Potato Health Research Update – Agriculture Agri-Food Canada

COVID-19 affected our ability to get out into the field to continue sampling and data collections we had started in 2019. However, we were able to pivot our efforts to remote work and accomplish many research objectives.

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Potato phenotyping

Phenotyping refers to measuring and characterizing differences between individual plants and varieties. This can include simple traits such as plant height and size and overall yield, but also includes more complex traits such as resistance to disease, resistance to stress induced by the environment (drought, temperature, nutrient, etc.), and storability. In a research setting we use phenotyping to describe how plants respond to their environment and in turn how their genetics contribute to this response. Many tools and methods have been developed to phenotype potato in the laboratory. The challenge is to translate this to growers and processors such that it can better inform decision makers. This is a primary focus of the Potato Health research program lead by Dr. Neilson.

Target traits for phenotyping

Phenotyping efforts are broken down into two broad categories: field phenotyping and storage phenotyping. Additionally we break phenotyping efforts down into market categories. While the end markets are different we use common equipment and methodology. Work has begun on rolling out phenotyping for research purposes and developing protocols for use of phenotyping platforms and equipment on farm and in storage. We are extremely thankful to growers who have collaborated with us with fruitful discussions and providing samples for us to work with.

Figure 1 Mosaicked image showing plant growth over time. An action camera was used to capture multiple images of a 10 hill row. The images were stitched together showing changes in biomass overtime. We are interested in tracing back seed physiological differences that account for plant growth rates and yield.

Automating stand counts, emergence, rate of canopy closure using field imaging.

Over the 2020 field season we trialed an inexpensive ground based phenotyping platform (Figure 1). This system uses an action camera (GoPro) on a gimbal operated by a technician. Advantages of using a ground based system compared to a UAV is ease of operation without the need of a special license, no limitations due to weather and data collection can be done quickly by a single operator. Our short term goal is to obtain images and relate them to on the ground data and from this digitize and automate agronomy measurements. Once the technical challenges have been overcome we can move to a UAV or other platform that can image larger fields.

Based on work done in 2019 we saw a great deal of variability between plants of the same variety within a single field in terms of yield and above ground biomass. This may be due to microclimates within the growing field or physiological differences between seed

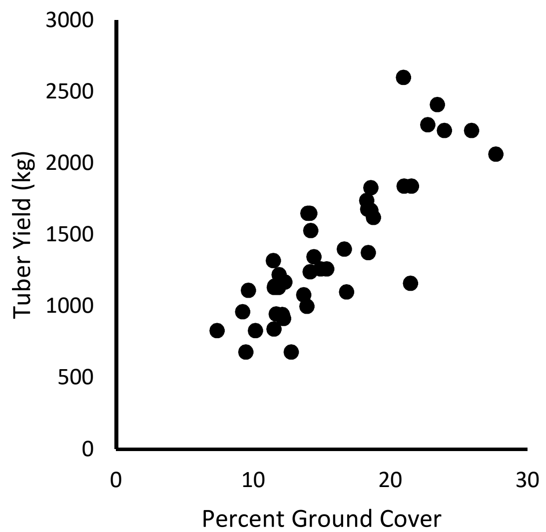

Figure 2 Percent ground cover and tuber yield. Ground cover was estimated using and inexpensive camera system. Early measurements, shortly after emergence are most informative for yield estimates.

tubers. We have found a good correlation (~0.85) between ground cover and tuber yield, though this only holds true at early time points (Figure 2). In this trial we estimated ground cover using an overhead imaging platform. There is an informative window for using this kind of imaging to estimate yield. This is because as the plants mature overlapping leaves cannot be seen by the camera. Thus it is important to collect data early in the growing season. An open question is whether yield models need to be customized for different varieties. It is apparent that there is a genetic component to above ground biomass and below ground tuber yield. There is likely an environmental component reflected in seed physiological differences as well. In the upcoming 2020 storage season we will be assessing physiological ageing of seed using non-destructive methods (see below) and planting these seed tubers in the 2021 growing season. The goal is to identify markers of physiological aging within storage and use this information to sort out vigorous seed.

Non-destructive measurements to assess sprout dormancy.

Sprouting in storage is an important trait for both seed and processing growers. In the fall of 2019 we began a storage trial to use non-destructive measurements to track physiological changes in seed tubers (Figure 3) and had planned to conduct multiple sprouting trials and plant tubers out in the field in 2020. We were able to complete some of the planned sprouting trials before COVID-19

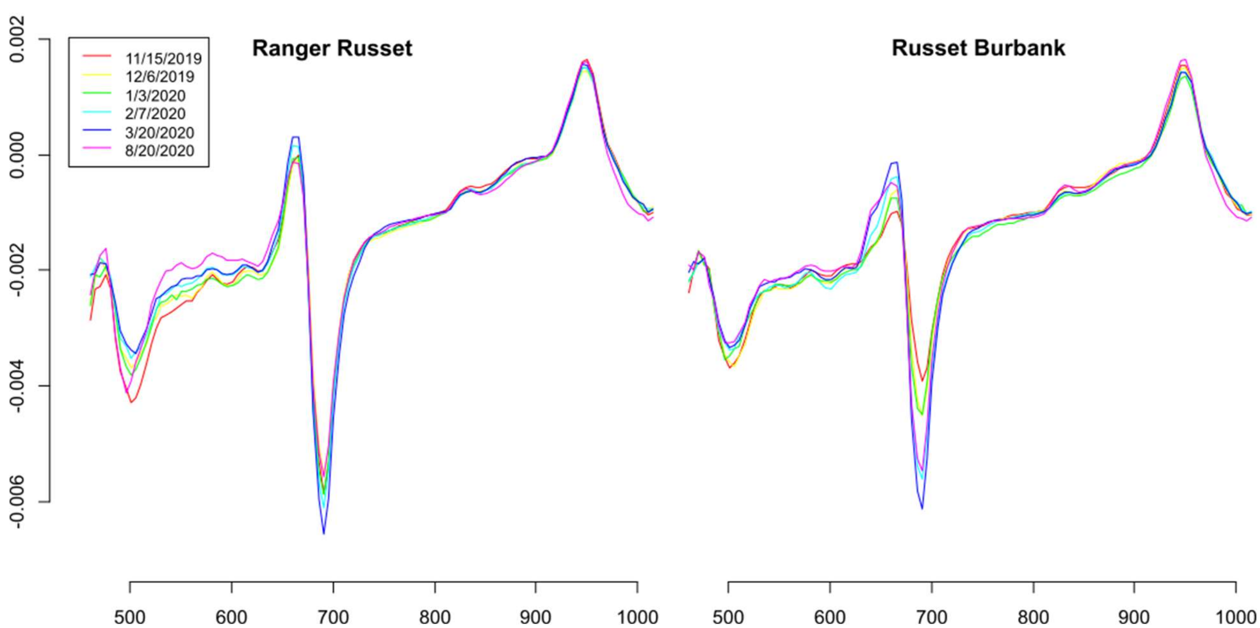

Figure 3 First order derivative of tuber reflectance over time. Changes over time were observed as well as differences between varieties. It is hoped that parts of the spectrum will prove informative on the timing of dormancy release in cold storage.

restrictions were put in place and were not able to plant tubers from this storage trial in the field. Instead our focus moved towards data analysis and examine long term storage effects (>12 months) once we were able to resume research activities. We used a spectroradiometer to measure reflectance in the visible and near infrared spectrum of the bud end of Ivory Russet, Ranger Russet and Russet Burbank seed tubers. Measurements were taken once a week from mid-November to March. We see general patterns in the spectrums from the three varieties and we also see changes in the spectrum over time. The next step is to identify which wavelengths are informative for sprouting behaviour. We are also repeating the trial with more varieties. We plan in 2021 to plant out the tubers from the storage trial currently underway. With this dataset we will be able to identify changes occurring in storage that are linked to performance in the field.

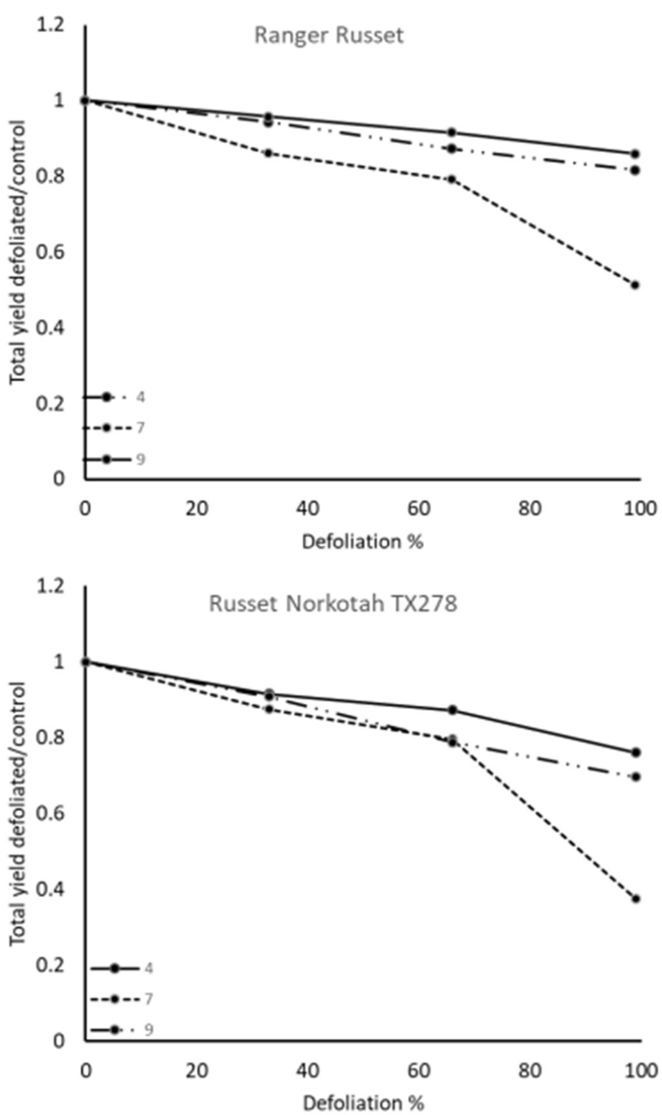

Figure 4 Effects of defoliation on total yield. Defoliation occurred at different plant growth stages. The timing and intensity of defoliation along with variety have an impact on marketable yield decreases. 4: pre-tuber initiation. 7: 50% tuber mass. 9:100% tuber mass

Determining effects of defoliation due to severe weather on potato production.

To ensure we are addressing the needs of industry we spent time over the summer consulting with growers on project ideas for upcoming research proposal calls. One topic of mind is the effects of severe weather on yield and storability (i.e. hail and early snow fall/freezing weather). As a starting point for such a project our research group began a literature review of published defoliation and freezing damage studies. Based on the preliminary research impacts on yield depends on the timing of the defoliation as well as the variety (Figure 4). From the collected data we aim to develop a model that can be used by growers to estimate losses following severe weather events. In the upcoming 2021 growing season we will be looking for partner growers to supply data and allow us to come on farm to collect samples. We have submitted a proposal to the Agricultural Funding Consortium to fund this research project in collaboration with the University of Lethbridge and Lethbridge College. A major component of this proposed research is rolling out phenotyping, as described in the previous section, onto the farm. This will allow for better estimation of the damage from severe weather and to track the recovery of the plants affected. Ideally we would like to develop management plans to help weather damaged crops recover rather than simply tallying the damage. Having an inexpensive method to track recovery is a first step towards this goal.

Soil health and soil carbon

A second major research area for the Potato Health program lead by Dr. Neilson is focused on soil health and how that translates to marketable yield for growers. Discussions with growers and other industry partners indicates that soil health is an important topic. In Alberta land that had not been used for growing potato, either irrigated land that has not been used for potato production or through expansion of irrigation into dryland corners, is now being considered. There is some evidence to indicate this virgin potato land has higher production than land currently used for potato production. In 2019 we collected soil samples, including land that had not been used for potato production, and had begun to process them over the winter. This work was put on hold due to COVID-19 restrictions. We had planned on collecting more samples in 2020 but were unable to visit grower fields. Our goal is to continue this work over the upcoming winter. Rather than doing microbial surveys, as has been done previously, we plan on performing targeted species analysis to look for beneficial microbes. The goal is to develop a rapid test that can be used for in-depth field sampling to support land management decisions. We hope to resume field sampling in 2021 and are discussing collaboration opportunities with researchers at the University of Lethbridge.

An important component of soil health is soil carbon. There is a concern that incorporating potato production, which requires land disturbance, into no-till operations will result in a net loss in soil carbon. There are a number of options available to growers to offset losses when growing potato on virgin land and to increase carbon capture in existing operations. We have submitted a proposal as part of a pan-Canadian research network to evaluate options to increase soil carbon through nurse crops, fall cover crops, green manure and other alternative cropping options. Beyond increasing soil carbon we will examine what impact these cropping options have on marketable yield and tuber storability. With this data we will perform an economic analysis to identify the costs and benefits to adopting carbon sequestering farming practices. We are seeking input from other grower groups to capture not only what is occurring during the potato production year but also the crops in between.

As part of this project we will make available modeling software (HOLOS) growers can use to see how their cropping choices affect long term soil carbon sequestration. If you are interested in trialing out the current version please contact holos@agr.gc.ca or visit https://bit.ly/holosaafc. We will be looking for partner growers in 2020 to help us roll this out and add more functionality and cropping options.

Acknowledgments

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We’d also like to thank the PGA research committee for allowing us to present our research findings and for providing their feedback on our research activities and proposals.

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