed treatments (Figure 1). All seed pieces (3-8oz when put into storage) had a single cut made by hand, to make relatively uniform seed pieces with the same cut profile.

Figure 1. Sprouting on Ramp Up tubers (right) compared to Constant tubers (left)

<u>Year 2 Test Plot Results and Discussion</u>

The 2016 and 2017 test plots were statistically similar, allowing the data from both years to be combined. Early seed crop planting and warming the seed before planting in year 2 increased the speed of emergence (Figure 2). There was also slightly lower total emergence (approximately 4% difference) from dryland seed compared to irrigated seed. Some trends and significant interaction effects were also observed, but these were not consistently strong sources of variation.

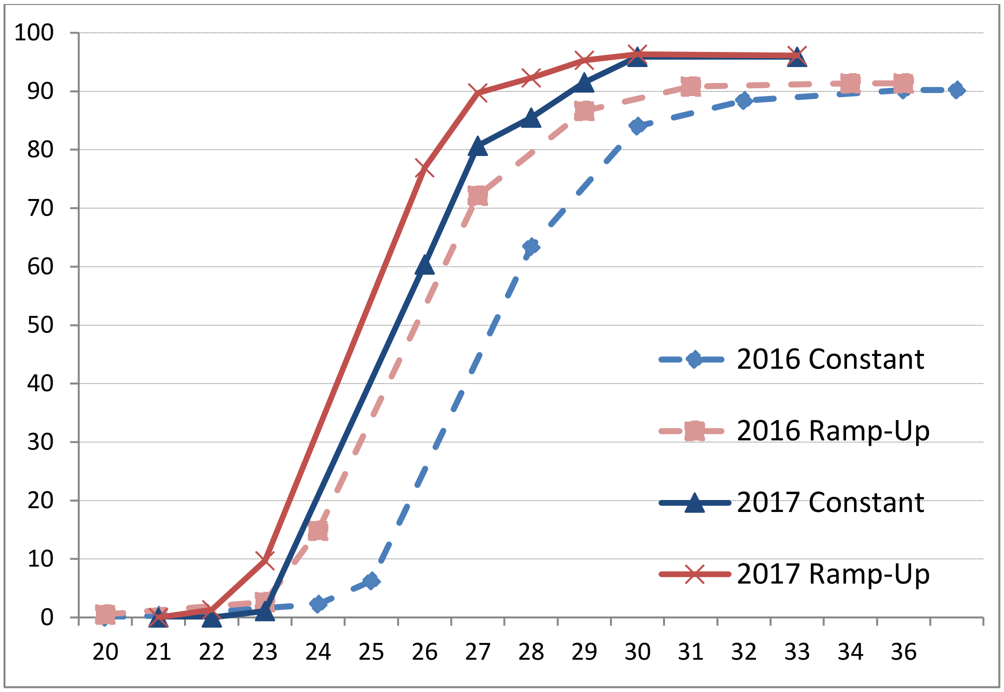

Figure 2. Effect of storage temperature on timing and percentage of emergence.

Early planting increased the number of tubers and stems per plant and decreased the percentage of oversized tubers (Table 3). Irrigated plots had a higher gross yield and a greater percentage of total defects (Table 3).Storage regime had the strongest impact on processing crop growth, and the characteristics of the tuber yield. The ramp up treatment had more tubers per acre and more stems per plant compared to the constant treatment (Table 3).

While storage regime did not have a significant impact on gross or marketable yield, it did have a significant impact on the tuber size profile (Table 3, Figure 3). All categories of size profile were impacted by the spring storage regime. The seed held at a constant temperature until a week before planting had more large tubers. The constant storage seed had more yield in the 6-10 oz, 10-12 oz and greater than 12 oz size categories, compared to the ramp-up storage seed. The seed that was ramped up and held at 10°C for a number of weeks before planting had more small tubers. The ramp up treatment had just over 10% more yield in tubers sized less than six oz (Table 3, Figure 3).

In 2018, the final Year 1 seed pieces will be planted at our Offsite location to provide a total of three years of data.

Table 3. Main factor effects on tuber number, stems per plant, defects and yields. Study years 2016 and 2017 are combined in this table.

	Tuber Number	Stems/Plant	Gross Yield (no dirt)	Total Defects	<3 oz	3-6 oz	6-10 oz	10-12 oz	>12 oz
	(#000/ac)		(cwt/ac)	(%)	(%)				
Planting	*	**							**
Early	173	4.2							7
Late	168	4.0							9
Harvest									
Early									
Late									
Moisture			*	**					
Dryland			578	4					
Irrigated			588	6					
Storage	***	***			***	***	***	***	***
Constant	159	3.9			7.8	31.7	40.2	10.3	9.9
Ramp up	182	4.3			10.6	40.7	35.4	6.7	6.6

, **, * indicate a significant effect of the main factor at P<0.1, P<0.05, P<0.01, respectively. Increasing number of stars indicate greater level of statistical significance of the effect. Blank squares indicate that the mean values are not significantly different from one another.*

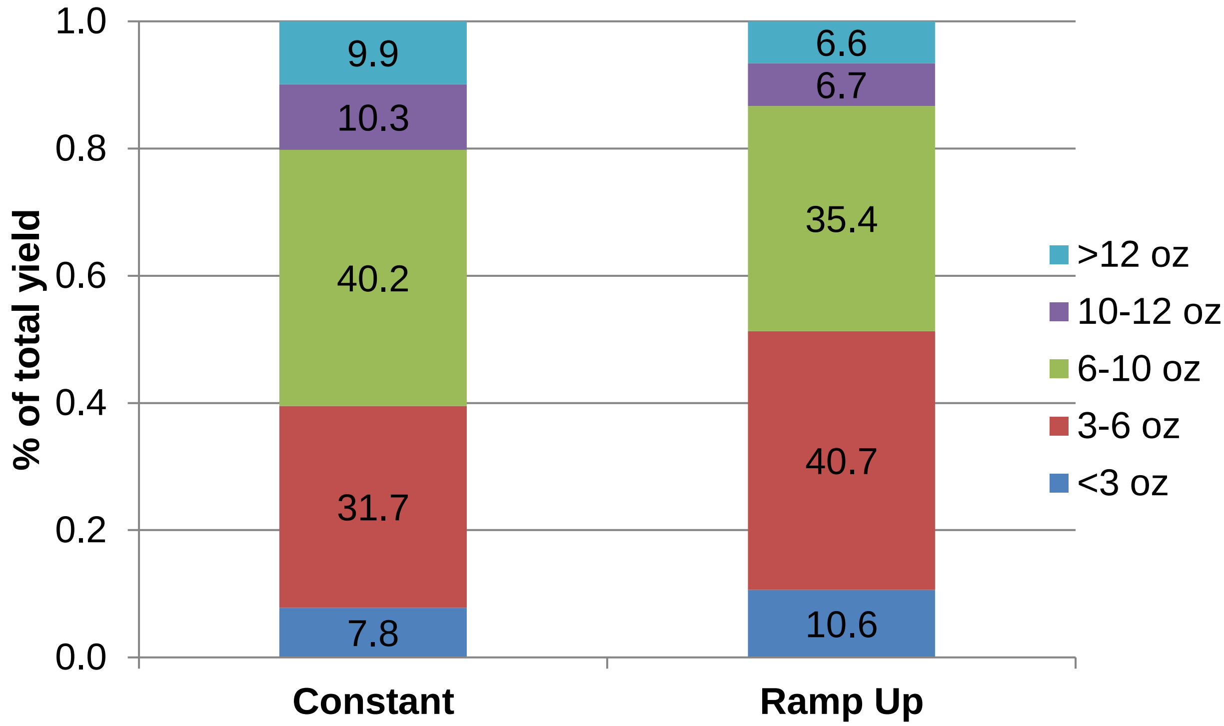

Figure 3. Processing crop (year 2) tuber size profile from the two seed crop storage regimes over 2 years of data collection.

Fumigation as a Mitigation Practice for Potato Early Dying

Principal Investigators: Mario Tenuta, University of Manitoba – Winnipeg, MB
Helen Tai, AAFC – Fredericton, NB
Claudia Goyer, AAFC – Fredericton, NB
Bernie Zebarth, AAFC – Fredericton, NB

Co-Investigators: Alison Nelson, AAFC – Carberry
MHPEC, Inc.

Support: Agri-Innovation Program, AAFC
MHPEC, Inc.

Progress: Year 3 of 3

Objective:
- Assess effects of fumigation on potato productivity and *Verticillium* species on commercial fields
- Develop gene expression indicators for Potato Early Dying disease stress in fumigated and unfumigated treatment strips
- Evaluate changes in diversity of bacterial and fungal microbial communities with fumigation and soil properties over a two-year time period in one commercial field

Key 2017 Message:
- Fumigation may rescue fields with high *Verticillium* levels, but fumigation in other fields is not likely to yield a return on investment.
- *Verticillium* levels in the soil bounce back in the yield following the potato crop.

Contact Information: mario.tenuta@umanitoba.ca

Project Report

Three trials in 2016 and two trials in 2017 were conducted on commercial potato fields to assess the effect of soil fumigation with Vapam with grower and processor cooperation. Fields were planted to Russet Burbank potatoes, with replicated treatment strips of a non-fumigated control or fall-applied Vapam (the fall just prior to the potato crop) at the recommended application rate. A minimum of 12 paired (fumigated vs. non-fumigated) sampling points were established per field, with multiple paired sampling points in each field strip replication. At the paired sampling points, plant and yield sampling, along with disease assessments were carried out in the potato crop. Soil and plant samples were collected to assess *Verticillium dahliae* levels in soil and plants. *Verticillium* soil densities were assessed with plate counting and molecular real time PCR assay on fall-pre-treatment, spring-post-treatment and fall-post-treatment soil samples. Species identification was done by PCR assay. In selected study fields, gene expression leaf disc samples, potato stem and soil endophyte samples were also collected for additional activities within the overall project.

In 2015, Field 2 was identified to be used for more detailed study including examination of soil microbial communities, effects on gene expression analyses, and post-potato phase soil *Verticillium* analysis. This field was pre-selected based on previous field history, and suspected high levels of soil *Verticillium* levels. Strong visual treatment effects were present in this field starting in mid-August 2016.

In the 2016 fields, one of three fields (Field 2) had very high *V. dahliae* soil levels prior to treatment (the pre-selected field for long-term soil microbial analysis). Fumigation reduced soil *V. dahliae* levels in two of the three fields in 2016. However, only Field 2, with very high pre-treatment levels of *V. dahliae*, had a significant reduction in visual disease and concurrent increase in yield (net yields of 458 cwt/ac vs. 372 cwt/ac for fumigated vs. non-fumigated, respectively). In Field 2, there was a 19% yield loss due to Early Dying from *Verticillium*. Spring 2017 analysis of soil from Field 2 shows that the soil *Verticillium* levels bounce back in the year following potato.

In the 2017 fields, *V. dahliae* analysis was completed on fall-pre-treatment samples. Analysis of the spring- and fall-post-treatment soil samples, yield and visual disease ratings is ongoing.

Results from the study indicate that fumigation may rescue fields with high *Verticillium* levels, but that fumigation in other fields is not likely to yield a return on investment. *Verticillium* levels in the soil bounce back in the yield following the potato crop. So, an outstanding question remains: is fumigation required every year for rescued fields?

Remote Sensing Techniques for Field Variability Mapping for Variable Rate Irrigation

Principal Investigators: Jarrett Powers, AAFC – Winnipeg
Alison Nelson, AAFC – Carberry
Heather McNairn, AAFC – Ottawa, ON

Co-Investigators: Bernie Zebarth, AAFC – Fredericton, NB

Support: Agri-Innovation Program, AAFC
MHPEC, Inc.

Progress: Year 3 of 3

Objectives: - Evaluate the ability and application of soil moisture data collected by an unmanned aerial vehicle (UAV) for variable rate irrigation (VRI)

Key 2017 Message: - The UAV radiometer was mostly effective in indicating surface soil moisture values, but was less effective when conditions were more uniformly dry.
- This technology could be a useful tool for the development of variable rate irrigation prescription maps, particularly when combined with soil and landscape information.

Contact Information: alison.nelson@agr.gc.ca

Project Report

2017 field studies were conducted to further evaluate the application of a radiometer-equipped UAV and in-situ soil moisture sensors to map changes in soil moisture levels and to use the information to assist in the development and implementation of prescription irrigation maps. Two producer fields and the CMCDC Offsite location were used to collect data throughout the growing season. Producer Field 1 was a non-irrigated field that was seeded to wheat. Producer Field 2 was under irrigated potato production. Four temporary soil moisture stations were installed on each field at pre-determined locations (Figure 1). Stevens hydraprobes were used to collect hourly soil moisture and temperature data at the 5, 15 and 30cm depth. A tipping bucket was installed on Field 1-1 to collect precipitation amounts during the growing season. The sensors were installed on June 8 and removed on August 15 (Field 1) and August 30 (Field 2). The following is a summary of field data that was collected at Field 1, the non-irrigated wheat field.

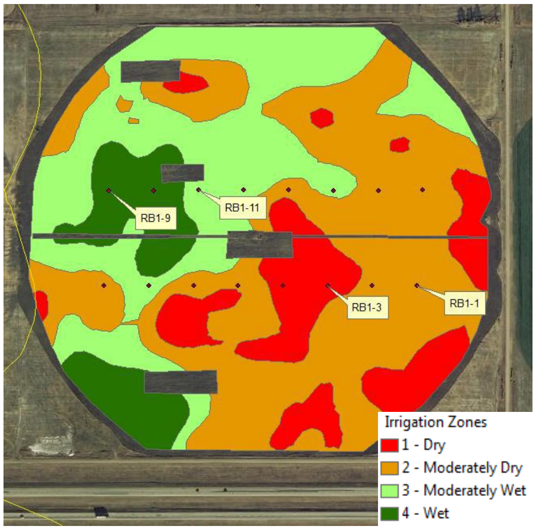

Figure 1. RB1 field located west of CMCDC-Carberry

Analysis of detailed soil survey data for the area shows soils at Field 1 to be a Fairlands (FND) series. These are well drained lacustrine soils with a SL-LS surface texture. Field Capacity (FC) is listed as 30% while Permanent Wilting Point (PWP) is 9%. Plant available water content (AWC) is 21%. The general target soil moisture level for irrigation is 70% of AWC. For this soil, 70% of AWC equates to 23.7% volumetric soil moisture.

Soils at this location are fairly uniform and elevation generally slopes east (high) to west (low). Using topographic and soil data, the farm's agronomic consultant provided a prescription irrigation map for this field. Temporary soil moisture stations were located in each of the 4 zones to monitor moisture levels during the season (Figure 1).

Analysis of the soil moisture data revealed no significant differences in soil moisture during the growing season. Precipitation amounts that were received from June – August totaled 140mm. This is only 64% of 30 year normal (220mm) for this area (Environment & Climate Change Canada). Soil moisture content was higher in the early part of the season, near field capacity of 30%. Given the similarities in soils and plant water loss, volumetric soil moisture levels at the 15 and 30cm depth dropped throughout the season to 10-15% at all 4 locations, staying just above PWP. Soil moisture levels at the 5cm level dropped steadily during the growing season to levels well below PWP.

Skaha Remote Sensing used a UAV to collect radiometer data 2 times during the growing season; May 31, June 1, 2 and July 14, 18. The radiometer measures the level of microwave emission emitted by the soil (top 10-15cm). Microwave emissivity is then correlated with soil moisture with dry soil having a higher emissivity than wet soils.

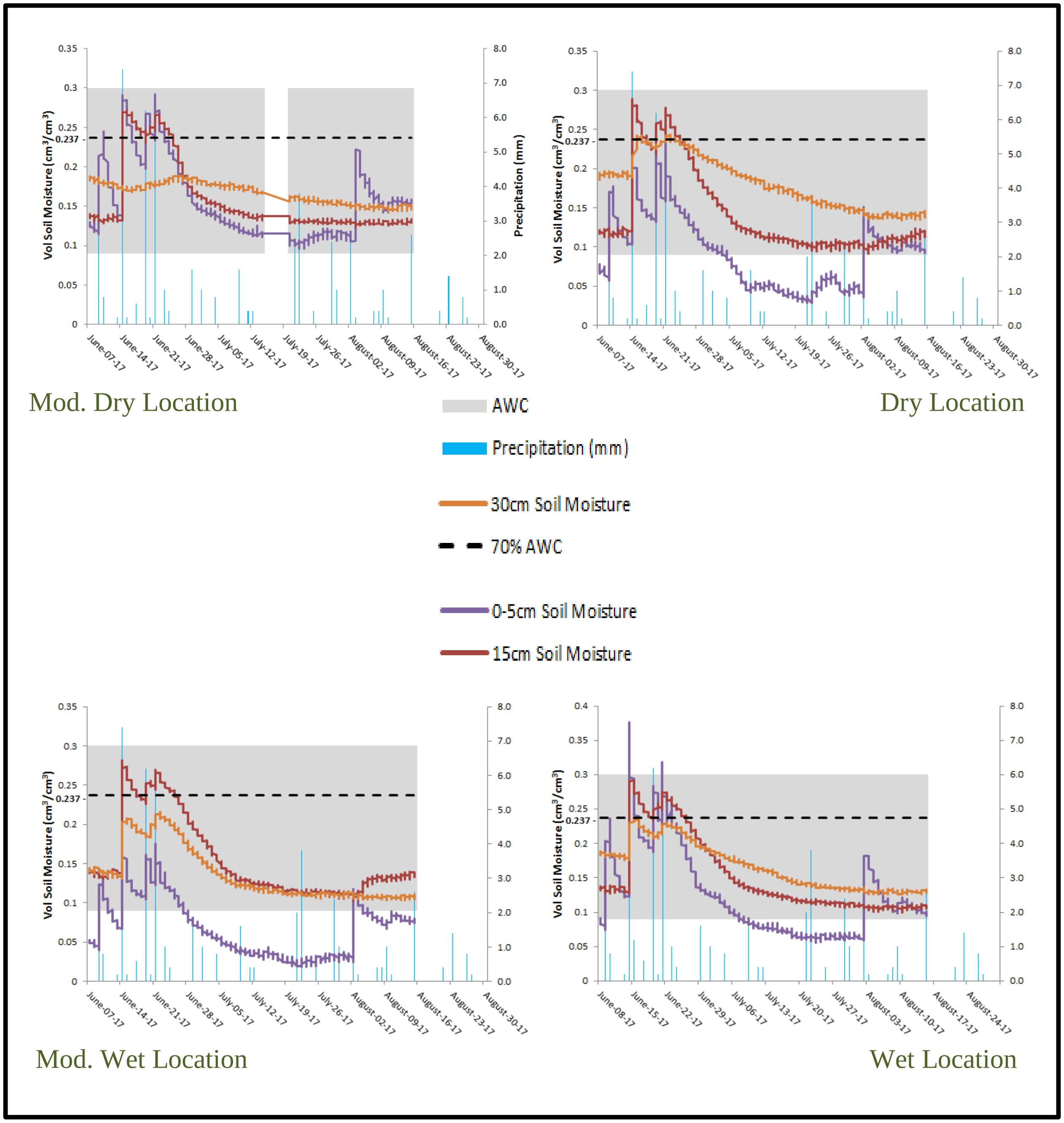

Figure 2. Field 1 soil moisture and precipitation June 8-Aug 15 at the four installed soil moisture stations. Each chart is data from a different location in the field.

Imagery from June 1 (Figure 3) shows generally dry surface soil conditions towards the eastern edge of the field (12-17%) and slightly wetter conditions on the lower sloped areas to the west. The imagery acquisition occurred prior to the installation of the temporary stations and precipitation that followed in mid-June. This increased soil moisture content at all stations and soil moisture readings approached the upper threshold of AWC. Imagery from the second collection on July 14 shows a clear dry trend across all areas of the field. Very little rain was received in the weeks before the July acquisitions. Surface soil moisture levels were mostly below PWP of 10% across the extent of the field. This is confirmed by data from the 4 stations which also recorded surface soil moisture readings below 10% at this time.

Overall, the radiometer did a good job of capturing the surface soil moisture values at both periods of the growing season. Visual comparison of the imagery that was collected on June 1 with the prescription map confirms the trend of drier zones in the eastern part of the field and wetter zones to the west. The trend is not as pronounced when comparing the July 14 imagery when conditions are extremely dry.

The collection of UAV radiometer soil moisture maps provides a good snapshot in time of the surface soil moisture condition and can assist in the development of irrigation maps based on soil and landscape factors. Monitoring of surface and root-zone soil moisture levels during the growing season provides valuable information on soil moisture fluctuations in relationship to soil water holding capacity. Knowledge of this information is essential in development of water scheduling for producers using variable rate irrigation technologies.

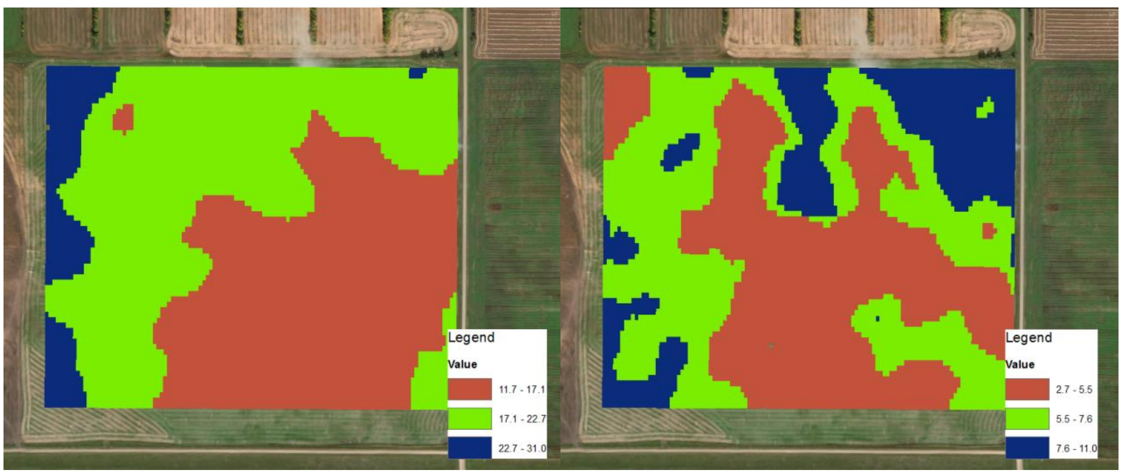

Figure 3. Radiometer surface soil moisture map at Field 1, June 1/2017 (left) and July 14/2017 (right)

Variable Rate Irrigation as a Technology to Improve Potato Yield and Quality

Principal Investigators:	Alison Nelson, AAFC – Carberry
Co-Investigators:	Bernie Zebarth, AAFC – Fredericton, NB
Support:	Agri-Innovation Program, AAFC MHPEC, Inc.
Progress:	Year 3 of 3
Objectives:	- Evaluate current VRI management techniques for their effectiveness in improving yield and quality of tubers across areas of soil moisture variability
Key 2017 Message:	- VRI systems can improve potato yield and quality, but weather conditions can greatly affect results. - Drier conditions during the growing decrease the effectiveness of VRI.
Contact Information:	alison.nelson@agr.gc.ca

Project Report

Two years of Variable Rate Irrigation (VRI) vs. Uniform Rate Irrigation (URI) study was completed by the end of 2017. Based on the topography, soil test and proximal sensor survey data, VRI prescription zone maps were developed at two test sites: one located at the CMCDC-Carberry research facility, and one located on a commercial field operating a VRI system. Prescription VRI maps for CMCDC-Carberry were developed by the project lead with consultation from an industry agronomist (Figure 1). The prescription map for the commercial field was developed by the farm agronomist (Figure 2). In both years, following the development of the prescription maps, replicated, paired comparison plots were identified within the study areas to test VRI management against Uniform Rate Irrigation (URI). The plots were located to capture yield and crop data across different irrigation management zones from the VRI prescription maps.

Continuous soil moisture monitoring was carried out in selected plots and zones at the study sites using Decagon field dataloggers and EC-5 and 5TM soil moisture sensors installed within potato rows at multiple depths. Tuber yield and quality and post-harvest soil sampling were carried out for site characterization.

Figure 1. VRI prescription map and paired VRI/URI plot locations for the CMCDC field. The VRI vs. URI plots for this study are the long narrow rectangles outlined in grey.

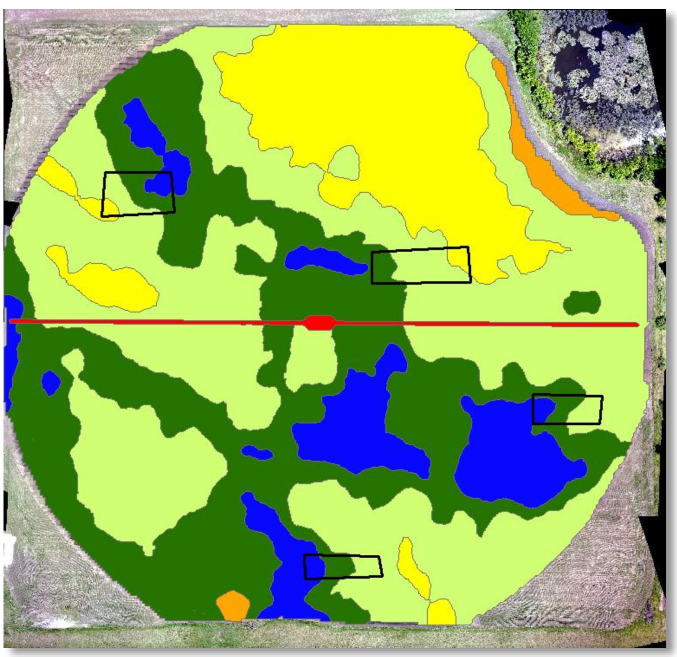

Figure 2. VRI prescription map and URI plot locations for the commercial field.

At the CMCDC-Carberry research site, there was no yield difference between the irrigation treatments in either year. However, VRI management did improve the quality profile of the yields. In 2016, the CMCDC-Carberry VRI plots had fewer total culls/tares than the URI plots (8.3 % vs. 16.6%), while in 2017, the VRI plots had 24 cwt/ac less yield in the <6 oz size category compared to the URI plots (Figure 4).

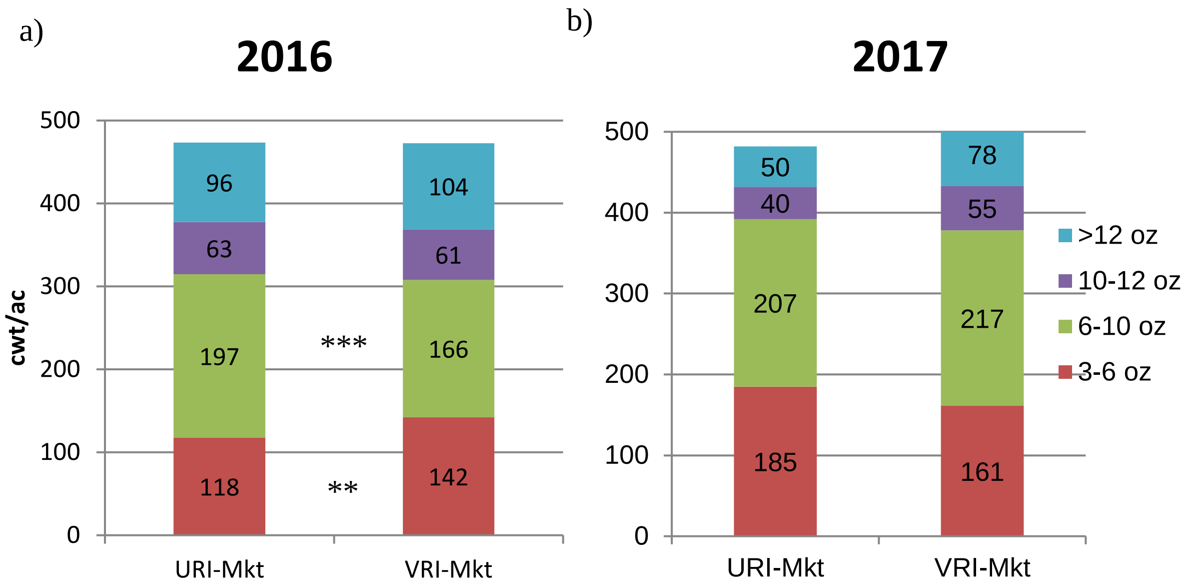

Figure 3. Comparison of CMCDC URI and VRI marketable yields and size profiles in a) 2016 and b) 2017.

In 2016, the commercial VRI field had 32 cwt/ac higher yields under VRI management, but no differences in culls or overall quality (Figure 4a). No differences were observed between the irrigation treatments in 2017 (Figure 4b). Low rainfall amounts in July and August 2017 meant very high crop irrigation water demands. Heavy irrigation water demand, combined with an early vine die-off in the commercial field may have contributed to the non-significant results in that field in 2017.

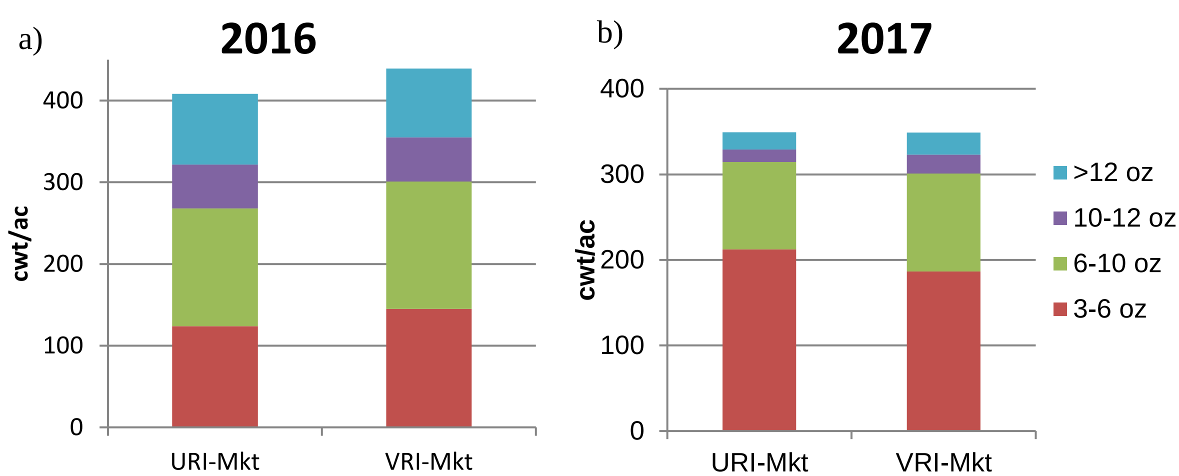

Figure 4. Comparison of commercial field URI and VRI marketable yields in a) 2016 and b) 2017.

It was hypothesized that VRI systems of water management would produce variable results, as each season and field have different weather conditions, abiotic and biotic stresses. The type and magnitude of the stresses can impact the effectiveness of a variable water management system. Results from this project indicate that VRI systems can improve potato yield or quality profile in some situations, but growing conditions may impact the effectiveness of the technology. Further study on production fields would assist in determining the level of variability on which return on investment could be expected.

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Heat Stress as a Limitation to Potato Yield

Principal Investigators:	Dr. Mario Tenuta, University of Manitoba – Winnipeg, MB Dr, Bernie Zebarth, AAFC – Fredericton, NB Dr. Helen Tai, AAFC – Fredericton, NB Dr. Alison Nelson, AAFC – Carberry
Scientific Support:	Agri-Innovation Program, AAFC MHPEC, Inc.
Progress:	Year 3 of 3
Objective:	- Assess effects of heat stress on potato productivity and quality - Develop gene expression indicators for heat stress in "warmed" and "ambient" plots
Key 2017 Message:	- Heat stress did not have a significant impact on yield or quality. - The 40% plant available water treatment significantly lowered yield.
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Project Report

A randomized complete block design, with four blocks was planted in 2017 to test the impact of heat stress and its interaction with water stress on Russet Burbank potatoes at CMCDC-Carberry. A split-plot arrangement for the treatments was used, with three soil moisture levels as the main-plot treatment (irrigation to maintain soil moisture at 80, 60 and 40% plant available water), and heat stress as the sub-plot treatment (heat chamber or ambient temperature). Water stress levels were maintained throughout the field season with overhead irrigation, and Watermark sensors installed in all plots were used to make irrigation decisions. Rectangular heat chambers (Figure 1) were installed and removed in sub-plots at various points in the growing season to test intermittent heat stress on potato yield and quality and gene expression at pre-selected time periods. The goal was to raise ambient temperatures by a few degrees Celsius for approximately 24 hours at a time. Canopy temperatures were monitored while the chambers were in place with infrared thermometers. The chambers were installed for approximately 24 hours, removed, and leaf disc samples collected immediately after removal for gene expression analysis using transcriptome sequencing.

Analysis of yield and quality factors has begun on the 2017 data. Initial analysis indicates that the 40% plant available water treatment significantly lowered yields (485 cwt/ac) compared to the 60 and 80% water treatments (539 and 524 cwt/ac, respectively). Water and heat treatments did not significantly impact specific gravity, tuber size profile, or fry colors. Previous work at CMCDC-Carberry has shown that patterns in fry quality impact of in-season water stress can develop over time in storage. In this study, fry colors were determined immediately after harvest. Harvest sample areas in this study were not large enough to store and fry test tubers at later time periods. We did not observe significant impacts ($P<0.05$) of the heat stress treatments, or the interaction of water and heat stress on the measured yield or quality values. Gene expression leaf disc samples are in the laboratory for analysis.

Figure 1. Rectangular heat chamber **–** built to span three potato rows and installed and removed multiple times in season.

Testing the Use of a Proximal Sensor for Measuring Soil Moisture Changes In-Season

Principal Investigators: Dr. Alison Nelson, AAFC – Carberry
John Fitzmaurice, AAFC - Winnipeg

Scientific Support: AAFC

Progress: Year 2 of 3

Objective: - Test the concept and field logistics of using an Em38 sensor for measuring in-season soil moisture changes over time.

Key 2017 Message: - A prototype design to pull an Em38 sensor through potato plots was tested in 2016, and modified in 2017
- Final data analysis on the feasibility of using an Em38 to test soil moisture levels in-crop will occur at the end of year 3.

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Project Report

Using already established water stress/heat stress trial plots in 2016 and 2017, a secondary study tested the concept of using an Em38 sensor to measure in-season changes in soil moisture. We are testing to see if an individual on a quad scouting a production-scale potato field could pull an Em38 sensor through an adjacent potato furrow to collect soil moisture data at the time of scouting. The Em38 is pulled across the soil surface, or slightly above the soil surface, causing little soil disturbance. The sensor has the potential to rapidly collect long transects of soil moisture data to depths of interest.

The plots used for this project were at the CMCDC-Carberry offsite location. The studies had a randomized complete block design, testing three different moisture regime treatments. The three moisture treatments of 40, 60 and 80 % plant available soil water were created using the lateral irrigation system and regular Watermark readings to maintain target soil moisture levels.

Soil testing has taken place to characterize the soil's properties at the study locations. EM-38 sensor readings were collected in each plot every two weeks during the growing season. After planting, locally calibrated Decagon soil moisture sensors (measuring dielectric constant) were installed in each plot to continuously monitor the soil moisture levels at three soil depths. The Decagon soil moisture data and EM-38 data from all years will be analyzed following the completion of the 3-year study to test the hypothesis that EM-38 readings in season can be used to measure soil moisture variability.

Figure 1. The Em38 in a cradle, offset from the ATV, with a GPS receiver mounted above it, to be pulled through the furrow between two potato rows. The cradle rides on the surface of the soil.

Potato Cropping Sequence

Principal Investigators: Dr. Jazeem Wahab, AAFC – Saskatoon, SK
Dr. Reynald Lemke, AAFC – Saskatoon, SK
Dr. Alison Nelson, AAFC – Carberry

Scientific Support: AAFC

Progress: Year 2 of 3

Objective:
- Evaluate the effects of previous crop residue and nitrogen fertilizer on soil properties and the growth and quality of potatoes.
- Evaluate the agronomic and economic efficiencies and environmental impact of nitrogen

Key 2017 Message:
- Crop residue type did not have a significant effect on potato yield or quality.
- Nitrogen rate significantly affected yield, specific gravity and tuber size.

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Project Report

Nitrogen (N) is one of the most limiting nutrients for potato and both previous crop and fertilizer rate have an effect on total soil nitrogen availability. Crop residues with a high carbon to nitrogen ratio can immobilize nitrogen when incorporated, making it unavailable to the next crop. Conversely, crop residues with a low carbon to nitrogen ratio can release nitrogen into the soil.

Potatoes were grown at CMCDC-Carberry under irrigation on a sandy loam with preceding crops of either wheat, canola or fababeans. Plots were fertilized with 0 (check), 75, 125 or 225 kg N ha^{-1}. Potato plant growth was measured using leaf area index and vine, root and tuber biomass sampling. After harvest, total and marketable yields were calculated. Tuber quality parameters measured included amount of defects, specific gravity, sugar ends and dark ends.

Crop residue type and the interaction between residue and N rate had no significant effect on any of the measured parameters. N rate had a significant effect on yield (P=0.005), with the 0 N treatment lower than the 75 and 150 kg N ha^{-1} treatments (488 vs 528 and 542 cwt ac^{-1}) (Figure 1). Specific gravity was also significantly affected by N rate (P=<0.001), with 150 kg N ha-1 having the lowest specific gravity (1.093) and 0 N having the highest (1.104) (Figure 2). N rate also had a significant effect on tuber size proportion in both the 3-6 oz (P=0.0013), 6-10 oz (P=0.0003) and 10-12 oz (P=0.0306) categories. The 0 N treatment had a significantly greater proportion of 3-6 oz tubers and a significantly smaller proportion of 6-10 oz tubers and 10-12 oz tubers (Figure 3).

N rate also had a significant effect on leaf area index, shoot and root biomass and number of dark ends. N rate did not have a significant effect on total number of defects, number of sugar ends or fry colour.

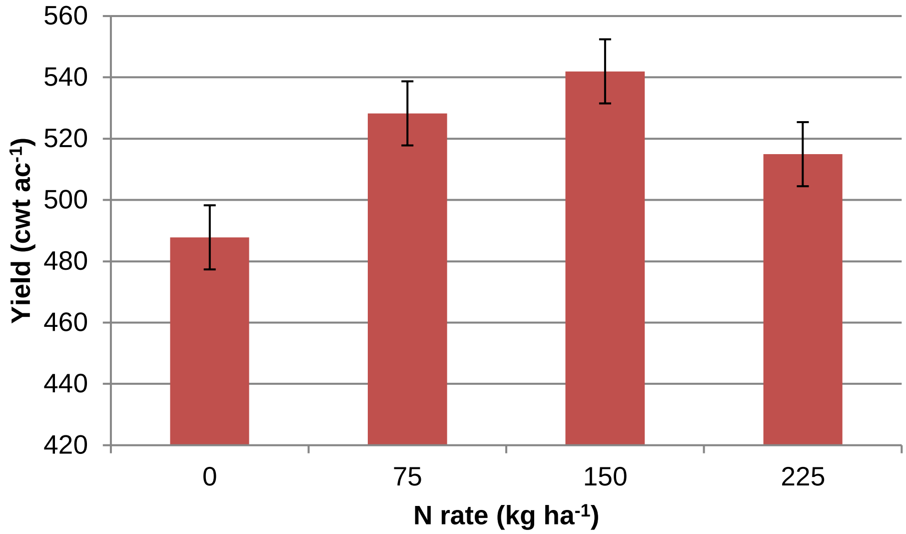

Figure 1. Effect of nitrogen rate on potato yield.

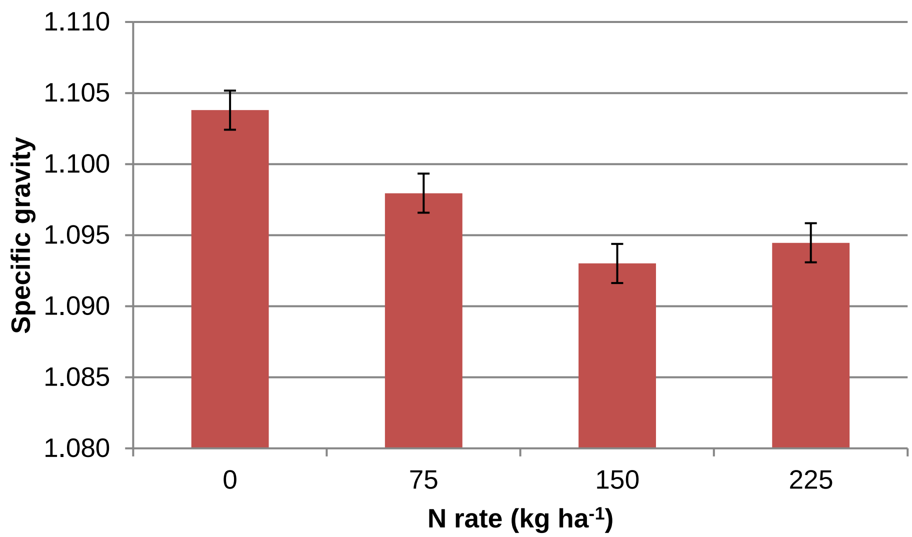

Figure 2. Effect of nitrogen rate on specific gravity.

At this site, previous crop did not impact the N dynamics affecting potato yield and quality. Highest yield and most optimal quality profiles were achieved with the 150 kg N ha^{-1} rate. Analysis of nitrous oxide emissions from this trial is ongoing. In 2018, all plots will be seeded to wheat. Plots will either be fertilized with a standard nitrogen recommendation for wheat or without any nitrogen. Greenhouse gas sampling will continue, along with measurements of plant tissue N and wheat yield and quality.

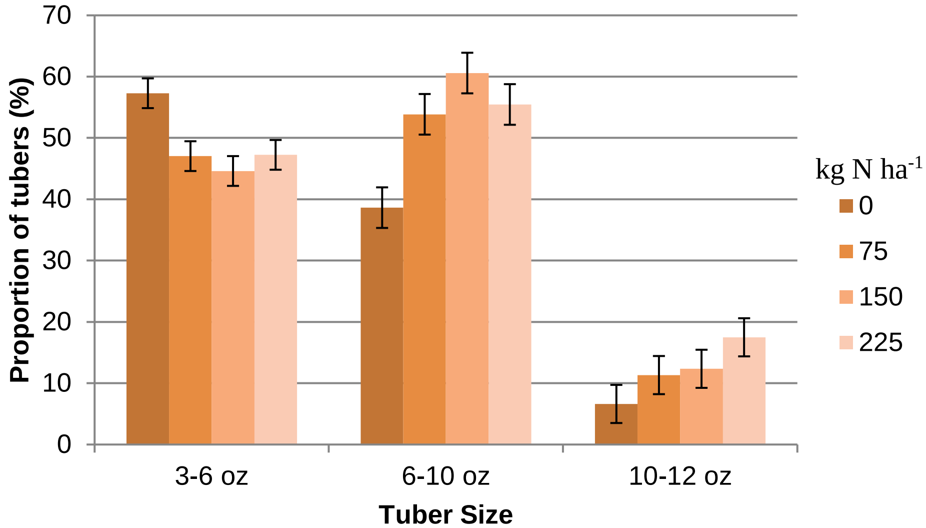

Figure 3. Effect of nitrogen rate on tuber size.

Potato *Verticillium dahliae* and Potato Early Dying Control Project

Principal Investigators: Darin Gibson, Gaia Consulting - Winnipeg
Dr. Alison Nelson, AAFC – Carberry
Manitoba Potato Research Committee
Dr. Mario Tenuta, University of Manitoba - Winnipeg

Scientific Support: CMCDC

Progress: Year 4 of 4

Objective: - Quantify impact of soil levels and remediation techniques on a native soil population of *Verticillium dahliae*

Key 2017 Message: - Fumigation and compost treatments were compared with a (no treatment) control of Potato Early Dying and *Verticillium dahlia.*
- In this non-replicated demonstration, the average potato yield from the fumigation strip was higher than the compost or control treatments, but was not statistically significant.
- Soil *V. dahliae* quantification is underway, and results will be shared when data analysis is complete.

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Project Report

This project, carried out at Winkler, was designed to help quantify the impact of two separate remediation techniques (compost and fumigation) on a native soil population of *V. dahliae*, the incidence of Potato Early Dying and tuber yield.

In 2014, an approximate 1-acre plot of potatoes was grown to establish the baseline levels of *V. dahliae* in the soil and observe the expression of potato early dying in the plot. The research plot area was selected to encroach into a saline zone, so observations could be made on the interaction of salinity and V. dahlia levels. In 2015 and 2016, rotational crops of canola and wheat (respectively) were grown, with fall compost and fumigation treatments applied. The study area was split into three, non-replicated demonstration strips:

- One strip received two fall applications of compost (one application in 2015 and a second application in 2016)
- One strip received a 2016 fall fumigation application of Metam Sodium
- One strip remained untreated

In 2017, the study area was planted to potatoes to test the impact of mitigation practices. Soil samples collected in spring and fall to measure *V. dahliae* levels. Yield samples were collected, and yield and quality was compared across treatments. As the demonstration plots were not replicated, results should be interpreted with caution. Average fumigation yields in the demonstration area were higher than the compost and control treatments, but t-tests comparing the fumigation yields to the control and compost did not indicate that differences were statistically significant. Tuber size profiles, defects and fry quality were similar across the various treatments.

The laboratory results of the soil *V. dahliae* levels will be compared following completion of the analysis. Soil levels of *V. dahliae* from 2014 will be compared with soil levels in 2017 under fumigation, compost and control treatments.

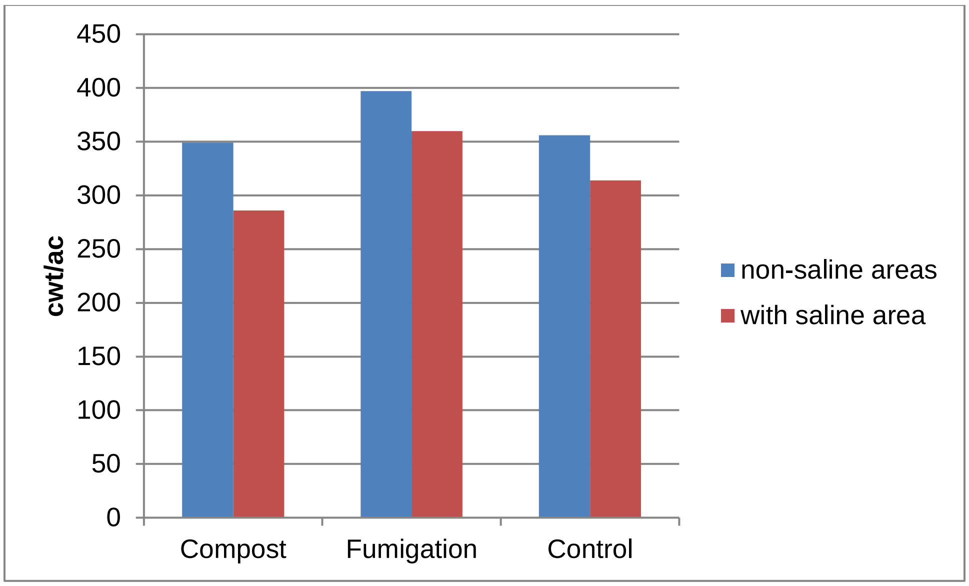

Figure 1. Average tuber yields by treatment. Blue bars do not include yields collected in saline area. Red bars are average yields, including saline area yields.