# 43rd Annual Meeting of the Western Committee on Plant Disease

## Thursday, October 18th, 2018

## Days Hotel & Suites, 5411-44th Street, Lloydminster, AB

## Pulse Disease Situation Report & Research Update


## H. Derksen & S. Chatterton


## Manitoba

**Summary of diseases diagnosed on pulse crop samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 2018**


Submitted by Manika Pradhan, Manitoba Agriculture


**Table 1.** Diseases diagnosed on pulse samples submitted to the MB AG Crop Diagnostic Centre (2018)

| CROP | SYMPTOM/ DISEASE | CAUSAL AGENT | NUMBER OF SAMPLES |
|---|---|---|---|
| Dry bean | Common blight | *Xanthomonas axonopodis* pv. *phaseoli* | 1 |
| | Root rot | *Fusarium oxysporum;* F. species | 2 |
| | General stress | Environmental | 1 |
| Fababean | Alternaria leaf spot | *Alternaria alternata* | 3 |
| | Anthracnose | *Colletotrichum* sp. | 1 |
| | Chocolate spot | *Botrytis sp.* | 1 |
| | Root rot | *Fusarium* sp. | 2 |
| | General stress | Environmental | 3 |
| | Herbicide injury | | 1 |
| Field pea | Alternaria leaf spot | *Alternaria* sp. | 1 |
| | Root rot | *Aphanomyces* | 1 |
| | Root rot | *Fusarium* sp. | 9 |
| | Root rot complex | *Fusarium* sp*., Rhizoctonia* sp. *Pythium* | 4 |
| | General stress | Environmental | 1 |
| | Nutrient deficiency | Undetermined | 1 |
| | Herbicide injury | | 6 |
| Lentil | Herbicide injury | | 1 |
| Soybean | Alternaria leaf spot | *Alternaria* sp. | 10 |
| | Anthracnose | *Colletotrichum* sp. | 6 |
| | Bacterial blight | *Pseudomonas* sp. | 7 |
| | Brown spot | *Septoria glycines* | 7 |
| | Downy mildew | *Peronospora manshurica* | 5 |
| | Leaf spot | ***Cercospora*** *kikuchii* | 1 |
| | Pod and seed rot | *Phomopsis* sp. | 2 |

| | | |
|---|---|---|
| Root rot | *Fusarium* sp., *Pythium* sp*., Rhizoctonia solani* | 42 |
| Root rot | *Phytophthora* sp*.* | 8 |
| Stem and flower blight | *Phomopsis* sp*.* | 4 |
| Stem rot | *Sclerotinia sclerotiorum* | 2 |
| General stress | Environmental | 40 |
| General stress | Physiological | 4 |
| Nutrient deficiency | Undetermined | 12 |
| Herbicide injury | | 25 |

**2018 SOYBEAN DISEASE SURVEY – FOLIAR DISEASES**

Fields surveyed by Manitoba Agriculture and Manitoba Pulse & Soybean Growers Association.
Summary prepared by Manitoba Pulse and Soybean Growers.

A soybean disease survey was conducted in 95 fields across Manitoba at two different crop stages. Crops were initially assessed at the R3 stage in mid-July and the same fields were assessed at the R6 stage in mid- to late August. Crops were assessed for the presence of bacterial blight, Septoria brown spot, downy mildew, white mould, pod/stem blight (Phomopsis), anthracnose, and frogeye leaf spot. Disease severity was measured for bacterial blight, Septoria brown, and downy mildew. At both survey timings, incidence of suspected Phytophthora root rot infection was also noted, and plant samples were collected for Dr. Debra McLaren, Agriculture and Agri-Food Canada. The results of the plant collections are reported in the section submitted by Dr. McLaren.

At the early survey timing, bacterial blight was the most prevalent disease, found in 93% of the 95 soybean fields surveyed across the province. Septoria brown spot was also highly prevalent, found in 91% of fields. Downy mildew was found in at least one field in all regions. As for stem diseases, white mould was not detected in any fields at the early timing, but pod/stem blight was detected in the eastern/Interlake and northwestern regions. Summarized results of all diseases at the early timing can be found in Table 2.

At the late survey timing, bacterial blight prevalence remained the same as the early timing. Septoria brown spot and downy mildew were again found in all regions and detected in 70% and 28% of fields, respectively. A lower percentage of fields had brown spot at the late timing due to advanced crop maturity, which prevented accurate disease assessment. This advanced maturity was caused by a lack of precipitation throughout the growing season in most regions. White mould was present in 3% of fields at the late timing and found only in the northwest region. Low white mould prevalence was also likely due to dry conditions. Pod/stem blight increased to only 4% at the late timing but was detected in the central and eastern/Interlake regions. Anthracnose prevalence of 2% remained the same at both timings, whereas frogeye leaf spot prevalence increased by 31% between the early and late timings. Finally, 18% of fields had suspected infection by Phytophthora root rot. Note that confirmation of Phytophthora root rot diagnosis is ongoing. Summarized results of all diseases at the late timing are presented in Table 3.

**Table 2.** Manitoba soybean disease survey early timing results of all diseases in 2018.

| Region (No. of fields) | Bacterial Blight | | | Septoria Brown Spot | | | Downy Mildew | | | White Mould | | Pod/Stem Blight | | Anthracnose | | Frogeye Leaf Spot | | Suspected PRR | | Root Rot | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) |
| Central (35) | 83% | 63% (57%) | 1.7 | 86% | 63% (57%) | 1.4 | 17% | 15% (3%) | 1.0 | 0% | 0% (0%) | 0% | 0% (0%) | 6% | 8% (0%) | 9% | 9% (1%) | 14% | 12% (2%) | 23% | 4% (1%) |
| Eastern/Interlake (29) | 97% | 74% (74%) | 1.3 | 97% | 74% (74%) | 1.0 | 10% | 3% (0%) | 1.3 | 0% | 0% (0%) | 7% | 5% (0%) | 0% | 0% (0%) | 14% | 6% (1%) | 3% | 18% (1%) | 52% | 5% (2%) |
| Northwest (8) | 100% | 74% (74%) | 1.2 | 100% | 74% (74%) | 1.7 | 38% | 23% (9%) | 1.1 | 0% | 0% (0%) | 13% | 4% (1%) | 0% | 0% (0%) | 0% | 0% (0%) | 13% | 44% (6%) | 0% | 0% (0%) |
| Southwest (23) | 100% | 17% (15%) | 1.4 | 87% | 17% (15%) | 1.2 | 39% | 17% (7%) | 1.1 | 0% | 0% (0%) | 0% | 0% (0%) | 0% | 0% (0%) | 22% | 5% (1%) | 4% | 20% (1%) | 13% | 4% (1%) |
| Manitoba (95) | 93% | 57% (54%) | 1.5 | 91% | 57% (54%) | 1.3 | 22% | 16% (4%) | 1.1 | 0% | 0% (0%) | 3% | 5% (0%) | 2% | 8% (0%) | 13% | 6% (1%) | 8% | 18% (2%) | 27% | 4% (1%) |

[1]Average percent prevalence across all fields surveyed.
[2]Average percent incidence in infected fields.
[3]Average percent incidence across all fields surveyed.
[4]Average disease severity in infected fields.

**Table 3.** Manitoba soybean disease survey late timing results of all diseases in 2018.

| Region (No. of fields) | Bacterial Blight | | | Septoria Brown Spot | | | Downy Mildew | | | White Mould | | Pod/Stem Blight | | Anthracnose | | Frogeye Leaf Spot | | Suspected PRR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Sev[4] | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) | Prev[1] | Inc[2] (Inc[3]) |
| Central (34) | 88% | 77% (77%) | 2.0 | 65% | 60% (57%) | 1.6 | 35% | 22% (9%) | 1.5 | 0% | 0% (0%) | 6% | 3% (0%) | 3% | 12% (0%) | 59% | 8% (5%) | 29% | 7% (2%) |
| Eastern/Interlake (29) | 100% | 56% (56%) | 1.2 | 86% | 84% (72%) | 1.2 | 17% | 52% (9%) | 0.6 | 0% | 0% (0%) | 7% | 3% (0%) | 3% | 2% (0%) | 28% | 3% (1%) | 17% | 12% (2%) |
| Northwest (9) | 89% | 76% (68%) | 1.6 | 44% | 49% (33%) | 1.5 | 56% | 52% (29%) | 1.4 | 33% | 8% (3%) | 0% | 0% (0%) | 0% | 0% (0%) | 11% | 2% (0%) | 22% | 32% (7%) |
| Southwest (24) | 92% | 64% (64%) | 1.4 | 67% | 50% (44%) | 1.2 | 21% | 44% (10%) | 1.2 | 0% | 0% (0%) | 0% | 0% (0%) | 0% | 0% (0%) | 54% | 10% (6%) | 0% | 0% (0%) |
| Manitoba (96) | 93% | 67% (66%) | 1.6 | 70% | 66% (58%) | 1.4 | 28% | 37% (11%) | 1.3 | 3% | 8% (0%) | 4% | 3% (0%) | 2% | 7% (0%) | 44% | 8% (3%) | 18% | 12% (2%) |

[1]Average percent prevalence across all fields surveyed.
[2]Average percent incidence in infected fields.
[3]Average percent incidence across all fields surveyed.
[4]Average disease severity in infected fields.

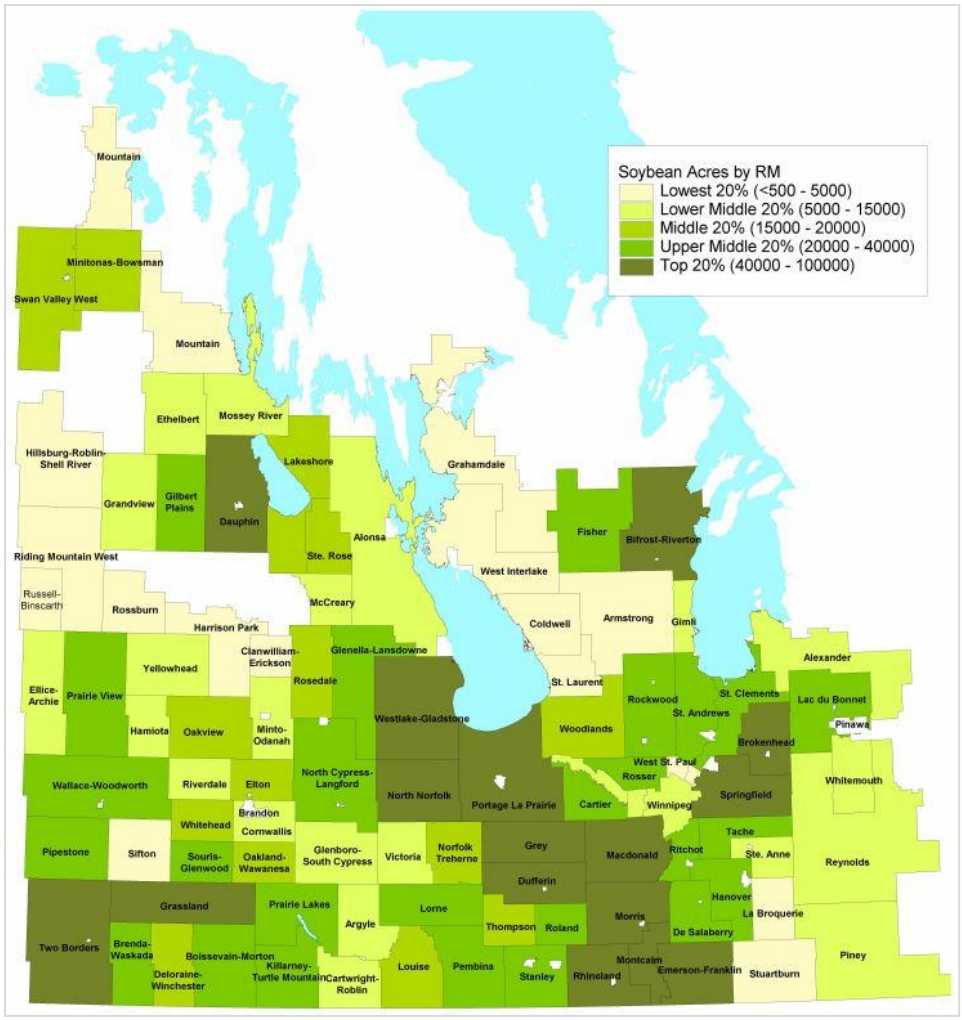


**Figure 1.** Soybean acres across Manitoba in 2017 used to select fields for the 2018 soybean disease survey. Source: Manitoba Agricultural Services Corporation (MASC).

## 2018 Root disease surveys of dry bean, field pea and soybean and Phytophthora root rot in Manitoba

Submitted by: D.L. McLaren, Y.M. Kim, R.L. Conner, H. Derksen, K.F. Chang, S.F. Hwang, T.L. Henderson, W.C. Penner, M.J. Thompson, D.B. Stoesz, T.J. Kerley, L. Stevenson, C. Tkachuk, and K. Brown-Livingston.

DRY BEAN

- During mid- to late-July, crops of dry bean were surveyed for root diseases at 40 different locations.
- Fusarium root rot (*Fusarium* spp.) was detected in all the crops that were sampled for root diseases with root rot ratings ranging from 2.8 to 6.4 and a mean of 4.6 on a 0-9 scale.
- Rhizoctonia root rot (*Rhizoctonia solani*) was detected in one of the crops surveyed at trace levels.
- The prevalence of halo blight (*Pseudomonas syringae* pv. *phaseolicola*) was assessed during the root disease survey in 40 crops and was observed in four crops with a disease incidence with a range from 5% to 15% and a mean of 7%.

- During mid-August, foliar diseases were assessed at 40 different locations and symptoms of common bacterial blight (*Xanthomonas axonopodis* pv. *phaseoli*) were observed in all of the surveyed crops. On a scale of 0-5, CBB severity ranged from 0.7 to 4.3 with a mean of 2.3.
- Bean anthracnose (*Colletotrichum lindemuthianum*) was not observed in 2018.
- Rust (*Uromyces appendiculatus)* symptoms were detected in three of the crops surveyed with a range from 5.0% to 11.7% and a mean of 8.3%.
- White mould (*Sclerotinia sclerotiorum*) symptoms were observed in one crop with a disease severity of 1%, based on percentage of plant tissue (stems and pods) infected.

FIELD PEA

- Crops of field pea were surveyed at 45 locations in Manitoba for root diseases during late-June (40) to late-July (5).
- Root rot was observed in every crop and disease severity ranged from 1.5 to 4.9 with a mean of 3.1.
- The most prevalent disease was Fusarium root rot (*Fusarium* spp.), which was detected in all crops that were sampled for root diseases.
- Plant samples were sent to Dr. Syama Chatterton's lab for *Aphanomyces euteiches* assessment; results will be available at a later date.
- Pea foliar diseases were surveyed at 44 locations during mid- to late-July when most plants were at the intermediate to round-pod stage.
- The most prevalent disease was mycosphaerella blight (*Mycosphaerella pinodes*), which was observed in all crops. Disease severity ranged from 2.3 to 8.6 with a mean of 4.9.
- Rust (*Uromyces viciae-fabae*) symptoms were observed in 39% of the crops (17/44) surveyed and disease severity (percentage of leaf area infected) ranged from trace to 1.4%.
- Downy mildew (*Peronospora viciae*) was assessed from plant samples collected and was identified in 16% of the crops (7/44) with a mean disease incidence of 16.2% in these fields. The percentage of leaf area infected ranged from trace to 1%.
- Bacterial blight (*Pseudomonas syringae* pv. *pisi*), anthracnose (*Colletotrichum pisi*) and white mould (*Sclerotinia sclerotiorum*) were not observed in any of the crops surveyed in 2018.

SOYBEAN

- Crops of soybean were sampled by Manitoba Agriculture at 95 locations in the province during mid-July to early-August.
- Plant samples from surveyed crops were submitted to AAFC-Brandon (66) and AAFC-Morden (29) for root rot ratings.
- Root rot was detected in all 95 of the AAFC surveyed crops and disease severity ranged from 3.4 to 7.3 with a mean of 4.6.
- The most prevalent root disease was Fusarium root rot (*Fusarium* spp.), which was detected in samples from all of the 42 crops that were assessed for root pathogens in the laboratory.
- Ninety-five crops that were surveyed for root rot and one additional crop were assessed in mid-July to late-August for phytophthora rot by AAFC, Manitoba Agriculture, and Manitoba Pulse & Soybean Growers. Soybean plants that were suspected of having phytophthora rot were

collected from 41 of 96 Manitoba fields for assessment in the laboratory. Approximately, sixty-eight percent (28/41) of fields had plant sample(s) from which *Phytophthora* spp. were isolated on cultural media.

- Molecular detection and identification methods will be applied to confirm the identify of *Phytophthora sojae* from the surveyed crops.
- Race identification of *Phytophthora* isolates will begin shortly at both AAFC-Brandon and AAFC-Morden.

## Saskatchewan

**Saskatchewan Ministry of Agriculture Crop Protection Laboratory, 2018**

Submitted by: Barbara Ziesman, Carter Peru, and Scott Hartley, Ministry of Agriculture (Saskatchewan Ministry of Agriculture)

**Table 4.** Diseases diagnosed on pulse samples submitted to the SK Ministry of Ag Crop Protection Lab (2018)

| Special Crop Sample Diagnoses | Details / Scientific Name | Number |
|---|---|---|
| **Chickpea** | | **11** |
| Fusarium root rot or fusarium wilt | *Fusarium* spp. | 10 |
| Root rot complex | Including an oomycete | 1 |
| **Fababean** | | **1** |
| Chocolate Spot and ascochyta leaf spot | *Botrytis* spp. and *Ascochyta* spp. | 1 |
| **Field Pea** | | **22** |
| Root Rot Complex | Including *Fusarium* spp. | 13 |
| | Including *Fusarium* spp. and oomycete(s) | 2 |
| | Including oomycete(s) | 7 |
| **Lentil** | | **17** |
| Environmental stress | wind | 1 |
| Root Rot Complex | Including *Fusarium* sp. | 5 |
| | Including oomycete(s) | 9 |
| | Including *Fusarium* spp. and oomycete(s) | 1 |
| Anthracnose | *Colletotrichum truncatum* | 1 |
| **Soybean** | | **2** |
| Stem canker | *Diaporthe phaseolorum* | 1 |
| Stem canker and fusarium root rot | *Diaporthe phaseolorum* and *Fusarium* spp. | 1 |

**Pulse Disease Situation Report**

Submitted by: Barbara Ziesman, Carter Peru, and Scott Hartley, Ministry of Agriculture (Saskatchewan Ministry of Agriculture)

General Comments:

According to the Saskatchewan Ministry of Agriculture's Crop Report (ending October 1, 2018), 73% of the 2018 crop has been combined. This is slightly behind the five year (2013 – 2017) average of 78% for this time. As of October 1st, 29% of the soybeans, 78% of chickpeas, 97% of peas and 98% of lentils have been combined.

Yields vary across the province depending on the moisture received but estimates are considered to be around average overall. Snow and rain in some areas in late in September have resulted in reduced crop quality (Saskatchewan Agriculture's weekly crop report ending October 1, 2018).

According to the Saskatchewan Agriculture's weekly crop report ending on September 10, 2018 pea grades were 50% 1 CAN, 46% 2 CAN, and 4% 3 CAN. Grades were reported when 94% of the peas had been harvested. Lentil grades, as of September 10, were 46 per cent 1 CAN, 49% CAN, 5% 3 CAN. Grades were reported when 96% of the crop had been harvested.

Rust was reported to be present in pea crops across the province this year. However, no formal survey was conducted to determine the prevalence, incidence or severity of this disease across in Saskatchewan in 2018.

**Saskatchewan Ministry of Agriculture Lentil Disease Survey**

Submitted by: Barbara Ziesman, Carter Peru, and Scott Hartley, Ministry of Agriculture (Saskatchewan Ministry of Agriculture)

A total of 70 lentil field were surveyed for the presence and incidence of disease in Saskatchewan. The survey was completed between July 18 and August 21 and ranged in staging from mid-pod to approximately 30% moisture content (desiccation stage). The number of surveyed crops was highest in the Southwest with 32 of the 70 crops surveyed located in this region. The distribution of the surveyed crops across the rest of the province was as follows: 9 (southeast), 11 (East-central), 15 (West-central) and 3 (Northwest) lentil crops. Disease assessments were made by examining 10 plants from each of 10 sites along a W-pattern in each field. Individual sites were located at least 50 m from the field edge and at least 50 m apart. Crops were assessed for the incidence of anthracnose (*Colletotrichum truncatum)*, ascochyta blight (*Ascochyta* lentis), sclerotinia stem and pod rot (*Sclerotinia sclerotiorum*), botrytis stem and pod rot (*Botrytis cinerea*) and stemphylium blight (*Stemphylium* spp.) and the prevalence of root rot complex (*Fusarium* spp / *Pythium* spp. / *Rhizoctonia solani* / *Aphanomyce euteiches*) and all previous listed diseases. Incidence is calculated as the percentage of plants assessed (out of 100 plants total per crop) with symptoms of the disease, while prevalence is a measure of the presence or absence of the disease in the field.

For the lentil crops surveyed, the reported crop health conditions ranged from poor to very good. Approximately 44% of the surveyed crops were reported to be of good to very good crop health. In

some crops there was evidence of other environmental stress including moisture and heat stress with 24% and 20% of the surveyed crops affected, respectively.

Anthracnose was the most prevalent disease in 2018 and was identified in 74% of the surveyed crops with an average incidence of 26%. Both the prevalence and incidence of anthracnose were highest in the Southwest (84% and 36% respectively).

Root rot complex symptoms were present in 57% of the surveyed crops with the highs prevalence occurring in the South east (89%) and West-central (12%).

The levels of the other diseases were generally low in all areas, which is largely due to drier conditions across much of the traditional lentil growing region. Botrytis stem and pod rot symptoms were not identified in any of the surveyed crops. While, sclerotinia stem and pod rot was present in 7% of fields and stemphylium blight has a prevalence of 16%.

**Table 5.** Disease incidence in Saskatchewan lentil crops surveyed in 2018 (Saskatchewan Ministry of Agriculture)

| Region[2] | Incidence of disease (%) (Incidence in only infected fields)[2] | | | | |
|---|---|---|---|---|---|
| | **Anthracnose** | **Ascochyta blight** | **Sclerotinia stem and pod rot** | **Botrytis stem and pod rot** | **Stemphylium Blight** |
| **SW** | 36 (43) | <1 (3) | <1 (3) | 0 | <1 (4) |
| **SE** | 14 (43) | <1 (1) | 0 | 0 | <1 (3) |
| **EC** | 14 (19) | 0 | 1 (16) | 0 | 0 |
| **WC** | 22 (30) | <1 (2) | 2 (17) | 0 | 1(4) |
| **NE** | 10 (10) | 0 | 0 | 0 | <1 (2) |
| **Overall** | 26 (35) | <1 (2) | <1 (11) | 0 | <1 (4) |

[1]Region: SW – Southwest, SE – Southeast, WC – West-central, EC – East-Central, NE – North-central
[2]Average incidence of disease for all crops surveyed (disease incidence averaged across only crops with disease symptoms)

**Table 6.** Prevalence of disease in Saskatchewan lentil crops surveyed in 2018 (Saskatchewan Ministry of Agriculture)

| Region[1] | Number of Fields surveyed | Per cent prevalence (number of fields with symptoms) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Root rot complex | Anthracnose | Ascochyta blight | Sclerotinia stem and pod rot | Botrytis stem and pod rot | Stemphylium Blight |
| **SW** | 32 | 50(16) | 84 (27) | 6 (2) | 6 (2) | 0 | 13 (4) |
| **SE** | 9 | 89 (8) | 33 (3) | 11 (1) | 0 | 0 | 22 (2) |
| **EC** | 11 | 36 (4) | 73 (8) | 0 | 9 (1) | 0 | 0 |
| **WC** | 15 | 80 (12) | 73 (11) | 13 (2) | 13 (2) | 0 | 27 (4) |
| **NE** | 3 | 0% | 100 (3) | 0 | 0 | 0 | 33 (1) |
| **Overall** | 70 | 57 (40) | 74 (52) | 7 (5) | 7 (5) | 0 | 16 (11) |

[1]Region: SW – Southwest, SE – Southeast, WC – West-central, EC – East-Central, NE – North-central

**2018 Survey of soybean in southeast Saskatchewan for Phytophthora rot**

Submitted by: D.L. McLaren, Y.M. Kim, S. Phelps, S. Roberts, M. Wigness, E. Moats, R.L. Conner, T.L. Henderson, , M.J. Thompson, and T.J. Kerley.

The soybean acres in Saskatchewan have increased in the past three years with 850,000 acres in 2017. The acreage in 2017 represents a huge increase from 230,000 acres in 2016. As this is a relatively new crop for Saskatchewan growers and phytophthora rot was identified in Manitoba soybean crops, expanding the survey into southeast Saskatchewan was of interest and it occurred in 2017 and 2018. The purpose of the survey was to identify the incidence of phytophthora rot in soybean in Saskatchewan and the potential identification of the races present.

SOYBEAN

- Plant samples from 20 crops of soybean were collected (early to late August) and shipped to AAFC-Brandon to be assessed for root rot.
- Root rot was observed in every crop and disease severity ranged from 2.8 to 5.3 with a mean of 4.2.
- Plant samples from 15 crops of soybean were collected (late July to late August) and shipped to AAFC-Brandon to be assessed for phytophthora rot.
- One plant from 15 fields (1/15) tested positive on cultural media as a *Phytophthora* spp.
- Molecular detection and identification methods will be applied to confirm the presence of *Phytophthora sojae* from the plant.
- From 2017 plants, two isolates from two fields were confirmed to be *Phytophthora sojae* by molecular identification.
- Race identification of *Phytophthora* isolates will begin shortly at AAFC-Brandon for the Saskatchewan isolates.

**Survey for root rot of field pea in Saskatchewan in 2018**

Submitted by Syama Chatterton, Christine Vucurevich, Michelle Hubbard, and Bruce Gossen

Twenty-five pea crops were surveyed for root rot in July 2018 in Saskatchewan. Roots from ten sites/field were dug up, and shipped to Lethbridge for rating, where they were washed and assigned a visual score for disease rating (1=healthy up to 7=dead).

Root rots were once again widespread in pea crops in SK in 2018, as 100% of pea crops surveyed had root rot. Root rot incidence and severity was slightly lower than in previous years at 85% and 2.8, respectively. Root rot severity ranged from 1 – 6.6.

Pathogen presence is currently being screened using PCR assays, but root rot symptoms observed were primarily characteristic of *Fusarium* spp., and/or *Aphanomyces euteiches*. Soils were also collected from select fields that showed variable levels of root rot, and will be tested to see how well our prediction of root rot risk, based on soil DNA analysis, matches the levels of root rot actually observed in the field.

**Pulse Pest Summary – Saskatchewan Pulse Growers**

Submitted by Sherrilyn Phelps, Agronomy Manager

LENTIL

Acres of lentils in Saskatchewan dropped approximately 575,000 acres from 3.9 M in 2017 to 3.3 M in 2018. Due to drop in red lentil prices there was a significant decrease in number of red lentil acres and increase in greens and blacks.

Overall foliar disease pressures were low in lentils in Saskatchewan in 2018 with drier conditions in main lentil growing areas of the province. Anthracnose on pods was suspected later in the season leading to browning and lack of pod fill is a few fields. Many lentil growers did spray fungicide at least once as a preventative measure, but second fungicide applications were not as common due to weather conditions not conducive for disease development. There were some root rot symptoms noticed, but no confirmation on significant yield loss.

Environmental impacts such as lack of moisture, heat banding, high temperature stress (bleaching), and hail damage were larger concerns for lentil growers in 2018.

Seed quality for planting in 2018 was good with highest frequency of disease free samples in last 5 years from four seed test labs. Seed quality from 2018 growing season is expected to be good as majority of lentils came off prior to the wet weather in September.

Insect issues were minimal in lentil for 2018.

PEA

Pea acreage dropped 230,000 acres to 1.9 M acres in 2018 which is compared to the acreage in 1998 (20 years ago). Lower prices and root rot issues are the main drivers for the drop in acreage.

In 2018 the overall foliar disease pressure was low in peas in Saskatchewan. However, root rots continue to be an issue despite the drier spring. Root rot was observed in peas across the province with majority of the reports from the northern areas of Saskatchewan. Yellowing and stunting of plants was noticeable in some fields with obvious root rots on the below ground portions even though conditions were fairly dry in spring. In some cases, fields with peas in 6 to 8 year rotations were also showing root rot symptoms suggestion longer rotations are needed for areas more prone to disease. Symptoms were greatly reduced on fields with extended pea rotations (>8 years). One field in EC region was worked

down due to severity of root rots and had been out of peas for 9 years. Top dressing fields with nutrients (N, micros) did seem to help them recover but yields were lower than healthy fields.
Minimal concerns were brought up with foliar disease in field peas. Fields may have received a first fungicide application as a precautionary measure, but second fungicide applications were very limited.
Rust was identified in pea plots in the Saskatoon area in July.
Pea leaf weevils were a concern in SW Saskatchewan going into the spring but based on the PLW risk maps. However there were few calls regarding high levels of PLW infestations in peas.

FABA BEAN

Faba bean acres in 2018 dropped to 34,300 in Saskatchewan which is very similar to Alberta acres of 34,700. Drier conditions during the growing season lead to low disease pressure in 2018.
Easy disease symptoms were found as lesions lower in the canopy in June from NE Saskatchewan and samples sent away for analysis to Crop Protection Lab in Regina. Samples were confirmed with Alternaria but no chocolate spot or ascochyta. It was suggested the lesions may have been environmentally related and Alternaria set in after the initial injury.
Chocolate spot in faba beans was once again noted in fields but disease incidence was not severe. Applications of fungicide did occur with some growers targeting early applications at early flower and others waiting until they saw the disease which meant they sprayed at later stages such as early to mid podding. Some growers opted not to spray fungicide as conditions were drier. At late podding stages it was easy to find chocolate spot lesions in all fields. Benefits of fungicide applications needs to be better understood along with when is appropriate timing. Risk of chocolate spot and ability to monitor disease development would be beneficial.
Aphids were found in faba bean fields once again but not in extreme numbers. Pea leaf weevil questions were received for faba beans but no incidence of infestations were reported.

CHICKPEA

Chickpea acres increased dramatically from 160,000 in 2017 to over 360,000 in 2018 due to attractive prices in chickpeas and lower pricing in other pulse crops. Despite the dry condition in 2018 disease management continues to be the main pest concern with chickpeas. How many fungicide applications are needed with the newer varieties is a gap in the research. Environmental damage was a concern for growers in 2018 with hail reported on a number of acres. Despite the lower disease pressure in 2018 chickpeas were sprayed multiple times (2-3 most common) with fungicides. Fusarium wilt was diagnosed in at least one chickpea field around Kenaston in 2018.
Reports of chickpea pods being nipped off and then the pods chewed and seed removed were likely result of rodents (voles, mice) or grasshoppers. No confirmation on actual predator was received.
Acres of chickpea flax intercrop increased in 2018 and estimates of 20,000 acres have been suggested. Intercrop is being used as a strategy to mitigate ascochyta as well as shorten maturity.

SOYBEAN

Acres dropped from 850,000 in 2017 to 450,000 in 2018. With the drier conditions in 2018 there was little disease issues reported.
Soybeans showing signs of yellowing later in the season were showing signs of root rot and possible phytophthora. However, samples sent for analysis showed very low incidence of phytophthora (1 out of

15 samples to date, McLaren report). Environmental damage from hail and fall frost, as well as iron deficiency chlorosis were reported in select areas.
No insect pest issues were reported in 2018 on soybeans.

DRY BEAN

Dry beans acres under dryland production increased dramatically in Saskatchewan in 2018 and were suggested to hit 4000 acres. Irrigated dry beans continue to be the main acreage at 8000 to 10000 acres. Yields were very good with little disease or insect concerns. Bacterial wilt was identified in a field of black beans.

**2018 Saskatchewan Chickpea Ascochyta Blight Survey**

Fields surveyed by Troy McInnis of Prairie Plains Agro, Moose Jaw, Michelle Hubbard of Agriculture and Agri-Food Canada and Shannon Chant, Crop extension specialist with the Government of Saskatchewan, Swift Current.
Summary prepared by Michelle Hubbard, Research Scientist in Pulse Pathology, Agriculture and Agri-Food Canada, Swift Current.

The survey was conducted towards the end of the 2018 growing season in chickpea fields in Saskatchewan. Only fields showing symptoms consistent with Ascochyta blight were surveyed. Pods had formed on the chickpeas surveyed. The survey aimed to report disease severity, to confirm the presence of *Ascochyta rabiei*, the causal agent of Ascochyta blight in chickpeas, and to determine if the pathogen was sensitive to strobilurin fungicides. These latter two objectives were met by extracting DNA from the sample and running a polymerase chain reaction (PCR) to detect strobilurin-sensitive or strobilurin-resistant *A. rabiei* (Delgado et al. 2013). Data on precipitation data and agronomic practices such as crop rotation and fungicide applications was also collected. Three random locations were survey in each field for disease severity. An average of these three ratings was taken. For some fields, only one sample saw collected for DNA extractions, while three samples were collected for this purpose from other fields.

Likely due to the dry conditions in south western Saskatchewan in 2018, all the fields surveyed had moderate disease pressure. Resistance to strobilurin fungicides was found in all fields. All the chickpea fields surveyed were planted to Kabuli type chickpeas. Table 7 summarizes the results. Figure 2 shows the approximate locations of the fields surveyed.

**Table 7.** Summary of 2018 survey of Ascochyta blight in chickpea in Saskatchewan.

| Field # | Mean disease severity for field (0-9) | Total precipitation for 2018 to date (mm) | Years since last chickpea crop | # of fungicide applications | # of strobilurin fungicide applications | *Ascochyta rabiei* confirmed | Strobilurin resistance detected | Strobilurin sensitivity detected |
|---|---|---|---|---|---|---|---|---|
| 1 | 4.0 | 200 | ≥4 | 6 | 2 | Yes | Yes | No |
| 2 | 4.7 | 192 | ≥4 | 4 | 2 | Yes | Yes | No |
| 3 | 5.3 | 200 | ? | 4 | 2 | Yes | Yes | No |
| 4 | 4.0 | 84 | 2 | 4 | 3 | Yes | Yes | No |
| 5 | 2.3 | 155 | 2 | 4 | 2 | Yes | Yes | No |
| 6 | 3.3 | 155 | 2 | 4 | 2 | Yes | Yes | No |
| 7 | 3.3 | 127 | ≥5 | 4 | 2 | Not yet assessed | Not yet assessed | Not yet assessed |

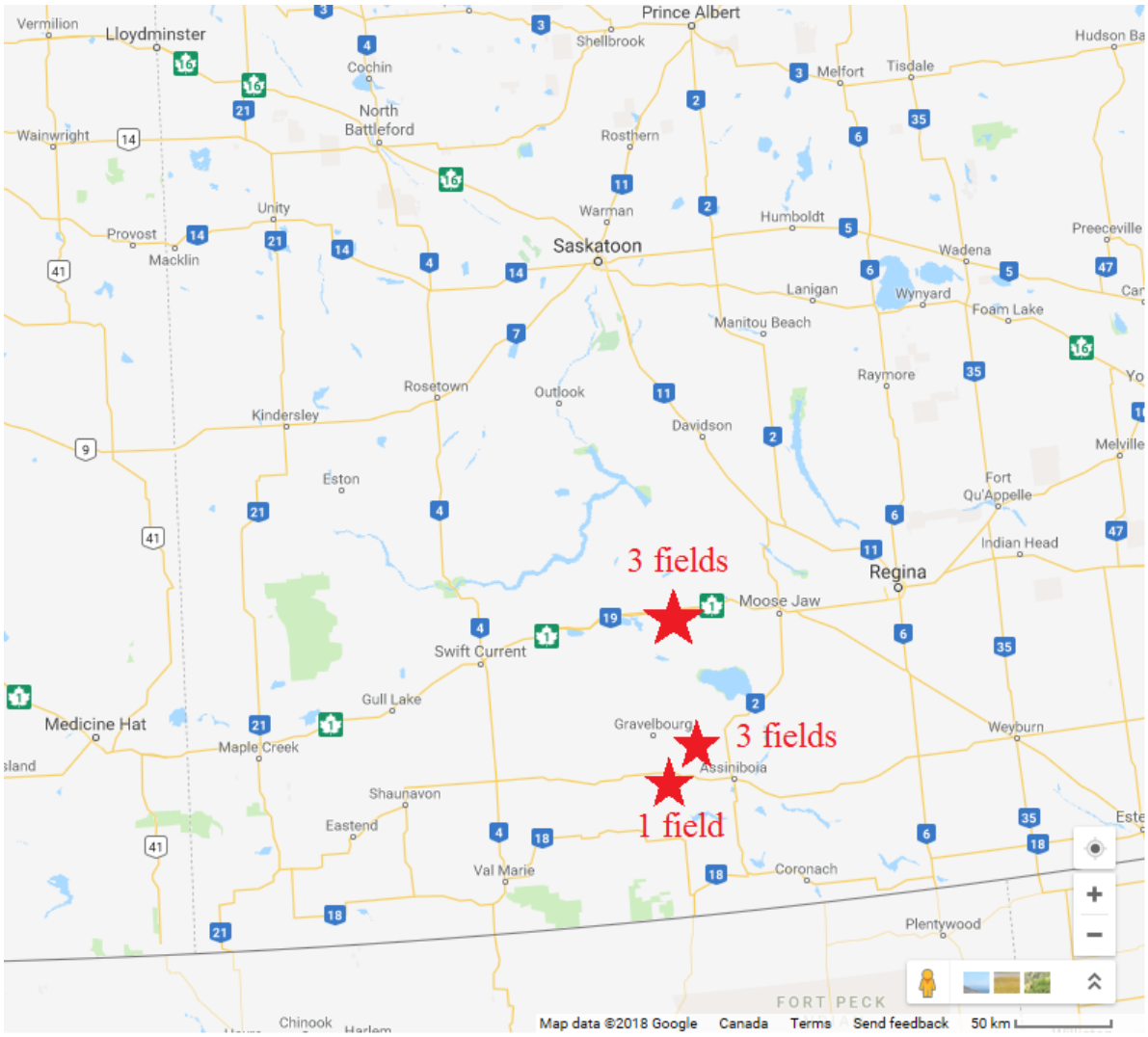


**Figure 2.** The approximate locations of the fields surveyed for Ascochyta blight in chickpeas towards the end of the 2018 growing season.

Reference:

Delgado, Lynnes, Meinhardt, Wise, Gudmestad, Bradley, Markell and Goswami (2013) Identification of the mutation responsible for resistance to QoI fungicides and its detection in *Ascochyta rabiei* (teleomorph *Didymella rabiei*). Plant Pathology. 62: 688-697. Doi: 10.1111/j.1365-3059.2012.02661.x

# Alberta

## Alberta Plant Health Lab

Submitted by: Krista Zuzak & Dr. Jie Feng

**Table 8.** Pulse disease samples submitted to the Alberta Plant Health Lab in 2018

| Crop | Symptom/ Disease | Causal agent | Number of Samples |
|---|---|---|---|
| Pinto bean | Root rot and seedling blight | *Fusarium* sp. | 1 |
| Yellow bean | Root rot and seedling blight | *Fusarium* sp. | 1 |
| | Leaf spot | *Botrytis* sp. | 1 |
| Chickpea | Root rot | *Fusarium* spp. | 1 |
| | Wilt | *Fusarium redolens* | 2 |
| Field pea | Wilt | *Fusarium* spp. | 1 |
| | Root rot and leaf wilt | *Fusarium* spp. | 1 |
| Soybean | Root rot | Fusarium *spp.* | 1 |
| | Root rot | *Rhizoctonia solani* | 1 |
| | Leaf deformation | Suspect Bean Common Mosaic Virus | 1 |

## Survey for white mould of dry bean in 2018

Submitted by Jonathan Reich, Natasha Tetzlaff, Mike Harding, Syama Chatterton

Fifteen commercial dry bean fields were surveyed weekly from July 23 to August 23 between Vauxhall, Taber, and Lethbridge. At each of ten sites per field, ten plants were inspected for white mould presence and severity (1 = no white mould; 2 = white mould present on 1 branch; 3 = white mould present on 2 branches; 4 = white mould present on main stem). An additional six fields were surveyed on September 7, and at each of 4 sites per field, 25 plants were assessed for white mould presence and severity (0 = no symptoms; 1 = infections on pods only; 2 = one-quarter of plant affected; 3 = one-half of plant affected; 4 = three-quarters of plant affected; 5 = main stem lesion near base affecting entire plant). Despite another dry growing season, white mould incidence increased to 25% in the region by mid-August, with some fields showing up to 85% disease incidence. Severity remained low in most fields, although a few fields reached a severity index of nearly 3 overall. As with last year, prevalence increased from 27% at the end of July to 100% by the mid-August.

**Table 9.** Summary of white mould survey results from fifteen fields in southern Alberta in 2018.

| Date | Prevalence (%) | Incidence (%) | | Severity | |
|---|---|---|---|---|---|
| | | Mean | Range | Mean | Range |
| July 23-25 | 27 | 1.7 | 0 - 15 | 1.03 | 1.0 - 1.3 |
| Jul 31 | 87 | 6.8 | 0 - 37 | 1.12 | 1.0 - 1.7 |
| Aug 8-9 | 87 | 22.2 | 0 - 65 | 1.40 | 1.0 - 2.3 |
| Aug 15-16 | 100 | 26.7 | 2 - 85 | 1.59 | 1.1 - 2.9 |
| Aug 23 | 100 | 24.0 | 2 - 51 | 1.58 | 1.0 - 1.3 |
| Sep 07 | 83 | 18.0 | 0 - 36 | 0.69* | 0.0 - 1.3 |

*NB: disease severity rating scale used on September 7 differed from that used for previous dates

**Survey for chocolate spot and other foliar diseases on faba bean in Saskatchewan and Alberta in 2018**
Submitted by Surinder Kaur, Robyne Bowness, Sabine Banniza, Syama Chatterton

In 2018, 16 commercial faba bean fields from Saskatchewan and 9 from Alberta were surveyed for chocolate spot at mid-pod stage (late July to mid August) (Table 10 & Fig. 3). Ten sites per field (at least 50 m apart) were sampled in an inverted U-shaped pattern, and the severity of foliar lesions on 10 plants per site was recorded. The ratings were done separately for upper, mid and lower canopy. The disease severity was rated as follows: 1 = healthy; 2 = small, discrete lesions (2-3 mm), covering 1-2% of leaf surface; 3 = some coalesced lesions covering 2-5% of leaf surface; 4 = large coalesced sporulating lesions covering 5-10% of leaf surface, 50% defoliation; 5 = extensive lesions on leaves, stems and pods covering > 10% of leaf surface, severe defoliation, heavy sporulation.

**Table 10.** Faba bean commercial faba bean fields surveyed in 2018 in Saskatchewan and Alberta

| **Field code** | **Province** | **Location** | **Date of survey** |
|---|---|---|---|
| 1801 | Saskatchewan | Codette | |
| 1802 | Saskatchewan | Scott | 30-Jul-18 |
| 1803 | Saskatchewan | Lake lenore | 31-Jul-18 |
| 1804 | Saskatchewan | Humboldt | 31-Jul-18 |
| 1805 | Saskatchewan | Wolverine | 31-Jul-18 |
| 1806 | Alberta | Rainy Creek | 7-Aug-18 |
| 1807 | Alberta | Rainy Creek | 7-Aug-18 |
| 1808 | Alberta | Lindholm | 8-Aug-18 |
| 1809 | Alberta | New Norway | 8-Aug-18 |
| 1810 | Alberta | Miller | 8-Aug-18 |

| | | | |
|---|---|---|---|
| 1811 | Alberta | Brickfords | 1-Aug-18 |
| 1812 | Alberta | Valley centre | 1-Aug-18 |
| 1813 | Alberta | Otto | 1-Aug-18 |
| 1814 | Alberta | Aspelund | 1-Aug-18 |
| 1815 | Saskatchewan | Duck Lake | 2-Aug-18 |
| 1816 | Saskatchewan | Lake lenore | 1-Aug-18 |
| 1817 | Saskatchewan | Tisdale | 1-Aug-18 |
| 1818 | Saskatchewan | Yorkton | 16-Aug-18 |
| 1819 | Saskatchewan | Yorkton | 17-Aug-18 |
| 1820 | Saskatchewan | CDC-219 | 17-Aug-18 |
| 1821 | Saskatchewan | Choiceland | 21-Aug-18 |
| 1822 | Saskatchewan | Zenon Park | 21-Aug-18 |
| 1823 | Saskatchewan | NE Tisdale | 21-Aug-18 |
| 1824 | Saskatchewan | NE Melfort | 21-Aug-18 |
| 1825 | Saskatchewan | | 15-Aug-18 |

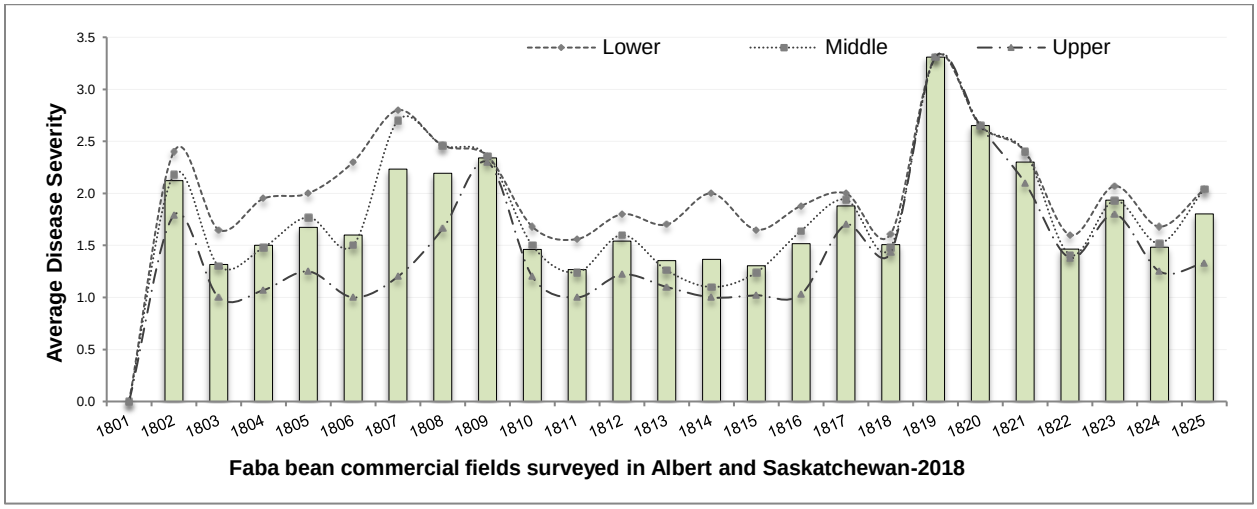


**Figure 3.** Chocolate spot severity measured from different commercial faba bean fields in Saskatchewan and Alberta during 2018 survey

All faba bean crops surveyed in AB and SK had foliar lesions (i.e. 100% prevalence). At each site, plants with symptoms were estimated at 49 - 100% but foliar disease symptoms were generally present at all 10 sites within each field. However, disease severity was very low across all fields with small discrete

lesions covering 1-2% of the leaf surface (Table 11). Disease severity and incidence was always highest in the lower canopy (DS mean = 2.06) and lowest in the upper canopy (DS mean = 1.5).

**Table 11.** Chocolate spot disease prevalence, severity, minimum and maximum disease severity

| Province | Prevalence (%) | Disease severity | | |
|---|---|---|---|---|
| | | Average | Minimum | Maximum |
| Alberta | 100 | 1.70 | 1.3 | 2.34 |
| Saskatchewan | 100 | 1.90 | 1.3 | 3.31 |

If lesions were present, leaf samples were collected, pressed and dried and then shipped to Lethbridge Research and Development Centre for pathogen isolation and identification. At Lethbridge, leaf samples were photographed prior to plating, the leading edge of a lesion excised, surface disinfested using 10% bleach, and then plated onto PDA. Plates were incubated for 7-10 days, and then margins of colonies transferred to a new plate in order to obtain pure cultures of each organism. Cultures were first grouped by colony morphology and given a presumptive genus id. If genus id was not obvious from morphology, DNA extraction and sequencing for ITS region will be done to determine genus. Further multilocus sequencing and/or morphological characterization of genera of interest will then be performed to id to species, followed by pathogenicity testing of select isolates/species.

A variety of symptoms were observed. Basically three different kind of symptoms were observed: flecked or small, discrete reddish lesions; medium size lesions that have a necrotic area in the middle; large necrotic or blackened areas on the leaf surface. A number of fungal genera were isolated from lesions (Table 12). Small, discrete reddish lesions, characteristic of the non-aggressive phase of chocolate spot (caused by *Botrytis fabae*), were common. We isolated nearly 8% of *Botrytis* from flecked and small, discrete reddish. *Stemphylium* spp. was frequently isolated from medium lesions that had blighted appearance and often started from the edge. *Alternaria* spp. were the most commonly isolated from almost all types of lesions but commonly isolated from large necrotic lesions because it is often present with other fungi, particularly *Botrytis* or S*temphylium*. It is likely acting as a secondary pathogen or saprophyte on lesions caused by more pathogenic species. *Fusarium* spp. was isolated with less frequency as compared to previous years.

**Table 12.** Foliar fungi isolated from faba bean survey 2018

| **Fungal genera** | **Total numbers** | **% of total fungi** |
|---|---|---|
| ***Alternaria spp.*** | 1125 | 54.5 |
| *Ascochyta spp.* | - | - |
| ***Botrytis spp.*** | 161 | 7.8 |
| *Cladosporium* | 124 | 6.0 |
| *Colletotrichum spp.* | 1 | 0.1 |
| *Epicoccum* | 33 | 1.6 |
| ***Fusarium spp.*** | 54 | 2.6 |
| Other saprophytes | - | 54.5 |
| ***Stemphylium spp.*** | 433 | 21.0 |
| **Unidentified^** | 135 | 6.5 |

^The isolates did not sporulate and will be identified using DNA sequencing.

**Figure 4.** Typical chocolate spots on faba bean leaves

**Figure 5.** Stemphylium blight on faba bean leaves

**Figure 6.** Large black lesions on faba bean leaves

**A survey of soybean diseases in Alberta in 2018**

Submitted by: M.W. Harding

Introduction & Methods: Seventeen soybean fields in Alberta were surveyed for foliar diseases, root diseases and root nodulation. The locations of the fields are shown in Figure 7. In all cases, prevalence was measured as the percent of fields with symptoms, and incidence was measured as the percent of plants showing symptoms. Foliar infections due to bacterial blight (Figure 8A) and brown spot (Figure 8B) were not discriminated, but rated as one "foliar infection". Foliar disease severity was rated using a 0-4 scale as described by Scherff, (1973). Root rot pathogens were not identified, but severity was rated using a 0-4 scale (Nyadoro et al., 2014). Nodulation in the root samples was rated using a 0 to 4 scale (Nyandoro et al., 2014).

Results & Discussion: For the diseases, foliar infection had the highest prevalence and incidence while white mould had the lowest (Table 13). Nodulation was seen in every field, but varied slightly in incidence and in the numbers of nodules per root (Table 13). Overall, diseases did not appear to be the major production constraint, rather the cold fall weather and early snowfall, leading to a shortened growing season, was likely a larger production problem, especially at the more northern latitudes.

References:

R. Nyandoro, K.F. Chang, S.F. Hwang, S.E. Strelkov, G.D. Turnbull, R.J. Howard, M.W. Harding, D.L. McLaren and R.L. Conner. The occurrence of soybean root rot in southern Alberta, Canada in 2013. 94: 198-200.

Scherff, R.H., 1973. Control of bacterial blight of soybean by. *Bdellovibrio bacteriovorus*, *328*, pp.400-402.

**Table 13.** Prevalence, incidence and severity of three diseases and nodulation.

| | Prevalence (%) | Incidence (%) | | Severity (0-4) | |
|---|---|---|---|---|---|
| | average | average | range | Average | range |
| Foliar Infection | 94.1 | 45.6 | 9-19 | 0.75 | 0-2.05 |
| Root Rot | 88.2 | 26.8 | 0-94 | 0.34 | 0-1.40 |
| White Mould | 58.8 | 2 | 0-5 | 0.07 | 0-0.19 |
| Nodulation | 100 | 99 | 95-100 | 1.5 | 1.05-2.17 |

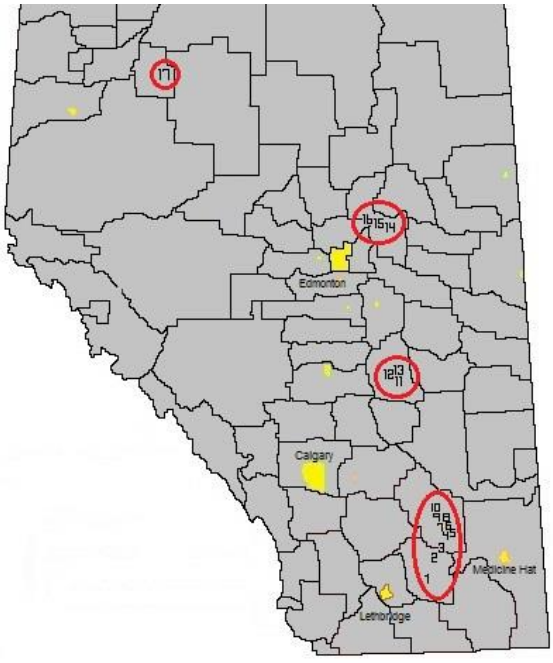


**Figure 7.** Soybean survey sample locations in Alberta, 2018.

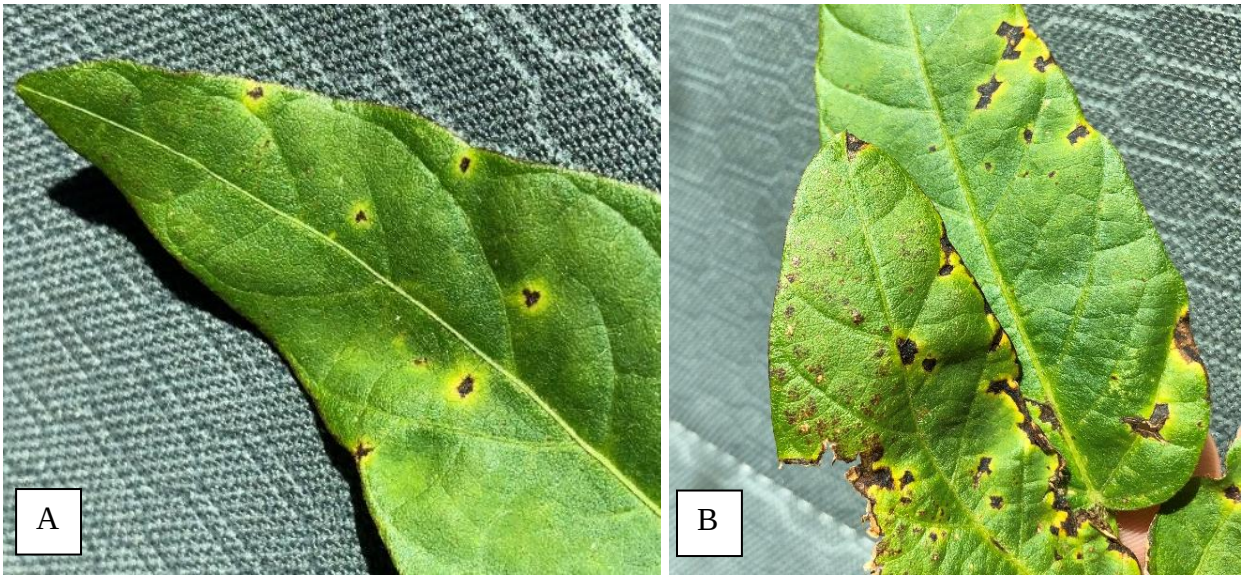


**Figure 8.** Foliar infections on soybean including bacterial blight symptoms (A) and septoria brown spot symptoms (B).

**Survey of diseases seen on field pea crops in Alberta in 2018**

Submitted by Mike Harding, Syama Chatterton, Robyne Bowness, Christine Vucurevich, Trina Dubitz, Greg Daniels and Dustin Burke.

Root rot:

Pea crops were surveyed for root rot in June-August 2018 in Alberta. A total of 25 to 50 roots from five to ten sites/field were dug up, and assigned a visual score for disease rating (1=healthy up to 7=dead). The presence of mycosphaerella blight and bacterial blight on peas was also noted and was estimated by a canopy rating (1-5) and plants were individually rated using a visual disease rating scale of 1-7.

Results of the root rot surveys are summarized in Table 14, and foliar diseases are reported in Table 15.

Root rots were once again widespread in peas in 2018, and 82 – 96% of pea crops surveyed had root rot, depending on region. Incidence was reported as the percent of roots within a field that had any root rot. A second incidence rating was calculated for the percent of roots with a severity rating of equal to, or greater than, 4. This second rating was calculated because roots rated from 1 – 3 were considered healthy – or with no significant yield loss, so those with a rating of 4 and above are those roots considered to have disease levels leading to yield and economic losses. Root rot incidence and severity was highest west-central Alberta.

**Table 14.** Root rot prevalence, incidence and severity in field pea crops surveyed in Alberta in 2018.

| | No. fields surveyed | Root rot prevalence (%) | Root rot incidence (%) | Root rot incidence > 3 (%) | Average severity (1-7) |
|---|---|---|---|---|---|
| **Pea** | | | | | |
| east-central AB | 34 | 82.3 | 38.3 | 13.5 | 1.78 |
| west-central AB | 23 | 95.7 | 84.9 | 30.0 | 2.43 |
| southern AB | 17 | 85.5 | 46.2 | 12.4 | 1.84 |
| Alberta (Total) | 74 | 90.4 | 49.0 | 13.3 | 2.00 |

Once again, mycosphaerella blight (MB) had a high prevalence, incidence and severity in pea crops in east-central Alberta. The canopy rating was intended to give a general, visual rating of the health of the crop where 1 = healthy plants (no yellowing), 2 = slight yellowing of lower leaves, 3 = yellowing of lower leaves up to the 3$^{rd}$ or 4$^{th}$ node, 4 = necrosis and/or stunting of at least half of the plants, and 5 all plants dead or nearly so. The healthiest canopies were reported in southern Alberta, and the least healthy in east-central Alberta. These reduced canopy health ratings were correlated with the prevalence, incidence and severity of mycosphaerella blight, which was also higher in the east-central region of Alberta. Finally, bacterial blight was reported in only two fields in Alberta, both in the east-central region.

A wet cycle of precipitation persisted across portions of central Alberta where pea fields were surveyed that was in stark contrast to the drought in the south of the province. A snapshot of this phenomenon is shown in the 30-day precipitation accumulation map for Alberta from June 11 to July 10, 2018 (Figure 9). Precipitation was likely a factor in the higher levels of mycosphaerella blight in central Alberta, and the appearance of bacterial blight in the central region only.

**Table 15.** Mycosphaerella blight incidence and canopy health in 74 field pea crops in Alberta in 2018.

| | No. fields surveyed | Canopy rating (1-5) | M. blight prevalence (%) | M. blight incidence (%) | Average severity (1-7) | Bacterial blight prevalence |
|---|---|---|---|---|---|---|
| east-central AB | 34 | 2.46 | 82.3 | 79.9 | 2.54 | 5.9 |
| west-central AB | 23 | 1.72 | 78.3 | 46.1 | 1.85 | 0 |
| southern AB | 17 | 1.61 | 17.7 | 7.1 | 1.15 | 0 |
| Alberta (Total) | 74 | 2.03 | 66.2 | 52.7 | 2.01 | 2.7 |

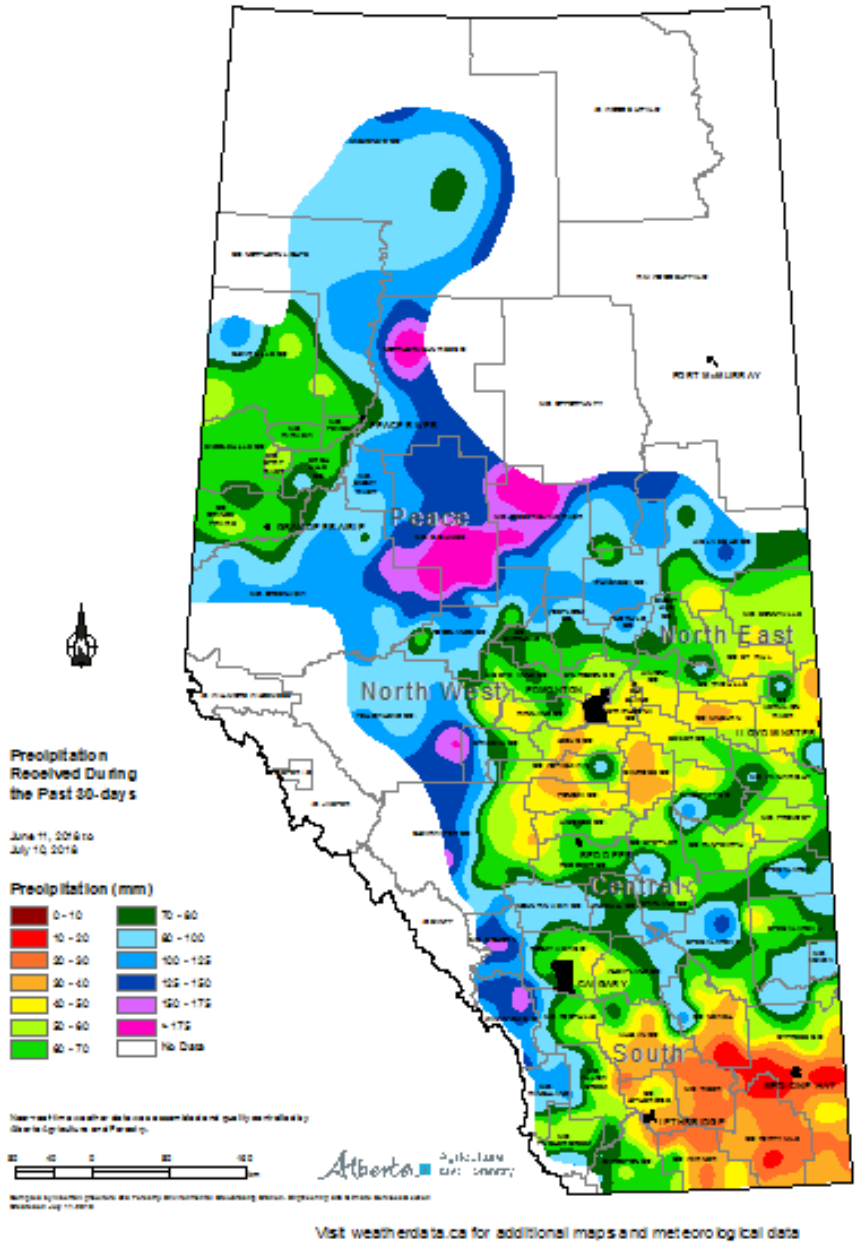


**Figure 9.** Total accumulation of precipitation in Alberta from June 11 to July 10, 2018. (source: https://agriculture.alberta.ca/acis/climate-maps.jsp)

**British Columbia**

Vippen Joshi indicated that there were no pulse diseases to report in British Columbia.

## Research Updates

**Saskatchewan Ministry of Agriculture are involved in the following project**:
Contans control of sclerotinia pod and stem rot in irrigated lentil and bean

**Saskatchean Pulse Growers support the following ongoing projects:**

1. Disease management in faba bean (Shirtliffe)
2. Diversifying cropping options for the brown soils through intercropping (Fernandez)
3. Strategies for effective and durable management of *Phytophthora* and root rot complexes of soybean (McLaren)
4. A new method for precise and reproducible phenotyping of *Phytophthora sojae* isolates in soybean (Belanger)
5. Breeding, physiology and agronomy to mitigate yield loss caused by root rots of pea (Chatterton)
6. Epidemiology of chocolate spot in faba bean (Chatterton)
7. Cover cropping as part of a rotation strategy to reduce pea root rot (Chatterton)
8. Fungicide timing to manage aschochyta blight in chickpea varieties with contrasting Ascochyta resistance (Hubbard)