Soil Health Demonstration Using Cocktail Cover Crop and Humalite

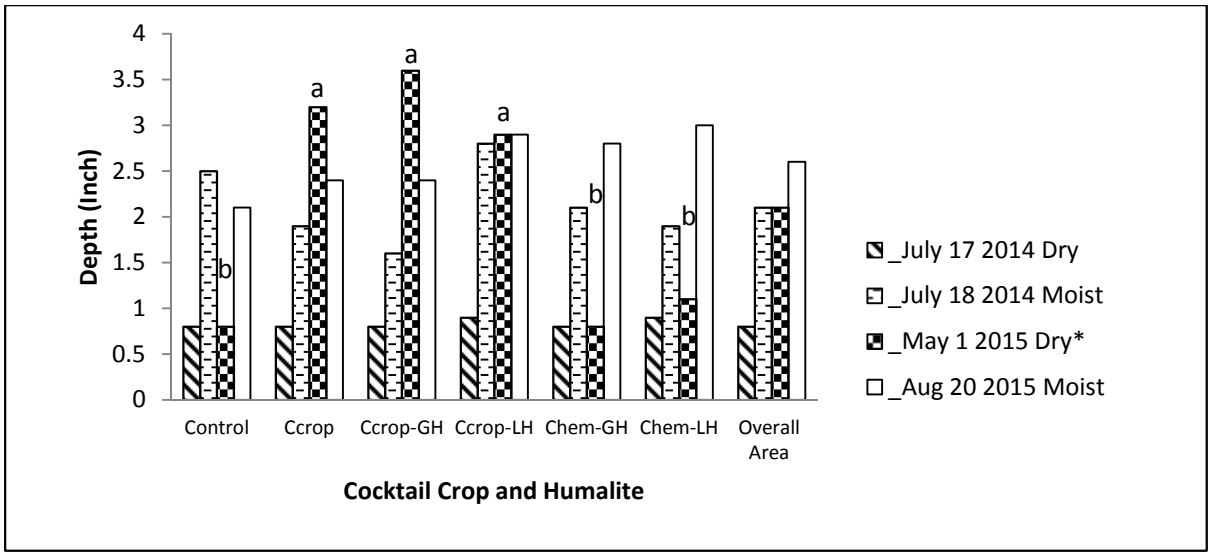
Cooperator: Charles Schmidt, Chinook SE 13-28-09-W4

Summary

A small plot was selected near Chinook to evaluate the effect of a cocktail cover crop (CCC) mix, chemfallow and different levels and types of humalite on the soil health condition. Granular (500 lb/A) and liquid (4 gallons/A) applications of humalite (weathered product of subbituminous coals and carbonaceous shales enriched with humic and other organic acids) were broadcasted onto the soil surface before seeding the CCC. The CCC mixture contained proso millet, field peas, fababean, oats, triticale and tillage radish. It was planted on August 11, 2014 at a rate of 30 lb/A on chem-fallow of 2013 canola. The cocktail mixes are typically seeded in mid-summer to give the crops growth opportunity before a killing frost but not long enough to set seed. Killing frost was not received until later in the fall, giving the plants 3 months of growth in 2014. During this period, it was expected that soil biological activities might be enhanced considering the different crop species involved in the mix.

The soil was very compacted according to penetrometer measurements taken before seeding. Two PSI (pound per square inch) measurements were taken at 2 dates in 2014: 200 and 300 PSI at two soil moisture contents, dry (July 17) and after rain (1 cm rain, July 18). At 200 PSI, the penetrometer was only able to enter into 0.8 inch into the dry soil but reached 2.1 inch into the wet soil. At 300 PSI, the penetrometer measured 1.8 inch and 4.5 inch respectively. Only 70% of plant roots are able to exert force equivalent to 200 PSI. Roots stop growing when the soil requires 300 psi to push through it. Therefore at this site, only 70% of the roots would go deeper than .8 inch into the dry soil and would stop growing at 1.8 inches. When the soil was wet, 70 % of the roots would reach 4.5 inches.

During 2015, evaluations of soil compaction were done to assess the impact of 3 months of CCC growth. Figure 1 shows the rooting depth compaction at the 200 PSI measured at different dates and soil moisture conditions.

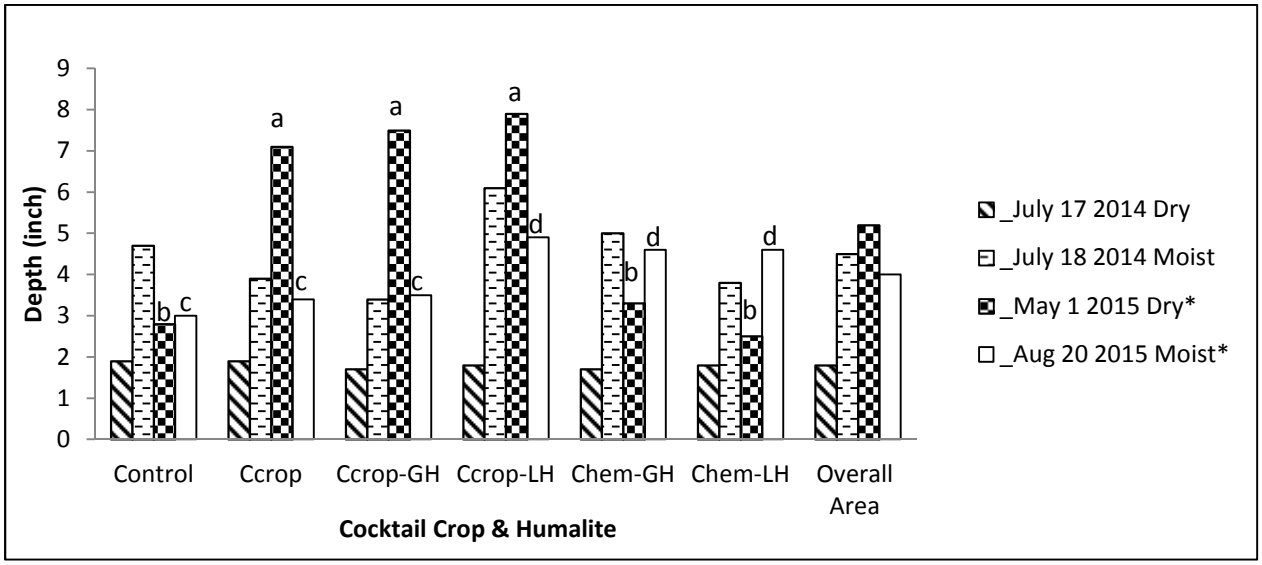


Ccrop=cocktail cover crop, GH=granular humalite, LH=Liquid Humalite, Chem=Chem fallow *Statistical significant different

Figure 1. Cocktail Cover Crop-Humalite effect on Soil depth Compaction at 200 PSI

Measurements of soil compaction done in 2014 and August 2015 were not statistical significant different. However, 3 months of cocktail crop growth, regardless of the humalite application (letter a), improved the rooting depth by more than 2 inch (~3.5 inch) when compared with the chem fallow and control (letter b) at the starting of the growing season (May 1, 2015).

Figure 2 shows the rooting depth compaction at the 300 PSI measured at the same time than the 200 PSI.



Ccrop=cocktail cover crop, GH=granular humalite, LH=Liquid Humalite, Chem=Chem fallow *Statistical significant different

Figure 2. Cocktail Cover Crop-Humalite effect on Soil depth Compaction at 300 PSI

The same trend is observed at the 300 PSI compaction measurements where the cocktail crop improved the rooting depth up to 8 inches when compared with chem-fallow at the start of the 2015 cropping season.

More years of evaluations are needed to further validate these findings. In addition, soil health assessments need to be done to evaluate the influence on microbial activity and/or aggregation stability that humalite may have had on the soil with CCC. However, at this point, these measurements indicate that cocktail cover crops have a positive impact on the soil health regardless of the humalite application. The significance of this impact on soil health is that subsequent crops have more rooting area available for the starting of the cropping season.

Weed evaluation was also measured (April 30, 2015) based on foxtail percentage: Chem fallow granular humalite (80%, **Picture 1**) >Chem fallow liquid humalite (70%) > Cocktail cover crop liquid humalite (40%) > Cocktail cover crop granular humalite (8%, **Picture 2**) = Cocktail cover crop alone (8 %).

Picture 1. Chem fallow granular humalite weed evaluation (Foxtail 80% April 30, 2015)

Picture 2. Cocktail Cover crop granular humalite/no humalite weed evaluation (Foxtail 8 %, April 30, 2015)

Another evaluation done in this demonstration was the visual evaluation of aggregate formation with cocktail cover crop and chem fallow. Pictures 3 and 4 show soil aggregation conditions (May 23, 2015) after being seeded with wheat. The chem fallow area (Picture 3) showed no indication of formation of soil aggregation. On the contrary, the cocktail site (Picture 4) presented lots of aggregates.

Picture 3. Chem fallow aggregate evaluation

Picture 4. Cocktail Cover Crop aggregate evaluation

Pictures 5 and 6 show a close up of the structure types of the soil after being under chemfallow (Picture 5) and CCC (Picture 6)

Picture 5. Chem fallow massive/platy structure

Picture 6. Cocktail cover crop granular (aggregated) structure

These preliminary findings show that with only 3 months of growing a cocktail crop allowed the biological component of this soil to start functioning properly. This is the first step for improving soil health. More evaluations need to be done not only to measure the stability of those aggregates but also the additive effect that humalite may have on microbial activity in this soil. This site will be monitored one more year.

CARA Shelterbelt Demonstration

CARA continues to maintain and monitor a Shelterbelt Demonstration site adjacent to the CARA Centre at Oyen. It was initially developed in the summers of 2003 with seedlings obtained from the PFRA Shelterbelt Enhancement Program. There were eight tree species planted in 2004, including Colorodo Spruce, Green Ash, Mountain Maple, Chokecherry, Villosa Lilac, Hawthorn, Sea Buckthorn and Silver Buffaloberry.

Once the seedlings were planted, a drip tape irrigation system was laid out at the base of the trees and then covered with a black plastic mulch. The black plastic mulch, which comes in rolls four feet wide, was placed along the entire length of the row and secured to the ground using an applicator pulled by a small tractor. Two discs, one on each side of the unit, cut a small trench in the soil when the machine moves forward. As the mulch unrolls, discs near the back of the unit throw soil over each edge of the plastic, securing it to the ground. A small hole is then cut where each seedling has been planted and the tree is gently pulled upright. The drip irrigation system consists of a plastic tape which has outlets at regular intervals that allow a slow trickle of water to be delivered directly to the root systems of the seedlings. At the CARA Centre, the water source includes two 1250 gallon water tanks on either side of the equipment storage shop.

Rain water is collected from the roof of the shop and then piped to the trees. Rainfall was very scarce in early 2015 so the drip tape system was only used once when there was enough water collected. Another source of water was applied directly to the heat stressed trees. The rain in August and September provided sufficient moisture for the remainder of the growing season.

Adequate precipitation during the past few years has limited the need for direct watering or by the drip tape. The progress of all species included in the demonstration has been maintained and monitored. Few losses have occurred and most species are showing good growth for our prairie climate. The plastic mulch has become weathered in places, particularly where it was not held firmly to the soil. Deer hooves have broken the plastic in several places. Damage from wildlife has also caused leaks in the drip tape.

Shelterbelt Mulch Demonstration

Applying mulch suppresses weeds, keeps soil warm in the winter and cools it in the summer. It also conserves moisture, supports and encourages numerous beneficial organisms such as earthworms and reduces stress in shallow-rooted plants. Mulch improves soil structure and drainage and can provide aesthetically pleasing and beneficial effects. Overall, the healthiest plants are those that have access to a consistent supply of water and nutrients and mulch helps with this. Mulches allow for moisture retention, weed reduction as well as increased competitiveness and survival in shelterbelts.

Objectives:

To demonstrate the benefits of various mulches for weed reduction and moisture retention in new shelterbelts.

Summary of mulch application and weed control:

Mulch	Application	Weed Reduction	Comments
Landscape Fabric/ Large Rock	High Labour	Medium	Fabric can be costly for long lengths of shelterbelts; good
Landscape Fabric/ Large Rock with Gravel	High labour	High	Can be costly for long lengths of shelterbelts; good
Landscape Fabric/ Gravel	Medium	High	Can be costly for long lengths of shelterbelts
Wood Chips	Medium	Low*	Cost depends on availability
Hay	Easy	High	Low cost
Straw	Messy/Medium	Medium	Low cost
Grass Clippings	Easy	Medium	Low cost
* Flax Straw	Easy	Undetermined	Low cost

*buckwheat seed came along with the chips

*Flax straw was applied in the summer of 2015

Observations:

Weed growth was monitored in 2015:

- Perennial sow thistle was a huge issue this year in the straw, hay and grass mulches. We had to pull back the majority of the mulches to remove the creeping root system to prevent further weed spread
- The most weed growth appeared in the rototilled area & the straw mulch
- The landscape fabric and rock had minimal to no weed production
- Buckwheat weed seeds were inadvertently imported with the wood chips when they were replaced in 2013, demonstrating the importance of knowing where the mulches are coming from and what may come along with it.
- The hay & straw mulches have deteriorated over the past two years, so a portion of the straw mulch was replaced with flax straw in the summer of 2015
- Moisture retention in the mulched strips was significantly better than that of the rototilled area. The trees required watering only once after planting and twice during the summer of 2013.

Bio-Control of Canada Thistle With the Stem Mining Weevil

Background

Canada thistle (*Cirsium arvense*) is a competitive noxious weed that is widespread across Alberta and much of North America. This perennial herb can grow up to 4 feet tall, has prickly leaves and urn-shaped purple flowers. It causes intensive crop losses from its extensive, horizontal creeping root system. Canada thistle is attracted to sites that have had disturbance and moisture, either by overgrazing, tillage and/or earthmoving. It is listed under the Alberta Weed Control Act as noxious. Canada thistle has a high tolerance to many different environmental conditions and is highly competitive with other vegetation. It is prevalent in many locations such as riparian areas that do not allow for chemical or mechanical control methods. Biological control agents, such as the weevil are of interest in controlling Canada thistle in sensitive areas.

There are 4 beetles that are considered as potential biocontrol agents for Canada thistle including the Stem-mining weevil, scientifically known as *Hadropontus litura* (formerly *Ceutorhynchus litura*). *H.litera* has one generation per year with 3 distinct stages of life: larva, pupa and adult. The adult lifespan is approximately 10 months as they overwinter in the soil and leaf litter, emerging in the spring to feed on rosette leaf foliage and stem tissue. Eggs are laid in May and June in the mid vein of the leaf and hatch 9 days later. The larva tunnel down the stem into the root collar consuming plant tissue and when several larva are present the stem turns black from tunneling and dies several days later. Early summer, once fully fed, the larva will emerge from the thistle shoot. This is the where the main damage happens to the thistle because it opens up holes to where secondary invaders, such as nematodes, parasite and fungi enter and further damage the stems. They then enter the soil, and the papal stage begins, in which they transform into adults. A few weeks later (late June and July) these new adults emerge from the soil and feed on the thistle foliage until heavy frost occurs in fall.

Reported success of the weevils seem to vary according to geographic locations. Research in the Eastern States, California and British Columbia have indicated that *h.litura* provides poor to moderate control when used alone; however, integrating additional tactics may enhance its efficacy. Research carried out in the mid-western states (i.e. Idaho and Montana) and Alberta indicate higher incidences of impact on Canada thistle populations. This could be open to a number of different interpretations but conjecture on the part of some researchers is that stronger winter conditions could be a factor in the geographic locations where Canada thistle are being negatively impacted by the stem mining weevil. Other biological factors, such as rust, might also be more readily apparent in these regions and so add to Canada thistle decline when the stem mining weevil is introduced.

The weevils we initially imported from Montana for this project in dishes of 105 individuals at $125 (US). The weevils do procreate every year and while some documentation indicates that they will migrate, as long as they have a food source they remain rather sedentary and populations expand within a thistle stand. As they reproduce and feed on Canada thistle, an absence of this habitat will eliminate their existence. Adults can fly very well and are active on warm summer days, however they are content to stay among the thistle patch.

Weevils are not '*a be all and end all'* for the eradication of Canada thistle but may have a place in controlling the weed in sensitive areas of the environment. CARA is working with other ARECA member groups to evaluate establishment, survival and impact of the *h.litera* at several locations in Alberta.

Objective:

To evaluate establishment, survival and affect of the Stem mining weevil on Canada thistle.

Project Description:

CARA, along with other ARECA member groups, introduced the Stem-Mining Weevil as a biological control agent to help control Canada thistle populations at various points in Alberta. The purpose of this project is to decrease and control Canada thistle populations in sensitive areas such as riparian zones, organic farms and native pasture. It is hoped the weevil may be a tool to reduce the use of chemicals to control weeds in sensitive areas.

The *h.litera were* imported from Montana and introduced to two sites in September of 2012 and again in September 2014, one in the MD of Acadia and to the second in Special Areas 4. Weather conditions and thistle stand qualities were recorded. The sites were visited in June 2015 to investigate winter survival rate of the weevils. Although no stem mining weevils (*Hadropluntus litura*) were observed, damage was found in the plants at the MD of Acadia site, so there is optimism that the stem mining weevils are living and reproducing in this stand. Definitive identification of the stem mining weevils were not observed in 2014 either.

A release of more weevils was planned for September of 2015. However, because of moisture conditions during August and early September in Montana the weevils could not be harvested. We will continue to monitor the survival and impact of the weevils and hope to release more in the fall of 2016.

Insect Forecast for 2016

CARA participated in the provincial pest monitoring program by monitoring bertha army worm, cabbage seedpod weevil, wheat midge and wheat stem sawfly populations. The following summaries were compiled by Scott Meers, Provincial Entomologist with Alberta Agriculture and Food. (http://www.agric.gov.ab.ca/app21/loadmedia)

Bertha Armyworm

Bertha armyworm (*Mamestra configurata*) was monitored in 2015 using a network of pheromone-baited traps placed in 265 locations throughout Alberta.

Bertha armyworm larva
Shelley Barkley, Alberta Agriculture and Forestry

Pheromone traps are used to determine the density and distribution of moths. This network of pheromone traps is organized by Alberta Agriculture and Forestry and individual traps are managed by a wide range of cooperators. Without dedicated and willing cooperators such a comprehensive monitoring system would not be possible. Our cooperators can submit their trap counts using their smart phones with a web based application.

Bertha armyworm adult
Shelley Barkley, Alberta Agriculture and Forestry

The bertha armyworm population in Alberta has mostly collapsed in 2015, especially in central Alberta. This is likely due to the impact of diseases and parasitism in the areas that previously had high populations.

There was very little need for spraying of bertha armyworm in Alberta in 2015 with the exception of a small area in the northern Peace Region. This small bertha armyworm outbreak unfortunately occurred in an area not covered by the pheromone trapping system.

It is difficult to accurately predict the 2016 bertha armyworm population based on the 2015 moth catch, but the trend appears to be lower populations in almost all regions of the province. The slightly elevated traps of southern Alberta, however, could also signal a potential for increasing bertha armyworm populations. Also experience has taught us that areas of small outbreaks such as the one in the northern Peace often get larger in the second year. In addition research has clearly shown that snow covers encourages successful overwintering. Once again it will be critical to have very good coverage of pheromone traps in 2016 to develop an early warning of potential problems during the coming growing season.

Bertha armyworm populations are normally kept in check by such factors as weather and natural enemies. Generally parasitism rates of 50 - 60 per cent in bertha larval populations have indicated the end of a local outbreak in the following year. As we saw in 2013 epizootic events (disease outbreaks) can have a major impact on the bertha armyworm populations. Only by continuing the monitoring program will we be properly prepared each season. In addition, maintaining the monitoring even in low flight years allows us to pick up trends and better predict when new major

outbreaks are starting.

Potential damage from bertha armyworm may be more or less severe than suggested by the moth count data depending on weather and crop conditions and localized population dynamics. An insecticide application is recommended when the larval numbers meet the economic threshold .The Alberta Bertha armyworm forecasting program has been done since 1995. Provincial government personnel, industry agronomists, Applied Research Associations, Agricultural Fieldmen and cooperating growers maintain the pheromone trap network. The cumulative moth count maps are maintained by Alberta Agriculture and Forestry.

During the monitoring season the map is a Google map which means you can move around, zoom in and click on the individual balloons. By clicking on a balloon it will show the organization that looked after that trap, what municipality the trap is in, the weekly count and cumulative count (all counts displayed are the average between the two traps at a site). During the trapping season the information is updated as the entries are made into the data collection website. The resolution is not accurate enough to pinpoint the exact location of individual traps.

The objective of the monitoring is to increase the awareness of canola producers to the damage potential of bertha armyworm. Forecast maps DO NOT replace field scouting. No field should be treated for bertha armyworm control without proper field scouting. Moth catches indicate the potential for damage but the actual populations must be assessed. Experience from 2012 has shown us that adjacent fields or even different parts of the same field can have greatly different bertha armyworm numbers.

Cabbage Seedpod Weevil

Cabbage seedpod weevil was first found infesting canola in southern Alberta in 1995. Since then, the weevil has spread to south-central Alberta and southwestern Saskatchewan. The distribution and abundance of the cabbage seedpod weevil has been monitored yearly in western Canada since 1997.

Predictive models based on climate data indicate that this pest will eventually disperse to all regions of canola production in western Canada, including the Peace Region.

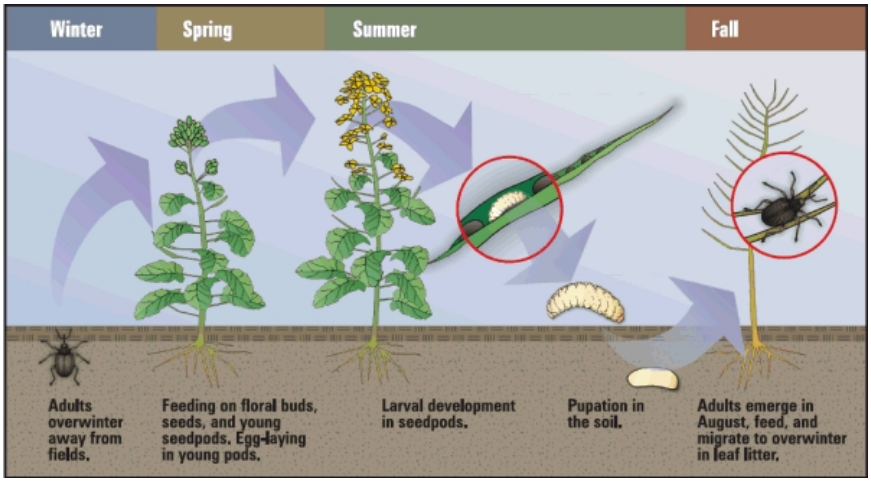
The 2015 survey covered all the canola growing areas of Alberta with 273 fields sampled in 49 municipalities and 56 calls from our online reporting tool.

The cabbage seedpod weevil was once again found at economic levels in southern Alberta including the Municipal District of Pincher Creek. In addition economic levels of cabbage seedpod weevil was found well north of Highway 1 into central Alberta. It will now be important to scout to make control decisions in central Alberta.

The range of economic levels did expand in 2015 and the northern range pushed even further into Lacombe County and well into Stettler, Paintearth Counties and the Municipal District of Provost. This expansion is further north than any range expansions in other years. Other northern range expansions in the past did not persist so it will be important to watch the population over the next couple years.

While this is not a true forecast, the numbers of weevils found through this survey in southern Alberta and the southern counties of central Alberta indicate a potential of economically damaging populations in the next growing season. Any producers growing canola in southern Alberta and into the south portion of central Alberta will have to check their canola crops as they come into flower.

The earliest flowering canola crops tend to have the highest risk from cabbage seedpod weevil and should be monitored very closely.



Cabbage seedpod weevil overwinters as an adult so the risk of infestation is further indicated by the adult population of the preceding fall. High numbers of weevil adults in fall will likely mean significant infestation levels in the following spring. This map does not adjust for the emergence of the new generation in the fall or overwintering conditions, although cooler temperatures and rainfall in August favors the development of the new weevil generation and may lead to higher numbers in the following year.

Cabbage seedpod weevil adult abundance is best monitored by using sweep net sampling. Sampling should begin when the crop first enters the bud stage and continue through the flowering period. Select ten locations within each field, and at each location count the number of weevils from ten 180 degree sweeps. Sampling locations should include both the perimeter and interior of the field to obtain a representative estimate of weevil numbers throughout the field.

This monitoring procedure will also give an indication of the number of lygus bugs present and may serve as an early warning for lygus damage, provided that the same fields are monitored into the early pod stage.

Wheat Midge

The wheat midge forecast for 2016 shows an overall lower level of wheat midge across Alberta. There has been a slight bounce back from the collapse of the extreme populations in the eastern Peace Region. Although wheat midge has not followed our forecasts very well in the Peace region it is important to note that there are likely sufficient populations of midge in the eastern Peace to fuel a resurgence if conditions are in the insects favor. (specifically delayed crops and higher than normal rainfall). Central Alberta has some areas of east of Edmonton with high numbers of wheat midge. The population has remains low in much of southern Alberta with the exception of some irrigated fields. Producers should pay attention to midge downgrading in their wheat samples and use this as a further indication of midge risk in their fields. Over the past several years the field to field variation has been very considerable throughout the province, especially in those areas with higher counts. Individual fields throughout Alberta may still have economic levels of midge. Each producer also needs to assess their risk based on indicators specific to their farm.

This forecast is not intended to take the place of individual field monitoring. The forecast for Alberta shows areas of risk for midge damage in 2016. It is important to note that over such a wide range, populations in individual fields can be and often are highly variable. Producers should plan to monitor their fields when the midge adults are flying and their wheat is in the susceptible stage. In all areas of the province growers are urged to monitor their wheat fields from wheat head emergence to anthesis for the presence of midge adults. Regular field scouting on multiple nights in succession is important in understanding the population in a particular field.


Parasitism

Although a number of factors influence the overwintering survival of the midge, the survey and map provide a general picture of existing densities and the potential for infestation in 2016. Weather conditions, specifically temperature and moisture will ultimately determine the extent and timing of midge emergence during the growing season. Temperature and wind also play critical roles in egg laying activities of the adult female wheat midge. **The level of damage from wheat midge is determined by the synchrony of wheat midge emergence and wheat and the number of wheat midge present.** Look for the results of our wheat midge pheromone trapping in June and July to help track the emergence of adult midge.

Parasitism of midge larvae by a small wasp species (*Macroglens penetrans)* has been important in keeping wheat midge populations below the economic threshold in many areas. These beneficial wasps tend to thrive in warm, dry conditions. Parasite populations increase and decrease with changes in the midge population and are very important in moderating population levels in Alberta.

It is important to understand that once midge has established in an area it unlikely to ever completely disappear. Low lying and moist areas in a field provide a refuge, enabling the population to survive even when conditions are not favorable in the rest of the field. These low population levels, however, also help sustain a population of natural enemies.


Wheat midge larva compared to canola seed

How the survey was done

The 2015 fall survey included wheat growing areas throughout Alberta. In total 337 samples were taken from 61 counties. The survey involves taking soil samples from wheat fields after harvest using a standard soil probe. Larval cocoons are washed out of the soil using a specialized series of screens. Larvae are counted, and then dissected to determine if they are parasitized. The midge density displayed on the forecast map is based on viable (live, non-parasitized) midge larvae.

Wheat Stem Sawfly

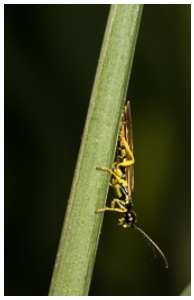
The area at risk of economically significant sawfly populations in 2016 will be limited to only a few areas. The 2015 field margin survey shows low populations in most of the area surveyed including the traditional sawfly areas in the Special Areas and the Forty Mile county.

The damage ratings are based on 93 fields in 20 municipalities. One field was found with a moderately elevated sawfly infestation in the MD of Willow Creek. Thirteen other fields were found with elevated but still low sawfly numbers in Willow Creek, Warner, Lethbridge, Vulcan, Forty Mile, Cypress, Newell, Special Areas 3 and (surprisingly) Flagstaff municipalities.

Overall the sawfly concern remains very low although there were more fields with elevated numbers and they were spread out throughout southern Alberta. This may represent the beginning of population resurgence in sawfly if dryer conditions continue.

Despite the low level of sawfly in the survey, individual fields may still have higher wheat stem sawfly populations than are indicated in the map. Overall there were zero or very low sawfly numbers in 79 of 93 (84%) of fields surveyed. (Field locations denoted by a black dot had zero sawfly found in the survey.) Thank you to Wayne Spurrill who reported sawfly damage in the Flagstaff county, as a result the survey was expanded further north to ensure this area was properly represented.

The Wheat Stem Sawfly Map is based on cut stem counts conducted after the 2015 harvest. The percent of stems cut by sawfly gives an indication of the number of reproductive adult sawflies that will emerge in late June through early July. Winter conditions have very little impact on sawfly populations and a high proportion of wheat stems cut in the fall will produce adults. Producers in areas with moderate to high levels of cutting should consider using solid stem wheat as a control strategy.


Wheat Stem Sawfly


Wheat stem sawfly damage


Wheat stem sawfly larva in stem

Female sawflies lay eggs inside grass and grassy crop stems; the eggs hatch and tunnel inside stems until the crop starts to dry down near harvest. As the crop starts to ripen the sawfly larva migrates to the stem base and cuts a notch most of the way through the stem. Feeding damage from the tunneling can result in hidden yield losses of 10 to 15 percent. Further yield losses can occur from lodging at harvest. More information can be found at wheat stem sawfly life cycle.

Parasitism can reduce populations and reduce the level of cutting. A parasitic wasp, *Bracon cephi*, has been shown to have significant impact on sawfly populations. The use of solid stem wheat varieties and the increase in parasitism are the major factors in lower sawfly populations in Alberta.