Yukon Agriculture Insect Survey Project 2021

Final Report

Scott Meers

Mayland Agriculture Consulting

Calgary, Alberta

January 31, 2022

Acknowledgements

Kristine Ferris from the Yukon Government for inviting me to participate in the study, organizing and overseeing the work on the ground. Also, thankyou to Tawni Drinnan, for an excellent job on running the surveys, sample collection and curation.

Meghan Vankosky, Agriculture and Agrifood Canada provided trap and monitoring supplies (through the Prairie Pest Monitoring initiative) for several of the surveys. Meghan's lab also processed the Swede Midge survey collections as part of their ongoing research on that insect.

Shelley Barkley, Alberta Agriculture, Forestry and Rural Economic Development accepted samples to the laboratory in Brooks, Alberta. Shelley also provided laboratory access for sample processing.

Boyd Mori, University of Alberta provided supplies for and processed the Canola Flower Midge survey. Boyd also generously performed DNA barcode analysis of specimens sent for identification. The importance of this can not be overstated, insect identification can be a prolonged and difficult task and the ability to obtain many determinations in a short time was instrumental to the success of this effort.

Thank you to the producers agreed to participate in insect and disease surveys in 2021. Access to crops to perform survey work is always critical to success and their participation is greatly appreciated.

Introduction

Agriculture in Yukon is a growing aspect of the economy. As the agriculture production base increases challenges such as insect pests will arise. In order to help producers prepare for these challenges the Government of Yukon has set out to do baselines surveys to determine potential risks. Mayland Agriculture Consulting was engaged to help guide and summarize the insect survey efforts in 2021. Insect surveys were designed to be very targeted to some species and also more open ended to try to capture a wide range of potential insect pests.

Surveys

In collaboration with Kristine Ferris, insect surveys to be completed in 2021 were planned and supplies obtained. The purpose of this project was to determine the presence of insects which have the potential to be pests to crops grown in Yukon agriculture. For this reason, a number of different approaches were taken. Pheromone testing is very specific to one pest but occasionally will yield other information. Hand collecting of insects actively causing damage is the most effective way of finding potential pests but often is not effective when pest levels are vey low. On the other end of the scale are sticky cards and sweep net sampling which can yield many insects, most of which are not pest species. This method of collection can yield interesting findings but must be balanced against large time commitments to sort through the samples. The absence of a target insect in any survey does not necessarily mean it is not present but rather it was not detected. Finding a target insect on the other hand does not necessarily mean it is or will become an economic issue. Finding a potential pest will help focus monitoring activities and inform management practices in the future. Insect pests identified are discussed further in the survey within which they were discovered. Based on the numbers of insects discovered in the survey it appears that in 2021 only root maggot was in sufficient numbers to merit concern.

Completed 2022 Insect Surveys

Survey	Crop	Pheromone	Collection Method	Date started	Date Completed
Bertha Armyworm	Canola	Yes	Bucket trap	17-Jun	13-Aug
Canola Flower Midge	Canola	Yes	Sticky Cards	24-Jun	13-Aug
Diamondback Moth	Canola	Yes	Sticky Cards	10-Jun	13-Aug
Swede Midge	Canola	Yes	Sticky Cards	10-Jun	13-Aug
Wheat Midge	Wheat	Yes	Sticky Cards	05-Jul	22-Jul
Visual	Various	No	Hand Collected	21-May	28-Jun
Flea Beetle	Canola	No	Sticky Cards	10-Jun	08-Jul
Root Maggot	Beets	No	Sticky Cards	22-Jun	29-Jul
Root Maggot	Cole	No	Sticky Cards	22-Jun	11-Aug
Root Maggot	Cole	No	Sticky Cards	23-Jun	17-Aug
Root Maggot	Cole	No	Sticky Cards	03-Jun	13-Aug
Sweep Net	Various	No	Sweep Net	13-Jul	05-Aug

Sample Identification

Throughout the sampling period almost all insect samples collected were labelled using the following convention. First and last initials of person collecting the sample, the year and then a sequential number starting at 1. The first sample, therefore, became TD21-1, the second TD21-2 and so on. All samples were recorded in a log book with relevant details. Samples were labelled with the sequential number and other relevant data. The technician involved in this work did a wonderful job of labelling samples and recording information. The result is a very complete dataset of the summer survey activity. It was a joy to work with the samples and manipulate the data because it was so well organized.

Insect Identifications

DNA Barcoding was utilized to identify insects from all surveys. Because of the volume of insects that are collected in insects surveys, a subsample of insects of interest were selected for DNA barcoding. In 2002 Dr Paul Hebert, University of Guelph proposed using mitochondrial gene cytochrome c oxidase I (COI) to develop a global bioidentification system. Since that time the system has grown to be a very strong resource for identification of insects. All insects successfully barcoded in this project were compared against a global database. Where good records of species exist, positive determinations can be made. Often, however, the insect that was barcoded is not found in the database. Inferences can be made to family, subfamily or genus depending on the percentage of match to known species. Occasionally, there is some confusion within the database arising from differences of identification of specimens used to create the database. This situation arose in some of the cutworm moth specimens (from the BAW survey). DNA extraction with leafhoppers proved to be difficult and many of the attempts failed. Enough were successful, however, to rule out known pest species. In all eleven insect species known to be potential pests were identified through the surveys conducted in 2021.

Confirmed Pest Species

Sample #	Crop	Date	Insect type	Collection	Final Determination	Family	Notes
21A	roadside	21-May	larvae	hand collected	Actebia fennica	Noctuidae	Black army cutworm
TD21-06	hay	16-Jun	larvae	hand collected	Actebia fennica	Noctuidae	Black army cutworm
TD21-28	cole	01-Jul	fly	sticky card	Delia floralis	Anthomyiidae	Turnip maggot
TD21-45	cole	20-Jul	fly	sticky card	Delia floralis	Anthomyiidae	Turnip maggot
TD21-57	canola	15-Jul	fly	sweep net	Delia florilega	Anthomyiidae	Root maggot
TD21-57	canola	15-Jul	fly	sweep net	Delia planipalpis	Anthomyiidae	Radish root maggot
TD21-25	cole	28-Jun	beetle	hand collected	Entomoscelis americana	Chrysomelidae	Red Turnip beetle
TD21-16	carrots	23-Jun	larvae	hand collected	Euxoa ochrogaster	Noctuidae	Red Backed cutworm
TD21-59	carrots	20-Jul	moth	hand collected	Euxoa ochrogaster	Noctuidae	Red Backed cutworm
TD21-57	canola	22-Jul	lygus	sweep net	Lygus borealis	Miridae	Lygus
TD21-20	canola	01-Jul	lygus	sticky card	Lygus keltoni	Miridae	Lygus
TD21-20	canola	01-Jul	lygus	sticky card	Lygus keltoni	Miridae	Lygus
TD21-24	cole	07-Jul	aphid	sticky card	Macrosiphum euphorbiae	Aphididae	Potato aphid
TD21-12	cole	28-Jun	flea beetle	sticky card	Phyllotreta striolata	Chrysomelidae	Striped flea beetle
TD21-20	canola	01-Jul	flea beetle	sticky card	Phyllotreta striolata	Chrysomelidae	Striped flea beetle
Several	canola	Several	moth	pheromone	Plutella Xylostella	Plutellidae	Diamonback moth

Survey Summaries

Bertha Armyworm (*Mamestra configurata,* Lepidoptera:Noctuidae)

Bertha Armyworm is a major pest of canola which is capable of completely devastating a canola crop. To prevent widespread outbreaks happening without warning a pheromone-based monitoring system has been developed on the Canadian Prairies which gives a 3-to-4-week warning period. Moth catches have been correlated to the potential for outbreaks. Catches more than 300 moths indicates the first warning level. The risk of damaging outbreaks increases with higher moth catches. Bertha armyworm is a native insect and outbreaks are cyclical. Populations are regulated by a wide range of natural enemies including parasitic flies, parasitic wasps, and diseases, both viral and fungal. This survey followed the protocol of the Prairie Pest Monitoring Network and supplies were obtained through the Network courtesy of Meghan Vankosky, Agriculture and Agrifood Canada. Key Finding: there were no individuals of *Mamestra configurata* found in any of the Bertha armyworm trap collections.

In canola growing areas of the prairie provinces there are always a few bertha armyworm moths caught in the traps every year. There are also always other moth species that are attracted to bertha armyworm pheromone traps. On the Canadian prairies the most common "contaminants" are in the genera *Agroperina* or *Leucania*. This is likely because of very similar pheromones and the contaminant moths are reacting to the pheromone. It is also possible that the moths could be seeking shelter and blunder their way into the traps. Of the moths caught in the bertha armyworm traps, most likely reacting to a pheromone, most common are the *Enargia* species moth caught in the final two weeks of the survey (based on the higher number caught). It is interesting that no bumblebees were caught in the bertha armyworm traps as this is a common problem in the northern parts of the canola growing areas, especially the Peace River region.

Moths Caught in Bertha Armyworm Traps

Sample #	Date	# Caught	Final Determination	Family
TD21-11	24-Jun	1	Mniotype pallescens	Noctuidae
TD21-22	01-Jul	1	Mniotype pallescens	Noctuidae
TD21-33	08-Jul	1	Apamea cogitata	Noctuidae
TD21-56	22-Jul	2	Apamea cogitata	Noctuidae
TD21-71	29-Jul	2	Enargia mephisto	Noctuidae
TD21-82	05-Aug	2	Enargia sp.	Noctuidae
TD21-92	05-Aug	8	Enargia sp.	Noctuidae
TD21-92	05-Aug	1	Euxoa comosa	Noctuidae

Canola Flower Midge

Canola flower midge (*Contarinia brassicola,* Diptera: Cecidomyiidae) is a minor pest of canola. It was first identified when doing survey work for Swede midge. As a new species it was described by Dr. Boyd Mori. Surveys were conducted across the Canadian prairies looking for the characteristic damage of bottle shaped flowers that contain the midge larvae. Canola flower midge was most often found in central areas of Alberta and Saskatchewan. Recently canola flower midge larvae have been found inside canola pods which may increase the importance of this insect as a pest. Further work is under way on the importance of the pod aspect of this insect in Canadian canola. This survey was done with protocol and supplies from Dr Boyd Mori, University of Alberta and trap evaluations were carried out by his technicians. No canola flower midge were found in this survey. Several midges not suspected of being *Contarinia brassicola* were found on the traps. These may be barcoded at a later date.

Diamondback moth

Diamondback moth (Plutella xylostella, Lepidoptera: Plutellidae) is a worldwide pest of crops in the Brassicacea family. On the Canadian prairies it is generally believed to not overwinter although that fact is occasionally questioned, especially in particularly mild winters. The Canadian prairies are repopulated by migration of diamondback moth southern parts of North America where they reproduce year-round. In those southern areas diamondback moth is major pest in vegetable production. On the Canadian prairies diamondback moth is an occasional pest of canola, seldom rising to levels that require control. It is often heavily parasitized and/or affected by fungal diseases which may often terminate or prevent outbreaks.

This pheromone based survey followed the protocol of the Prairie Pest Monitoring Network and supplies were obtained through the Network courtesy of Meghan Vankosky, Agriculture and Agrifood Canada. Low levels of Diamondback moths were found in all but one week of sampling. Although the numbers are very low in the Yukon collections, (in problem populations weekly catches often surpass 200 moths) there appears to be two peaks in June 10 to 17 and July 29 to August 5. This could represent the in-migration generation followed by a second generation that reproduced in the Yukon. It is important to stress that moth catches in these numbers do not represent a substantial or worrisome population.

Wind trajectory work is done by Agriculture and Agrifood Canada to indicate when winds are likely to bring diamondback moths into the Canadian prairies. It would be interesting to see if that system could identify the possible sources of the Yukon population.

Diamondback Moth Trap Results

Sample Number	Date out	Date Collected	Trap 1	Trap 2
TD21-08	17-Jun	24-Jun	1	1
TD21-19	24-Jun	01-Jul	1	0
TD21-02	10-Jun	17-Jun	3	5
TD21-30	01-Jul	08-Jul	1	0
TD21-41	08-Jul	15-Jul	0	0
TD21-53	15-Jul	22-Jul	1	0
TD21-69	22-Jul	29-Jul	2	6
TD21-80	29-Jul	05-Aug	6	3
TD21-90	05-Aug	13-Aug	2	1

Swede Midge

Swede midge (*Contarinia nasturtii*, Diptera: Cecidomyiidae) is a serious pest of canola in parts of eastern Canada but it has not become an important pest on the Canadian prairies. It was reported in east central Saskatchewan but recent surveys have been unable to find it again. Swede midge can also be a serious pest of vegetables in the Brassicacea family. In Ontario substantial damage has been done to the cole crop industry by swede midge. This survey was done with protocol and supplies from Dr Meghan Vankosky, Agriculture and Agrifood Canada, Saskatoon and trap evaluations were carried out by her technicians. No swede midge were found in this survey.

Wheat Midge

Wheat midge (*Sitodiplosis mosellana*, Diptera: Cecidomyiidae) is a major pest of wheat on the Canadian Prairies. It is widespread across the entire wheat growing area of the prairies. Annual surveys are conducted using soil samples to create forecast maps to help producers plan control methods if necessary. Midge tolerant wheat has greatly reduced the incidence of wheat midge problems as well as the use of insecticides. Wheat midge larvae feed directly on developing wheat seeds with populations potentially reaching astronomical proportions. It is possible to have several wheat midge larvae feeding on a single developing kernel. Wheat midge populations tend to increase in wet years and decrease in dry years as the life cycle is favored by rainfall and wet soils.

This survey followed the protocol of the Prairie Pest Monitoring Network and supplies were obtained through the Network courtesy of Meghan Vankosky, Agriculture and Agrifood Canada. Pheromone sampling is used to help identify spikes in wheat midge numbers. High pheromone catches are followed up by field scouting to determine if economic thresholds are met and insecticide control needed. The wheat midge pheromone is highly effective but works on an extremely short range. There were no individuals of *Sitodiplosis mosellana* found in any of the Wheat Midge trap collections. There was one midge that looked like *Sitodiplosis mosellana* on the pheromone trap. Barcoding indicated that it was only 85% similar to *Sitodiplosis mosellana*, placing it in the same family. Although the suspect insect resembled a wheat midge in size and color it was definitely not the pest species. Since this is a project to establish the presence or absence of pest species next year the traps should be place in wheat stubble if this project is continued.

Macroglens penetrans is an important parasitoid of wheat midge and has helped reduce populations of the pest. The parasitoids were not barcoded but the samples have been retained and could be processed at a later date if wheat midge is identified in the Yukon.

Wheat Midge Trap Results

Sample #	Trap out	Trap collected	Midge*	Parasitoid**
TD21-34-1	05-Jul	08-Jul	0	0
TD21-34-2	05-Jul	08-Jul	0	0
TD21-40-1	08-Jul	13-Jul	0	0
TD21-40-2	08-Jul	13-Jul	0	0
TD21-46-1	13-Jul	15-Jul	0	0
TD21-46-2	13-Jul	15-Jul	0	0
TD21-52-1	15-Jul	20-Jul	0	1
TD21-52-2	15-Jul	20-Jul	0	1
TD21-62-1	20-Jul	22-Jul	0	0
TD21-62-2	20-Jul	22-Jul	1	0

*Potential wheat midge. **Potential wheat midge parasitoid, *Macroglens penetrans*.

Hand collected specimens

Six separate collections by hand were obtained through the sampling period. This is a highly effective way of identifying pests because they can be observed in conjunction with a crop and any damage they are causing.

Three different pest species were identified using this collection method. Not included in the table below are two ants collected from carrots that turned out to be a wood ant, *Formica glacialis*.

The roadside and hay collections of May 21 and June 16 both turned out to be Black army cutworm (*Actebia fennica*) which is a recognized pest of forestry significance. *A. fennica* is generally considered to be a specialist of plants in the genus *Vaccinium* but in outbreak phase can become highly polyphagous, feeding on a wide range of species including conifers in the genus *Pinaceae*. Pest status in agricultural crops is not widely documented but potential for damage to agricultural crops does exist, especially in areas that are adjacent to forested lands.

Cutworm collections from the carrot field (June 23 larvae and July 20 as a pupa that then emerged as a moth) both turn out to be red backed cutworm (*Euxoa ochrogaster*). Red backed cutworm is a serious pest of field crops throughout the prairie provinces and outbreaks can cause extensive damage to a wide variety of crops. Red backed cutworms lay their eggs in the fall, and the larvae hatch in the spring. It is the larval stage that causes the damage. Cutworm moths are highly mobile, with females searching out favorable egg laying locations. Pheromones are available for most of the pest species of Noctuidae but there is poor correlation between catches of *Euxoa ochrogaster* moths with pheromone baited traps and potential outbreaks of the larval stage.

The hand collected beetles from June 28 were Red Turnip beetle, *Entomoscelis americana.* This is a potentially devastating pest of crops in the family Brassicacea. This pest has a very interesting life history. Adults go through a summer aestivation, emerging in the fall to lay eggs on or near plants in the brassica family. Eggs overwinter and larvae hatch in the spring, feeding until mid-spring, pupation is quick with adults emerging in late spring. The life cycle may vary in the Yukon based on the compressed season. Cole crop producers who notice red turnip beetle in the fall should move next years planting as

far as possible from the current planting to avoid damage from larval feeding. Both adult and larval damage can be serious but usually larval feeding is of greater concern due to the plants being smaller when they are active.

Pest Insects From Hand Collections

Sample #	Crop	Date	Insect type	Final Determination	Family	Common Name
21A	roadside	21-May	larvae	*Actebia fennica*	Noctuidae	Black army cutworm
TD21-06	hay	16-Jun	larvae	*Actebia fennica*	Noctuidae	Black army cutworm
TD21-16	carrots	23-Jun	larva	*Euxoa ochrogaster*	Noctuidae	Red Backed cutworm
TD21-25	cole	28-Jun	beetle	*Entomoscelis americana*	Chrysomelidae	Red Turnip beetle
TD21-59	carrots	20-Jul	moth	*Euxoa ochrogaster*	Noctuidae	Red Backed cutworm

Sticky cards

Assessments of sticky cards was a very time-consuming process. It was not possible to count all insects stuck to the cards. Insects of special interest were tracked. Parasitic wasps were tracked on many of the cards and were in a wide range of species from very small to large ichneumonids. No attempt to identify parasitic wasps was made. Many of the cards had large numbers of a single species of psyllid. Those numbers were tracked and a graphic summary is provided below. Barcode determination identified the psyllid only to family.

Canola Sticky Cards - Flea Beetles

Sticky cards were place in canola to look for flea beetles. The most significant finding was the confirmation of *Phyllotreta striolata,* striped flea beetle. Stripe flea beetle was found on sticky cards collected July 1. In addition, several more striped flea beetle we captured on sticky cards collected from cabbage at Farm 3 on June 28 and July 7. Root maggot catches were much lower in canola than in sticky cards set up in cabbage. *Lygus keltoni* was confirmed by bar coding from canola sticky cards. An interesting insect captured in canola was *Ceutorhynchus neglectus,* commonly known as flixweed weevil, not a pest but an insect that attacks a common weed. Unfortunately, flixweed weevil is not an effective biological control agent of flixweed. Other insects were barcoded from sticky cards placed in canola but none were of significance.

Canola Sticky Card Barcode Samples

Sample #	Crop	Date	Collection	Final Determination	Family	Notes
TD21-09 3A	canola	24-Jun	sticky card	Ceutorhynchus neglectus	Curculionidae	flixweed weevil
TD21-20 1A	canola	01-Jul	sticky card	Lygus keltoni	Miridae	lygus
TD21-20 2A	canola	01-Jul	sticky card	Phyllotreta striolata	Chrysomelidae	flea beetle
TD21-20 4A	canola	01-Jul	sticky card	Lygus keltoni	Miridae	lygus
TD21-20 4B	canola	01-Jul	sticky card	Phyllotreta sp.	Chrysomelidae	flea beetle

Beet Sticky Cards

Sticky cards were placed on beets from June 22 through July 29. Two sticky cards were placed in the beet planting and changed weekly. The sticky cards were assessed looking for beet leaf miner or other potential pests. Three samples were taken from the sticky cards and sent for DNA analysis. A rove beetle came back as *Atheta subsinuata* which is a predator of small arthropods. Another came back to the genus *Macrosteles*, a leafhopper. The third was a fly that was close in appearance to beet leaf miner. The fly came back to the family Anthomyiidae (same family as beet leaf miner) but it was not the beet leaf miner. The sticky cards in beets were targeting the beet leaf miner, *Pegomya hyoscyami*, but none were found. The last two weeks had substantial insect removed by bird feeding as evidenced by feathers stuck to the cards and the absence of insect bodies (only wings remained for many of the insects).

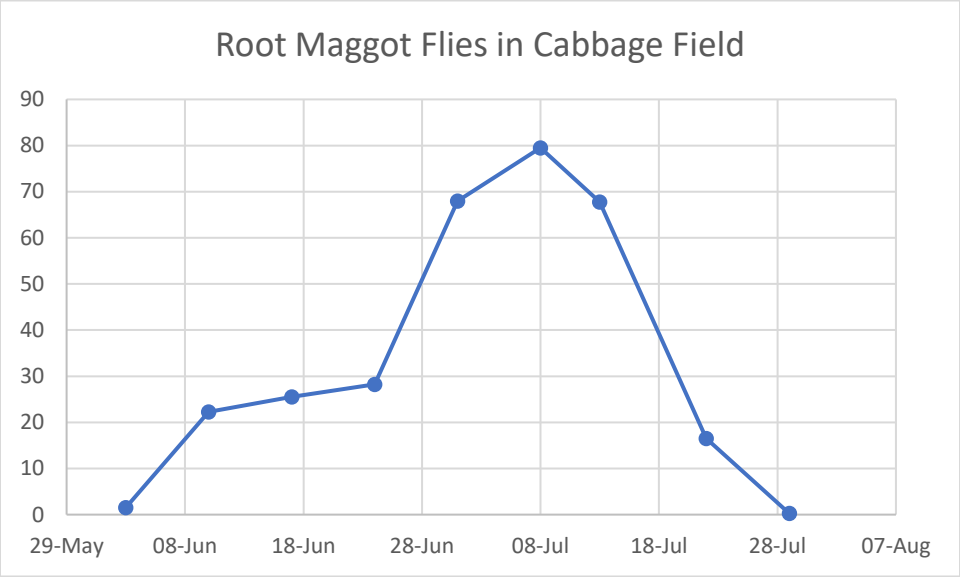
Cabbage Sticky Cards

Sticky cards were set out in cabbage/cole crops on three farms with the primary target of root maggot flies. The most complete data set was from the largest of the three farms, it clearly shows the seasonal activity of root maggot flies, with peak activity the first week of July. The Turnip Root Maggot fly *Delia floralis* was confirmed by DNA barcoding and is one of the species making up the root maggot complex affecting the cole crops. Root maggot fly collections were much lower at one of the market gardens presumably because the crop was grown under tunnels. The stiped flea beetle, *Phyllotreta striolata* was confirmed by DNA barcoding from a sticky card at one of the market gardens. Several leafhoppers were identified to genus by DNA barcoding but none appear to be known pest species, although it is possible that they could become pests in Yukon Agriculture. One very interesting discovery via barcoding was the presence of Macrosiphum euphorbiae, the Potato Aphid. This species is a known vector of several virus diseases and is very polyphagus, not just feeding on potatoes. A psyllid in the family Aphalaridae was prominent on all yellow sticky cards. Again, the most complete data set from the largest cabbage field shows the season flight activity of this species. Although this species is unlikely a crop pest the sticky card data may be important in elucidating more about the species if the Canadian National Collection is interested in pursuing identification.

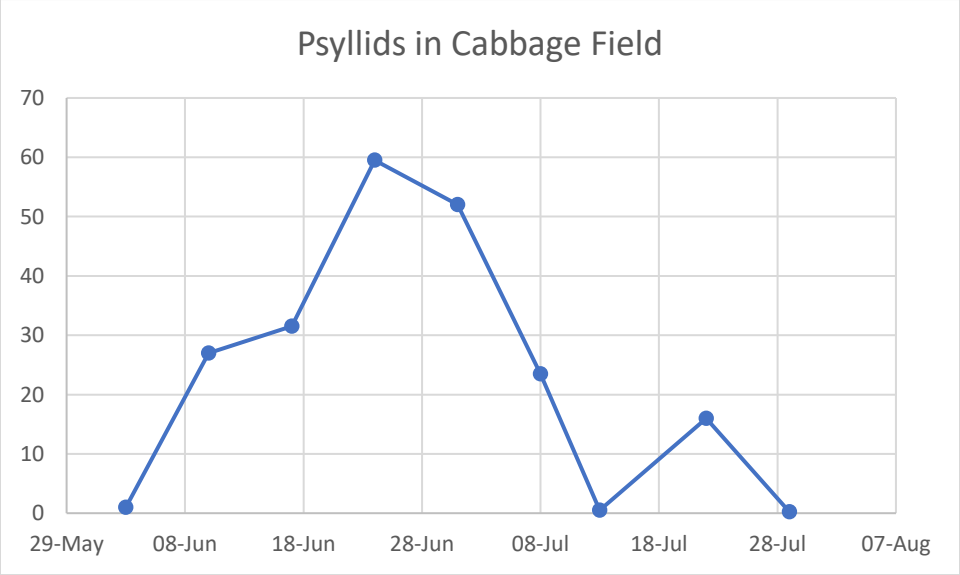
Cole Crop Sticky Card Barcode Samples

Sample #	Crop	Date	Collection	Final Determination	Family	Notes
TD21-12 3A	cole	28-Jun	sticky card	Phyllotreta striolata	Chrysomelidae	flea beetle
TD21-24 3A	cole	07-Jul	sticky card	Macrosiphum euphorbiae	Aphididae	Potato aphid
TD21-27 1B	cole	29-Jun	sticky card	Cuerna striata	Cicadellidae	leaf hopper
TD21-28 NA	cole	01-Jul	sticky card	Delia floralis	Anthomyiidae	Turnip maggot
TD21-35 1A	cole	13-Jul	sticky card	Empoasca sp.	Cicadellidae	green leafhopper
TD21-35 2B	cole	13-Jul	sticky card	Cicadellidae	Cicadellidae	leaf hopper
TD21-45 2B	cole	20-Jul	sticky card	Delia floralis	Anthomyiidae	Turnip maggot
TD21-45 2C	cole	20-Jul	sticky card	Macrosteles sp.	Cicadellidae	leaf hopper
TD21-63 3A	cole	29-Jul	sticky card	Macrosteles sp.	Cicadellidae	leafhopper

Seasonality of Root Maggot Flies



Seasonality of Psyllid



Sweep Net Samples

Sweep net samples were taken in three crops with potatoes being swept twice. Each sweep net sample consisted of 3 sets of 25 sweeps. Instructional videos were supplied to help with taking proper sweep net samples. As can be seen in the tables below a wide array of insects can be found using sweep net samples, only a few will be pests, many others will be carrying on life cycles not related to the crop in any way. Some are simply accidental tourists.

Sweep net samples

Sample #	Crop	Date	Parasitoids	Root Maggot	Thrips	Leaf Hoppers	Other flies	Lygus	Barcode Samples
TD21-47-1	Wheat	13-Jul	2		5		16		1
TD21-47-2	Wheat	13-Jul	2		1		15		2,2A, 2B,2C
TD21-47-3	Wheat	13-Jul	1		1		61		3, 3A, 3B
TD21-57-1	Canola	15-Jul		1	8	2	9		1, 1A
TD21-57-2	Canola	15-Jul	1	1	15			2	2,2A,2B, 2C,2D
TD21-57-3	Canola	15-Jul	1		6		11		3
TD21-66-1	Potato	05-Aug	2			2	31		1
TD21-66-2	Potato	05-Aug					11		
TD21-66-3	Potato	05-Aug					27		3
TD21-85-1	Potato	21-Jul					3		
TD21-85-2	Potato	21-Jul				1	2		2
TD21-85-3	Potato	21-Jul					5	1	

Wheat samples were largely flies with a few thrips and parasitic wasps. Some species of thrips can rarely become a problem in cereal crops but this is rare. The thrips were not sent for barcoding. Some of the flies were barcoded and showed a range of different groups. The Muscidae family flies and fungus gnats generally perform recycling functions in the ecosystem. Dance flies are often predators of other insects. One sweep net sample had a large number of Chironomidae flies which are an aquatic midge whose larvae live in water bodies. No potential pests were identified in the wheat sweep net samples. It is typical of wheat sweep net samples to have very little diversity.

Canola sweep net samples are often much more diverse which was not the case with these samples. There were some interesting insects identified in the sweep net samples. Two different species of *Delia* flies were identified from the sweeps. Both *D. planipalpis* and *D. florilega* are known to attack plants in the Brassicaceae family. Also, *Lygus borealis* was identified from one of the samples. L. borealis is part of a complex of insects in the genus that can be significant pests of canola if they occur in high enough numbers. Producers in the prairie provinces monitor lygus populations after flowering using sweep net samples to determine thresholds. There is some level of control operations for lygus in canola every year on the Canadian prairies. A couple other insect of interest were identified from the canola sweeps, a parasitoid in the subfamily Cremastinae which is a group of parasitic wasps that tend to specialize on lepidopteran (moth and butterfly) larvae. The other insect of interest that was found in the canola sweeps was *Polymerus vulneratus*, a plant bug that looks like a lygus but has reddish "eyespots" on its wings. This insect is seldom found in canola and has not been associated as a pest of canola. It is more often found in sweeps of alfalfa in Alberta. Often insects in flowering canola are feeding on nectar and may not actually be pests. A number of thrips were found in the canola sweeps that were not sent for barcoding but were keyed to western flower thrips, *Frankliniella occidentalis.* Western flower thrips are common in canola flowers but are not considered pests. Occasionally very high numbers of thrips can be found associated with canola flowers but seldom can measurable damage be ascribed to their presence.

Potato sweep net samples had very few insects. This is a common finding. Two flies and one leafhopper were sent for barcoding. Only the leafhopper was successful and to was identified to the genus *Macrosteles*. The aster leafhopper M. quadrilineatus is a serious pest of many types of plants because it can vector the disease aster yellows. This result also means that there is no association in the barcode database for the insect from the sweep net sample.

Insects barcoded from sweep net samples.

Sample #	Barcode #	Crop	Collection date	Final Determination	Family	Notes
TD21-47-1	1	wheat	13-Jul	Sciaridae	Sciaridae	Fungus gnat
TD21-47-2	2	wheat	13-Jul	Helina spinosa	Muscidae	
TD21-47-2	2A	wheat	13-Jul	Coenosia verralli	Muscidae	
TD21-47-2	2B	wheat	13-Jul	Bicellaria furcifer	Hybotidae	Dance fly
TD21-47-2	2C	wheat	13-Jul	Extraction Unsuccessful		
TD21-47-3	3	wheat	13-Jul	Smittia leucopogon	Chironomidae	Aquatic midge
TD21-47-3	3A	wheat	13-Jul	Extraction Unsuccessful		
TD21-47-3	3B	wheat	13-Jul	Lycoriella flavipeda	Sciaridae	Fungus gnat
TD21-57-1	1	canola	15-Jul	Delia planipalpis	Anthomyiidae	Radish root maggot
TD21-57-1	1A	canola	15-Jul	Polymerus vulneratus	Miridae	Plant bug
TD21-57-2	2	canola	15-Jul	Aphididae	Aphididae	Aphid
TD21-57-2	2A	canola	15-Jul	Cremastinae	Ichneumonidae	Parasitoid
TD21-57-2	2B	canola	15-Jul	Delia florilega	Anthomyiidae	Root maggot
TD21-57-2	2C	canola	15-Jul	Polymerus vulneratus	Miridae	Plant bug
TD21-57-2	2D	canola	15-Jul	Lygus borealis	Miridae	Lygus
TD21-66-1	1	potato	21-Jul	Macrosteles sp.	leaf hopper	Leaf hopper
TD21-66-3	3	potato	21-Jul	Extraction Unsuccessful		
TD21-85-2	2	potato	05-Aug	Extraction Unsuccessful		

Possible Follow-up Surveys and Work

Root Maggots. Because root maggots appear to be one of the moist significant pest species found in the 2021 surveys a follow-up survey to determine the actual species causing damage could be carried out. This would involve collecting larvae from roots of affected plants and determining species through DNA barcode.

Beet Leaf Miner. Visual surveys looking for mines in beet leaves followed by collection of larvae and DNA barcoding to determine species.

Visual surveys. Because the most effective method for connecting pest species to actual damage is to catch them in the act, mor emphasis could be placed on observing insect damage on plants and collecting insect responsible for the damage.

Wheat Midge. If wheat midge is present in the Yukon it is in very low numbers. A future survey of this type could place traps in last years wheat crop to increase the chance of catching wheat midge if they are present. Also the Braconidae wasps from wheat midge traps could be barcoded if wheat midge are found. Wheat midge parasitoids are attracted to the wheat midge pheromone so this could be an effective way of discovering them.

Thrips in canola. Dr Ken Fry conducted a survey of thrips infesting canola flowers. This could be replicated in the Yukon.

Species records. Following up on the species discovered in this survey a paper listing new species determinations for the Yukon could be prepared.

Diamondback moth. Agriculture and Agrifood Canada prepares wind trajectories to determine the source of insects coming into the Prairie Provinces. We could request that they look at possible sources of DBM in the Yukon. An alternative possibility for determining the source of the moths could be to use stable isotope analysis. Also, if diamondback moth continues to show up in the Yukon, a study to look at parasitism might be in order.

Residuals. At this point the traps and insects not consumed by identification work remain in a freezer with Alberta Agriculture. A decision will need to be made regarding their future. There are groups that would be interested in looking through these to confirm other (non-pest) species that are found in the Yukon.

Leafhoppers. Because barcoding didn't work well to identify leafhoppers, work with the National Collection in Ottawa could be undertaken to determine the species being found on the sticky cards. There are a number of insects left on cards that were not sent for barcoding.

Psyllid. Because the sticky cards give a very good timeframe of the psyllid the National Collection in Ottawa may be interested in following up for species identification.