2021 Pulse Agronomy Workshop

Day 1: Follow-up Questions

What is the potential for pulse crop expansion in the world with the disease pressure that exists with these crops?

Dr. Sabine Banniza, University of Saskatchewan:
All other crops also have disease pressures (think e.g., Fusarium Head Blight in wheat, clubroot in canola). The limiting factor in some countries may be lack of diversity or very short in crop rotations in particular when it comes to root rots.

Dr. Marie-Laure Pilet-Nayel, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (France):
Disease pressure exists on many species, which have nevertheless developed in the world. Efforts must continue to identify and combine methods to manage root diseases in pulse crops, which development is necessary worldwide for the protein supply and agroecological transition.

Is there research going on looking into GMO pulse varieties that you are aware of?

Dr. Sabine Banniza, University of Saskatchewan:
I don't think so. Before you can develop a GMO, you have to understand the genes that are involved, and we have only scratched the surface of that.

Dr. Marie-Laure Pilet-Nayel, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (France):
I am not aware of any research being done on pulse GMO varieties resistant to root diseases. Pulse crops are generally recalcitrant to the regeneration of transformed cells, so this research issue is not easy to address, additionally to the gene discovery issue. Moreover, GMO is not necessarily suitable for selecting complex genetic resistance.

Would you see any benefit from inoculants containing bacillus subtilis and does the "biofilm" provide the root protection from any of the pathogens discussed today?

Dr. Sabine Banniza, University of Saskatchewan:
Maybe, maybe not. There is a lot of ongoing research on potentially beneficial microbes to manage in particular Aphanomyces, but almost all of this is in the lab or growth chamber phase. And as Dr. Lyndon Porter explained, none of the available biologicals have convinced growers so far.

Is there research looking at root rot diseases from a total soil genome perspective? For example, what microbes are missing (pathogen antagonists) instead of what pathogen is present?

Dr. Sabine Banniza, University of Saskatchewan:
Yes, there are several studies underway to look at the microbiome where they are trying to compare field soils where there is a lot of root rot with that where there is little to see how the soil microbial communities differ. But again, they are at an early stage.

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
Yes, and there have been a couple of papers published recently on this topic, one from my group and one from Dr. Luke Bainard's group. So far, there was been no core microbiome discovered that separates a "healthy" soil from an "infested" soil. Also because of the nature of microbiome discovery using meta-barcoding, a lot of these studies actually miss Aphanomyces in the soil, because it is an oomycete, not a fungus, therefore a different "barcode" is needed to find it and other oomycetes. But if we use that barcode, then we'd miss the other organisms. So, we need more robust techniques for being able to discover the entire spectrum of organisms within a soil.

Regarding Fusarium spp., are they mainly spread through residue or are most soil-borne?

Dr. Sabine Banniza, University of Saskatchewan:
They can be spread through residue and will survive in the soil as saprophytes on organic matter.

How applicable do you think the EVA (Evaluation of Aphanomyces risk) tool is for producers here in Western Canada?

Dr. Anne Moussart, Terres Inovia (France):
The EVA tool has been developed using a database gathering information from 795 French fields with different inoculum potentials. French conditions are different from Canadian conditions, so the EVA tool is probably not adapted for producers in Canada.

It was mentioned that there is less impact of root rot disease today in France than 20 years ago. How long did it take for growers who stopped regularly growing peas to get comfortable to adopt them back as a regular part of their rotation?

Dr. Anne Moussart, Terres Inovia (France) &
Dr. Marie-Laure Pilet-Nayel, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (France):
It depends on the initial inoculum potential of their field, but about 15 years. In a heathy field soil, a minimum return frequency of 6 years is recommended in France to reduce the risk of diseases, in particular root diseases.

How long are spores present in the soil for?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
There's no hard and fast number, but past research estimates 6 to 10+ years, and is dependent on soil conditions.

Why is there higher seed production on canola stubble compared to cereal stubble?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
That appeared to be location-specific, as we didn't find the same result at the Lacombe and Saskatoon locations for this trial.

If spring 2022 is dry again will a seed treatment on yellow pea be recommended to aid in Fusarium suppression?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
Yes, there are better results with seed treatments against Fusarium, but seed treatments only target the early seed stage. Late-season Fusarium root rot can still occur even with a seed treatment. However, some species of Fusarium often occur on seed, so a seed treatment at least help with infection that starts due to inoculum on seed.

Regarding the saturated vs. not saturated soil experiment: Do you know anything about how the microbiome composition changes in general with the treatments you applied? Do you think this effect you observed with one pathogen but not the other could be due to differences in the abundances of particular members of the rhizosphere microbiome acting as potential inhibitors?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
In this case, the experiment was performed with autoclaved soil that presumably eliminates most microbes, and then re-inoculated with Aphanomyces and/or Fusarium avenaceum. So, the microbiome would not have played a role in the results we found in this greenhouse experiment. Under field conditions, there are likely different microbes that perform better under wet vs. dry condition that maybe contributing to more or less disease under conducive or non-conducive conditions!

As you are seeing some impacts with alternative pulses in rotation with some projects and sites - do you have any thoughts on the impact of soil fertility? Pulses in rotation may have better N and P in soils - could this impact plant health?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
Yes, this thought has crossed my mind - that some of the benefit we're seeing from including alternate pulses in a rotation may be due to residual N benefits. We have hundreds of soil samples collected and stored from these trials, and are just trying to find the time to process them all for nutrient and microbiome analysis.

Are there any early indications of what soil characteristics might be contributing to the disease-suppressive soils?

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
This does appear to be microbiome-related, as we did see more disease develop when soils were autoclaved (sterilized) compared to non-sterilized. So, this would indicate that the suppression is due to biological factors. I have sent some of these soils to a colleague at NRC for analysis of the microbiome, and results are pending. I can say that the couple of soils showing this behaviour did not have a history of growing pulses, but both had a history of applying compost/manure to soils.

With faba and chickpea being considered resistant to Aphanomyces, what impact do you think increasing these alternative pulse crops into rotation will have on root rot pressure as a whole given that they are all susceptible to Fusarium?

Dr. Sabine Banniza, University of Saskatchewan:
All pulse crops appear to be susceptible to Fusarium species, and these species obviously can infect the cereals as well. Therefore, replacing a chickpea or faba bean for a lentil or pea (both of which are also susceptible to the Fusariums) will probably not make a difference in terms of Fusarium pressure, unless certain strains of those Fusarium species are specialized, which is not very likely, at least with regard to the different pulse crops. With pea and lentil, you have to deal with Aphanomyces and Fusarium, with faba (probably) and chickpea you "only" have to deal with Fusarium.

How many Aphanomyces races have been identified in Saskatchewan?

Dr. Sabine Banniza, University of Saskatchewan:
So far, we have identified two pathotypes: the highly virulent pathotype I, which represents most of the isolates we tested, and a very few isolates of the less virulent pathotype III. However, there was a wide range of virulence among the isolates belonging to what we consider pathotype I, including isolates that were quite a bit more virulent than the international standard for pathotype I.

Dr. Porter mentioned different regions in the US having different key Fusarium spp. Is there any indication of localized differences also in Saskatchewan?

Dr. Sabine Banniza, University of Saskatchewan:
I think the species spectrum of Saskatchewan and Alberta is fairly similar to that of North Dakota, probably based on cropping systems, soil, and climate. Whether we have regional differences here in Saskatchewan is a good question. It would not surprise me considering the differences in soils and climate. Dr. Chatterton has some data on that as we surveyed across soil zones for Aphanomyces root rot for her project, so maybe she can comment. Other than that, I don't think anybody has looked at that in detail.

Dr. Syama Chatterton, Agriculture & Agri-Food Canada:
In the root rot surveys where we were looking at Fusarium species, we did see differences on a provincial scale, e.g., there was more *F. graminearum* and *F. culmorum* in Manitoba and Saskatchewan, and very little in Alberta, and this has to do with higher FHB prevalence in these provinces. We did also find some differences in prevalence of other species, like higher % prevalence of *F. solani* and *F. redolens* and *F. oxysporum* in Saskatchewan than in Alberta, in some years. However, I did not look into localized regional differences in Alberta or Saskatchewan by soil zone or climate, but it is entirely possible that this could occur. It may be time to revisit that data and re-analyze by soil zone!

Regarding the "cost prohibitive" seed treatment that worked for Aphanomyces - how expensive is it and will it possibly come down in price (patent expires)?

Dr. Lyndon Porter, USDA Agricultural Research Service:
The active ingredient in the seed treatment that has shown the best efficacy against Aphanomyces root rot is hymexazol. I am not sure why it is so expensive to produce, but the cost has not come down in years and is therefore not anticipated to come down in the future. I am not aware of any patent that is expiring. The product is used to manage Aphanomyces root rot on beets under the brand name Tachigaren 70WP. Beet seed is small enough that it is not cost prohibitive to treat large amounts of beet seed with the product. Last time I calculated the cost for peas it was well over $1,000 to treat 100 pounds of seed. The current price for 250 milligrams of hymexazol is around $383.

What are the soil levels that would be associated with higher risk for pulses nematodes? What are the cut-off growers can use for deciding whether fields are higher risk? Is there anything that can be done to control nematodes?

Dr. Lyndon Porter, USDA Agricultural Research Service:
Field research still needs to be conducted to determine economic threshold levels associated with each parasitic nematode species impacting the different pulse crops in the US. In North Dakota, our principal pea production area in the US, seven plant parasitic nematodes species have been found to impact the peas. Each species would likely have a different economic impact level. In greenhouse studies, it was determined that three nematodes (Pratylenchus neglectus, Pratylenchus thornei and Paratylenchus hamatus) impacting pea and lentil production in Idaho reduced plant height in comparison with controls an average of 50 to 70% when the soil was infested with 500 nematodes per 250 grams of soil. *(continues on next page)*

(continued from previous page) In many fields where nematodes have been considered to be the primary factor contributing to field loss, nematode levels were often found above this 500 nematode per 250 grams of soil level. However, field threshold levels still need to be established. Cultivars can vary greatly in their susceptibility to nematodes, so thresholds also need to be identified for each pulse cultivar. The principle economical means to control nematodes under dryland cropping systems will be to develop seed treatments, resistant cultivars, crop rotations, and identify potential green manure cover crops that could be incorporated into the soil to manage nematodes. Currently there is a seed treatment called Avicta developed by Syngenta that contains the active ingredient abamectin that provides protection against a broad spectrum of plant parasitic nematodes. This product is currently only registered for use on corn, soybean, and cotton but may become available for peas, chickpeas, and lentils in the future. I am not aware of breeders currently selecting for nematode resistance in our pulses. Crop rotations that reduce the counts of pulse-impacting nematodes needs to be determined. Incorporating green manure cover crops, such as mustards containing high levels of glucosinolates (natural fumigants) has been used to try to manage nematodes but has shown mixed results and is not a common practice in the US pulse-growing regions at this time. Commercial fumigants are available to manage nematodes, but they are cost-prohibitive in dryland pulse production.

It was mentioned Fusarium/Pythium are greater in soils that are compacted (by rolling). Have growers being trying to avoid rolling or implementing other management strategies to reduce impacts of compaction such as deep tillage or controlled traffic?

Dr. Lyndon Porter, USDA Agricultural Research Service:
Soil that is compacted year after year may have more Pythium and Fusarium in them because the plants growing under those conditions are more likely to become infected and contribute to the pathogen load in the soil. Compaction also favors the development of root rot caused by Pythium and Fusarium by doing the following things:

1) Reduces or slows plant emergence that can favor infection, particularly for Pythium.
2) Restricts root development and growth that can stress the plant.
3) Lowers oxygen in root zone which can stress the plant and make it more susceptible.
4) Restricts water percolation which can favor an environment for infection, particularly for Pythium.

Grower that are doing conventional tillage may choose on occasion to do deep tillage to break up compacted soil or a hard pan that has developed. Mostly we have just made growers aware that if they do not need to roll, often there is no need to compact the soil to improve seed/soil contact. If you are also growing upright varieties with minimal risk of lodging, you may also choose not to roll the soil because you are not as concerned about an uneven field to harvest from.