CMCDC

2015 POTATO PROJECTS REPORT

Canada

MHPEC Inc.

Manitoba

Contents

2015 Field Season Review

The 2015 season was very busy at CMCDC-Carberry, with positive interest for collaborative research and demonstration at the site. With a long-term lease at the "Carberry Offsite" field, we have established a 3-year rotation plan of research-wheat-canola, to achieve three small fields on the lot approximately 11 acres each in size. The Carberry Offsite was fully allocated to potato research in 2015. The research field at Carberry Main Site was also full, with both Diversification and Potato/Environment projects present.

The weather, for the most part, cooperated in Carberry. Potato research projects were successfully executed in the field, with a fairly long growing season. As with every season, a few surprises came along: a storm in the Carberry region July 12th brought high winds, a lot of water, and some hail; as well, the appearance of European Corn Borer through the plots and fields in the area was unexpected. However, the 2015 AAFC trials at Carberry should show strong results for nutrient modelling work and nutrient stress gene expression testing happening at AAFC labs in Quebec and New Brunswick, as confounding factors in the field were kept to a minimum.

I served as the interim project lead for the MHPEC II GF2 Potato Field Variability Project throughout the 2015 field season while the Manitoba Potato Research Committee conducted a search for an Applied Potato Agronomist. Field selection, project protocols, budget planning and procurement were undertaken in the spring to mid-summer. We were able to get data collected, and start the research activities for this project with the generous help of the Manitoba Potato Research Committee, a number of contractors, and the CMCDC staff and summer students. It was a great testament to the close-knit community in Manitoba that we were able to successfully achieve the field activities under the challenge presented. With Oscar Molina in place as the Potato Agronomist, he is now leading the Field Variability Project.

2015 marked the final season for two AAFC-funded projects aimed at modelling Nitrogen release in irrigated potato production (Page 21) and gene expression testing of nutrient stressed potatoes (Page 23). These studies were designed, in part, to help us fill in gaps regarding nitrogen release and use in potatoes under a number of different environments and management systems. These projects are also testing a new laboratory method (gene expression testing) to determine potato plant health in-crop. Gene expression testing is an exciting concept that has been under development at the AAFC Fredericton Research and Development Centre. Previous research demonstrated this concept successfully in other crops such as corn. To do this more basic, detailed research, we need large, collaborative projects with AAFC potato researchers at a national scale – where the protocol and sampling plans are consistent across the country. CMCDC has been pleased to partner with leading researchers from AAFC Fredericton and other sites to ensure that Manitoba irrigated potato production is represented in national research efforts and results. Plant, soil and leaf disc sampling occurred at regular intervals throughout the season in these trials; requiring sample preparation before shipment to collaborating laboratories.

A number of MHPEC-led potato projects were in the field this summer. A study looking at Water Use/Stress in Russet Burbank potatoes (Page 11) on the light-textured soil was completed jointly with Gaia Consulting at Carberry. All field sampling and treatment application were completed by CMCDC; plot maintenance, harvest and grading activities were completed by Gaia. The Winkler Verticillium project (Page 17) was extended from a 3-year to a 4-year project to ensure field treatments aligned with emerging research results from the University of Manitoba. Results from previous work indicate that compost requires time and medium to high application rates to potentially impact V. dahliae populations. Gaia Consulting was hired to complete the field work for this project. Canola was cropped over the Verticillium study area, and a strip of compost applied to one treatment area in fall 2015. A Seed Physiological Age Trial (Page 19) was started in 2015 with seed treatment plots at Carberry Main Site. Seed from the 2015 season is being stored at the University of Manitoba Horticulture Storage Facility, to be grown out in test plots in 2016. The VRI demonstration project (Page 15) had a VRI demonstration day August 11th, with participants from AAFC; MAFRD; MHPEC; University of Manitoba; consulting companies; equipment manufacturers and suppliers; and from the community – around 60 people attended the half day event.

Approval of a national AAFC Agri-Innovation Project P342 "Securing Export Markets for Potato Processors by Mitigating Limitations to On-Farm Yield" was announced late in the season. This project has activities in Manitoba related to Variable Rate Irrigation, Verticillium management and heat stress. The project involves large amounts of coordination with the University of Manitoba, CMCDC and AAFC researchers, with Dr. Mario Tenuta as a key participant in some of the activities in Manitoba. Work with VRI (Page 24) includes: exploring new field mapping technologies for their applicability for creating a VRI prescription, as well as testing the performance of VRI vs. uniform irrigation across an area of variability. The Verticillium sub-project involves fumigation treatments applied in replicated strips to production fields, and tracking the impact of the fumigation on the Verticillium population, as well as the disease incidence in potatoes following application. Gene expression testing and tracking the impact of fumigation on the entire soil microbial community over time for disease stressed plants will occur in one chosen study field as well. Fumigation treatments were applied in the fall 2015. A final sub-project in Manitoba is looking at the impact of heat stress on potato yield and quality is planned to start in 2016, with a graduate student running the project at CMCDC-Carberry Offsite, with support from CMCDC staff for field plot execution and sampling. As we anticipate having to contend with more extreme weather events going into the future, this trial is aimed at understanding the impact of periods of heat stress on potato growth, yield and quality.

We are looking forward to another full growing season, with many new and ongoing potato and environment research projects slated for 2016.

Alison Nelson, Agronomist, CMCDC

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 this includes three full-time and two seasonal staff positions, summer students, support for operating costs, infrastructure support and services.

Manitoba's commitment is through Manitoba Agriculture, Food and Rural Development (MAFRD), which provides one staff position, one staff-equivalent in part-time support from other MAFRI 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 MAFRI's Carberry Growing Opportunities Center and Manitoba Conservation and Water Stewardship 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 the compilation of an Annual Report released in early spring and a series of 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 2015

1. Long-term Phosphorus Demonstration
2. Gluten Strength Wheat Trial
3. Western Forage Trials (est. multiple years)
4. Soybean Inoculant Trial
5. Soybean Moisture Variety Trial
6. Potato Nitrogen Optimization/Modelling Trial
7. Potato Gene Expression Indicators Trial
8. Secan Demonstration
9. Potato Seed Physiological Age Trial
10. Potato Extra Test Plot
11. Gaia Potato Variety Trial
12. High Yield Wheat and Protein Trial
13. Plant Growth Regulators on Wheat and MCVET Fall Rye Trial
14. Energy-Dense Annual Forage Evaluation and MCVET Winter Wheat Trial
15. Winter Wheat High Yield Trial
16. Soybean Crop Residue Trial
17. Soybean Trial
18. Soybean Seeding Date Trial
19. Secan Soybean Demonstration
20. Soybean Variety Trial
21. MCVET Buckwheat Trial
22. Hemp Variety Trial
23. Corn Variety Nursery
24. Corn Yield Trial
25. Forage Barley Trial
26. Forage Barley Trial
27. Field Efficiency/Runoff Monitoring Trial
28. Gaia Potato Trial
29. Cereal Breeding Disease Nursery

CMCDC Carberry Offsite 2015 – Potato Trials

1. Water Use Efficiency Trial
2. Gaia Creamer Trials
3. Gaia Yara Fertility Trial
4. Gaia Gowan Early Blight Trial
5. Gaia UofM Nitrogen Management Trial
6. Gene Expression Indicators Trial
7. Extra Test Plot
8. Gaia Stoller Trial
9. Nitrogen Optimization/Modelling Trial
10. Gaia UPI Early Blight Trial
11. Gaia Bayer Trial
12. Gaia Arysta Early Blight Trial
13. Gaia Dow Re-Cropping Trial

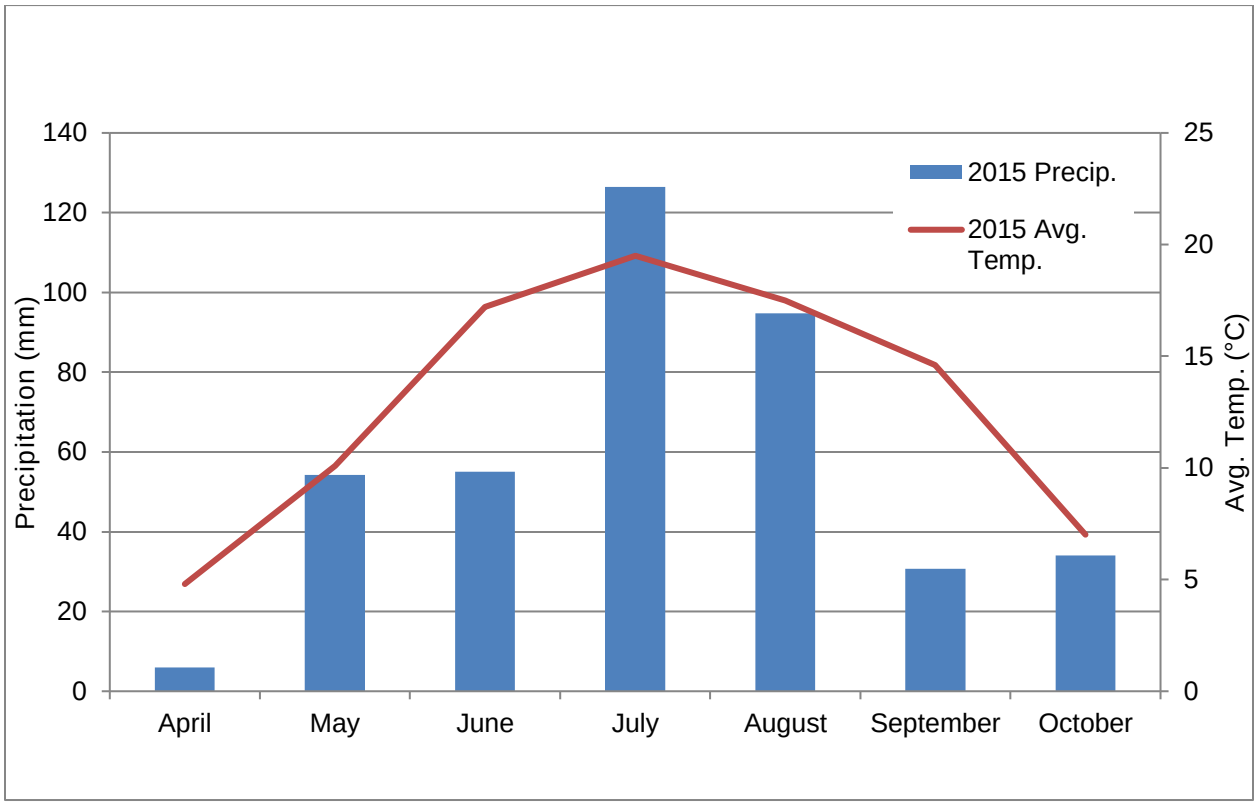

Figure 1. 2015 growing season precipitation and monthly temperatures at CMCDC-Carberry.

Staff at CMCDC Carberry 2015

Full time staff	Supporting CMCDC Partner	Position
Brian Baron	AAFC	Site Supervisor
Craig Linde	MAFRD	Diversification Specialist
Alison Nelson	AAFC	Agronomist (Winnipeg)
Sherree Strain	AAFC	Office Administrator
Seasonal/Term staff		
Eric Claeys	AAFC	Field Operations Assistant
Dave Paluch	*AAFC*	*Field Operations Assistant* *Retired June 2015*
Amanda Kowalchuk	MHPEC	Potato Research Technician
Summer students/Casual staff		
Laura Ferguson	AAFC	Summer Research Assistant
Victoria Jackson	AAFC	Summer Research Assistant
Colby Robertson	AAFC	Summer Research Assistant
Nathan Henderson	AAFC	Summer Research Assistant
Mackenzie Shamanski	MHPEC	Summer Research Assistant
Darcy Manns	MHPEC/MAFRD	Summer Research Assistant
Beverly Mitchell	MHPEC	Summer Research Assistant

Figure 1. Some of our hard-working summer crew – (back row, from left: Laura Ferguson, Victoria Jackson, Mackenzie Shamanski, Darcy Manns; in front: Colby Robertson)

Water Use Efficiency of Russet Burbank Potatoes on a Light Textured Soil

Principal Investigators: Alison Nelson, AAFC – Carberry
Darin Gibson, Gaia Consulting Ltd. - Winnipeg
Manitoba Potato Research Committee

Support: CMCDC

Progress: Year 2 of 3

Objective: - Identify water requirements for high yield and quality processing potatoes on a light-textured soil

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

2015 Project Report

This study is a joint project with Gaia Consulting, carried out at the CMCDC-Carberry offsite field. The study is designed to compare increasing levels of irrigation application on the yield and quality of Russet Burbank potatoes grown on a light-textured soil. Results will demonstrate the water requirements for high yield and quality processing potatoes on light-textured soil typical of the conditions found on the majority of Manitoba's processing potato acres. Treatments included watering potatoes to 80%, 60% and 40% plant available water.

Treatments included watering potatoes to 80%, 60% and 40% plant available water. To make irrigation decisions, trigger points for Watermark soil moisture sensors were determined at the start of the project for each of the three water treatments. Each plot had Watermark sensors installed at 12" and 24" depths, and average readings across all plots of the same treatment were used to make irrigation decisions. Other soil sensors were installed in plots to continuously measure volumetric water content. Every two weeks following 50% crop emergence, leaf area index, crop biomass and rooting depth was determined to evaluate in-season crop growth. Two rows of each plot were harvested for tuber yield and quality determination according to processing contracts.

The site chosen for the 2015 growing season had a uniform texture in the top 30cm (sandy loam with 78% sand, 14% silt and 8% clay) between the blocks.

Figure 1. 2015 Water use plots. Large set-backs are required between plots to ensure that water treatments are applied to each treatment accurately. Areas of missing plants are from in-season destructive sampling.

The number and amount of final water applications varied between the three treatments by the end of the 2015 growing season.

- 40PAW: 11 apps for a total of 6” of water applied
- 60PAW: 21 apps for a total of 12” of water applied
- 80PAW: 30 apps for a total of 17” of water applied

On the sandy loam texture at the study site, a minimum of 6” of supplemental water was required to maintain the lowest treatment level of soil moisture through the growing season in 2015.

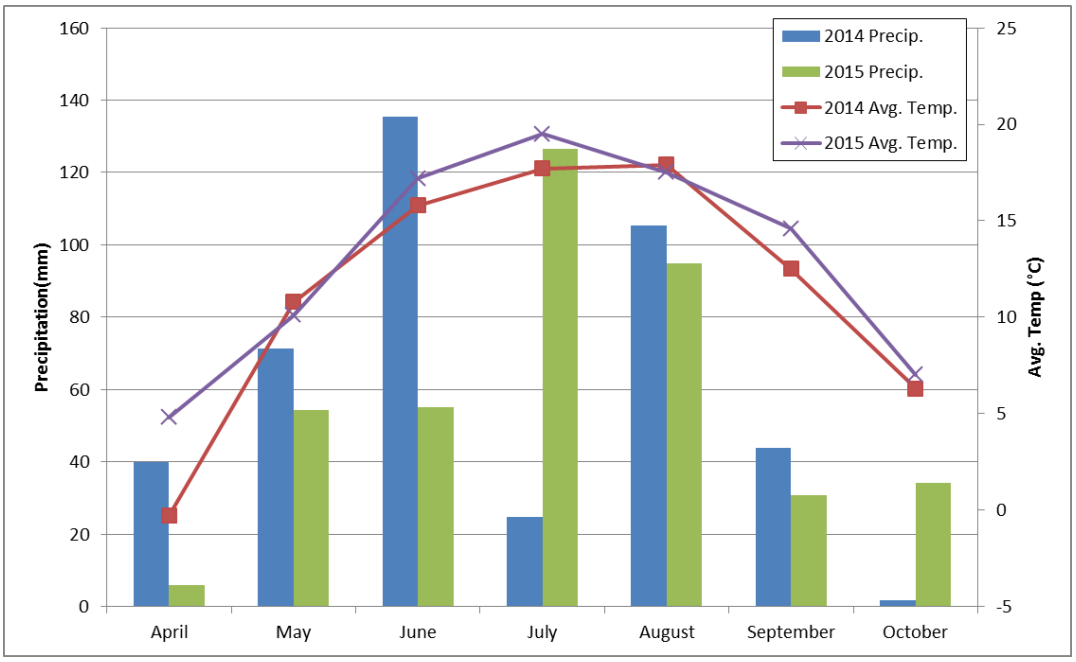

Figure 2. Monthly weather data for 2014 and 2015 growing seasons.

Irrigation treatment differences were apparent through crop growth measurements. Figure 3 shows that the leaf area index was higher in the higher soil moisture treatments. The dashed lines represent the averaged LAI by date (solid lines are raw values).

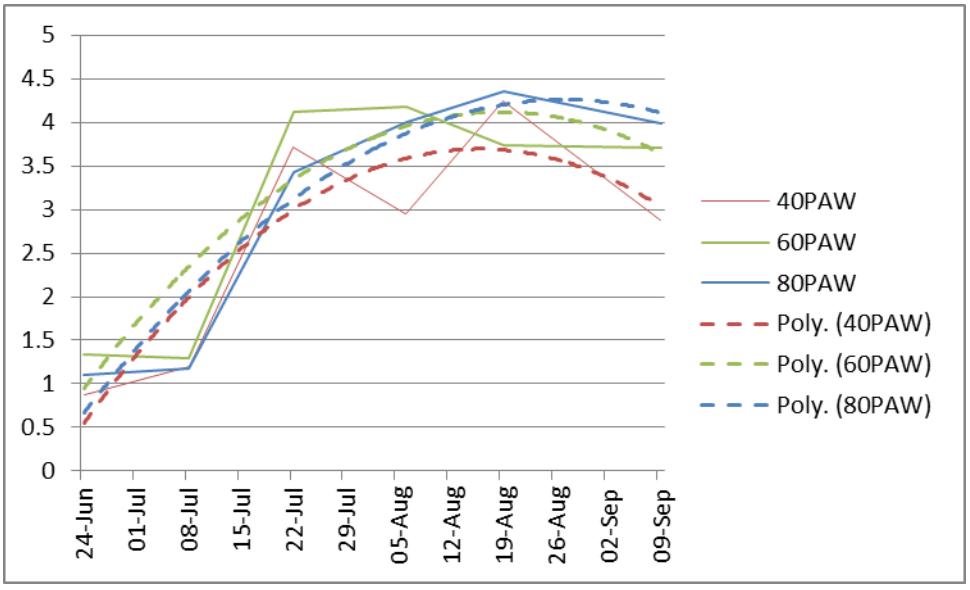

Figure 3. Leaf Area Index values for treatments over the growing season.

Yield and tuber quality were assessed in both years of the study. No significant differences in total yield or quality were observed in 2015 (Table 1 & 2). However, a pattern (P=0.1 at 3 month fry test) towards increased incidence of sugar ends as soil moisture levels decreased

was observed. In 2014, the 6 month fry test showed a significant (P<0.05) increase in sugar ends in the 40PAW treatment.

Table 1. Tuber yield and size profile for water treatments in 2015.

	Yield (cwt/ac)					
Treatment	< 3	3-6 oz	6-10 oz	10-12oz	> 12 oz	Total
1 80 % ASW	10.8 a	85.4 a	160.1 a	63.4 a	171.7 a	491.2 a
2 60 % ASW	21.2 a	122.0 a	197.5 a	54.2 a	84.9 a	479.8 a
3 40 % ASW	14.7 a	108.5 a	173.2 a	48.2 a	145.9 a	490.5 a
LSD P=.05	ns	ns	ns	ns	ns	ns
CV	49.1	28.7	21.1	25.6	34.3	5.1
Treatment Prob(F)	0.3391	0.4086	0.5181	0.4828	0.1726	0.828

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2. Fry color and sugar ends for water treatments in 2015.

	Mean Fry Colour			Sugar End %		
Treatment	1 Month	3 Month	6 Month	1 Month	3 Month	6 Month
1 80 % ASW	0.50 a	0.07 b	0.10 ab	26.7 a	26.7 a	36.7
2 60 % ASW	0.37 a	0.20 a	0.17 a	40.0 a	30.0 a	53.3
3 40 % ASW	0.33 a	0.13 ab	0.03 b	46.7 a	46.7 a	65.9
LSD P=.05	ns	0.09	0.09	ns	ns	ns
CV	20.4	30.6	40.8	23.3	25.6	24.4
Treatment Prob(F)	0.1322	0.0400	0.0400	0.1111	0.0968	0.1106

Variable Rate Irrigation CMCDC Project

Principal Investigators: Alison Nelson, AAFC – Carberry
Manitoba Potato Research Committee

Support: CMCDC

Progress: Year 2 of 3

Objective: - Demonstrate different methods of mapping field variability
- Upgrade CMCDC Offsite research later to VRI technology

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

2015 Project Report

This project was designed to "ground truth" a mitigation strategy for soil moisture variability within processing potato fields. The CMCDC-Carberry Offsite field has been established as a testing and demonstration site for Variable Rate Irrigation (VRI) technology.

In 2015, the lateral move irrigation system at Carberry Offsite was retrofitted with a Trimble VRI system. Activities undertaken to acquire and set up a VRI system included: researching various suppliers and systems, purchasing the system, installation and testing the system through the summer. The majority of the field equipment installation happened mid-June, and by early July, we were able to use the VRI system to apply differential water rates and treatments to research plots. Within the first season, the VRI system significantly improved our operational efficiency when irrigating potato trials.

Figure 1. Lateral move irrigator with upgrade to Variable Rate Technology.

Similar to previous years, field variability information was collected on the site. Multiple surveys and imagery have been taken over the two years of the project to gather best practices for various mapping technologies. For soil remote-sensing technologies of soil apparent electrical conductivity (e.g. Veris, EM-38), it is important to ensure that the field has been managed evenly across the entire mapping area prior to the survey being completed, that soil conditions at the time of the survey are noted, and Veris mapped zones are sampled for laboratory testing of soil properties within zones.

Drone images were taken on the entire field at two points in the growing season – spring bare soil and at full crop growth. An image taken of bare soil can show areas of standing water, which may be caused by a number of underlying factors (topography, soil texture, soil profile, etc.), it can also be used to generate a topographic plan, depending on the technology used to capture the image. Even light conditions across the duration of a drone flight ensure that the image quality and lighting is consistent, which will in turn produce images whose variability is indicative of the field variability.

A field demonstration of the VRI system was held at the CMCDC Offsite Field in early August, with experts and representatives from various sectors of the irrigation community speaking about their experiences and knowledge of VRI systems. About 60 people attended the half-day event. As VRI continues to be an area of interest for the local community, CMCDC will continue to build upon our activities around this new system of water management and share our learnings with the community.

Complementary research project proposals have been approved through other funding streams to build on this project, investigate the impact of VRI technology on tuber yield and quality, as well as test novel methods to map and measure soil moisture variability.

Figure 2. Screenshot of Trimble Connected Farm Irrigate-IQ™ system used for control and monitoring of the CMCDC VRI system.

Potato Verticillium dahliae and Potato Early Dying Control Project

Principal Investigators: Alison Nelson, AAFC – Carberry
Manitoba Potato Research Committee
Mario Tenuta, University of Manitoba - Winnipeg

Support: CMCDC

Progress: Year 2 of 4

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

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

2015 Project Report

A project at CMCDC-Winkler was designed to help quantify the impact of specific remediation techniques on a native soil population of *V. dahliae,* the incidence of PED and tuber yield. This demonstration is designed to complement and inform the larger provincial field variability project investigating production-scale site-specific remediation techniques for Potato Early Dying (PED) complex.

In 2014, an approximate 1-acre plot of potatoes was grown to establish the baseline levels of Vert. in the soil, and observe the expression of potato early dying in the plot. The research plot area was selected to encroach into a known zone of soil salinity so observations could be made on the interaction of salinity and Vert. levels.

In 2015, the entire study area was planted to canola, and managed as a rotational crop. Emerging evidence from the University of Manitoba indicates that for effectiveness, compost should have a moderate to high total application rate, and a period of time to potentially affect Verticillium populations in the soil. With this information, the project design was altered to include two consecutive fall applications of compost prior to re-cropping to potatoes, to get a moderate rate of compost application on over two years, and to allow time for the compost to impact the soil microbial population. The 2014 plot of potatoes was split into three treatment strips: one strip receiving two fall applications of compost (in 2015 and 2016), one strip receiving a 2016 fumigation application of metam sodium, and a third control strip receiving no mitigation treatment for Verticillium. The entire trial area will be planted to potatoes in 2017, and the impact of the mitigation treatments on Vert. levels, potato early dying incidence and crop yield will be compared with each other, and with a control strip where no mitigation treatment was applied.

Seed Physiological Age of Russet Burbank Potatoes

Principal Investigators: Alison Nelson, AAFC – Carberry
Manitoba Potato Research Committee

Support: CMCDC

Progress: Year 1 of 3

Objectives:
- Determine the impact of seeding date, harvest date and soil moisture regime of a potato seed crop on physiological seed age and subsequent field performance of the seed for cv. Russet Burbank
- Determine the impact of two seed potato storage regimes on subsequent field crop performance for cv. Russet Burbank
- Establish base seed performance values and physiological measures for future seed physiological age studies in Manitoba

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

2015 Project Report

Growing and storage conditions of a potato seed crop are known to affect the physiological age of, and the performance of the potato 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.

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

Early and late planting dates
Early and late termination and harvest dates
Irrigated and dryland production
Constant and ramp-up storage temperature regimes

A total of 16 seed crop treatments were obtained (Table 1). The interaction of all possible seed crop treatment combinations on subsequent crop performance will be tested in a randomized complete block design trial, slated for CMCDC-Carberry Offsite in 2016. A second season of seed crop treatments will be grown in 2016, with test plots in 2017.

The planting dates were April 30th and May 15th for the early and late planting treatments, respectively. Dates for stand termination in the early and late harvest treatments were August 13th and 27th, respectively. The tubers were dug 19 days following halum killing in both cases when field conditions were suitable for harvest.

Table 1. Treatment listing for the potato seed physiological age trial (planting date, harvest date, moisture regime, and storage temperature regime.

Treatment	Planting	Harvest	Moisture	Storage
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

The major objective of the project is to see how the seed from the 2015 plots performs when planted out in the following year. Because the plots were not replicated in 2015, we must interpret the data from this initial study year with caution. However, the data did show some expected trends in the impact of the field treatments on the seed crop yield and profile. The E3 seed plots that were planted early and harvested late had higher tuber yields and a larger tuber size profile of tubers.

Emergence dates were impacted by planting date. Ground crack in the early planted plots was observed 27 days after planting (DAP) (May 27), versus 19 DAP (June 3) in the late planted plots. Over 90% emergence in the early versus late planted plots was at 39 DAP (June 8) and 35 DAP (June 19), respectively. Soil temperatures in the dryland versus irrigated plots were not different throughout the growing season.

Nitrogen dynamics modeling for potato production in Canada

Principal Investigators: Nicholas Tremblay, AAFC – QC
Athyna Cambouris, AAFC - QC

Co-Investigators: Helen Tai, AAFC – Fredericton, NB
Bernie Zebarth, AAFC – Fredericton, NB
Alison Nelson, AAFC – Carberry

Support: AAFC

Progress: Year 3 of 3

Objective: **-** Model nitrogen release under Manitoba irrigated potato crop conditions for development of a decision support system for nitrogen management.
- Test plant gene expression for nitrogen stress in season

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

2015 Project Report

Two AAFC-led potato research trials were conducted at CMCDC in 2015 under an umbrella of two larger research projects spearheaded by research scientists from the Potato Research Centre in Fredericton, and Quebec. The projects have different treatments, but share some common objectives

The third year of a three-year field trial was conducted at CMCDC-Carberry, Manitoba using cultivar Russet Burbank as part of a larger experiment being conducted at various sites in Canada. In Manitoba, the field trial is replicated at two sites to represent divergent soil types for nutrient management. The main objectives of the study are to model nitrogen release in potato crops in different environments. The current field trials will be used along with previous studies done across Canada to develop decision support systems for site-specific nitrogen management. Modeling efforts in other crops are also underway under the larger project scope. The field trial was a randomized complete block design with four replicates and six treatments: four N rates (60, 120, 180 and 240 kg N/ha), applications were split to have 60 kg N/ha were broadcast and incorporated at planting and the remainder of the treatment rate applied as broadcast and incorporated at hilling. In addition to the four N rates, a negative control (i.e. 0 kg N/ha) and a positive control (180 kg N/ha all up-front at planting) were included. Nitrogen source used was urea.

Crop performance will be assessed by determination of total and marketable tuber yield, tuber specific gravity, as well as internal and external defects. Chlorophyll meter measurement, petiole and gene expression leaf samples were done two times in all plots, and each site during the growing season to evaluate measures of in-season plant nitrogen sufficiency. Petiole and gene expression samples were shipped to the Fredericton laboratory for analysis and

comparison of various methods of identifying plant nitrogen stress in season. Soil mineral N concentration to 60-cm depth was measured pre-plant to determine plant available N at planting, as well as after tuber harvest to determine residual soil mineral N. Other measurements were taken throughout the season to determine N levels in soil, plants as well as other crop performance measures.

Results for the trials are being combined across all sites in Canada. Laboratory determinations and statistical analysis are being conducted and lead by researchers in Quebec and Fredericton.

Figure 1. Recording raw harvest weights in the field.

Gene expression testing of potato nutrient stress

Principal Investigators: Helen Tai, AAFC – Fredericton, NB
Bernie Zebarth, AAFC – Fredericton, NB

Co-Investigators: Alison Nelson, AAFC – Carberry

Support: AAFC

Progress: Year 3 of 3

Objective: - Test potato plant gene expression for multiple nutrient stresses in season

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

2015 Project Report

The final year of an AAFC field trial was conducted at CMCDC-Carberry in 2015 using cultivar Russet Burbank as part of a larger, national project. This work will help to evaluate a potential new laboratory method of identifying crop stresses in season. Crop stresses that are being tested with this method include nutrient (including combinations of nutrient stresses) and water stress, as well as potentially disease stressors.

The experiment in Manitoba is designed to test all potential combinations of Nitrogen, Phosphorus and Potassium stress on gene expression indicators in plant leaf tissue in season. The trial is a randomized complete block design with four replicates and eight treatments: all combinations of nitrogen, phosphorus and potassium at sufficient or absent levels. Fertilizer was applied all pre-plant as a broadcast incorporated granular application. Crop performance was assessed by determination of total and marketable tuber yield, and tuber quality. Chlorophyll meter measurements, petiole and gene expression samples (leaf disc samples taken with a hole punch) were collected three times over the growing season in all plots. All petiole and gene expression samples were shipped to the Fredericton laboratory for analysis. Soil nutrient concentration to a 60-cm depth was determined pre- and post-plant. Total biomass was sampled once in all plots before crop senescence.

Results from the trials are being determined in the laboratory and combined with other sites across Canada, as well as across field seasons.

Remote Sensing Techniques for Field Variability Mapping for Variable Rate Irrigation

Principal Investigators: Alison Nelson, AAFC – Carberry

Co-Investigators: Jarrett Powers, AAFC – Winnipeg
Heather McNairn, AAFC – Ottawa, ON
Bernie Zebarth, AAFC – Fredericton, NB

Support: Agri-Innovation Program (AAFC & MHPEC)

Progress: Year 1 of 3

Objectives: - Evaluate soil-based and aerial-based remote sensing mapping techniques for usefulness in Variable Rate Irrigation applications

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

2015 Project Report

Interest in VRI technology is targeted at ensuring even yield and quality across an entire field, reducing production loss and improving the local sector competitiveness. As a newly emerging technology, no scientific investigations have been undertaken in the local area; and research has mainly focused on input efficiency impacts or improvements to hardware and control and automation (Evans et al. 2013).

Apparent electrical conductivity (ECa) maps, gathered with EM-38 or Veris meters can be used to map variation in soil properties over a field, quickly and with little field disturbance on bare soil. However, bulk soil electrical conductivity can be affected by a number of soil properties, including texture, organic matter, clay content, salinity and moisture content, so interpretation of variability maps require knowledge of the site and conditions at the time of data collection. Remote sensing imagery methods have also shown potential to be used for the delineation of management zones and monitoring of crop growth status. A passive radiometer mounted on a drone could hold potential for mapping soil moisture variability within a field for VRI applications.

This project is designed to investigate the applicability and methodology of Veris mapping technology and UAV-mounted radiometer for creating VRI field prescriptions. As well, the impact of current VRI prescription mapping and VRI management practices on potato yield and quality will be field tested against uniform irrigation in a small plot study.

The study site (~20 acres) within the larger field (~55 acres) was established in 2015, which was in canola production. A 30 m sampling grid was established in the field, and the area has been soil sampled. A Veris survey was collected to coincide with the soil sampling. Samples from the grid soil sampling were sent to a commercial laboratory for analysis of selected soil factors

relating to crop growth and moisture holding capacity. Soil texture analysis was completed on subsamples at the CMCDC-Carberry facility. The soil properties analyzed were also chosen to include factors that can affect ECa readings (from Veris or EM-38). A soil pedologist was also contracted to complete a detailed soils report on the soil at the research site, based on three pits dug in the rotational fields on the site.

Figure 1. Soil pedologist taking notes on soil profile and characteristics at one of three soil pits dug at CMCDC-Carberry

A second Veris survey will also be collected in the spring of 2016, with the fall survey being representative of expected “dry” soil conditions, while the spring survey is expected to represent “wet” soil conditions. The results from these surveys will be compared to the soil test results in 2016.

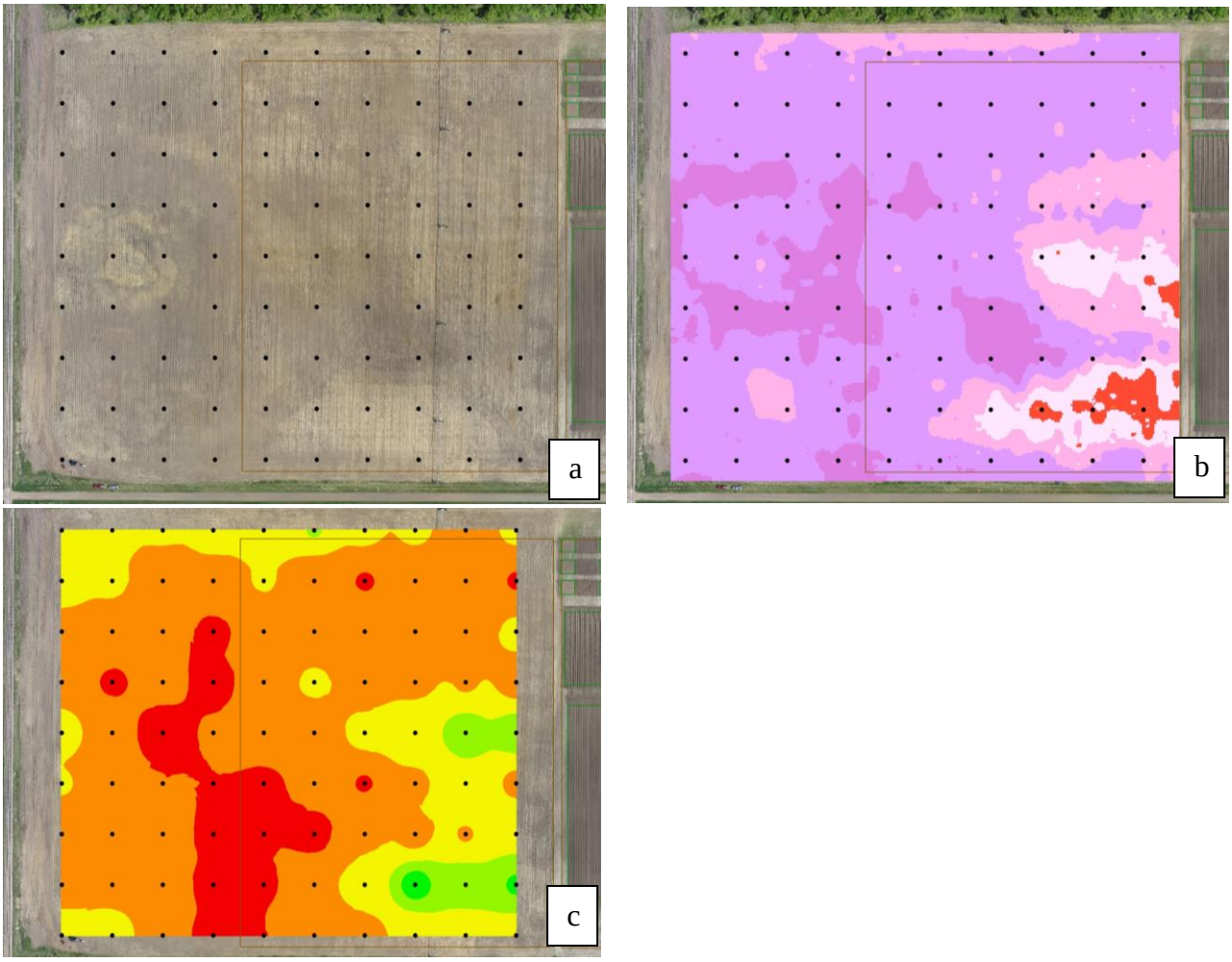

Figure 2. Maps showing the 30m grid soil sampling points (a), the Veris EC map (b), and the %OM from the grid soil sample results (c). These maps and data will be used to compare methods of VRI prescription mapping and also used to develop a VRI prescription map for locating VRI test plots in 2016.

In addition to the ground-based soil measurements taken in 2015, Radar sensor measurements were collected during the growing season on potato plots adjacent to the 2016 study site using the Canadian RADARSAT-2 satellite. This was done to test the concept of using Radar measurements to delineate within-field zones of soil moisture and crop growth in potatoes for use in precision irrigation management applications. Preliminary work on some potato fields has shown some promise for the use of this data to identify moisture variability, provided additional controls are implemented to mitigate the impact of potato hills on the data (McNairn, pers. comm.), however the resolution of zones may be too coarse for precision agricultural applications. To address the issue of resolution, a pilot project was completed in fall 2015 in Manitoba grain fields to determine the feasibility of using a UAV-mounted passive radiometer to create much higher resolution soil moisture maps. The report concluded that deploying a

passive radiometer mounted to a UAV to measure soil moisture of an agricultural field works and can create a map of soil moisture variability of a field.

Based on results from the UAV radiometer pilot project, we will be collecting soil moisture data with the UAV-mounted Radiometer on the Variable Rate Irrigation study fields at key points during the 2016 growing season as part of this project.