Yukon Territory Crop Disease Surveillance Project 2021
Final Results Report

Prepared by

Ron Howard, RJH Ag Research Solutions Ltd.
Box 1456, Brooks, AB T1R 1C3

and

Kristine Ferris, Agriculture Branch, Energy, Mines and Resources
Yukon Government, P.O. Box 2703, Whitehorse, YT Y1A 2C6

1.0 Introduction

Crop agriculture is an expanding and economically important industry in the Yukon Territory. Like other production areas in Canada, diseases, insect pests and weeds can threaten crop yields and quality. Having a basic knowledge of the prevalent pest risks in Yukon crops will help producers to recognize existing threats and to adopt management strategies that will assist in avoiding or minimizing potential losses. The Agriculture Branch committed to undertake a second consecutive season of disease and insect pest surveys on forage grasses, wheat, canola and selected horticultural crops, including haskaps, potatoes and assorted vegetables, on six farms in the Whitehorse area in summer, 2021. Sincere appreciation is expressed to the individuals who cooperated in the survey by allowing their crops to be examined and for sharing their field records and crop observations.

This report will focus on the crop disease surveys that were conducted by Agriculture Branch staff between June and August with the assistance of Dr. Ron Howard, Plant Pathologist, RJH Ag Research Solutions Ltd., Brooks, AB. A report on the concurrent insect pest surveys led by Mr. Scott Meers, Agrologist, Mayland Consulting, Calgary, AB was published separately.

2.0 Objectives of the Survey

The key objective of the crop disease survey was to determine the identity and incidence, severity and prevalence of the major diseases occurring in commercial field plantings of the cereal, forage, oilseed and horticultural crops mentioned above. This information will be used to help plan future pest surveys, as well as to help producers to develop or refine integrated pest management (IPM) strategies for their operations. RJH Ag Research Solutions Ltd. was contracted to help with the design and conduct of the 2021 survey, to facilitate the diagnosis of crop disease problems, and to prepare a report on the results of this project.

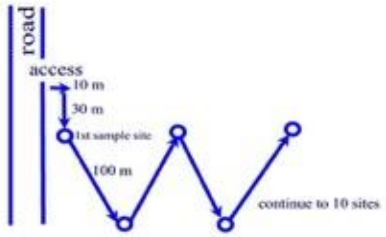
3.0 Scope of the Survey

At the outset of this survey project, which was launched in 2020, relatively little was known about the specific types of plant health problems affecting field crops grown in the Territory, their distribution, and the kinds and levels of damage they were causing. An inaugural disease and insect pest survey, which was carried out in summer, 2020, covered several crops and fields on two farms in the Whitehorse area and served to gather some preliminary information on the kinds of problems that were present. The crops surveyed included cereals (barley and wheat), oilseeds (canola) and vegetables (beets, broccoli, cabbage, carrots, potatoes and turnips). Fields were visited one or more times in the mid- to late growing season (July/August) at a time when damage from most of the common pests and diseases were noticeable or abundant. Surveyors looked for infected and infested plants and collected representative samples for identification of the causal agents. They also gathered information on the general abundance of the pests and assessed the extent of crop damage.

The 2021 survey was organized along the same lines as the 2020 campaign, but was broader in scope and included a fruit crop (haskap) and two types of forage grasses (bromegrass and timothy) for the first time. Wheat and canola were once again included in the survey, as were market garden vegetables, especially napa and green cabbages and potatoes.

4.0 Expected Outcomes

The key outcomes of this project were to create lists of the major and minor diseases observed in the surveyed crops and to estimate their incidence and the extent of damage they were causing. The information gathered will be of historical and scientific importance to the agricultural industry in the Yukon and to the scientific community in Canada. Samples of some of the diseased plants collected during the survey were sent to the Alberta Plant Health Laboratory in Edmonton, AB for a definitive diagnosis. Photographs of the symptoms observed were sent to plant pathologists and agronomists in western and central Canada for help in identifying the specific diseases observed. This information will be used to design future systematic surveys of Yukon crops and to facilitate extension efforts with Yukon producers.



5.0 General Disease Assessment Methods

Disease symptoms were visually assessed on a crop-by-crop basis by determining their incidence, severity and prevalence as follows:

- Incidence – Percentage of plants, leaves, heads, kernels, etc., damaged in the target crop
- Severity – Proportion of the leaf, fruit, head, root/canopy area, etc., affected by a specific disease or disorder.
- Prevalence – The overall proportion of fields surveyed with a specific disease or disorder.

Specific field survey protocols were used for each crop included in the 2021 disease survey and mainly followed the same methods used for the 2020 survey. In addition, partial lists of the major diseases known to occur on these crops based on the 2020 Yukon survey or on historical surveys on these same crops in Western Canada, were also provided to the survey team.

Basic production information, such as the name and location of each farm visited, the producer's name and contact information, and general cultural practices, varieties being grown and cropping history, was obtained from the cooperating producers wherever possible. Survey data were initially recorded on paper forms and later transferred to Excel spreadsheets to facilitate summarization and analysis. Background information and data collection forms for the field surveys were provided for use by the surveyors.

Digital photos and/or subsamples of the various types of diseased plants encountered during the field surveys were taken wherever possible. These images were reviewed by Ron Howard and occasionally by other specialists in Western Canada. Selected plant samples for disease diagnosis were sent to the Alberta Plant Health Laboratory (APHL) in Edmonton, AB for confirmation of the pathogen(s) involved.

6.0 Survey Procedures and Results

<u>6.1 Cereals</u>

A single field of Canada Western Red Spring Wheat was surveyed for foliar diseases on June 17 and on July 1, 13 and 29. Plant samples were taken along a W-shaped transect for a total of five sampling points for the field (<50 ac), as shown in the embedded diagram. The first three visits involved visual inspections and the final one included destructive sampling wherein plants were

dug up and removed from the field for disease assessment at a lab space in Whitehorse, where the roots were washed free of soil and the plants examined for symptoms.

On the first survey date (June 17), the growth stages of the crop across the field were variable, depending on the sampling location, and ranged from plants being about 15 cm tall with erect leaves to those that were ca. 45 cm tall with the second nodes already visible on the stems. No foliar disease symptoms were evident on any of the plants observed on this date (Table 1).

Table 1. Observations of symptoms in a wheat field surveyed for foliar diseases on June 17 and July 1, 2021.

Sample No.	Foliar disease symptoms*	June 17		July 1	
		Disease incidence (%)**	Disease severity (0-4)***	Disease incidence (%)**	Disease severity (0-4)***
1	None	0	0	0	0
2	Brown spots	0	0	20	<1
3	None	0	0	0	0
4	Brown spots	0	0	10	<1
5	Dry lower leaves	0	0	30	<1
Mean	**- -**	**0**	**0**	**12**	**<1**

* The leaf spot and browning symptoms occurred on the lower leaves and were not characteristic of a specific infectious disease.
** DI = % plants affected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms.

On July 1, the second survey date, the crop was in the early boot to full boot growth stages. A few plants showed purpling of the nodes, while some others exhibited browning and drying of the lower leaves (Table 1). A relatively small number of plants had brown or yellow spots on the lower leaves, which were not characteristic of a specific leaf spot disease. The average disease incidence for the five sampling sites was 12% and the severity was <1 on a four-point scale.

Foliar disease incidence and severity levels slightly decreased as the season progressed (Table 2). On July 13, the crop was at the early to late anthesis growth stage and a small amount of yellowing was seen on the lower leaves of a few plants, which might have indicated natural senescence or nitrogen deficiency. Foliar disease incidence and severity ratings were both classified as zero. While walking between sampling points and again at the edge of the field, single stems of volunteer barley with heads exhibiting the classic symptoms of loose smut (*Ustilago hordei*) (Fig. 1) were observed.

By the last sampling date (July 29), plants were at the late flowering to the milk/soft dough growth stages. Two types of foliar abnormalities were noted at this time, which included bleaching of the awn tips (Fig. 2) and yellowing of the lower leaves (Table 2). The awn discoloration may have been caused by a light frost that occurred just prior to sampling. An additional harmful effect of the frost may have been damage to some of the florets at the tips of the heads, which resulted in no kernels being formed. The leaf yellowing may have been a continuation of similar symptoms seen on July 13 or a sign of early senescence. No distinctive symptoms of infectious diseases were noted on either this or the prior sampling date.

Table 2. Observations of symptoms in a wheat field surveyed for foliar diseases on July 13 and 29, 2021.

Sample No.	Disease symptoms*	July 13		July 29	
		Disease incidence (%)**	Disease severity (0-4)***	Disease incidence (%)**	Disease severity (0-4)***
1	None	0	0	0	0
2	None	0	0	0	0
3	None	0	0	0	0
4	None	0	0	0	0
5	None	0	0	0	0
Mean	**- -**	**0**	**0**	**0**	**0**

* Some plants showed bleaching of the awn tips and yellowing of the lower leaves purpling, reddening or yellowing of the leaf tips, which may have been caused by a light frost and natural senescence, respectively.
** DI = % leaves affected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms.

No plants with distinctive symptoms of infectious leaf diseases were observed on any of the survey dates, so no plant samples were collected and submitted to the Alberta Plant Health Lab for the determination of potential causal agents.

6.2 Forages

Surveys of established forage grass fields were carried out on two ranches in the Whitehorse area in June and July following the same procedures used for cereal crops (see Section 6.1).

1. Timothy field

A field of timothy hay was surveyed for foliar diseases on June 16 and 29. The crop was just starting to head out on June 16, when the field was first visited, and the stand generally appeared healthy; however, several bare spots, which appeared to the result of elk feeding, were noticeable. In addition, some plants showed purpling of the leaf tips, which may have been caused by a temporary phosphorus deficiency. A few plants also showed a reddish-yellow leaf coloration, which might also have indicated a nutritional problem. During the second visit

(June 29), the crop was fully headed out and dark-colored lesions were noticed on the leaves of several plants (Fig. 3), but the average disease incidence (<2%) and severity (<0.1) were very low (Table 3). The crop was harvested before a final field visit could be made.

Table 3. Observations of foliar symptoms in a timothy grass field surveyed for foliar diseases on two dates in June, 2021.

Sample No.	Disease symptoms*	June 16		June 29	
		Disease incidence (%)**	Disease severity (0-4)***	Disease incidence (%)**	Disease severity (0-4)***
1	Red/yellow leaf color	10	0.1	0	0
2	Dark leaf spots	0	0	10	0.1
3	None	0	0	0	0
4	Dark leaf spots	0	0	10	0.1
5	Dark leaf spots	0	0	10	0.1
Mean	**- -**	**2.0**	**<0.1**	**6**	**<0.1**

* Some plants showed purpling, reddening or yellowing of the leaf tips, which may have been caused by transient nutrient deficiencies.
** DI = % leaves affected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms.

Symptomatic leaves were collected on June 29 and sent to the Alberta Plant Health Lab. A list of the bacteria and fungi recovered from the samples is given in Table 4. Three genera of fungi were isolated, but they were not characterized to the species level nor were they inoculated back onto the respective hosts to prove their pathogenicity. In published reports from other regions, the fungus *Neoascochyta exitialis* has been reported to cause leaf spots on members of the Poaceae family, which includes timothy. *Phaeosphaeria nodorum* (syn. *Parastagonospora nodorum*) is a common pathogen of wheat in the Prairie Provinces, where it causes glume blotch, a head disease. The pathogenic bacterium *Pseudomonas coronafaciens* has been found to cause leaf spots on timothy and other grass species in parts of southern Canada.

Dr. Henry Klein-Gebbinck, Agriculture and Agri-Food Canada, Beaverlodge, AB, reviewed photographs of the symptomatic timothy leaves and noted that *Phaeosphaeria* (Stagonospora leaf spot) and *Cladosporium* (purple leaf spot) have both been reported on timothy in Western Canada. Unfortunately, it was beyond the scope of this project to verify the pathogenicity of

the bacterial and fungal isolates derived from infected plant tissues. This would have required the inoculation of the presumptive pathogen(s) back onto the hosts and the development of symptoms closely resembling those seen on the original host material from the field. The final step required to confirm pathogenicity would have been to successfully reisolate the presumptive pathogen(s) from the symptomatic host tissues.

Table 4. A Summary of the diagnostic results from the Alberta Plant Health Lab, Edmonton for timothy plant samples taken on June 29, 2021.

Sample Number	Symptoms	Diagnosis
(APHL Report #1149)		
1	Leaf spots and discoloration	Fungi: *Cladosporium* sp.*, Neoascochyta exitialis, Phaeosphaeria* sp. Bacteria: *Bacillus pumilus*, *Bacillus* spp., *Pseudomonas coronafaciens*

2. Bromegrass field

A field of bromegrass hay on a second ranch near Whitehorse was surveyed for foliar diseases on June 15 and 28 and on July 7.

The second nodes were visible on the plants on the first survey date and the crop generally appeared healthy; however, a few plants showed leaf spotting symptoms (Fig. 4), but the average disease incidence and severity ratings were very low (Table 5). By June 28, the crop was fully headed out and more dark-colored lesions were noticed on some of the leaves, but the mean disease incidence (2%) and severity (0.02 on a scale of 0-4) were still very low. On the final sampling date (July 7), the stand was close to maturity and the average leaf spot incidence had increased slightly to 8%, whereas the mean disease severity remained very low at 0.07. Some plants were dug up and the roots washed and examined. Some root and crown rot symptoms were evident, but disease incidence and severity ratings were not done.

Table 5. Observations of foliar diseases in a bromegrass hay field which was surveyed on three separate dates in June and July, 2021.

Sample No.	Disease symptoms*	June 15		June 28		July 7	
		Disease incidence (%)	Disease severity (0-4)	Disease incidence (%)	Disease severity (0-4)	Disease incidence (%)	Disease severity (0-4)
1	Leaf spotting	0	0	0	0	30	0.25
2		0	0	0	0	0	0
3		0	0	0	0	0	0
4	Leaf spotting	0	0	0	0	10	0.1

5	Leaf spotting	10	0.25	10	0.1	0	0
Mean		**2**	**0.05**	**2**	**0.02**	**8**	**0.07**

* Dark brown leaf spots with chlorotic margins.
** DI = % plants, leaves or heads infected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms.

Symptomatic leaves were collected from the bromegrass field on June 28 and July 7 and sent to the Alberta Plant Health Laboratory, Edmonton. A list of the bacteria and fungi recovered from the diseased leaf tissues is given in Table 6. For the June 28 samples, three genera of fungi were isolated, but were not characterized to the species level. *Cladosporium phlei* is known to cause purple spot in timothy and has been reported from the Peace Region of Alberta. *Epicoccum* is sometimes found as a contaminant in grass seed. *Pezizomycetes* has not been reported to attack bromegrass and may have been present on the sample as a saprophyte. *Fusarium* species are common pathogens on forage grasses and can cause diseases such as head blight and crown and root rots. *Microdochium nivale* is a widespread snow mold pathogen on many species of cereals and grasses. *Arthrinium* has not been recorded as a pathogen on bromegrass in Canada; however, it has been reported as an endophyte on timothy and a few other grass species. *Epicoccum* has occasionally been detected as a contaminant on grass seed.

Table 6. A Summary of the diagnostic results from the Alberta Plant Health Lab, Edmonton for bromegrass samples taken on June 28 and July 7, 2021.

Sample Number	Symptoms	Diagnosis
(APHL Report #1149)		
1	Leaf spots and discoloration	Fungi: *Cladosporium* sp., *Epicoccum* sp., *Pezizomycetes* sp.
(APHL Report #1184)		
1	Leaf spots and discoloration	Fungi: *Epicoccum* sp., *Fusarium* sp., *Microdochium* sp., *Arthrinium* sp.

6.3 Oilseeds

A single field of Polish canola near Whitehorse was surveyed for foliar diseases on June 17, July 1, 15 and 27, and on August 12.

The north and south halves of the field were surveyed separately, following the same protocol used for cereals (see Section 6.1). Ten destructive samples were taken from the field on July 27, although no replicated destructive sampling took place. Five symptomatic plant samples were taken from this field on two other dates and sent to the Alberta Plant Health Lab for diagnosis.

One group of samples had leaf lesions, while the other was a single stunted plant with some root discoloration.

On the first survey date (June 7), the crop was at the 2-4 leaf stage and appeared healthy, apart from some insect feeding damage. By July 1, by which time the crop was starting to flower, the plants were still exhibiting signs of insect damage, but no symptoms of infectious diseases were apparent. By July 15, most plants were at the late flowering stage and looked healthy, except for a purple coloration that was seen on the lower stems of several plants, which appeared to be a physiological disorder. On July 21, the crop was at the late flowering stage and the bottom leaves on some plants were wilting and turning yellow, which appeared to be the result of dry soil conditions. Once again, no symptoms of infectious diseases were visible in the crop at the various sampling points in the field. On the last (July 27) sampling date, the crop growth stages ranged from late flowering to early pod ripening. The plants remained free of infectious disease symptoms; however, evidence of frost damage, which had occurred on July 16, was seen as dieback of the top florets on some plants (Fig. 5). The frost event severely damaged blossoms on the main racemes of many plants and some of them attempted to reflower (Fig. 6).

Ten destructive samples were taken from the field on July 27 for close visual examination. Two subsamples of symptomatic plants were collected and sent to the Alberta Plant Health Laboratory, Edmonton. A list of the fungi recovered from the samples is given in Table 7. The leaf lesions yielded two genera of presumed saprophytic fungi, *Epiccocum* and *Cladosporium*, and one potential pathogen, *Alternaria*, which can cause black spot, a leaf and pod disease. The Lab recovered three *Fusarium* species, which are known to cause root rot in canola, from the roots of the stunted plant. *Phoma lingam* causes blackleg on canola, but the sample submitted to the APHL did not have any of the characteristic symptoms of that disease.

Table 7. A Summary of the diagnostic results from the Alberta Plant Health Lab, Edmonton for canola samples taken on July 27, 2021

Sample Number	Symptoms	Diagnosis
(APHL Report #1224)		
1	Leaf spots and discoloration	Fungi: *Epicoccum* sp., *Alternaria* sp., *Cladosporium* sp.
(APHL Report #1225)		
1	Plant stunting	Fungi: *Fusarium tricinctum*, *F. culmorum*, *F. avenaceum, Alternaria, Podospora/Phoma, Ulocladium*

6.4 Fruits

A producing haskap orchard near Whitehorse was selected for surveying.

The orchard was surveyed on four dates: June 10 (early bloom), June 23 (full bloom), July 5 (developing fruit) and July 20 (mature fruit). On each date, the surveyor walked up and down the length of the orchard between two rows of trees stopping every 75 paces to examine the

trees at each stop for a total of ten stops. The leaves, branches and fruit were rated for disease incidence (% leaves, berries or branches affected) and severity (proportion of the leaves, berries or branches showing damage based on a 0 to 4 scale, where 0 = no disease and 4 = severe disease). The results of these observations are given in Tables 8 and 9.

Table 8. Observations of foliar and fruit disease/environmental damage symptoms on haskap bushes in an orchard, which was surveyed on two dates in June, 2021.

Site no.	Disease/damage (D/d) symptoms*	D/d incidence (%)**	D/d severity (0-4)***
June 10			
1	Distorted shoot tip	0	0
2	None	0	0
3	Puckered leaves on shoot tip	0	0
4	Puckered leaves on shoot tip	0	0
5	Puckered leaves on shoot tip	0	0
6	Puckered & torn leaves on shoot tip	0	0
7	None	0	0
8	Puckered leaves on shoot tip	0	0
9	Puckered leaves on shoot tip	0	0
10	None	0	0
Mean		**0**	**0**
June 23			
1	Leaf cupping	10	0.1
2	Rust-colored leaves	10	0.1
3	Rust-colored leaves	20	0.1
4	A few rust-colored spots	20	0.1
5	None	0	0
6	Dead branch	0	0
7	Slight leaf cupping	0	0
8	None	0	0
9	None	0	0
10	Brown spots on leaf edges	10	0.1
Mean		**7**	**0.05**

*A visual rating of symptoms potentially caused by infectious diseases or physiological stresses.
** DI = % leaves affected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease or abiotic stress symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptom

Table 9. Observations of foliar and fruit disease/environmental damage symptoms in a haskap orchard which was surveyed on two dates in July, 2021.

Site No.	Disease/damage (D/d) symptoms*	D/d incidence (%)**	D/d severity (0-4)***
July 5			
1	Some old, wrinkled leaves	0	0
2	Some brown spots on leaf tips	20	0.1
3	Some rusty spots on leaves	10	0.5
4	Rusty spots on leaves and berries	10	0.5
5	Rusty spots on leaves and berries	10	0.5
6	Rusty spots on undersides of leaves	20	0.1
7	Rusty spots on leaves	20	0.1
8	Rusty spots and undersides of leaves	20	0.1
9	Rusty spots on leaves	10	0.1
10	Leaves and berries sparse	0	0
Mean		**12**	**0.2**
July 20			
1	Some leaf brown/weathered leaves	0	0
2	One dead branch (mechanical injury)	0	0
3	None	0	0
4	Some brown/weathered leaves	0	0
5	Some brown/weathered leaves	0	0
6	Some brown/weathered leaves	0	0
7	Some brown/weathered leaves	0	0
8	Some brown/weathered leaves	0	0
9	Some brown/weathered leaves	0	0
10	Some brown/weathered leaves	0	0
Mean		**0**	**0**

*A visual rating of symptoms potentially caused by infectious diseases or physiological stresses.
** DI = % leaves affected.
*** DS = Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease or abiotic stress symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms.

Most, if not all, of the visual symptoms observed on the haskap bushes resembled the types of damage caused by physiological stresses. A heavy frost early in the season caused obvious visual damage to the trees and may ultimately have been responsible for symptoms such as leaf puckering (Fig. 7) and a rusty discoloration (Fig. 8) on the leaves. Subsequent weathering may

have aggravated these symptoms. A dead branch observed on one tree during the June 23 survey appeared to mechanical damage and may have been caused during harvesting or by heavy snow during the winter of 2020-21.

Several pictures of the orchard and some of the affected trees were sent to Dr. Bob Bors, an Associate Professor in the Department of Plant Sciences at the University of Saskatchewan, Saskatoon, for review. Dr. Bors is a noted fruit breeder and has developed and released several haskap varieties during his career. He commented that most of the pictures depicted physiological disorders potentially caused by factors such as wind, sunscald and bird damage. He also noted that some of the trees appeared stunted, which may have been due to aggressive competition from underseeded grasses. He also commented that some of the leaf spotting may have been due to infection by the *Botrytis* fungus which causes gray mold disease. Due to time constraints, no samples of symptomatic leaves or branches were collected and sent to the Alberta Plant Health Lab for diagnosis of potential pathogens

6.5 Vegetables

6.5.1 Cabbages

Field 1: The cabbage planting was surveyed on June 24, July 8 and 22, and on August 8. At each date, the surveyor walked up and down the length of the field between two rows of cabbages stopping every few paces to examine the plants at each stop for a total of ten stops. The plants were examined for both infectious and non-infectious diseases. On the first survey date (June 24), the crop was growing well and had no obvious disease symptoms; however, many eggs of the cabbage root maggot were observed to have been laid at the stem bases of most of the plants examined. No symptoms of infectious diseases were seen in the crop on the three subsequent survey dates; however, occasional symptoms of intumescence/edema (water congestion in the leaf tissues), tipburn (calcium deficiency) and leaf variegation (chimera; a genetic disorder) were observed on a few isolated plants. Insect damage became much more serious with the appearance of cutworms and wireworms in the crop as the season progressed.

Field 2:
Two types of cabbages were grown at this farm in 2021, green and napa.

The survey procedure was similar to the one used at Field 1. On the first survey date (June 23), both the green and napa cabbages appeared to be disease-free (Table 10). By July 6, the green cabbages still looked healthy, but one out of six napa plants at sampling site #4 had symptoms of basal stem rot. On July 20, both the green and napa cabbages were still symptomless. By August 3, the napa cabbages (site #1) were significantly affected by tipburn (Figs. 9 & 10), whereas the green cabbages (sites nos. 2 & 3) appeared healthy. On the final sampling date (Aug. 17), 100% of the napa cabbages were affected by tipburn and the severity rating was 4. By contrast, none of the green cabbages had any disease symptoms.

The napa cabbages at this farm were severely affected by tipburn and what appeared to be secondary bacterial soft rot (Fig. 11). Two napa plants with root decay were collected in mid-August and sent to the Alberta Plant Health Laboratory for diagnosis. The Lab isolated the plant

pathogenic bacterium *Lelliotta amnigena*, which has been reported to cause soft rot diseases in carrot, lettuce, onion and several other horticultural crops internationally.

Table 10. Observations of foliar diseases in a field of green (G) and napa (N) cabbages at Field 2, which was surveyed for foliar diseases in June, July and August, 2021.

Sample site	June 23*		July 6*		July 20*		August 3*	
	DI (%)**	DS (0-4)***	DI (%)	DS (0-4)	DI (%)	DS (0-4)	DI (%)	DS (0-4)
1	G=0	G=0	G=0	G=0	G=0	G=0	N=29	N=4
2	G=0	G=0	G=0	G=0	G=0	G=0	G=20	G=3
3	G=0	G=0	G=0	G=0	N=0	N=0	G=0	G=0
4	--	--	N=17	N=0.1	--	--	--	--
Mean	G=0	G=0	G=0 N=17	G=0 N=0.1	G=0 N=0	G=0 N=0	G=10 N=29	G=1.5 N=4

* No foliar disease symptoms were observed on June 23 and July 20. On July 6, one plant exhibited basal stem rot and on August 3, tipburn and brown leaf spotting were observed.
** DI = Disease Incidence (% plants affected).
*** DS = Disease Severity (Proportion of the canopy affected based on a 0-4 rating scale, where: 0 = no disease symptoms, 1 = 1-10% of the crop canopy showing symptoms; 2 = 11-25% showing symptoms, 3 = 26-50% showing symptoms, and 4 = >50% showing symptoms).

In recent years, farms in the Whitehorse area have encountered cabbage tipburn and internal browning, which are physiological disorders of similar origin, in previous seasons. Chinese (napa) cabbage is particularly susceptible to this problem. Brussels sprouts, green and colored cabbages and cauliflower can also be affected. Field 2 took five soil samples from various areas of its farm in early June, 2021 and submitted them to Element Labs in Edmonton, AB for a farm soil analysis. These results reports are currently being reviewed by vegetable specialists in other parts of Canada order to determine if any excesses, deficiencies or imbalances of nutrients, pH, electrical conductivity, cation exchange capacity and other chemical and physical characteristics are present that could help explain the susceptibility of cruciferous vegetables to tipburn and internal browning at this farm.

Field 3:

A variety of organic cruciferous vegetables and some red beets were examined at this location. The survey procedure used was similar to the one used at Field 1. The cruciferous vegetables included bok choy, broccoli, and napa, red and green cabbages. These crops were surveyed on four dates, i.e., June 22, July 7, July 21 and August 4. Injury from foliar-feeding caterpillars and cabbage root maggots was the primary pest issue in the cruciferous vegetables at this farm throughout the growing season. No specific disease symptoms were seen on any of the four survey dates. The beets also exhibited foliage damage caused by leafmining insects and one

plant was observed with leaf spot symptoms resembling those caused by *Phoma beta*. This disease was previously observed during the 2020 vegetable disease survey in the Yukon.

6.5.2 Potatoes

Field 1:
A field with four varieties was surveyed for foliar diseases on June 22, July 8 and 21, and August 3. The survey method was similar to that used for the cabbages.

The plants were examined for both infectious and non-infectious diseases four times during the growing season. On the first survey date (June 22), the crop had just begun to emerge and appeared very healthy, apart from some minor yellowing and crinkling of the leaf tips on the occasional plant and some insect feeding damage. On July 8, by which time the crop was just starting to flower, the plants generally looked very healthy. By July 21, most of the crop was at the early flowering stage and most plants showed evidence of light frost damage, i.e., yellowing and browning of the upper leaves (Fig. 12). On August 3, the final sampling date, the crop was at full bloom and there was widespread evidence of frost damage to the foliage throughout the field. The most typical symptoms were a brown to black discoloration or spotting on the leaves, especially on the youngest ones, as well as on some of the flowers. In addition, a recent windstorm had caused much of the crop to lodge. There were no distinctive symptoms of any infectious diseases on the foliage on any of the survey dates.

Field 2:
A small potato planting was surveyed at this market garden.

The survey method was similar to that used for the cabbages. The potatoes were grown under row covers for most of the growing season and showed no symptoms of infectious diseases on the foliage. The vine growth was heavy and some of the stems had snapped under their own weight and because of strong winds. No symptoms of infectious diseases were noted.

7.0 Summary
A summary of the crops surveyed in 2021 and the main diseases encountered is presented in Table 11. Most occurred at relatively low levels and did not appear to be causing significant damage; however, assessing actual levels of yield and quality losses was beyond the scope of the survey. As crop production intensifies in the Yukon, it is expected that disease levels will increase over time and some economic losses will occur.

Table 11. Summary of diseases observed during surveys on cereal, forage, oilseed, fruit and vegetable crops in the Yukon Territory in 2021.

Crops	Diseases
Wheat	Leaf spotting, yellowing and browning (possible nutrient deficiencies)

	Bleaching of awn tips (frost injury)
Bromegrass	Leaf spots (*Neoascochyta exitialis, Phaeosphaeria nodorum Pseudomonas coronafaciens, Cladosporium* sp.)
	Leaf discoloration (possible nutrient deficiencies)
Timothy	Leaf spots (*Cladosporium* sp., *Epicoccum* sp., *Pezizomycetes* sp. *Microdochium* sp.)
Canola	Leaf spots (*Alternaria* sp.)
	Stunting (*Fusarium tricinctum*, *F. culmorum*, *F. avenaceum, Alternaria, Phoma* sp.)
	Blossom dieback (frost injury)
Haskap	Puckered and discolored leaves (frost injury, sunscald, weathering) Fruit damage (weathering, wind, birds)
Cabbage	Intumescence/edema (water congestion)
	Tipburn (calcium deficiency and associated nutrient imbalances)
	Variegation (chimera)
	Soft rot (*Lelliotta amnigena* and other bacteria)
Potato	Leaf discoloration (frost injury)

8.0 Scientific and Technical Support

Manpower support to assist directly or indirectly with the crop disease survey carried out in 2021 came from various sources. Agriculture Branch staff had the major responsibility for conducting the survey, including contacting growers for permission to survey fields, arranging the survey schedule, visiting the farms to collect data and samples, forwarding selected samples to the Alberta Plant Health Lab, preliminary compilation of the data for the final report, and providing copies of the survey reports to cooperating growers.

The following individuals and organizations provide technical advice and/or logistical support to the project:

- Agriculture Branch, Energy Mines and Resources, Whitehorse, YT
  Ms. Kristine Ferris, Mr. Randy Lamb, Mr. Brad Barton, Ms. Tawni Drinnan and Ms. Temesha Debler
  [Project funding and management, liaison with cooperators, field surveys, data collection and tabulation, preparing and shipping samples to the Alberta Plant Health Lab, and assistance with preparing reports]
- Alberta Plant Health Laboratory, Alberta Agriculture and Forestry, Edmonton, AB
  Dr. Jie Feng, Ms. Snezana Dijanovic and Messrs. Alian Sarkes, Yalong Yang and Kher Zahr
  [Assistance with plant disease diagnoses]
- Beaverlodge Research Farm, Agriculture and Agri-Food Canada, Beaverlodge, AB
  Dr. Henry Klein-Gebbinck, Plant Pathologist
  [Advice on forage grass disease diagnosis]

- Canola Council of Canada, Fairview, AB
  Mr. Jason Casselman, Agronomy Specialist
  [Advice on canola disease diagnosis]
- Spencer Horticultural Solutions, Stettler, AB
  Mr. Robert Spencer, Horticulturist
  [Advice on vegetable disease management]
- University of Guelph, Guelph, ON
  Dr. Mary Ruth McDonald, Professor
  [Diagnosis and management of cabbage diseases]
- Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON
  Mr. Travis Cranmer, Vegetable Crops Specialist, Guelph, ON
  [Management of nutritional disorders in cabbage]

9.0 Future Plans

It is hoped that the crop disease surveys in the Territory can be continued in 2022 and include some of the same field and horticultural crops that were examined in 2020 and 2021. It would be desirable to focus on the crops where diseases appear to be having the biggest impact in order to estimate the economic impact and to determine if disease management practices should be improved in order to reduce yield and quality losses. This approach will, of course, depend on the availability of adequate manpower and budget resources from the Agriculture Branch of the Yukon Government.

10.0 Photographs

Figure 1. Loose smut on volunteer barley.

Figure 2. Frost damage on wheat.

Figure 3. Leaf spot on timothy.

Figure 4. Leaf spot on bromegrass.

Figure 5. Frost damage killed young canola blossoms at the top of the main raceme.

Figure 6. Reflowering in canola after frost killed most blossoms on the main raceme.

Figure 7. Wrinkling on haskap leaves likely caused by late spring frost injury.

Figure 8. Leaf damage on haskap possibly caused by frost and/or wind damage.

Figure 9. Symptoms of internal tipburn on napa cabbage.

Figure 10. Symptoms of internal tipburn on napa cabbage.

Figure 11. Symptoms of bacterial soft rot on napa cabbage.

Figure 12. Symptoms of frost injury on potato leaves.