Cluster 2 – Non-confidential Summary

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1. CLUSTER PROJECT DETAILS

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Project number: AIP-CL03
Name of Project: Pulse Science Cluster 2
    Activity #: T2.A13.V1
    Name of Activity: Soybean Root Rot: Investigation and Integrated Management Strategies
    Name of Sub-activity
      Sub-activity 1. To determine the potential yield loss caused by root rot pathogens of soybean in western Canada.
      Sub-activity 2. To Identify the major root rot pathogens of soybean in western Canada and determine their aggressiveness toward soybean though pathogenicity testing.
Project research period: April 1, 2013 to March 31, 2018
Principal investigator and research collaborators:
      Sub-activity 1. Debra McLaren, Robert Conner and Bruce Gossen
      Sub-activity 2. Stephen Strelkov, Debra McLaren, Robert Conner

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NON-CONFIDENTIAL ABSTRACT/SUMMARY (For use in publications and pulse grower websites)
- Overall project objectives, methodology, research design & findings from project start to March 31, 2017.
- **500 words** in lay language.
- To be used "as is" with no additional permissions sought prior to use.

Sub-activity 1.

The objective of Sub-Activity 1 was to determine the potential yield loss caused by root rot pathogens of soybean in western Canada. During 2014 to 2017 at Brandon and Morden (McLaren and Conner), and 2015 to 2017 at Saskatoon (Gossen), five soybean cultivars were evaluated in field trials for their yield response against five root pathogens: *Fusarium acuminatum, F. avenaceum, F. oxysporum, F. proliferatum* and *F. graminearum*. All field trials went according to plan except at Brandon in 2014 when the site was lost due to flooding. In 2014 at Morden, differences between the impact of the *Fusarium* spp. on root and shoot biomass were evident. Yields at harvest (2014) for both Brandon and Morden were not available due to unforeseen circumstances.

From 2015 to 2017, differences in seedling emergence, root rot severity, root and shoot biomass and seed yield were often observed among the soybean cultivars in each experiment at Brandon and Morden. One soybean cultivar frequently displayed higher emergence rates in five of the six site-years following the inoculation treatments. Shoot and root biomass also were reduced by inoculation with certain root pathogens in some of the soybean cultivars. During 2015 to 2017 at Saskatoon, seedling emergence was similar among cultivars and the inoculum treatments, and root rot severity was very low. In 2015, seed yield did not differ between inoculation treatments, but significant differences occurred among cultivars. In 2016, yield values were similar, disease severity was low and yields did not differ between cultivars and inoculum treatments. Percent dry matter data (shoots) from 2016 showed no differences among cultivars or the various inoculum treatments with similar results in 2017.

The impact of plant pathogens on root system morphology may result in decreased yield. Several root parameters were measured using an image analysis system (2016 and 2017) beginning with the cultivars LS004R21 and 24-10RY and the pathogens *Fusarium acuminatum, F. avenaceum, F. oxysporum, F. proliferatum* and *F. graminearum*. Root systems were scanned and digital image analysis was conducted. Yield was measured in field plots. Root morphology impacts varied among *Fusarium* spp. Inoculation of LS004R21 with *F. oxysporum* (2016 and 2017) reduced root length, root

diameter (2017 only) the number of root tips, the number of root forks and the number of crosses compared with the untreated control treatment. With 24-10RY, inoculation with *F. graminearum* (2016 and 2017) reduced the number of root tips and crosses, while *F. proliferatum* reduced root length, root diameter (2017 only), surface area and volume compared to the untreated control treatment. Some *Fusarium* spp. did not cause severe root rot symptoms in the field as compared to the untreated control, but still caused yield losses. It appears that detrimental effects on root morphological characteristics may be important indicators of yield loss.

Sub-activity 2.

Soybean root disease surveys in Manitoba 2013-2017: A total of 40, 41, 40, 40 and 106 commercial soybean fields were surveyed for root diseases in Manitoba in 2013, 2014, 2015, 2016 and 2017, respectively. Root rot was detected in all fields surveyed in each year. Using a scale of 0 (no disease) to 9 (death of plant), mean root rot severities (2013-2017) ranged from 2.2 to 5.6. In recent years, root rot has become more severe with an average severity of 2.2 (2012-2013) compared with 4.6 in the following four years (2014-2017). No survey data is available prior to 2012.

Fusarium root rot was detected in 2013, 2014, 2016 and 2017 in all fields (98% in 2015) that were sampled for root diseases. It has remained the most prevalent root disease of soybean for several years. In-depth studies on root pathogen identification were conducted for two years (2012 and 2017) in three different commercial soybean fields. A total of 1920 single-spore isolates were obtained and revealed nine (2012) and 10 (2017) different *Fusarium* spp., respectively. The following *Fusarium* spp. were common to both studies: *F. avenaceum, F. tabacinum, F. redolens, F. oxysporum, F. equiseti, F. acuminatum, F. graminearum* and *F. culmorum.*

Pathogenicity testing: A set of *Fusarium* spp. were screened for pathogenicity on soybean and rated using a severity scale of 0 to 9. An isolate of *F. avenaceum* was the most aggressive, followed by *F. oxysporum* and *F. graminearum.* Although many *Fusarium* isolates of other species were not as aggressive, the abundance of some of these less aggressive, but pathogenic isolates would have an impact on soybean productivity as part of the root rot complex. Generally, an average of three different *Fusarium* spp. were isolated from each symptomatic soybean root. An important finding from this research was the first identification of *Fusarium graminearum* as a cause of root rot in soybean in western Canada.

PCR-based assays were developed for specific *Fusarium* spp. and the quantitative PCR data showed significant variation in the concentration of *F. graminearum* among fields, as well as variation among years and geographical areas. Quantitative PCR analysis is a very useful tool for evaluation of *F. graminearum* inoculum loads, and demonstrated the spatial and temporal variation that exists in the levels of this pathogen. This sub-activity provided training for two postdoctoral fellows.

Detection of *Phytophthora sojae* in soybeans in western Canada: A survey of Manitoba soybean fields during 2014 to 2017 identified *P. sojae* in 25%, 3%, 38% and 28% of fields, respectively. Races from western Canada were identified (McLaren and Conner) based on the pattern of their reactions on a set of soybean differentials. In Manitoba, the most common races were 4, 25, 28 and 3. Two *P. sojae* isolates from Alberta were identified as races 4 and 28. In 2017, two

isolates of *P. sojae* were identified from Saskatchewan soybean fields and their race determination is ongoing. This project provided the first reports of *Phytopthora* spp. causing root rot of soybean in western Canada.

Completed report to be sent to stoms@saskpulse.com by March 30, 2018