CMCDC

2020

MHPEC Inc. acts as the industry partner in managing the Canada-Manitoba Crop Diversification Centre (CMCDC).

CMCDC's programs are broadly classified as water and irrigation, applied potato research, environmental, and crop diversification. This partnership between the three partners provides a unique opportunity for collaborative research which amplifies the scale and significance of research that can be done.

Keystone Potato Producers Association, McCain Foods Canada, and Simplot Canada II constitute the partners of the Manitoba Horticulture Productivity Enhancement Centre (MHPEC Inc.)

OUR GOAL

to provide leadership and vision through cooperation, coordination and strategic collaborations between industry members and the scientific community, resulting in the development of a research program that will ensure the long term sustainability of the potato industry in Manitoba.

FROM THE SITE MANAGER

Thank you for taking the time to read and review our 2020 report and looking forward to the 2021 year. I have been employed by Manitoba Horticulture Productivity Enhancement Centre (MHPEC) since early November 2020 and find it both exciting and challenging.

The Canada Manitoba Crop Diversification Centre (CMCDC) was established between the Government of Canada, the Government of Manitoba, and Manitoba Horticulture Productivity Enhancement Centre Inc. (MHPEC). The Centre's mission, in brief, is to facilitate the development and adoption of science-based solutions for agricultural crop production. This is accomplished through the design, development, and adaptation of best management practices with a focus on water management, crop diversification and environmental stewardship. Its strategic areas include sustainable irrigation, sustainable potato production, improving the environmental sustainability of intensive crop production, and crop diversification.

Here at the MHPEC site we are fortunate to have the support of our three industry partners Keystone Potato Producers Association, Simplot Canada Ltd., and McCain Foods Canada that allows us to operate and conduct research for the potato industry, as well as other trials on crops. The results of this collected data are then entered and published for distribution to all interested stakeholders in potato production. These reports and full report are also available online at www.mbpotatoresearch.ca

Since March due to Covid-19 restrictions, our offices have been closed to the public and access can be granted by appointment only. With the limited access to our site, all our outdoor activities including Crops-A-Palooza, field days, and tours had to be cancelled. As we look forward to 2021, it is shaping up to be similar to last year as all tours and field days are unfortunately on hold at this point.

In closing I would like to thank you for taking the time to read and review this publication. We welcome, any and all, researchers, commodity groups and interested industry parties to bring forward your research projects for discussion. We are always open to the possibility of new research and trials at our site.

Call us at 204-834-2007

Garth Christison

Site Manager for MHPEC Inc, CMCDC Carberry

Conducting Research at CMCDC Carberry

BENEFITS OF CONDUCTING RESEARCH AT CMCDC CARBERRY

- Soil types that match light and heavy soils used in Manitoba crop production
- Irrigated or dry land available
- Ability for the site to provide other services – tillage, sprays, specialized crop research and precision agricultural equipment
- Low overhead costs
- Soil optix available for nutrient mapping
- Drone imaging available for canopy reflectance measurements
- Decades of historical data, maps, soil horizons, and surveys onsite
- Access to dedicated research staff onsite with experience conducting trials with potatoes, grains, brassica crops, legumes, forages, and specialty crops
- Proximity to Environment Canada and Agriculture and Agri-Food Canada weather stations
- Easy access at the junction of highways #5 and Trans-Canada highway #1
- Proximity to Carberry growers and central placement in Manitoba's processing potato region

On site events and extension

- Annual field day
- Extension workshops
- Demonstrations
- Boardroom, classroom, laboratory space also available to rent

Potato Program

Zack Frederick, PhD, P. Ag

Applied Research Agronomist

MHPEC Inc.

CMCDC Carberry

Cell: 204-841-3632

Zack received his Master of Science in Plant Pathology with a minor in fungal and Oomycete biology from Cornell University in 2013

Zack received his Doctor of Philosophy in Plant Pathology with a minor in fungal and Oomycete biology from Washington State University in 2017. Zack's advisers included Drs. Dennis Johnson, Mark Pavek, Debra Inglis, and Weidong Chen, and his research and extension program focused on disease management strategies for soilborne fungal diseases of potato in Washington State's Columbia Basin with a focus on Verticillium wilt. Zack was awarded the J. de Weerd Fellowship in Potato Research in both 2015 and 2016. Zack was also an ARCS scholar (Achievement Rewards for College Scientists) from 2013 to 2017.

Zack has been the principal investigator of a research and extension program from 2017 to the present day for the Manitoba Horticulture Productivity Enhancement Centre (MHPEC) Inc. Zack's efforts to study Manitoba's potato yield variability have highlighted the importance of Verticillium wilt identification and management, as well as nutrition optimization for regional nitrogen and sulfur programs. Additional research is currently underway to study black dot and powdery scab identification and management, the development of disease-suppressive soils, irrigation decision support tools, seed cutter disinfection, and the implementation of precision agriculture tools into research with UAVs and a remote sensing device called Soil Optix.

Crop Diversification Program

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I was born & brought up on a family farm. I have approximately 12 years of professional experience related to agricultural research and demonstration. I received a M.Sc. in Agricultural & Biosystems Engineering from the University of Manitoba (Soil and Water Engineering focus), and a B.Sc. in Agricultural Engineering (Irrigation & Drainage Engineering focus).

I currently work as Diversification Specialist with Manitoba Agriculture and Resource Development, in Carberry at the Canada Manitoba Crop Diversification Centre, where I am supporting MHPEC in executing a small plot research program with expertise in crop agronomy, soil and water engineering, experimental field plot design, and management of field research activities. Moreover, I have sound working experience of precision agriculture technologies such as GPS, Real Time Kinematic (RTK) guidance systems, operation and maintenance of farm scale equipment, and grain cleaning equipment. I am also certified in WHMIS and Emergency First Aid/ CPR/ AED Level A from the Canadian Red Cross.

CMCDC's goals are to increase profitability, sustainability, and adaptability of local farms; accelerate the adoption and commercialization of research innovation at the farm level; facilitate the adoption of technical innovation or practices from outside of the province or country; and improve the overall growth of the agriculture, agri-food and agri-product sectors. Transfer of knowledge is a priority and project results, technical information and emerging opportunities are accessible through annual reports, field days, tours, and display booths at agriculture trade fairs. Financial support is provided through Canadian Agricultural Partnership (CAP), a federal-provincial-territorial government initiative.

MHPEC Sulphur Study 2019-2020

Principal investigator: Zack Frederick (author)
Technician: Jane Giesbrecht (co-author)
Summer students: Jessica Kalyniuk, Matthias Schira, Nicole Buurma

Introduction:

The Field Variability Study (FVS) was conducted from 2015 to the present day with the overall goal of identifying and remediating factors responsible for variable processing potato yield. Fifty-five soil, plant, and environmental factors were identified in 23 grower fields and each factor was ranked according to impact on potato yield in a new partial least squares model generated in 2020.

Soil sulphur availability has been identified as the fourth most influential variable responsible for differences in total yield at row closure, which is approximately late June to Early July. Soil sulphur availability at all sampled soil depths throughout the growing season swept the top nine most influential variables responsible for variation in the 6-10, 10-12, and 12+ oz yields.

The assumed ideal soil sulphur test is 40 lbs in potato (as published by the University of Manitoba in Agvise's soil sulphur guidelines at https://www.agvise.com/wp-content/uploads/2017/03/Sulphur-Magnesium-and-Chloride-guidelines.pdf).

The FVS also offered insight into the amount of soil sulphur typically seen in grower fields, which ranged from 0-120 lbs, regardless of sampling date. In a cursory examination of the data set, 40-60 lbs of sulphur appeared to be the beneficial amount of available soil sulphur, where compromised yields were observed outside of this range. The lowest yields appeared to be associated with sampling sites with virtually no soil sulphur, which was especially prevalent in sandy soils. This cursory examination was done by hand did not have the benefit of any statistical test or association.

The goal of this study was to identify the exact range of soil sulphur needed by row closure and possible products and rates needed to accomplish the task in order to achieve desired benefits to total yield and larger tuber size categories (6+ ozs). Outcomes of this study were set in the context of small, controlled research plots to demonstrate the importance of a unique sulphur fertilizer regime to potato growers in order to justify field-scale validation studies that are necessary for industry adoption.

Brief Conclusions:

The significant interaction of year makes it reasonable to compare simple effects such as asking the question: in both 2019 and 2020, did a particular sulphur fertilizer rate have an impact on total yield?

The simple effects in the results pictured below indicate all three rates of Tiger Combo and magnesium sulphate have significant impacts on total yield, dollar value per cwt, and 10-12 oz yield. There is a problem in that these simple effects do not translate well into comparisons that Tiger Combo or magnesium sulfate at 100 lbs by row closure significantly improved total yield because the yields of the same treatment were so drastically different in 2019 and 2020.

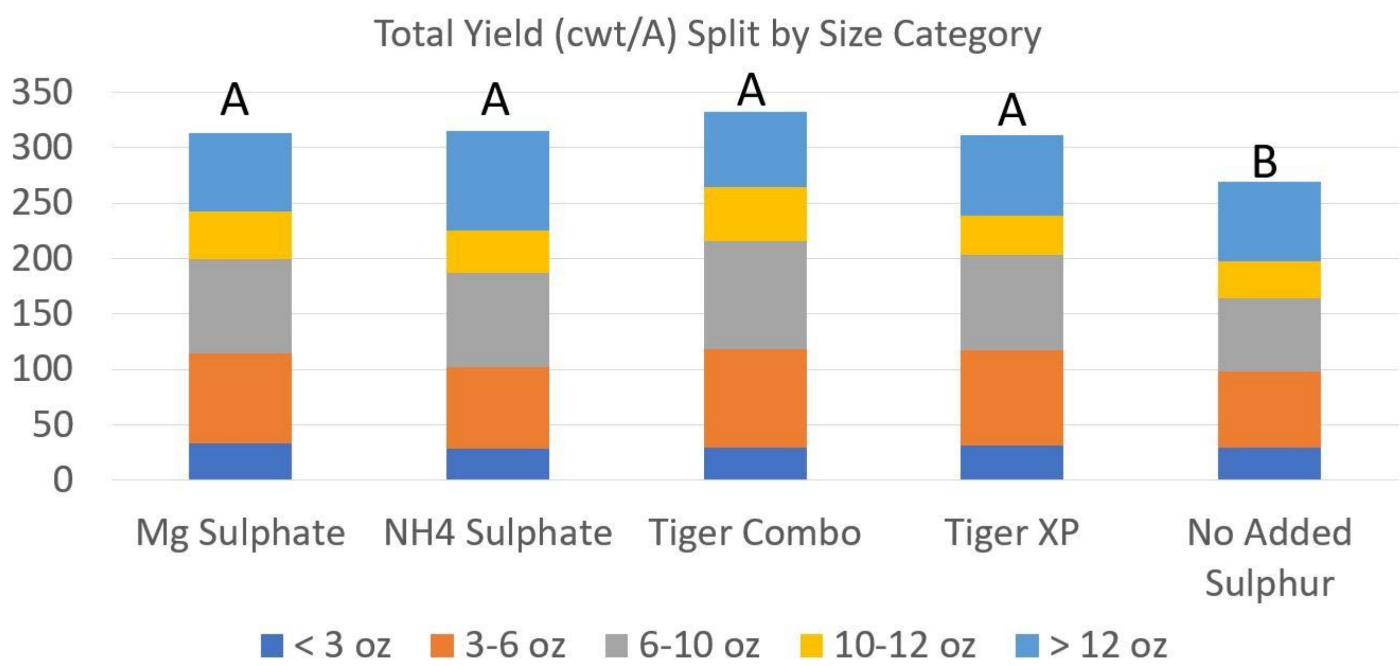


Fig. 1 The total yield by each fertilizer product consisted of the average of the twelve replicates of each fertilizer product (treatment rates combined) with each column separated by the tuber size profile. NH4 Sulphate refers to ammonium sulphate and Mg Sulphate refers to magnesium sulfate. Letters denote statistical differences as determined by the mixed procedure with Tukey post-hoc tests with significance determined at $P \leq 0.05$. There was a significant effect ($P = 0.0164$) of fertilizer product use on total yield when the rates of each fertilizer were combined in the 2020 analysis. All fertilizers improved total yield when compared to the negative control. There were no significant total yield differences between the fertilizer products.

The results from 2020 support that using virtually any of the four sulfur fertilizers, regardless of rate, provides improvements to total yield, dollar value, and 10-12 oz yield when compared to the treatment that received no additional sulfur. Of the four fertilizers, magnesium sulfate and Tiger Combo were the most consistent in producing significantly greater total yield, dollar value, and 10-12 oz yield when compared to the treatment that received no additional sulfur (see below). It could be possible that the use of any small amount of sulfur fertilizer on sandier soils, such as the one the present experiment was planted on, can provide basic improvements to yield and dollar value, specifically in the 10-12 oz tuber size category and the bonuses that come with having more tubers that are larger.

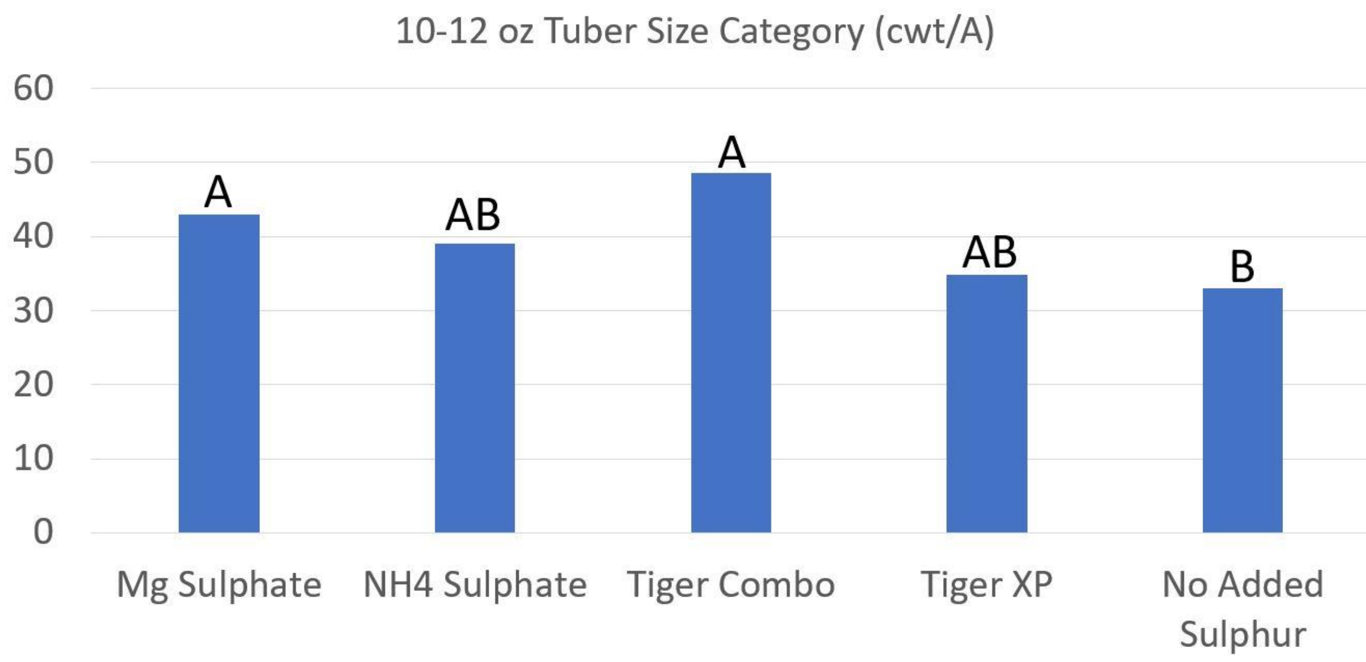


Fig. 2 The 10-12 oz yield for each fertilizer product that consisted of the average of the twelve replicates of each fertilizer product (treatment rates combined). NH4 Sulphate refers to ammonium sulphate and Mg Sulphate refers to magnesium sulfate. Letters denote statistical differences as determined by the mixed procedure with Tukey post-hoc tests with significance determined at $P \leq 0.05$. All fertilizers improved total yield when compared to the negative control except the Tiger XP ($P = 0.8950$) and Ammonium Sulphate treatments ($P = 0.9750$).

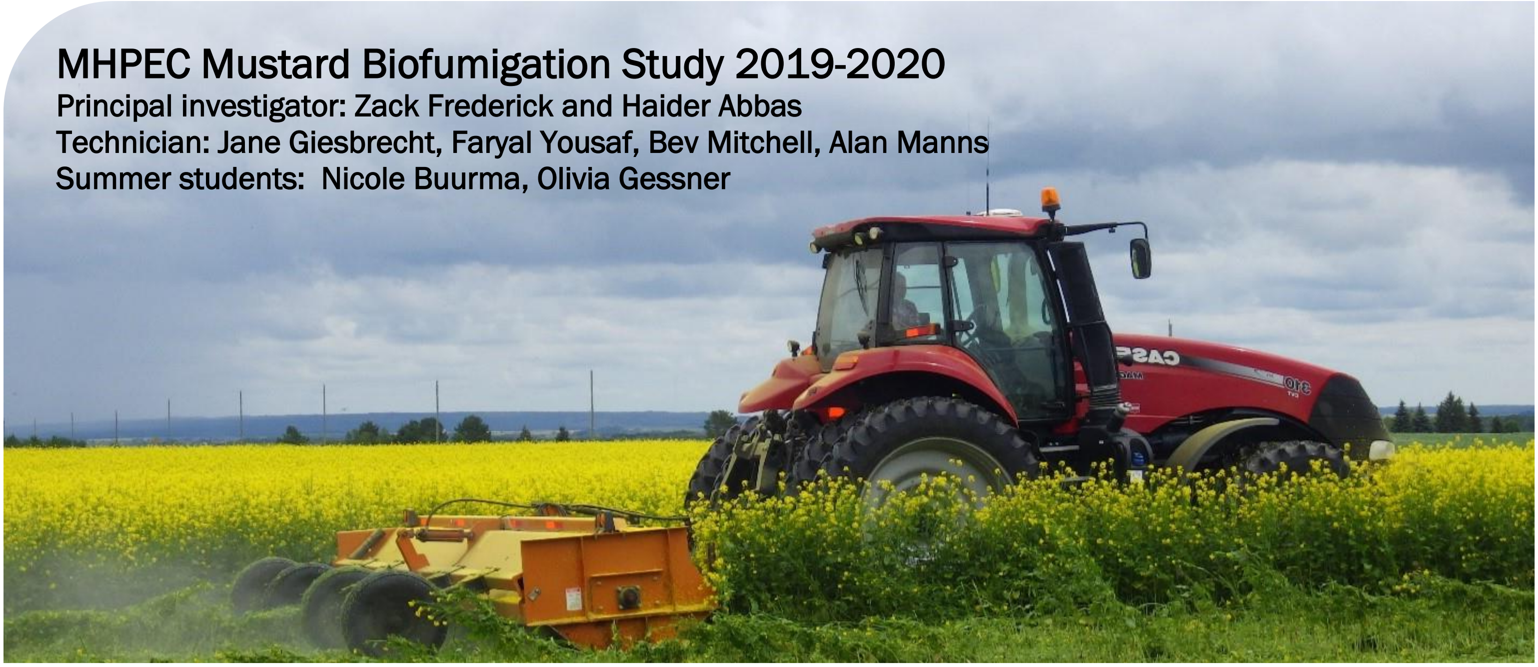
The present study was set up with the assumption that the ideal soil sulphur test is 40 lbs in potato (as published by the University of Manitoba in Agvise's soil sulphur guidelines at https://www.agvise.com/wp-content/uploads/2017/03/Sulphur-Magnesium-and-Chloride-guidelines.pdf).

Because of the significant interaction of year, any combined analysis and interpretation of main effects with fertilizer use on yield would be nonsignificant. For example, this would mean the same treatment, such as Tiger Combo 100, would have significantly different yields between 2019 and 2020 as a result of some factor external to the study. A possible explanation for why lower yields were observed in plots receiving the same treatment in 2020 compared to 2019 can be drawn from Dan Sawatzky in Spud Smart Magazine from the fall 2020 issue (page 54) that the 2020 growing season had "drier, hotter weather following which resulted in some heat stress expression through heat runners, especially in the Russet Burbank crop."

At least one additional year of study is needed to ensure that a target of 60 lbs of soil sulfur by row closure ensures that at least 40 lbs remains in sandy soils approximately two months after fertilization (row closure) and that this target provides the desired improvements to yield and value. If successful, these experiments should pave the way to changes in the blend of fertilizer that growers broadcast preplant in Manitoba in order to manage sulfur deficiency in the most cost-effective manner possible.

MHPEC Mustard Biofumigation Study 2019-2020

Principal investigator: Zack Frederick and Haider Abbas
Technician: Jane Giesbrecht, Faryal Yousaf, Bev Mitchell, Alan Manns
Summer students: Nicole Buurma, Olivia Gessner



Introduction:

Biofumigation describes the elimination or suppression of soilborne pests, pathogens and weeds by gases emitted from buried biomass from members of the Brassicaceae family (e.g., brown mustard, oriental mustard, radish, etc.). Biomass is pulverized and incorporated into moist soil to convert glucosinolates into degradation products such as isothiocyanates. The process has been developed and experimentally validated as a control measure of Verticillium wilt of potato in the United States and Europe. However, the methods of growing the mustard crop and the effectiveness of the process to reduce Verticillium wilt in Manitoba have yet to be validated in regionally with all cultivars of mustards.

The overarching goal of this study was to explore a way to economically manage Verticillium wilt of potato in Manitoba using a mustard crop as a biofumigant green manure to kill *Verticillium* propagules in soil and/or suppress the disease. More specifically, experiments were conducted to determine agronomic inputs to maximize biomass of mustard cultivars 'Andandte', 'AC Volcan', 'Caliente Rojo', and 'Cutlass'. Additional studies examined field-scale mustard biofumigation to verify *Verticillium* CFU/g soil before and after biofumigating, as well as mustard biomass at the time of biofumigation. The conclusions of this project will scientifically reinforce growers' efforts to reduce Verticillium wilt with evidence to support choices to effectively and economically manage the disease for their entire operations.

Objectives and Deliverables:

1. [Haider Abbas] Characterize agronomic practices for mustard cultivars 'Andandte', 'Caliente Rojo', 'Cutlass', and 'AC Volcan' necessary to achieve maximum biomass to theoretically maximize glucosinolate production.

    a. Practices to target: planting date (Mid July, Late July, Aug 1, Mid Aug), flea beetle control, minimum inputs (irrigation, N+S fertilization) needed to achieve max biomass, seedbed preparation (stubble type, chaff spreading, best seed-to-soil contact ratio)

    b. Deliverables

        i. Develop list of recommended and experimentally verified practices to successfully use mustard biofumigants as part of program to manage Verticillium wilt in Manitoba

        i. Improve recommendations for the inevitable question of "does this process work with other mustards?"

        ii. Develop experimental evidence to make the call for Canada-bred mustards for biofumigation (if existing mustards will not suffice)

2. [Zack Frederick] Evaluate whether mustard biofumigation with "Caliente Rojo" reduces *Verticillium dahliae* soil CFU and/or Verticillium wilt of potato

    a. Deliverables

        i. Implement and validate the applicability of a real-time *Verticillium dahliae* quantification tool for soil testing

        ii. List approximate number of acres planted, and practices used to grow the crop

        iii. Individual grower will have comparison of numbers of Verticillium propagules at three timings: 1) before mustard biofumigation 2) one-month post-biofumigation and 3) post-potato production.

        iv. Disease ratings will occur in the potato rotation to document visual reduction of disease, possibly as response to Verticillium wilt

            1. Severity of Verticillium wilt symptoms
            2. Severity of black dot symptoms
            3. Severity of Rhizoctonia symptoms

        v. Calculate cost of use for reduction in Verticillium CFU/g or Verticillium wilt

Conclusions:

Objective 1:

Planting date, presence of cereal's stubbles and seed treatment significantly impacted mustard yield and characteristics. The early seeded mustard planting date had the highest yield, population, height, and early season vigor. On the other hand, the late seeded mustard planting date had the lowest yield, population, height, and early season vigor.

The mustard grown in this trial did not produce as much biomass as commonly seen in producers' field in the Carberry area, where mustard has become a popular biofumigant. It is possible that more mustard biomass is needed to have a stronger impact on subsequent potato plantings.

In addition, growers have experimented with rolling, packing, or irrigating freshly incorporated mustard to help create a seal over the soil surface and increase release of biofumigants in the soil. It is possible that other techniques may be more effective at using mustard as a biofumigant. Additional research is needed to continue developing best agronomic practices for this pest control measure.

When managed properly mustard offers another tool to help growers control soilborne pests and diseases. It is important to strictly follow the outlined cultural practices to have any chance of success using mustard as a biofumigant. A high infestation rate of flea beetles was observed in the study areas which effected the capacity of biomass production of mustard varieties, highlighting a potential change that needs to be made for growing mustards in Manitoba. Proper chopping of plant material and soil incorporation is of utmost importance. Although mustard is a remarkable biofumigant, it could have other benefits that is expected from any other cover crop such as; prevention of soil erosion, recycling of soil nutrients, improved soil structure and maintaining soil organic matter. Interestingly, there are other crops that show possible biofumigation effect such as but not limited to; buckwheat, pearl millet, Sorghum-Sudan grass, rape seed and oil seed radish.

CMCDC will test the biomass production from treated mustard varieties planted at four seeding dates (June 1, June 15, July 02, and July 15) during the 2021 planting year again. For this purpose, cereal crops of fall rye, and winter wheat were seeded as a stubble crop in the fall of 2020.

Objective 2:

1. Deliverables

   i. Implement and validate the applicability of a real-time *Verticillium dahliae* quantification tool for soil testing
      a. Completed in 2019. PSI is running qPCR markers developed by Guillaume et al. (2011) for *V. dahliae* every year of study.

   ii. List approximate number of acres planted, and practices used to grow the crop
      a. Completed every year. Since 2019, 100 - 300 acres of biofumigant mustard are planted across the province and new recommendations are developed annually (see supplementary file on recommendations for current best practices that is posted to mbpotatoresearch.ca).

   iii. Individual grower will have comparison of numbers of Verticillium propagules at three timings: 1) before mustard biofumigation 2) one-month post-biofumigation and 3) post-potato production.
      a. Ongoing – more fields are needed for completed analysis

   iv. Disease ratings will occur in the potato rotation to document visual reduction of disease, possibly as response to Verticillium wilt
      1. Severity of Verticillium wilt symptoms
      2. Severity of black dot symptoms
      3. Severity of Rhizoctonia symptoms
         a. Ongoing – this process is a year behind point iii, meaning more fields are needed to complete the analysis

   v. Calculate cost of use for reduction in Verticillium CFU/g or Verticillium wilt
      a. Will be calculated once a large biomass crop has been successfully demonstrated to reduce *V. dahliae* microsclerotia in soil and/or Verticillium wilt in the subsequent potato crop.

Although only two fields survived to biofumigate in 2019, useful observations were still gathered to add to the collection of information that the project leads have amassed so far. Superficially, it appears as if biofumigation did work to reduce *V. dahliae* microsclerotia in one field in 2019. More fields and years of study are necessary to assert if the biofumgiation process can achieve the objective to control Verticillium wilt of potato in Manitoba.

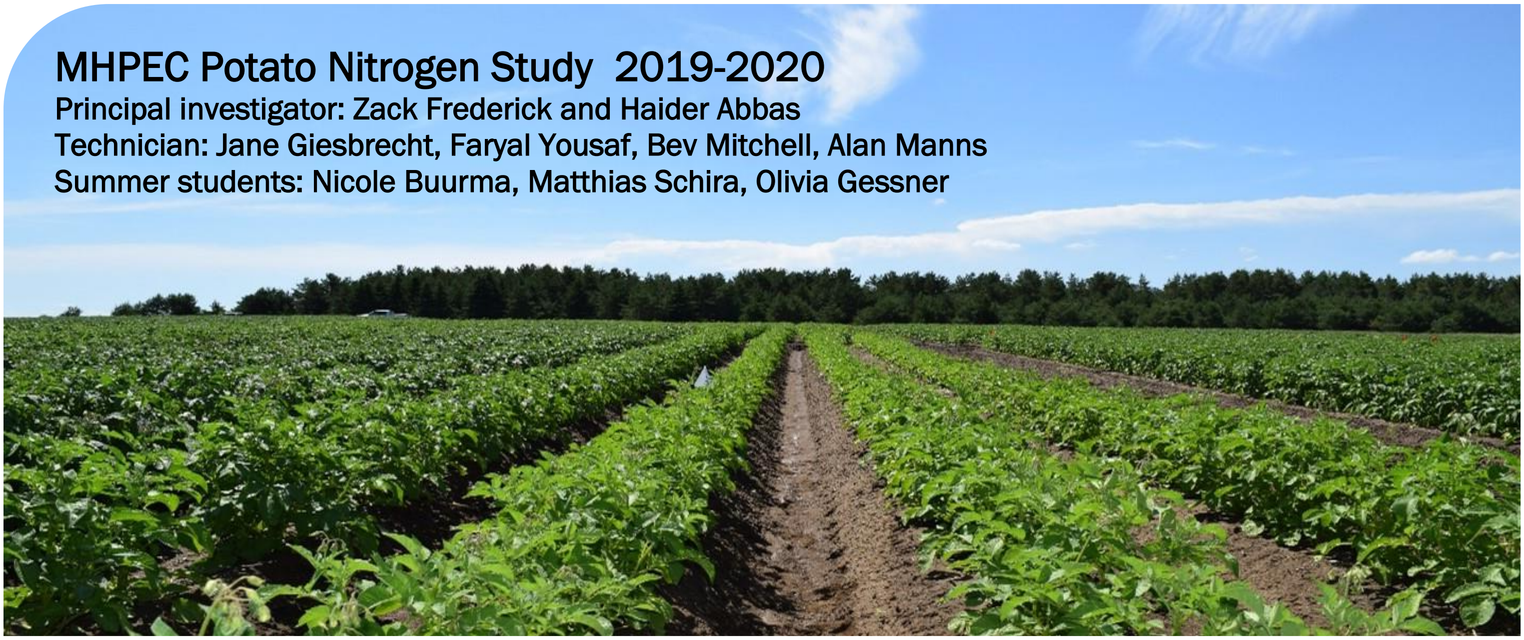
Additional anecdotal observations were also recorded in 2019. Chaff spreading is necessary on rye and wheat fields before seeding mustard because a thick mulch reduces soil to seed contact and reduces germination and growth, leading to mustard that is at the cotyledon stage after a month and a few inches tall after two months of growth. Flea beetle damage was severe in 2019, but markedly less so in fields that were not in Carberry or had stubble to protect mustard seedlings. Even a rigorous insecticide program did not afford the same protection as the presence of stubble. It was also surprising to see that a dryland field was so effective in 2019 to raise a mustard crop using only precipitation and two flea beetle insecticide treatments, granted a crop of rye was lost to plant the mustard in May. Growers and consultants have also expressed interest in whether mustard biofumigation has any control of powdery scab, can build organic matter, or can reduce wind erosion.

All fields survived to biofumigate in 2020, however the amount of biomass and levels of *V. dahliae* CFU differed dramatically between fields. Superficially, it appears as if biofumigation did work to reduce *V. dahliae* microsclerotia, but the analysis must include more fields from a variety of soil types and varying pressures of Verticillium wilt. The data set is too narrow at present to definitively state that mustard biofumigation works as intended to reduce Verticillium wilt in Manitoba, especially given the amount of sampling error showing up in the standard error of each figure.

Additional anecdotal observations from 2020 suggest the fields with the most mustard biomass generally had seed drilled at rates of 6-10 lbs per acre and were planted in early June and biofumigated in mid-July. These fields required fairly frequent irrigation in the first two weeks after planting and needed a total of 6-9 inches of water depending on the sand content of the soil. The sandiest soils in Shilo seem to need 3 extra inches of water (9 inches total) and 130 lbs more nitrogen to achieve the same biomass result as in the Carberry area. Shilo may even need an increase of nitrogen to 180 lbs N, with most being applied through frequent (weekly) fertigation events that put down approximately 30 units of N because of the sandy soil's propensity to leach. Generally, 70-90 units of nitrogen are needed at plant and the remainder is fertigated on. Fertigation began after 30 days with 20-25 units of nitrogen per application and 5 units of sulphur. At least 30 units of sulphur recommended to be available throughout the growing season (adjust sulphur fertilizer ratio to 6:1 nitrogen to sulphur fertilizer). These changes to our guidelines should allow more growers to hit the biomass targets and are very timely and helpful as the project progresses into identifying whether biofumigation reduces Verticillium wilt by giving us more fields where success was likely to occur.

MHPEC Potato Nitrogen Study 2019-2020

Principal investigator: Zack Frederick and Haider Abbas
Technician: Jane Giesbrecht, Faryal Yousaf, Bev Mitchell, Alan Manns
Summer students: Nicole Buurma, Matthias Schira, Olivia Gessner



Introduction:

Objective 1:

The Field Variability Study (FVS) was conducted from 2015 to the present day with the overall goal of identifying and remediating factors responsible for variable processing potato yield. Approximately 55 soil, plant, and environmental factors have been identified in 23 grower fields and each factor has been ranked according to impact on potato yield. Lower petiole nitrate and soil nitrogen at row closure are associated with total yield negatively (i.e., lower petiole nitrate and/or lower soil nitrogen at row closure is associated with the lowest yielding sampling points). These yield associations were found at the mid-bulking and row closure growing stages of 'Russet Burbank' in Manitoba, which roughly approximates to early August and early July, respectively.

The FVS also offered insight into the amount of soil nitrogen typically seen in grower fields at row closure, which ranged from 4-320 lbs from 0-30 cm in depth. In a cursory examination of the data set, 130-180 lbs of nitrogen appeared to be the beneficial amount of available soil nitrogen, and compromised yields were observed when nitrogen test above or below this amount. The lowest yields appeared to be associated with sampling sites with under 50 lbs of nitrogen at row closure. This cursory examination did not have the benefit of any statistical test or association.

The goal of this study was to identify the exact range of lbs of soil nitrogen needed by row closure and possible products and rates needed to accomplish the task. Outcomes of this study are set in the context of small, controlled research plots to demonstrate the importance of a unique nitrogen fertilizer regime to potato growers in order to justify field-scale validation studies that are necessary for industry adoption.

Objective 2:

The addition of nitrogenous fertilizers to the agricultural systems has an impact on the composition of air which is 79% nitrogen. The N in the air is present in the form of N_2 molecules, which is not directly available to the plants. That is why inorganic or mineral fertilizers are supplied to the plants to meet the crop nutrients demand. These fertilizers supply a form of N, called fixed nitrogen, that plants can easily uptake. In an inorganic fertilizer, N in the form of ammonium ion (NH_4^+) is converted into nitrite ions (NO_2^-) by soil bacteria of the Nitrosomonas species through biological oxidation (Nitrification). The nitrite ions are further converted into nitrate ions (NO_3^-), the plant available form, at soil temperature above 10 °C by the Nitrobacter species. Nitrate is highly soluble and eventually leaches down into the deeper soil layers because of its low adsorption capacity in the soil. If soil becomes water saturated causing anaerobic conditions, Nitrate-Nitrogen (NO_3-N) may be lost to the atmosphere through a reduction process called denitrification. Complete conversion from NH_4^+ to NO_3^- takes place within a month of application.

$$NH_4^+ \leftrightarrow NO_2^- \leftrightarrow NO_3^-$$

Like all other crops, a substantial amount of fertilizer-N is required to get the optimum yield and quality of potato tuber and to tolerate the diseases as well. In addition to nitrogenous fertilizers, irrigation management also plays a significant role in improving the crop yield. Potato tubers are very sensitive to water stress. Yield may be significantly reduced by water deficit. On the other hand, excessive water application may result in respiration stress and denitrification. Maximum potato production is achieved when the soil moisture is sustained at an optimum level and N is frequently available during the peak demand period within the potato root-zone. In order to achieve high potato yield with minimum water quality impact, both nitrogen and water management should be taken into account.

A combination of fertilizer application and irrigation management during the early growth stages of potato affects the tuber yield. Both over- and under-application of irrigation water and nitrogenous fertilizers, affect the nitrogen dynamics within the potato root-zone. The highly soluble NO_3-N will be leached below the root-zone due to excessive water application. That is why over-application of irrigation water causes contamination of ground water and surface water by leaching and surface run off, respectively. However, the total N uptake by plants is also substantially restricted by water deficits.

Intensive over-application of fertilizer is one of the main contributors to lower yield and elevated NO_3-N concentrations in groundwater. If the excess N is not utilized by the crop, N may accumulate within the root-zone in the form of NO_3-N which can leach below with a rainfall or supplemental irrigation event causing an increase in the NO_3-N concentrations in the groundwater. If the soil becomes saturated, this nitrogen may be lost to the atmosphere in the form of nitrous oxide (N_2O) gas by denitrification, which destroys the stratospheric ozone contributing to global warming.

Nitrate leaching in the agricultural soil is influenced by many factors such as the irrigation system/applicator, irrigation management, N fertilizer management (N rate, application method, and splitting), soil characteristics, and rainfall patterns. Soil thickness and distance between the bottom of the root-zone and groundwater table also plays a role in determining the potential for ground water contamination. If the plants roots are closer to the water table, nitrate leaches into the groundwater more easily.

The results from numerous studies have proven that excessive irrigation and heavy rainfall are the main drivers of NO_3-N losses from plant root-zone. This loss can be controlled by irrigation management (that subsequently governs the volume of subsurface drainage water) and fertilizer management. The timing and scheduling of irrigation directly affects nitrate leaching. A proper water management can minimize N losses from the plant root-zone and improve the N uptake. If there is a significant difference between the irrigation supplies and the evapotranspiration demand of crop, the application of N fertilizers assessed for full irrigation may result in "unintentional" over application of N fertilizers causing the potential for N losses. Soil type and soil physical properties also affect nitrate leaching potential.

Impact of different nitrogen application treatments on nitrate dynamics within the potato root-zone was studied in Carberry, Manitoba. The objective of this study was to examine the effects of different nitrogen application rates on nitrogen dynamics within the potato root-zone in a loamy sand soil, and to analyze the nitrate leaching potential below the root-zone.

Conclusions:

Objective 1:

MHPEC's 2020 nitrogen study was based upon statistical associations created from the larger field variability study that encompassed observations from 23 grower fields over five years. The goal of this study was to identify the exact range of lbs of soil nitrogen needed by row closure and possible products and rates needed to accomplish the task to ultimately improve yield and quality of processing potatoes. It is suspected that larger tuber size profiles are found when 130-180 lbs of nitrogen are found in 0-30 cm of soil at row closure based on this initial study, but this statistical association needs to be verified as cause and effect through further study.

While statistically significant observations were made for differences between fertilizer rates on available nitrogen at row closure, the targets for row closure soil tests were not met. Any discussion of statistically significant results does not encompass the biological phenomenon because treatment goals were not met.

In general, the treatments of ESN and urea where 40 or 130 lbs were expected by row closure ended up having far more soil nitrogen than anticipated. Treatments of ESN and urea where 180 lbs were targeted by row closure appeared to be on target on average between all the replicates, but the large error bar indicates that some individual plots could be off from target by 50 or more lbs. Neither fertilizer treatment could achieve targets of 280 lbs of nitrogen in a soil test by row closure. An unexpected, unrepeated observation came from the urea 180 lbs treatment, which had more >12 oz percentage of tubers than urea treatments with more or less nitrogen (280 and 40 lbs, respectively). More study would be required to identify if this was a spurious event or something more meaningful, but the results are muted by the fact that soil targets by row closure were generally not met.

While negative results are generally undesirable in applied research, this study indicates that on this lighter soil type, unblended ESN and urea cannot possibly meet nitrogen goals by row closure at any of the rates evaluated.

The original research question remains unanswered using these four rates of ESN and Urea. Grower feedback has indicated that a blend of nitrogen fertilizers is often employed on-farm, and the exact blend varies by consultant. **Answering the original research question requires going back to the community monitor a wide range of nitrogen programs in order to select promising candidates to use in a study formatted much like the present study**. It is anticipated that other treatments may yield the desired result can overcome the deficiencies outlined in the first two years of this study.

Objective 2:

The importance of fertilizers in improving the crop yield and quality can never be underestimated. Nitrogen (N), potassium (P) and phosphorus (K) are the predominant fertilizers, generally applied to meet the crop nutrients demand, if the native soil supplies of these nutrients are limited. Nitrogen (N) is one of the essential fertilizers that affects plant growth and plays a significant role in optimizing the crop yield. Like all other crops, a substantial amount of fertilizer-N is required to get the optimum yield and quality of potato tuber and to tolerate the diseases as well. In addition to nitrogenous fertilizers, irrigation management also plays a significant role in improving the crop yield. Potato tubers are very sensitive to water stress. Yield may be significantly reduced by water deficit. On the other hand, excessive water application may result in respiration stress and denitrification. Maximum potato production is achieved when the soil moisture is sustained at an optimum level and N is frequently available during the peak demand period within the potato root-zone. In order to achieve high potato yield with minimum water quality impact, both nitrogen and water management should be taken into account.

Intensive over-application of fertilizer is one of the main contributors to lower yield and elevated NO_3-N concentrations in groundwater. If the excess N is not utilized by the crop, N may accumulate within the root-zone in the form of NO_3-N which can leach below with a rainfall or supplemental irrigation event causing an increase in the NO_3-N concentrations in the groundwater.

Potatoes require comparatively less N during the early part of the growing season i.e., sprout development, and vegetative growth stages compared to the later part i.e. tuber initiation, and tuber bulking stages. Excessive N application during the early part of the growing season leads to delay onset of the tuber initiation stage and decrease the yield. Potato requires an adequate and steady supply of N from tuber formation to bulking. Therefore, potato growers apply approximately 25-50 % of the total recommended N at the beginning of the growing season and the remainder is applied at the tuber initiation stage. Although this scheduling improves the yield and quality of tuber, it is costly and labor intensive. Controlled release nitrogen (CRN), also known as polymer coated urea (PCU), and environmentally smart nitrogen (ESN) is a cost-effective N application source. A micro-thin polymer coat facilitates the release of N at a controlled rate and minimizes N losses from the soil. The rate of N release from PCU is controlled by soil temperature and soil water content. When water is applied to the soil by supplemental irrigation and/or rainfall, it enters into the polymer coated fertilizer granule and dissolves the N into soluble form within the granule. As temperature increases, this nitrogen solution moves out through the polymer coated fertilizer granule into the soil solution in the plant available form.

Support Staff:

MHPEC's research program is supported by a research technician and seasonal staff.

Jane Giesbrecht has been MHPEC's research technician from 2019 to the present day. Jane began working for MHPEC as a summer student in 2018 and graduated into the technician role. Jane received her Bachelor of Science in Bioanthropology in 2019 from the University of Winnipeg. Jane completed training in advanced drone piloting in 2020 and now operates CMCDC's UAV and precision agricultural research equipment. Jane's current roles also include the implementation of MHPEC research projects such as planting, collecting soil and plant samples, grading, and analysis.

Sherree Strain, Beverly Mitchell, Alan Manns, Alex Christison along with summer students, are critical staff members whose efforts are essential for work at the research site.

CROPS-A-PALOOZA

is a one day, in-field learning event featuring top-notch farmers, researchers, and agronomy professionals all focused on ensuring you are equipped with the tools needed to grow the best crops possible.

There were 18 stations in the 2019 Crops-A-Palooza event:

10. A Change in the Forecast
11. Cover Crops 101
12. What's new in Weed Technology
13. Managing Insect Pests
14. Value of Seed Treatments
15. How Deep are Your Roots?
16. Crack Open the Pod of MPSG Research and Resources
17. Maximizing Winter Wheat Yields with Proper Nutrition
18. What You Need to Know About Managing Your High Yielding Spring Wheat

1. Take a Stand with Canola Plant Populations
2. Show me the Money: Oilseed sunflower marketing options
3. Pushing Nitrogen Rates in Oats
4. Hempstablishment
5. Space It Till You Make It
6. Every Day is Fry Day – From Potato to French Fry
7. Real Ag Live
8. Ag in the Classroom: Scavenger Hunt
9. Keep it Clean!

CMCDC is planning to hold Crops-A-Palooza in 2022

In 2021,

Crop Diversification is anticipating conducting 46 trials.
Some potato crop experiments are listed below:

1- Impact of different nitrogen treatments at nitrogen dynamics within the potato root-zone to analyze the nitrate leaching potential below the root-zone.

2- Development of agronomic practices for the production of mustard in the cereals' stubbles for bio-fumigation of potatoes. (CMCDC)
Project-1: Fall Rye Stubbles (Bono Variety)
Project 2: Winter Wheat Stubbles (Wildfire Variety)
Project 3: Impact of different nitrogen treatments on mustard growth

3- Controlling Soil Erosion in Potato Farming Systems

4- Effects of Soil Compaction in Potato Crop

For your questions and feedback on the diversification program,
contact Haider Abbas at haider.abbas@gov.mb.ca

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For project findings and recommendations,

please visit https://mbpotatoresearch.ca/ for our 2020 Annual Report