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Canada

Science Edition 2021

canola DIGEST

The Source For Canada's **Canola Growers**

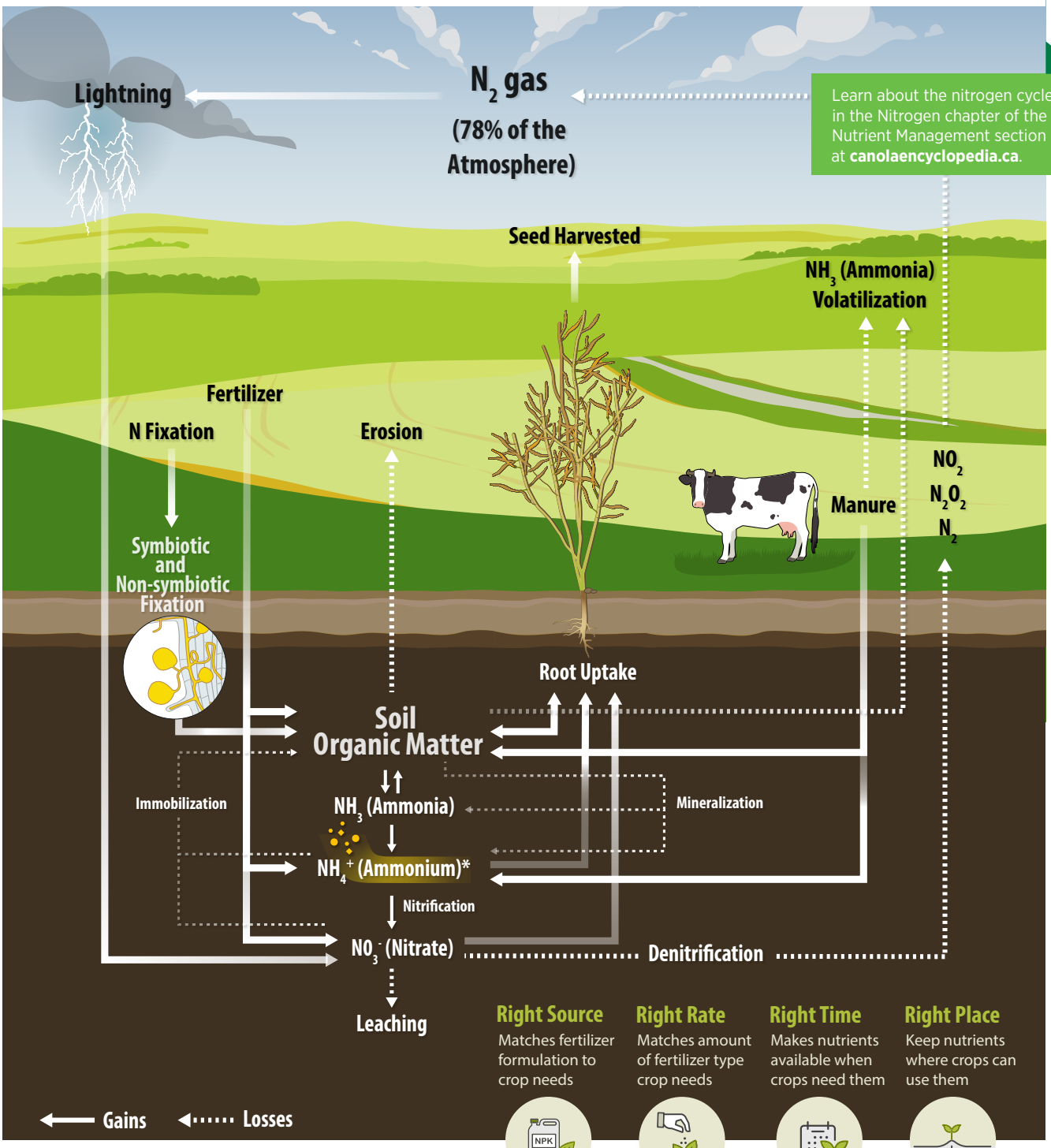
SCIENCE EDITION

SOIL HEALTH

Studies completed in 2021 include a soil health assessment protocol and fertilizer strategies to improve yields, logistics and carbon sequestration.

Nitrogen Cycle

Gains Losses



*Factors conducive to NH_3 formation, volatilization and toxicity:

Chemical Composition of Soil

- High pH
- High concentration of $CaCO_3^-$

Weathering Conditions

- High temperatures increase reaction rates and soil drying, concentration of NH_4^+ and NH_3
- Optimum moisture content for dissolving fertilizer

Other Conditions Conducive to Volatilization Losses

- High wind velocity
- Soil quality allowing rapid air exchange (Sandy, lumpy soil or porous soil)
- Fertilizer, manure or legume residue left at or near soil surfaces

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Results into action

Canola growers across the Prairies fund agronomy research through their annual levy payments to SaskCanola, Alberta Canola and Manitoba Canola Growers. The research leads for each organization explain their commitment to share these results and to show growers how to get a return on their research investment.

AMY MANGIN
Manitoba Canola Growers
Research Manager

As the research manager with Manitoba Canola Growers Association, I'm responsible for research priorities, funding, exploring new research collaborations and on-farm research.

My curiosity has driven my research career. I had no intention of doing grad school. I wanted to farm and work as an agronomist after my undergrad degree. But as soon as I started working, I quickly realized that things aren't as simple as I had thought, and there are a lot of unknowns when making production decisions. My curiosity got the best of me, and I ended up in grad school. That is where I realized that a lot of issues have already been researched, but farmers aren't aware of and don't have access to the results in a format they can use.

This job with MCGA allows me to bridge that gap between farmers and researchers to ensure that all the research we fund is aligned with Manitoba farmer priorities and that they can use these results to make meaningful on-farm decisions.

Canola Digest Science 2021 is one of the many resources available to all farmer members raising awareness of the great research being done across Canada.

amy@canolagrowers.com

BRITTANY HENNIG
Alberta Canola
Research Director

After my BSc degree in agriculture, I never had a solid answer when people asked me what was next in my career. I could, however, say that they'd never find me back in school or in research.

Well, those "feelings" changed after covering Autumn Barnes's leave as an agronomy specialist with the Canola Council of Canada. I realized how much I needed to know the science behind all things agriculture. I like being able to understand what makes a trial design statistically credible, whether the research can be appropriately duplicated, and if the results are meaningful and/or applicable.

So I went back to university for a Master's degree studying clubroot disease. While taking my MSc, I worked part-time as the research administrator with Alberta Canola. With the degree complete, I took the position of research director.

As research director, I will ensure the objectives of grower-funded research projects align with Alberta Canola's research priorities, that grower-dollars support innovative and leading research, and that results make their way back to canola farmers in a practical, timely, and useful matter – like this Canola Digest Science magazine!

brittany@albertacanola.com

DOUG HEATH
SaskCanola
Research Manager

I've been involved in research and development for several different crops – either hands-on in the lab or in research project management – for over 25 years, but I keep coming back to canola research. As research manager for SaskCanola, I am proud to continue to help develop this important crop and see the impact it has for farmers to be successful.

I'm a strong believer in applied research to get practical solutions into farmers' hands for their canola fields, and for developing a strong canola value-chain with new uses for canola products. To get there also requires investing in some basic or proof-of-concept research and even sometimes developing tools to do new research.

The research team at SaskCanola is always considering how a research proposal will benefit farmers directly in the near term. We also have a vision for research that will lead to future benefits and create tomorrow's competitive canola varieties for Canadian farmers. We want farmers to know about all the progress being made with their research investment. To find out more about this progress, please take time to read the results shared in this magazine and look out for many resources and events throughout each year.

dheath@saskcanola.com

PROVINCIAL RESEARCH BULLETINS

4 | SaskCanola

Higher than usual blackleg symptoms are attributed to increased canola production under tight crop rotations and the breakdown of resistance (R-genes) by new races of the blackleg pathogen. SaskCanola provides research-driven tips for blackleg management, and encourages growers to do a blackleg race test. With this information, growers can choose the right blackleg resistance source for the farm.

6 | ALBERTA CANOLA

Over the last year, Alberta Canola invested $940,000 toward funding 14 new projects representing $7.7 million worth of research. Every $1 of farmer levy that Alberta Canola invested was matched by more than $8 from partners and funding programs. A theme for new projects is pest management – looking for ways to reduce insect, disease and weed impact on canola yield.

8 | Manitoba Canola Growers

A Manitoba Canola Growers survey of members found that 100 per cent of those surveyed experienced higher than normal flea beetle pressure in 2021. Improved flea beetle management is the goal for a few grower-funded research projects, including a University of Manitoba study to update thresholds, and an AAFC study investigating how hairy canola can deter flea beetle feeding.

FEATURES

10 Five CCC agronomy priorities for canola

The Canola Council of Canada agronomy team has five science-based agronomy priorities that will show the biggest improvements for farm profitability, sustainability and productivity for canola growers. They are: Use 4R nutrient management practices; choose the best seed traits for each field; achieve a uniform five to eight plants per square foot, identify and manage the top yield robbers, and every seed is sacred: deliver them all.

11 Canola Encyclopedia: top 10 topics for 2021

The Canola Encyclopedia (**canolaencyclopedia.ca**) is the complete guide to growing canola in Canada. Top-clicked sections will reflect the production challenges each year. For 2021, flea beetles was the most popular pest chapter, followed by cutworms, clubroot and lygus bugs.

12 Canola Research Hub: top 10 most-clicked projects for 2021

This article lists the top 10 most-clicked reports at the Canola Research Hub (**canolaresearch.ca**) for 2021. The top three are "On-farm survey of combine grain loss", "Pre-harvest herbicide and desiccation" and "Methods to estimate pod drop and shatter".

13 How an on-farm trial can be like a vacation

This article provides the basic framework for effective on-farm trials. Like vacations, on-farm trials require some planning to get the most out of them, and their benefits extend beyond completion of the project. Watch for results from Agriculture and Agri-Food Canada's Living Labs Initiative, which takes a unique approach to on-farm research.

Credit: iStock.com/jradelta

Canola Council of Canada Innovation Strategy

The Canola Council of Canada has engaged its members and other canola stakeholders in a series of consultative meetings to help update the canola innovation strategy. The strategy will identify challenges and opportunities in all aspects of canola innovation, as well as provide direction and framework for collaboration on future innovation.

Global demand for vegetable oils and protein remains strong, but climate change and climate change policy will influence production practices in Canada and around the world. One objective of the innovation strategy will be to identify research priorities and then outline a plan to collaborate with major funders – including the Government of Canada – on research projects that will help achieve productivity goals for Canadian canola farmers and processors as well as goals for nutrient use efficiency, carbon sequestration, biodiversity and more.

REPORTS FOR RECENTLY COMPLETED RESEARCH

PLANT ESTABLISHMENT

14 Field study compares canola emergence based on wheat residue treatment

Key result: This study compared two choppers and three post-harvest residue treatments of wheat residue and found no significant differences in canola emergence across treatments. However, the researcher still recommends proper residue management for a good canola plant stand.

15 Cultivar the major management factor for canola emergence rate

Key result: Of the things growers can control to improve canola emergence percentage, cultivar choice is the most influential, this study found. Seeding date also influenced emergence, but this was mainly a function of environmental conditions. All environmental variables influenced emergence, and temperature and heat units were consistently more influential than precipitation and moisture.

FERTILIZER MANAGEMENT

16 New soil health score can measure benefits of farm management

Key result: Researchers developed a Saskatchewan soil health assessment protocol and scoring functions, providing the foundation for tools to transform a farmer's routine soil test data into a Saskatchewan Soil Health Score. These scores can track soil health status over time, and can measure the effect of farm management on soil health status.

17 Study compares seven strategies to reduce fertilizer inputs

Key result: This Manitoba study found that nitrogen source did not affect canola yield, but fertilizer placement and timing did.

18 Deep-banding fertilizer may have logistical benefits

Key result: Overall, crop response was generally not linked to deep or shallow placement of phosphorus or potassium. Deep banding (5-6") these nutrients at higher rates once every three years is an option if logistics make it a challenge to apply these products in a shallow band at the time of seeding.

19 Tips to improve safety of seed-placed fertilizer

Key result: Farmers can increase the seed safety of higher phosphorus rates by increasing seed bed utilization (narrower rows or wider openers) and applying only phosphorus (not nitrogen or sulphur) fertilizer in the seed row.

INTEGRATED PEST MANAGEMENT

20 Updated lygus threshold of 2-3 per sweep

Key result: This study validates a new threshold for lygus in canola. The general pattern is that abundances below two lygus per sweep do not reduce yield. Thus, the threshold of two to three lygus per sweep (20-30 per 10 sweeps) is recommended. Because current canola cultivars appear to tolerate lygus damage better than older cultivars, reducing this threshold as prices of canola increase is not recommended.

21 Biodiversity from non-crop areas can boost beneficials, possibly yield

Non-crop areas within or near to fields can serve as a source and a destination for beneficial insects at different times of the season. A correlational study of 60 million seeded acres of yield data obtained from Agricultural Financial Services Corporation (AFSC) showed that counties in Alberta where fields tend to contain more non-crop areas also have slightly higher canola yields.

22 Diverse weed management can protect herbicide efficacy

Key result: Effective herbicides remain a critical part of integrated weed management. Steps taken now to increase diversity in the management strategy, while herbicides are still effective, is crucial to maintaining control of weed populations in the long term.

NEW AND ONGOING PROJECTS

24 Canadian canola researchers have dozens of ongoing projects

New studies launched in the past year are exploring biologicals for nitrogen fixation and insect management, phenology-based weed control, and new techniques to breed for blackleg resistance. Canola farmers across the Prairies fund many of these projects through their levy payments to SaskCanola, Alberta Canola and Manitoba Canola Growers. Some are funded through the Canola AgriScience Cluster, a partnership between Agriculture and Agri-Food Canada (AAFC) and the canola industry under the Canadian Agricultural Partnership (CAP).

Credit: Baoluo Ma

Blackleg – the silent yield robber

Are you managing this disease effectively?

Blackleg, caused by the fungal pathogen *Leptosphaeria maculans* (*L. maculans*), is a serious canola disease that can cause significant yield losses and reduce the sustainability of canola production if it is not managed effectively. Blackleg has been a production challenge in Canada since 1970. In the 1980s, yield losses of up to 50 per cent were reported in individual fields.

This disease has been managed effectively for the past 20 years by combining blackleg resistant varieties, extended crop rotations and sound agronomics. However, over the past 10 years, researchers have found evidence of a steady increase in disease incidence and severity in previously resistant varieties. Growers also reported higher than usual blackleg symptoms in fields grown with resistant hybrids.

The main reasons for higher blackleg disease impact can be attributed to increased canola production under tight crop rotations and the breakdown of resistance (R-genes) by new races of the blackleg pathogen on canola hybrids grown across the Prairies. According to Statistics Canada, canola acres have doubled over the past 20 years. Tighter crop rotations have increased the selection pressure for virulent races of the pathogen, resulting in a loss of resistance to blackleg in current hybrids that are dependent on single resistance genes.

Sustainable canola production in Western Canada will require the adoption of innovative blackleg control strategies by growers.

BEST MANAGEMENT PRACTICES FOR CONTROL OF BLACKLEG

Integrated pest management strategies are the cornerstone of sustainable blackleg management to minimize yield loss and maintain the effectiveness of resistant canola hybrids. The following best management practices are recommended in Western Canada:

1. USE EXTENDED CROP ROTATIONS

The major source of inoculum for *L. maculans* is previously-infected canola stubble. Extended crop rotation will allow more time for pathogen inoculum levels to decline, which will reduce the incidence and severity of blackleg in fields. Maintaining a minimum break of two years between canola crops is recommended to fight against the breakdown of current blackleg resistance in cultivars and allow effective long-term blackleg disease management.

2. SCOUT FOR DISEASE INCIDENCE, SEVERITY, AND HYBRID PERFORMANCE ACROSS FIELDS

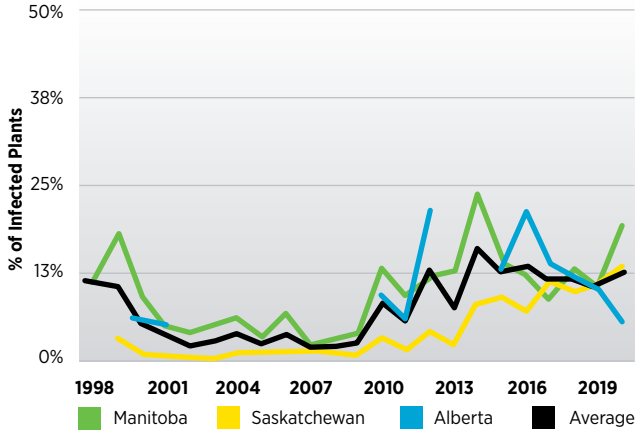
Disease scouting and accurate diagnostics are essential in blackleg management. Knowing disease incidence and severity across a field will allow growers and agronomists to evaluate the effectiveness of current management strategies and indicate the need to select a different control method, if required. Blackleg disease symptoms can be confused with other diseases such as gray stem or verticillium stripe. Successful blackleg disease scouting begins with knowing disease symptoms and depends on timing and proper scouting protocols. For the disease rating scale and detailed scouting protocol, visit **blackleg.ca**.

3. GROW RESISTANT (R) CANOLA HYBRIDS AND ROTATE RESISTANCE GENETICS

Blackleg resistance is composed of two main mechanisms: quantitative (also called adult plant resistance) and qualitative (or race-specific resistance). Both resistance types are common in resistant hybrids and play a significant role in blackleg management.

- Quantitative resistance is expressed at the adult plant stage as reduced development of necrotic tissue at the stem base compared to that found in susceptible varieties. It is race non-specific, meaning it will help reduce the infection caused by any blackleg race within the field by slowing infection as it moves into or down the plant stem.
- Qualitative resistance is usually effective at the initial infection site on the cotyledons and leaves and is controlled by race-specific resistance genes. For qualitative resistance to work specifically for a defense response in the plant to be induced the resistant gene present in the hybrid canola needs to match the specific blackleg races within the field. Once this happens, the plant stops the disease from spreading past the site of infection.

Blackleg Disease Inidence in Canada



Source: Justine Cornelsen, Agronomy Specialist, Canola Council of Canada
Data from Provincial Canola Disease Surveys

4. APPLY BLACKLEG SEED TREATMENTS OR AN EARLY-SEASON FOLIAR FUNGICIDE

A seed treatment fungicide protects plants from blackleg when they are most susceptible. An early-season foliar fungicide application can help prevent yield losses if applied during the cotyledon to the two-leaf stage. Later foliar application can help reduce the inoculum in the field but is less effective in limiting yield loss. To determine blackleg yield loss, please use the new Blackleg Yield Loss Calculator at **canolacouncil.org/calculator**.

5. MANAGE BRASSICA-RELATED WEEDS AND VOLUNTEER CANOLA

Volunteer canola and related weeds such as stinkweed, shepherd's purse, wild mustard, and flixweed are all blackleg hosts. Blackleg can be better managed by controlling these weeds. This will prevent inoculum build-up in the field and improve the benefits from crop rotation.

Canola cultivars with resistant ("R") ratings for blackleg can still get the disease. Cut stems at harvest to check on the level of blackleg infection. If the disease is present in R cultivars, consider a long break between canola crops and a different R-gene source.

Blackleg can survive for two years, or longer, on infected canola stubble. A minimum break of two years between canola crops is recommended to fight against the breakdown of current blackleg resistance in cultivars and allow effective long-term blackleg disease management.

WHY IS BLACKLEG RACE TESTING NECESSARY?

Canadian growers rely on hybrid resistance to effectively manage the blackleg disease. In Canada, all commonly grown varieties of B. napus canola carry moderate to high resistance to *L. maculans*. However, exclusive reliance on genes to fight against *L. maculans* is not sustainable due to the increasing number of instances where resistance has failed.

Growing hybrids with the same blackleg resistance genes repeatedly can lead to changes in the race profile of the blackleg pathogen population in a field, enabling it to overcome the resistance deployed in the hybrid. Rotation of cultivars with different resistance sources is recommended as one of the effective strategies to reduce resistance erosion, minimize disease severity, and demonstrate better stewardship in canola fields.

Another way to prolong the effectiveness of specific resistance genes (R-gene) is by matching the resistant gene present in the hybrid canola with the specific blackleg races within the field. Once this happens, the plant stops the disease from spreading past the site of initial infection.

To effectively manage blackleg, growers and agronomists need to know which blackleg races are present in their fields before selecting a resistant hybrid. Blackleg race testing provides valuable information about the pathogen race identification for a specific field, then growers and agronomists can choose the most effective resistant hybrids for that field.

In 2021, SaskCanola, in collaboration with the Saskatchewan Ministry of Agriculture, offered free blackleg race ID testing to farmers and agronomists in Saskatchewan. During this growing season, agronomists and growers who participated in the blackleg race testing program found it useful for next year's hybrid selection.

"The blackleg sampling program was so easy for my clients to take advantage of – a quick phone call to SaskCanola got them the code they needed, and I was already in their fields to collect the samples as part of my disease surveying. The producers' results from this program are so valuable in helping them manage the disease on their farms," says Kaeley Kindrachuk, agronomy extension specialist with SaskCanola, who previously worked as a crop extension specialist.

For more details on how to participate in the "blackleg race testing" program, please visit **SaskCanola.com**.

Sustainable canola production in Western Canada requires growers and agronomists to adopt science-based, sound, integrated management strategies to produce canola. We invite growers and crop production advisors to participate in provincial disease testing programs or utilize other similar programs and tools to assist with their management decisions. For more information about blackleg and current research, please visit **www.saskcanola.com/production/blackleg.php**.

Credit: shutterstock.com/megaflopp

Update on agriculture research in Alberta

Over the last year, Alberta Canola invested over $900,000 toward funding 14 new projects representing approximately $7.7 million worth of research. Every $1 of farmer levy invested by Alberta Canola was matched by more than $8 of investment by research partners and funding programs.

A reoccurring theme throughout the bulk of the projects was to reduce a pest's impact on canola. This objective was explored through many means, including germplasm and genetic evaluation, pest monitoring systems, nematode biocontrol, pest biology, and novel control methods, to name a few.

Although canola hybrid systems can shift attention away from weeds, the rise in herbicide-resistant weeds is concerning and therefore, unique approaches to manage them are necessary. Breanne Tidemann at Agriculture and Agri-Food Canada - Lacombe is characterizing cleaver populations and biotypes in western Canada for their long-term management, while Charles Geddes at Agriculture and Agri-Food Canada - Lethbridge manipulates weed seed production based on the life cycle timing of the weed. Both projects aim attention at further understanding and identifying herbicide-resistant weed biotypes.

Over the past several years, a quarter of Alberta Canola's research funding dollars have gone towards canola disease research due to newly emerging and challenging diseases like clubroot and fusarium wilt. Stephen Strelkov from the University of Alberta will continue to broaden our knowledge of clubroot disease through pathotype surveillance and observing the disease's relationship with canola roots and fertilizer application. Additionally, he has teamed up with Edel Pérez López from the University of Laval in Québec, a new researcher to Alberta Canola, to develop a laboratory method to differentiate pathotypes of the clubroot pathogen. Furthermore, fusarium wilt is a canola disease expanding across the Canadian prairies. Sheau-Fang Hwang at the University of Alberta will explore its occurrence, host range, development, cultivar resistance, and yield losses within Alberta.

With an increasing global focus on environmental stewardship and climate change, there's been a greater need to address the physiology of the canola plant. Linda Gorim at the University of Alberta is evaluating canola germplasm for photosynthetic efficiency, while Alicia Ziemienowicz at Agriculture and Agri-Food Canada - Lethbridge looks at developing canola that can fix its own atmospheric nitrogen.

In addition to agronomic research and genetic development, Alberta Canola has allocated $150,000 over three years to monitor water in wetlands and promote best management practices for their stewardship. The Crop Sector Working Group (CSWG), three major life-science companies; Syngenta, BASF, and Bayer Crop Science – Canada, and the Pest Management Regulatory Agency (PMRA), have all partnered together with additional support from Results Driven Agriculture Research (RDAR) and the Canadian Agricultural Partnership (CAP) to produce a comprehensive and extensive report. This collaboration is necessary to ensure that the environmental stewardship practices are sound, and innovative crop protection tools continue to be available to farmers. Ultimately, the scientific data will identify the effectiveness of wetland management practices in mitigating the movement of crop protection products into wetlands and aquatic ecosystems.

New Research Projects for 2021

Project Title	Researcher(s)	Alberta Canola Funding	Total Project Cost
Evaluating canola germplasm for photosynthetic efficiency	Dr. Linda Gorim University of Alberta	$25,000	$409,000
Biological nitrogen fixation in canola	Dr. Alicia Ziemienowicz AAFC Lethbridge	$37,500	$1,100,000
Insecticide susceptibility and resistance monitoring of flea beetles in canola	Dr. Boyd Mori University of Alberta	$73,735	$590,920
Study of the effects of *Brassica* root architecture and fertilizer application on clubroot disease severity and yield	Dr. Stephen Strelkov University of Alberta	$25,000	$375,000
Manipulating weed seed production through phenology-based weed control	Dr. Charles Geddes AAFC Lethbridge	$29,000	$797,093
Understanding *Fusarium* wilt and root rot of hybrid canola: occurrence, host range, disease development, resistance and yield losses	Dr. Sheau-Fang Hwang University of Alberta	$130,000	$992,000
Exploring further possibilities and advancements of using bio-control entomopathogenic nematodes (EPNs)	Dr. Shabeg Briar Olds College	$20,280	$121,400
Incorporation of abiotic and biotic factors for development of stage-structured predictive models of flea beetles (Coleoptera: Chrysomelidae) on canola in Alberta	Dr. Maya Evenden University of Alberta	$20,000	$253,676
Using avirulence markers to predict the phenotypes of clubroot pathotypes	Dr. Edel Pérez-López Université Laval	$124,344	$497,375
Clubroot pathotypes and second-generation resistance	Dr. Stephen Strelkov University of Alberta	$77,625	$310,500
Enhance understanding of cleavers populations in Western Canada	Dr. Breanne Tidemann AAFC Lacombe	$51,800	$207,200
The role of insect feeding and plant defense responses in Aster Yellows disease epidemiology	Dr. Sean Prager University of Saskatchewan	$124,441	$248,882
Building bridges to success - Accessing *Brassica* diploid variation for canola improvement	Dr. Steve Robinson University of Alberta	$55,000	$140,000
Promotion of wetland stewardship best management practices through a targeted water monitoring project	Tony Ciarla Millenium EMS Solutions Ltd.	$150,000	$1,674,687

Alberta Canola's new research director

Alberta Canola is pleased to welcome Brittany Hennig in a new role as research director. You may recognize Brittany from her part-time work with Alberta Canola as research administrator while attending the University of Alberta over the past three years. Before graduate studies, Brittany covered Autumn Barnes's parental leave as an agronomy specialist with the Canola Council of Canada in southern Alberta (2017-18) and as an agronomist at an independent fertilizer dealership in the Edmonton area (2013-17). Having completed her Master of Science degree this past summer, she has joined us full-time to lead our research funding programs. As research director, Brittany will be working with our partners in the canola industry, the Alberta Ag Funding Consortium, the Canola Agronomic Research Program, and our research partners at the various research organizations across Canada.

Challenging spring raises concerns

The spring of 2021 offered less than ideal conditions for canola establishment. Manitoba Canola Growers conducted a survey to better understand exactly what Manitoba farmers faced this spring.

SURVEY RESULTS

- 90 per cent of growers indicated that they faced drought conditions and as a result the majority of canola was seeded 1 or more inches deep to try hit moisture.
- 81 per cent of respondents seeded their canola in the second or third week of May.
- Once canola emerged it faced harsh environmental conditions where 67 per cent faced frost, 70 per cent faced extreme heat, 77 per cent faced extreme wind events and drought conditions continued. Additionally, 100 per cent of the farmers that responded indicated that they experienced higher than normal flea beetle pressure. With an already stressed crop, flea beetle damage was extensive and occurred quickly. Insecticide seed treatments were only partially effective and the majority of fields were sprayed with a foliar insecticide one or more times.

To address concerns raised from this survey we want to share research resources that are currently available and share some ongoing research worthy of keeping an eye on.

CONCERNS RAISED

Apparent reduction in early season vigour resulting in slow stand establishment

Canola faced with numerous harsh conditions this spring (cold/dry soil, frost, heat, wind, insect pressure) resulting in slow emergence and poor establishment. Canola Council of Canada outlines best management practices (BMPs) to ensure you are doing everything in your power help get your canola off to a good start in Canola Encyclopedia (***canolaencyclopedia.ca***) under the Plant Establishment section. If you have any variety-specific concerns, please contact your seed representative to ensure your 2022 seed choices are the best suited for the growing conditions on your farm.

Insecticidal seed treatments and foliar applications were only partially effective for flea beetle control

The efficiency of many seed treatments relies on soil moisture, and some modes of action are more dependent on soil moisture than others. Therefore, in dry spring conditions, such as 2021, product differences can be magnified.

Foliar insecticides should be applied on a warm, sunny day when flea beetles are feeding for best control. Canola Council of Canada's Canola Encyclopedia outlines other BMPs for foliar insecticide applications. Look in the Insects section for the Flea Beetles chapter, which includes insecticide control options.

Populations of flea beetles have shifted to include more striped flea beetles than ever before. MCGA funded research by Juliana Soroka shows that control options for flea beetles aren't always able to control striped flea beetles as well as they control crucifer flea beetles. For full research reports on population shifts and how these shifts may be influencing control, search for "flea beetles" on the Canola Research Hub at **canolaresearch.ca.**

Economic thresholds for foliar insecticide applications are outdated and don't take into consideration current cultivars, plant stands and environment conditions

An ongoing MCGA-funded research project at the University of Manitoba by Alejandro Costamagna is working to update the economic thresholds for flea beetles for modern varieties using current plant densities. To check out project objectives and progress, go to the Canola Research Hub at **canolaresearch.ca** and search for "integrated approaches for flea beetle control".

Hot and dry conditions promote rapid flea beetle feeding and movement, which should be taken into consideration when making control decisions. Agriculture and Agri-food Canada (AAFC) research scientists, including Juliana Soroka, demonstrated how environmental conditions influence flea beetle activity. Check out the full report on the Research Hub by searching "spring flea beetle injury".

Is there a possibility for genetic resistance for flea beetles?

Researchers at AAFC, led by Dwayne Hegedus, are investigating canola that will produce hairs (trichomes) to deter flea beetle feeding. Keep up to date on this project by searching "genetic resources for flea beetle resistance" on the Canola Research Hub.

Credit: iStock.com/Tomasz Klejdysz

Manitoba Canola Growers Association welcomes new research manager

"I'm very excited to take on this role with MCGA. This opportunity really stood out for me as it lets me use my research background to ensure that farmers' voices are heard and are directing research being funded with their levy dollars," explains Mangin. "My goal is to ensure that farmers are not only aware of the research being funded, but know how the results of the projects will help them target challenges they are facing on their farms."

Mangin received her undergraduate degree in agronomy at the University of Manitoba (U of M) and worked as an agronomist for Pembina Co-op before starting her master's degree (MSc), centred on herbicide resistance, at the University of Alberta.

After receiving her MSc, Mangin went on to work as a research agronomist in the soil fertility lab at the U of M and is currently finishing up her PhD in the Department of Plant Science at the U of M.

"MCGA's research file has grown in recent years, driving the need to introduce a dedicated manager who can take our research and extension capabilities to the next level for our membership," says Delaney Ross Burtnack, executive director. "Amy brings expertise, innovation and vision that we look forward to tapping into."

Research and agronomy have always been important and valuable program areas serving canola farmers in Manitoba. Introducing a dedicated research manager will further advance the strong canola research network and ensure efficient resource utilization, allowing MCGA to bring even greater value back to Manitoba farmers by growing our ability to connect farmers' needs with research results.

"Farmers need innovation to manage changing pest pressures, changing climate, and changing market demands, all while continuing to operate a successful and sustainable farm business," says Clayton Harder, MCGA president. "As our research program continued to grow and evolve, the board recognized this opportunity to expand our resources dedicated to research and agronomy in Manitoba, to the benefit of farmers. We are introducing this three-year term position to explore how we can level up our research and extension work, ideally transitioning to permanent support at the end of the term."

To learn more about research funded by MCGA visit our website at **www.canolagrowers.com.**

The Canola Council of Canada agronomy team has put together five science-based agronomy actions that will show the biggest improvements for farm profitability, sustainability and productivity for canola growers.

5 CCC AGRONOMY PRIORITIES FOR CANADA

By Clint Jurke

1. USE 4R NUTRIENT MANAGEMENT PRACTICES

All farms will benefit from applying the right fertilizer products at the right rate, right time and right place to improve yield, reduce losses and increase profits. A balanced crop nutrition plan applied at the right rate for each field or each zone within fields can improve economic and environmental sustainability of canola. Discover more science-based 4R practices at **canolacouncil.org/4R**.

Canola Council of Canada (CCC) agronomy specialists encourage farmers to use soil tests and set fertilizer rates based on soil test recommendations for their target yields. In the CCC grower survey from last winter, participants said fertilizer costs were a big barrier to profitability, and that probably hasn't changed with higher fertilizer prices over the past few months. CCC fertilizer management messages are based on the 4R principles, which will help to improve nutrient use efficiency and return on investment from fertilizer.

2. CHOOSE THE BEST SEED TRAITS FOR EACH FIELD

CCC agronomy specialists encourage farmers to make seed decisions based on the best traits for each field. This can include disease resistance, days to maturity, pod-shatter resistance and more. To weather-proof canola, choose cultivars that provide consistent high-yield performance in various conditions and pest scenarios. Use the tool at canolaperformance-trials.ca to compare cultivars.

Try new cultivars all the time. Seed companies provide excellent genetic solutions to many of the disease and harvest challenges, but those traits need proper stewardship to protect them. That means scouting. That also means rotation of genetic sources of resistance to help protect those valuable traits, including clubroot and blackleg resistance, from pathotype/race shifts within the field population.

3. ACHIEVE A UNIFORM 5 TO 8 PLANTS PER SQUARE FOOT

Two meta-analyses based on newer canola studies in Western Canada show that a stand with five to eight plants per square foot can maintain the yield potential of canola. Uniformity is also key. To reach maximum yield potential, a consistent and uniform plant stand across the entire field is required; furthermore, this will lead to consistent growth stage timing, which helps with pesticide application timing.

To set seeding rates that will achieve the target stand, use the calculators at **canolacalculator.ca**.

4. IDENTIFY AND MANAGE THE TOP YIELD ROBBERS

Canola growers can find all kinds of things in their fields. The key is to focus time and inputs on the most important yield loss factors. Scout regularly to see what pests, environmental factors or mechanical issues (seed placement, sprayer settings, etc.) cause the greatest loss for each field.

Participants in the CCC grower survey ranked flea beetles the pest of highest economic risk to canola in all regions. Sclerotinia stem rot was second everywhere except southwest Saskatchewan, which had herbicide-resistant weeds in second. The survey showed that top-yielding farmers are more likely to spray fungicide for sclerotinia stem rot. This makes logical sense, given that conditions favourable for sclerotinia are also favourable for higher yields. CCC agronomy specialists want to make it as easy as possible to make the right fungicide decision on every field, every year.

Find scouting and management tips for flea beetles, sclerotinia stem rot and all other major pests in the Diseases, Weeds and Insects chapters at **canolaencyclopedia.ca**.

For timely tips through the growing season, sign up for Canola Watch at **canolawatch.org**.

To connect with a Canola Council of Canada agronomy specialist, find their names and contact info at **canolacouncil.org/staff/**.

5. EVERY SEED IS SACRED: DELIVER THEM ALL

The ideal is to deliver every seed at No.1 grade, and leave none behind. To do this, give all seeds time to mature, harvest with minimal losses and store canola without spoilage. The Harvest and Storage chapters at **canolaencyclopedia.ca** have tips for these objectives.

Grower survey results suggest that canola growers, in general, may achieve yield improvement through later swathing. The survey also showed that straight cutting is associated with higher yields for survey respondents who farm in the southwest Prairies.

—Clint Jurke is director of agronomy for the Canola Council of Canada. Email jurkec@canolacouncil.org.

The Canola Encyclopedia at canolaencyclopedia.ca is the complete guide to growing canola in Canada. Content is science-based and constantly updated with new research projects. This article lists the top 10 Canola Encyclopedia pages for 2021.

CANOLA ENCYCLOPEDIA TOP TEN:

TOPICS FOR 2021

The Canola Encyclopedia at canolaencyclopedia.ca has science-based management tips for weeds, insects and diseases, and information on everything from plant establishment, nutrient management, harvest loss and storage tips. Click tracking at the Canola Encyclopedia is a good indicator of production issues each year. Here are the top 10 most-clicked encyclopedia pages for 2021.

By Cass Cardy

1. GROWTH STAGES. The Growth Stages chapter is always popular. It describes all stages of canola plant development from germination to senescence.

2. FLEA BEETLES. Warm, dry conditions during canola establishment made it a busy year for flea beetles. One online commenter called the Flea Beetles chapter "extremely helpful!" Page views picked up from mid-May to mid-June and peaked on June 3 – likely in response to the June 2 Canola Watch, which had a flea beetles quiz and links to the Canola Encyclopedia chapter.

3. CUTWORMS. Clicks for cutworms increased significantly from the end of May and into July this year, which is peak season for damaging larvae to be feeding on canola. I know this because the chapter now features a new cutworm lifecycle graphic, which neatly compares larval feeding times for redbacked, dingy and pale western cutworms.

4. HISTORY OF CANOLA SEED DEVELOPMENT. This chapter sees steady traffic throughout the entire year since it offers more historical factoids than agronomy advice. It explores the Brassica species and canola fatty acid profiles, making it a valuable resource for researchers, students, growers and anyone else who finds themselves canola curious.

5. CLUBROOT. This is a dense chapter, with nine sections that cover everything from clubroot prevention to management and ongoing research. Visitors can use the new "Jump to section" feature to navigate with ease and speed. The Clubroot chapter peaked this fall when we added a new Clubroot Management factsheet, which highlights the importance of using CR cultivars early to keep spores low.

Explore the Canola Encyclopedia at **canolaencyclopedia.ca**.

6. LYGUS BUGS. Due to this summer's extremely dry conditions, canola was at a higher risk of lygus damage and outbreaks were reported across the Prairies. Our data shows a considerable spike in traffic to the Lygus Bugs chapter for the months of July and August, with folks searching Google for information on new thresholds, damage and lifecycle.

7. SCLEROTINIA STEM ROT. Traffic to the Sclerotinia chapter spiked early July, during canola's flowering stage when infection is most likely to occur. The chapter has valuable information on sclerotinia identification, best management practices and a new disease cycle infographic. Canola Watch had timely recommendations on June 30 and a sclerotinia quiz on July 7, both of which drove page view spikes.

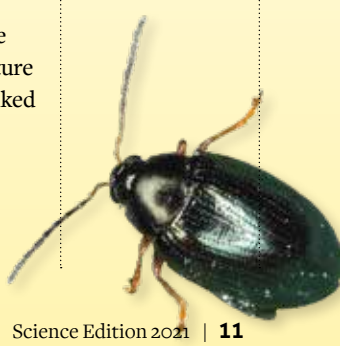
8. WEED MANAGEMENT. When to spray canola? Tips for canola herbicides? Common weeds in canola? Agronomists can find answers to these questions and more in the Weed Management chapter. This chapter received steady traffic for most of the growing season, peaking early June with the release of a Weed Management quiz in Canola Watch. The chapter is riddled with charts, graphs and videos to visually support its detailed instructions.

9. BLACKLEG. The Blackleg chapter saw steady traffic throughout all of 2021 as agronomists prepared for the growing season and the website installed new resources like the Blackleg Yield Loss Calculator, and the Blackleg Management Guide, posted in March.

10. TIME OF SEEDING. This section of the Plant Establishment chapter has everything you need to make decisions on canola seeding timing, from cool temperature considerations to tips for late-seeded canola. Traffic spiked on April 14 this year thanks to Canola Watch articles on early seeding and spring prep jobs.

—Cass Cardy is a communications coordinator with the Canola Council of Canada.

For the Canola Watch quizzes, which drove a lot of traffic to the Encyclopedia, go to **canolawatch.org** and click on "Quizzes" in the Quick Links box.



The Canola Research Hub at CanolaResearch.ca is a free and accessible comprehensive source of leading canola research for growers, agronomists, researchers and others who work with canola. Here are the Top 10 most popular Hub reports for 2021.

CANOLA RESEARCH TOP TEN:

TOP 10 PROJECTS ON THE RESEARCH HUB

Since its launch in January 2021, the Canola Research Hub has added over 50 projects to its research library and 18 blog posts on various agronomic topics. This article lists the top 10 most-clicked research reports on the Hub website.

By Taryn Dickson

1. ON-FARM SURVEY OF COMBINE GRAIN LOSS. In-field testing of 50 combines (six manufacturers, 40 models) across the Prairies in 2019 reported harvest losses between 0.2 bu./ac. and 4.1 bu./ac., and an average loss of 1.3 bu./ac. (or 2.8 per cent of yield). This Prairie Agriculture Machinery Institute (PAMI) survey highlighted the importance of setting combines for current weather conditions and to reassess combine losses as conditions change throughout the harvest day and season.

2. PRE-HARVEST HERBICIDE AND DESICCATION. Pre-harvest herbicide and desiccant options provided dry-down benefits in this three-year Indian Head Agricultural Research Foundation (IHARF) study – if used according to their labels. However, fields with low weed populations, dry late-season weather, and early maturity showed relatively little benefit to using a pre-harvest application.

3. METHODS TO ESTIMATE POD DROP AND SHATTER. In this University of Manitoba study, pod-retention resistance was remarkably consistent for individual cultivars over years and locations. As well, correlation analysis confirmed catch tray observations that the relationship between pod drop and seed shatter events was weak and that they would be considered independent events.

4. ENVIRONMENTAL FOOTPRINT OF CANOLA. This Agriculture and Agri-Food Canada (AAFC) life cycle assessment provides insight on the role canola can play in improving soil carbon stores. The study shares how cropping systems involving canola can be designed to maximize carbon sequestration through early planting and use of full season crops.

5. DEFINING BEST MANAGEMENT PRACTICES FOR USING SUPPLEMENTAL HEATING. In this two-year storage study, PAMI found that adding supplemental heat to natural air drying (NAD) systems can be a lower-capital alternative to dedicated heated-air dryers. It also reported that fuel type has the greatest impact on operating costs – with natural gas having lower cost than diesel and propane, if access allows.

6. INTEGRATED APPROACHES FOR FLEA BEETLE CONTROL. This University of Manitoba study suggests that the nominal economic threshold of 25 per cent defoliation is correct for flea beetles. Trial results showed that varying plant densities would produce different amounts of defoliation for the same number of flea beetles.

7. DETERMINING THE OPTIMUM PLANT DENSITY IN CANOLA. The University of Saskatchewan meta-analysis found that canola farmers should target populations greater than five per square foot to seek maximum returns on seed, as lower plant populations will often have yield loss.

8. GETTING MORE BANG FOR YOUR BUZZ. This University of Calgary study showed that total canola yield and quality were higher in canola plants exposed to insect pollination. Pollinators reduced the negative effects of drought with approximately 20 per cent higher yield, regardless of whether the drought was experienced during the seedling or the pod-filling stage.

9. CANOLA RESPONSE AND MINIMIZING NITROGEN LOSSES IN A TWO-PASS SYSTEM. The nitrogen sources examined in this University of Manitoba study did not affect canola yield, but placement and timing did. Spring surface applications had lower yields than shallow or deep banding. Fall surface applications had lower yield (13 bu./ac.) than spring surface applications. Surface application of granular urea consistently had greater NH_3 emissions than subsurface placement.

10. USING AVIRULENCE MARKERS TO PREDICT THE PHENOTYPES OF CLUBROOT PATHOTYPES. This Université Laval research looked for reliable screening techniques to assess the durability of new forms of clubroot cultivar resistance and to identify and categorize new and existing clubroot pathotypes. This could empower producers to make informed decisions about the most suitable canola cultivar for a field.

—Taryn Dickson is resource manager for Crop Production and Innovation with the Canola Council of Canada. Taryn also manages the Canola Research Hub.

For a short summary and link to the full report for each study, enter the headings below (Ex. "On-farm survey of combine grain loss") into the Keyword Search box at the Canola Research Hub website, **canolaresearch.ca**.

This article provides the basic framework for effective on-farm trials. Like vacations, on-farm trials require some planning to get the most out of them, and their benefits extend beyond completion of the project.

How an on-farm trial can be like a VACATION

Credit: iStock.com/LuckyBusiness

By Taryn Dickson

Do the research studies described in this magazine make you want to test a new product or practice on the farm? Similar to the way planning for a vacation can provide emotional benefits even before you leave for it, the benefits of conducting an on-farm trial aren't limited to the final values after harvest is complete.

1. START WITH THE QUESTION YOU WANT TO ANSWER. Perhaps you want to know whether something you've done for years actually provides enough benefit? Or whether a new product, technique or management option could provide more benefit than your current practice?

2. CHOOSE A FIELD FOR THE TRIAL. Design the trial to keep keep everything the same between treatment and the non-treatment areas. For trial design tips, the Canola Council of Canada has protocols at www.canolacouncil.org/research/#onfarm-research

3. TAKE NOTES ALL SEASON. Track the environmental conditions and everything you do on that piece of land and how you do it, so you have some factors to consider when assessing the results. Side benefit: This will help you think more critically and objectively about all management choices (and which decisions to test in future trials). To make note-taking easier, **www.canolacouncil.org/research/#onfarm-research** has data collection sheets.

4. FOLLOW THE TRIAL THROUGH TO HARVEST. This is easier said than done, especially when the favourable harvest window is always an uncertain length of time. To make it easier, involve an agronomist and ask them in spring to help you harvest it. Or put a research-minded employee in charge of the trials. Or get neighbours involved and offer to share results in exchange for some harvest help.

For more tips and links: Read "Quick tips for on-farm trials" in the Fundamentals section at **canolawatch.org**.

Find trial protocols and data collection sheets at **canolacouncil.org/research/#onfarm-research**.

5. COMPARE YOUR RESULTS WITH SIMILAR EXPERIMENTS. Check to see if your results align with other similar comparisons. This could include quality trials from local research centres. Search for results from completed projects at Canola Research Hub (**CanolaResearch.ca**).

6. TALK TO OTHERS ABOUT WHAT YOU FOUND. Share your experiences and findings with your farm employees, your agronomist, other farmers and researchers. This can help put results into context, assess the quality of the trial and implications for the results on your farm.

7. REFLECT, CONGRATULATE AND DECIDE. Trials are challenging. If you get through it, give yourself credit and reflect on the value of experience. If you concluded that you need more data to make a better decision, you can plan the same trial in another field or two the following growing season. If you are done with trials, you likely have a better perspective on what makes a quality trial and apply that to all future research you look at.

8. REPEAT THIS PROCESS AS MANY TIMES AS YOU LIKE!

Just like the vacation that you're still looking forward to but haven't taken, the additional benefits of learning from conducting an on-farm trial are valuable – whether they lead to a change in management decision or not.

—Taryn Dickson is resource manager for Crop Production and Innovation with the Canola Council of Canada.

LIVING LABS

The Agriculture and Agri-Food Canada (AAFC) Living Laboratories Initiative takes a unique approach to on-farm research, bringing together farmers, scientists and other partners to co-investigate best management practices (BMPs) that farmers are interested in implementing. Some of the BMPs include perennial and cover crops, soil health and fertility monitoring practices, nutrient management to reduce losses and water quality management. Research also incorporates socio-economic aspects. AAFC has a living lab operating in Manitoba. This approach will be further expanded through the new Agricultural Climate Solutions Program, with new labs in Saskatchewan and Alberta starting in Spring 2022.

For more information on collaborators and projects, search for "Living Laboratories Initiative" at **agriculture.canada.ca**.

Field study compares canola emergence based on wheat residue treatment

KEY RESULT:

This study compared two choppers and three post-harvest residue treatments of wheat residue and found no significant differences in canola emergence across treatments. However, the researcher still recommends proper residue management for a good canola plant stand.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:
"Effect of cereal crop residue distribution on the following year's canola emergence and yield" Katelyn Blechinger, Prairie Agricultural Machinery Institute

FUNDING:
SaskCanola, SaskWheat

Uneven and poorly distributed residue can lead to challenges, including uneven seed depth the following spring, blocked drill openers, and uneven plant stands and emergence. Because Western Canadian producers often rotate wheat and canola crops, the objective of this project was to analyze canola emergence and yield based on different wheat residue harvest management strategies.

Each site used a full quarter section of land to accommodate real-world equipment and management techniques. Researchers repeated the trials at a different location each year to account for different soil properties, climatic variation and management. The Year 1 (2018) site was near the town of Delmas, Year 2 (2019) was near Saint Front, and Year 3 (2020) was near Nipawin.

Although this study did not show significant differences in canola emergence across treatments, heavy patches of residue can greatly reduce canola emergence, as shown in these two treatments.

Each site year started with a wheat harvest comparing two different combine choppers (representing "good" distribution vs "poor" distribution) as well as three post-harvest treatment areas (a check with no further management, a heavy-harrowed treatment, and a tilled treatment). All treatments were replicated. Sites were planted to canola the following spring, and measured for soil moisture, soil temperature, plant emergence counts, leaf staging, weed counts and end-of-season yield.

RESULTS

The after-market (AFT) choppers used throughout these trials provided a more even field finish than the poorly set original equipment manufacturer (OEM) choppers. The AFT choppers also provided smaller, fractioned residue than the OEM. The OEM chopper left the majority of the residue directly behind the chopper, which caused a strip pattern through the fields.

The post-harvest treatments aided in spreading the OEM residue clumps and provided minimal (visual) differences in the AFT treatments. The heavy-harrow treatment facilitated some clumps to be evened out, as well as some of the finer residue pieces to be incorporated into the soil. The tillage treatment incorporated more of the residue and provided a blackening effect on the soil surface.

However, when analyzing canola emergence across the three treatment years, researchers found few significant differences. The results varied by year between emergence inside and outside the chaff row. In Years 1 and 3, the emergence was higher outside the chaff row whereas in Year 2 the emergence was higher in the chaff row. This could be due to the very dry spring, resulting in moisture being the limiting factor, which was held in the residue and allowed for a better emergence. When comparing the emergence by chopper, there were few significant differences found that varied across year. Comparing the post-harvest treatments, the results varied each year with mostly the harrow or check treatment having the higher emergence count compared to the tillage. However, Year 3 did see a trend toward the harrow treatment experiencing the highest emergence across all treatments when comparing post-harvest treatments. This, however, was just a trend, and few significant differences were found in the data.

Although the results did not show many significant differences in canola emergence across treatments, some differences were noted. Proper residue management is recommended for a good plant stand, ease of in-field management, and a good canola harvest outcome.

Future work on this topic may consider analyzing results based on longer crop rotations and tillage treatments, as well as other factors that may be affected by the treatments (i.e., soil microbial community, disease pathogen levels, etc.). Results may have differed if trials were conducted on the same site over a number of years.

Credit: iStock.com/mountana

Cultivar the major management factor for canola emergence rate

KEY RESULT:

Cultivar choice is the most influential factor for canola emergence percentage, this study found. Seeding date also influenced emergence, but this was mainly a function of environmental conditions. All environmental variables influenced emergence, and temperature and heat units were consistently more influential than precipitation and moisture.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"An on-farm approach to monitor and evaluate the interaction of management and environment on canola stand establishment" Christiane Catellier, Indian Head Agricultural Research Foundation

FUNDING:
SaskCanola

Studies have shown that seeding speed and depth, seeding date, seed size, row spacing, crop rotation, and stubble management will influence canola establishment, but results of these studies are inconsistent across Western Canada where environmental conditions are variable and can be significantly yield-limiting. This observational on-farm study was conducted to improve our understanding of the interactive effects of management and environment on canola stand establishment.

This study was conducted on commercial canola fields in collaboration with six local producers around Indian Head, Saskatchewan, from 2018-20.

Environmental and agronomic data (see the table) were collected from several fields throughout the growing season and the producers provided their individual crop management data. Researchers used modelling to examine the additive and interactive effects of management and environment on the speed, temporal uniformity, and spatial uniformity of canola emergence.

CULTIVAR AND SOIL TEMPERATURE KEY FOR EMERGENCE RATE

The top-ranking model, which weighted significantly higher than other models, showed an 80 per cent probability that "cultivar" and "average soil temperature 14 days after seeding" were the most influential management and environmental variables on canola emergence rate. The top-weighted model also had a significant interaction between cultivar and soil temperature, indicating that cultivars' emergence rates were differentially affected by soil temperature.

CULTIVAR AND SOIL TEMPERATURE KEY FOR EARLY SEASON VIGOUR.

The top-ranking model showed a 99 per cent probability that cultivar and average soil temperature 21 days after the seeding were the most influential management and environment variables on canola growth rate. The top-ranked model again included a significant interaction between cultivar and soil temperature.

Higher air temperature, soil temperature, and heat units before and after seeding were associated with earlier emergence and higher early growth rates. Greater precipitation before seeding was associated with a faster growth rate, while higher soil moisture was associated with a delayed start and slower growth rate.

NO CLEAR MAJOR INFLUENCE ON SPATIAL UNIFORMITY

Model weights were lower overall when competing models were compared, indicating that the prediction of spatial uniformity was more uncertain than emergence rate or growth rate, and that the variables measured were more equal in their influence on spatial uniformity. Environmental variables were more influential than management variables overall.

In summary, this study identified canola cultivar and post-seeding date temperature as the two most influential management variables that consistently impacted emergence response variables. Seeding date was also consistently and significantly influential on emergence, however the effect was not additive when combined with environmental variables, indicating that the effect of seeding date was mainly a function of environmental conditions. Temperature and heat units were consistently more influential on emergence than precipitation and moisture.

Overall, the study was valuable in demonstrating the potential of on-farm observational studies in agronomic research. Future expansion of this observational study to different agricultural production regions would benefit producers.

DATA COLLECTED AT EACH SAMPLING SITE	
Spring soil test	Macronutrients (N, P, K, S)
	Soil organic matter
	Soil pH
	Cation Exchange Capacity
Surface residue before and after seeding	
Spring plant density	2, 3, and 4 weeks after seeding
Canola growth Stage (BBCH decimal scale)	2, 3, and 4 weeks after seeding
Weekly monitoring data	Soil moisture, temperature, and precipitation
Producer-reported management data	Seeding date, rate, TKW, seed treatment, cultivar
	Fertilizer (N, P, K, S) form, rate, placement, and timing[1]
	Row spacing[2], seeding speed
	Crop type in the previous 3 years
Regional weather data	Daily mean temperature, growing degree days, precipitation

[1] Information regarding fertilizer form, placement, and timing was not provided in enough detail in most cases to include in the analysis.
[2] Producer-reported row width was used to calculate plant density but was not included in the analysis.

New soil health score can measure benefits of farm management

KEY RESULT:

Researchers developed a Saskatchewan soil health assessment protocol and scoring functions, providing the foundation for tools to transform a farmer's routine soil test data into a Saskatchewan Soil Health Score. These scores can track soil health status over time, and can measure the effect of farm management on soil health status.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"Developing a soil health assessment protocol for Saskatchewan producers: Phase I" Kate Congreves and Athena Wu, Department of Plant Sciences, University of Saskatchewan

FUNDING:

SaskCanola, Saskatchewan Ministry of Agriculture (Agriculture Development Fund), Western Grains Research Foundation (WGRF), SaskWheat

Soil health is an essential component of long-term sustainable agriculture. Even though soil health attributes have been identified and various soil health testing protocols have been developed around the world, no standardized science-based soil health test is available to producers in Saskatchewan and the Prairie provinces. The objective of this research is to develop a new Saskatchewan Soil Health Assessment Protocol (SSHAP) tailored to Saskatchewan's semi-arid climate and major soil zones.

In fall 2018, researchers collected soil samples (0-15, 15-30, and 30-60 cm depths) from 55 arable fields across Saskatchewan along with a couple of native prairie samples to compare. Soil health scores were developed in relation to the individual soil attribute measurements along with predictive models.

- For the 0-15 cm soil depth, attributes with the greatest weight and therefore the most influence on the soil health score include phosphorus (P), total carbon (TC), active carbon (AC), soil organic carbon (SOC), total nitrogen (TN), and nitrous oxide (N_2O).
- For the soil depth of 15-30 cm, attributes with the most influence on the soil health score are: TC, SOC, field capacity (FC), P, TN, and wet aggregate stability (WAS).
- For the 30-60 cm depth, SOC, FC, manganese (Mn), TN, zinc (Zn) and TC have the greatest influence.
- Overall, soil carbon and nitrogen indices, including SOC, AC, TN, TC and soil protein, produced the highest weighting factors.

The average Saskatchewan Soil Health Score (SSHS) is 56.97 per cent for the 0-15 cm soil depth, 63.88 per cent for 15-30 cm, and 64.33 per cent for 30-60 cm. The overall SSHS for the 0-60 cm ranged from 41.24 to 77.05 per cent. The highest score belonged to the native prairie soil. The overall SSHS for the 0-60 cm depth did not differ across soil zones.

For the most part, canola and cereal crop yields were not well correlated to the SSHS, although the correlation appeared to be stronger during dry years, particularly for cereals.

Credit: Kate Congreves

Athena Wu, research technician with Kate Congreves, collects soil samples in the field.

KEY MESSAGES

- A Saskatchewan soil health assessment protocol and scoring functions were successfully developed. This provides the foundation for developing tools that are capable of transforming a farmer's routine soil test data into a Saskatchewan Soil Health Score.
- Saskatchewan Soil Health Scores can track soil health status over time and provide scientific information needed to inform and adjust management plans.
- Research results showed that soil carbon (C) and nitrogen (N)-indices primarily drive soil health differences, and therefore indicate that management decisions aimed at improving C and N sequestration will also improve soil health scores.
- Healthier soils may help safeguard crop yields during sub-optimal dry growing conditions. Further research is warranted to confirm the observed apparent relationship between soil health and yield during dry years.

Soil health improvement takes time. Saskatchewan soils hold great potential for carbon sequestration and storage (as Brian McConkey et al. have demonstrated), but changes in soil organic matter or total carbon may only be detected in the long-term – five to 10 years, or more. Soil organic matter is a crucial metric for soil health, but it is difficult to interpret in the short-term.

Published Report: Wu, Q., and Congreves, K.A., 2021. "A soil health scoring framework for arable cropping systems in Saskatchewan." Canadian Journal of Soil Science.

Study compares seven strategies to reduce fertilizer inputs

KEY RESULT:

This study compared seven cropping systems in year one, followed by canola in year two and wheat in year three. On a benefit:cost ratio basis, three treatments – year-one cattle manure, year-one green manure crop, and annual application of bio-stimulants – would perform better than other cropping systems investigated in this study.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"Strategies to reduce fertility inputs and improve soil health and carbon sequestration in mixed crop-livestock systems" Akim Omokanye Peace Country Beef & Forage Association (PCBFA)

FUNDING:
Alberta Canola, Alberta Wheat, Alberta Agriculture & Forestry

Alberta Agriculture and Forestry's recent AgriProfit$ report showed that fertilizer costs constitute up to 25 per cent of the total variable costs in cereal production, and up to about 30 per cent for canola. This is compelling producers to seek options that will improve soil nutrients and overall soil health, while reducing fertilizer input expenses, but not sacrificing yield.

In Alberta, integrated crop-livestock systems are receiving renewed interest. Producer motivations are varied, but often include risk reduction through diversification, increased nutrient and land-use efficiency, and climate resilience.

This project was carried out to see how different cropping systems, including a cover crop cocktail of diverse species (CCC), livestock integration, and the use of manure and foliar fertilizer could improve soil health, fertility savings, and carbon storage over a three-year period on two soil types – grey soils at Fairview in the northwest and brown soils at Sedalia in the east.

The seven cropping system options, planted in year one:

- Peas as a cash crop (control)
- Barley with soil rejuvenation program using soil and foliar biostimulants (which were applied all three years)
- Barley with a beef manure application
- CCC grazed as a standing crop
- CCC (high legume percentage) for greenfeed
- CCC rolled as a green manure
- CCC swathed and grazed

After year one, all seven treatments were seeded to canola in year two and wheat in year three.

RESULTS

Generally, greater improvement in grain yield came from cropping treatments with the application of manure in the first year, the use of a CCC as green manure, and the annual application of bio-stimulants for seed treatment and foliar application.

Canola yield was significantly influenced by prior cropping treatments at both sites, with the beef manure and barley in year one producing the highest seed, followed by barley with the annual bio-stimulants. At site one (Fairview), only these two treatments produced significantly higher seed yield than the control. At site two (Sedalia), those two treatments plus the CCC as green manure clearly showed significantly higher seed yield than the control.

On a benefit:cost ratio basis, the application of manure in year one, the annual application of bio-stimulants, and the use of a CCC mixture for green manure in the first year of a three-year cropping system would perform better than other cropping systems investigated.

In general, all cropping treatments seemed to provide some form of nutrient credit to the system.

Enrichment of soil organic carbon (SOC) through sequestration of atmospheric CO_2 in agricultural soils is important because of its impact on soil quality, agronomic production, and mitigation of climate change. In the present study, the treatments did not impact SOC. A long-term study would be required to monitor any improvement in SOC. Previous research showed that a high SOC concentration can be achieved through adoption of appropriate crop rotations, integrated soil fertility management, judicious rates of mineral fertilizers and organic amendments, and conservation tillage methods.

YIELD RESULTS FOR CANOLA (YEAR 2) FOR EACH TREATMENT

YEAR 1 TREATMENTS	YEAR 2 CANOLA YIELD (BU./AC.), SITE 1	YEAR 2 CANOLA YIELD (BU./AC.), SITE 2
Peas as a cash crop (control)	37c	31bc
Barley with yearly bio-stimulants	42b	41a
Barley with beef manure	47a	44a
CCC grazed as standing crop	37c	29c
CCC (high legume) as greenfeed	28d	39abc
CCC rolled as green manure	NA	40a
CCC swathed and grazed	29d	27c
Mean	36.7	37.3
P-value	0	0.04
CV %	4.5	13.7

Yields with the same letters (a, b, etc.) are not different according to LSD at P = 0.05; CV indicates coefficient of variation. A value of less than 15 is considered good for yield trials; P-value for cropping treatment x yield. P of less than 0.05 (or 19+ out of 20) is ideal; NA, data not available.

Deep-banding fertilizer may have logistical benefits

Credit: iStock.com/Lex20

KEY RESULT:

Overall, crop response was generally not linked to deep or shallow placement of phosphorus or potassium. Deep banding (5-6") these nutrients at higher rates once every three years is an option if logistics make it a challenge to apply these products in a shallow band at the time of seeding.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"Deep banding immobile nutrients under direct seeding systems to improve crop production and tackle nutrient stratification," Vance Yaremko, SARDA Ag Research

FUNDING:
Alberta Canola, Alberta Innovates, Alberta Wheat

Long-term direct seeding is associated with increased stratification of nutrients, with greater concentration of nitrogen (N), phosphorus (P) and potassium (K) in the top 2" of soil and lower concentrations below 2". Nutrient stratification results from (a) the minimal mixing of near-surface applied fertilizers and (b) the cycling of nutrients from deep to shallow soil depths through above-ground plant decomposition of crop residues and resulting nutrient accumulation. Will deep banding of nutrients address any issues related to nutrient stratification?

Information to answer this question for Alberta soils and crop growing conditions is lacking. This project assessed whether deep banding of immobile nutrients (P, K and copper) can reduce nutrient stratification while improving nutrient uptake and crop production on land previously under direct seeding for >10 years. The overall objective is to increase the efficiency of P, K and copper fertilizers to improve the production of canola, peas, and wheat on direct-seeded fields.

The project compared (a) a deep banding application at 5-6" once at the beginning of the three-year study and (b) annual shallow banding at around 2" every year for three years. The deep-banding treatment used three times the recommended rate and shallow banding followed recommended rates at seeding. Researchers conducted small-plot replicated trials on farmland previously under direct seeding for at least 10 years at three sites (Lethbridge, Vegreville and Falher) representing diverse soil types and growing conditions of Alberta.

RESULTS

Overall, while the biomass and yield of crops were occasionally increased in response to P, K and phosphorus-potassium-copper (PKCu) treatments in some study site years, crop response was generally not linked to deep or shallow placement of these nutrients. Sometimes deep banding was better, sometimes shallow banding was better. No conclusions could be drawn about nutrient stratification, likely because of the short three-year period of the trial.

Provincial websites for the Canadian Prairies suggest immobile nutrients placement below the depth of seeding may improve availability under dry conditions, because fertilizer is in a moist part of the root zone for a longer period. Also, some consultants recommend deep banding of immobile nutrients. However, the increased mechanical disturbance may add to variable costs, soil moisture loss, and soil erosion potential.

In view of earlier studies and results for this project, researchers suggest the following:

- Either method may be used in consideration of the logistics at the farm and prices for fertilizers.
- Deep banding will need another pass on the land that entails extra cost, but it may be helpful in the following situations: (1) If the available seeding drill does not have an adequate number of tanks to apply different fertilizers at seeding. (2) Less fertilizer to handle at seeding may reduce seeding time when delayed seeding usually reduces crop yield.
- If the available drill has a sufficient number of tanks and there is enough time for seeding, shallow annual applications are appropriate. It will save cost on the extra pass and avoid soil disturbance for deep placement.
- Deep banding could be accomplished in fall to take advantage of available time, dry soil conditions and possible fertilizer price advantages.

This trial raised more questions that researchers hope to answer with further research. Questions include: Can a producer bank phosphorous in the soil for future use by crops? Can a producer apply a three- or four-year supply of phosphorous in a shallow band instead of a deep band and not reduce crop production? How will these practices affect soil health in the long term?

Tips to improve safety of seed-placed fertilizer

KEY RESULT:

Farmers can increase the seed safety of higher phosphorus rates by increasing seed bed utilization (narrower rows or wider openers) and applying only phosphorus (not nitrogen or sulphur) fertilizer in the seed row.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:
"Reducing toxicity of seed-placed phosphorus fertilizer in oilseed crops ," Patrick Mooleki, AAFC Saskatoon

FUNDING:
SaskCanola, Alberta Canola

Current recommendations for safe rates of seed-placed phosphorus (P) recommendations are based on one configuration: 1" opener and 9" row spacing. At this configuration, the safe rates of seed-placed P for canola are 15, 20 and 25 lb./ac. of P_2O_5 for Alberta, Manitoba and Saskatchewan, respectively. However, these rates are not adequate to meet P requirements of canola. The option is to sideband or mid-row band high rates of P. Unfortunately, many farmers do not have these options and use openers that place seed and the fertilizer in the same space or near each other.

As a result, farmers often ask if they can increase seed-placed P when using a wider opener. The objectives of this project were to determine the maximum safe rate of seed-placed P fertilizer with different opener widths and row spacing, and to develop guidelines for producers and crop advisors to use.

Researchers conducted a two-year field study (2018 and 2019) at five locations: Saskatoon, Melfort and Scott in Saskatchewan, and Brooks and Lethbridge in Alberta. The study was conducted as a three-way design with the following treatments: Row spacing at 9" and 12"; opener width at 1", 2" and 4"; and phosphorus rate at 20, 35, 50 and 65 lb./ac. of P_2O_5.

Results indicated that canola growers can apply higher rates of seed-placed phosphorus fertilizer by increasing seed bed utilization (SBU). They can do this by narrowing row spacing from 12" to 9" and/or increasing opener width from 1" to 4". Higher SBU results in reduced P toxicity and more plants per unit area.

NOTABLE OBSERVATIONS

- Increased opener width can cause seeding problems. In many cases, the combination of 9" row spacing and 4" opener width threw too much soil on rows of front openers, which buried the seeds and reduced plant population. This problem was most pronounced on soils with a clay texture. One solution is to reduce seeding speed.
- In this study, grain yield was lower with all opener sizes at 12" row spacing than with 9" row spacing.
- While increasing P rate resulted in increased P toxicity, leading to death of some seed and seedlings, the increased amount of available P helped the surviving plants achieve higher yield.
- Toxic effects of seed-placed P fertilizer were less than expected. This indicates, the researchers say, that canola can tolerate higher levels of seed-placed P when nitrogen and sulphur are not placed with the seed.

In conclusion, the researchers think that this study did not have sufficient information to change the guidelines for safe maximum rates of seed-placed P fertilizer for canola. One limitation is that the study excluded seed-placed nitrogen and sulphur, so the higher rates of seed-placed P looked safe enough. The second limitation was the failure to separate the beneficial effect of increased P rate with the compensatory ability of a canola crop. While increasing P rate resulted in increased P toxicity, surviving plants with higher rates of P yielded better than the more numerous plants at low rates of P. The study needed to supply the same amount of P to all treatments, using the same seed-placed treatments with the balance side banded. The third limitation was time. Two years were not sufficient to lead to strong conclusions of the findings.

Mooleki's research found that higher seed-bed utilization from the narrower row spacing of 9" could improve the crop safety for seed-placed phosphate. It also improved yields.

NARROW ROWS IMPROVE YIELDS, FERTILIZER SAFETY

ROW SPACING	OPENER WIDTH	Grain yield (bu./ac.)
9"	1"	52
	2"	50
	4"	51
12"	1"	48
	2"	49
	4"	48

Updated lygus threshold of 2-3 per sweep

KEY RESULT:

This study validates a new threshold for lygus in canola. The general pattern is that abundances below two lygus per sweep do not reduce yield. Thus, the threshold of two to three lygus per sweep (20-30 per 10 sweeps) is recommended. Because current canola cultivars appear to tolerate lygus damage better than older cultivars, reducing this threshold as prices of canola increase is not recommended.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"Validation of lygus and other insect pest thresholds in commercial farms throughout the Prairie Provinces,"
Hector Carcamo, AAFC Lethbridge

FUNDING:
Alberta Canola, SaskCanola

Lygus bugs are a sporadic pest of canola at the pod stage. Economic levels of damage are more common in Alberta, specifically from Edmonton to southern Alberta. In the Peace Region, some growers are concerned that lygus pose a risk even at earlier bud and early flower stages. Lygus are sometimes a concern in the Meadow Lake area of Saskatchewan and in southern Manitoba. Outbreaks over wider areas can occur during extreme dry and hot summers, as observed in 2021 throughout Canada.

Insecticide spraying during late flower or early pod is becoming a common practice in some regions, but there has been no agreement on economic thresholds and we have limited data for the benefit of spraying at the mid pod stage. The traditional threshold has been one to two lygus per sweep. However, in west central Alberta this threshold is considered too low. In recent years, most fields in this region exceed two lygus per sweep. Therefore, applying the current low threshold would result in excessive, potentially unnecessary insecticide sprays with added costs and detrimental impact on beneficial insects, spiders and pollinators.

Credit: Keith Gebert

OBJECTIVES

- Validate lygus economic thresholds in commercial canola fields.
- Determine the impact on lygus from spraying for other pest insects that may reach nominal economic thresholds. (Examples are flea beetles in central/northern areas, and cabbage seedpod weevils in the south.)
- Document landscape features that can influence risk of lygus damage.

RESULTS

The main accomplishment is the validation of a new threshold for lygus in canola. Despite large variability at many levels (within a field, between fields and years), the general pattern is that abundances below two lygus per sweep do not reduce yield. In fact, at low abundances (below one per sweep), yields were, on average, higher in fields left unsprayed compared to those sprayed at the late flower/early pod stage. This may result from damage caused by ground spraying at the late flower stage or early pod stage or from indirect impacts of the insecticide on beneficial predators and pollinators. Thus, the threshold derived from a previous cage study of two to three lygus per sweep is recommended. Because current canola cultivars appear to tolerate lygus damage better than older cultivars, reducing this threshold as prices of canola increase is not recommended.

A second important finding is that lygus bugs no longer reach pest status in most regions of the Prairies. It appears that pest risk from lygus occurs mainly in a narrow corridor between Edmonton and Lethbridge and towards the foothills. The main pest species of lygus are Lygus keltoni with *L. lineolaris* more prevalent in the northern portion of this corridor. Furthermore, in the southern portion of this corridor it appears that new cultivars may be less susceptible to lygus damage than older cultivars. Significant yield losses were not observed in the new study (2016-2019) in contrast to a related study done from 2010-2013 where older hybrid cultivars were planted. The role of shatter resistant cultivars in reducing insect pod damage warrants further study.

Landscape factors affect lygus abundance in southern Alberta. Researchers determined that regions with fewer canola fields could result in higher lygus pest abundance because they concentrate in the fewer fields. This may explain why lygus are less of a problem in the Peace Region. Previous cropping history in a landscape had no effect on lygus abundance, which is not surprising given the high dispersal ability of these bugs.

An important lesson from this research is that studying interactions between pests is a major challenge due to logistics. Finding sites where a given pest will damage a crop is already difficult enough, from a timely research perspective. Finding one where two pests will be high enough that a proper experiment can be executed is even more difficult (even though farmers see this often). Nevertheless, the researchers say it would be of interest to keep track of lygus bugs in fields where flea beetles, seedpod weevils or diamondback moths delay crop maturity.

Biodiversity from non-crop areas can boost beneficials, possibly yield

KEY RESULT:

Non-crop areas within or near to fields can serve as a source and a destination for beneficial insects at different times of the season. A correlational study of 60 million seeded acres of yield data obtained from Agricultural Financial Services Corporation (AFSC) showed that counties in Alberta where fields tend to contain more non-crop areas also have slightly higher canola yields.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:

"Surveillance networks for beneficial insects: Can natural habitats serve as insect reservoirs, and do they contribute to canola yield?,"
Paul Galpern, University of Calgary

FUNDING:
SaskCanola, Alberta Canola, Manitoba Canola Growers

The objectives were to survey 150 sites in and near cultivated cropland for beneficial insect diversity and abundance. Paul Galpern and his research team would then use farmer yield data, remote sensing, Agriculture and Agri-Food Canada (AAFC) crop inventory data, and in-person assessments to determine the amount of natural and semi-natural areas in and around annual cropland. With this information, the researchers could determine suitability of variously diverse croplands for beneficial insect habitat, and determine if these spaces contribute to or detract from crop yield.

Galpern and team identified 375 species of wild/native bees in or near fields, many of which are very rare. Fifteen species were at over half the sites, indicating a core group of canola-friendly bees. They also found dozens of rare species of spider in and near crops, and identified 57 species of ground beetle in and near cropland. The conclusion is that non-crop areas within or near to fields are likely to serve as a source as well as a destination for beneficial arthropods at different times of the season. Study locations that had smaller patches of non-crop area that were more evenly distributed had higher abundances of many bee species.

As for the yield benefit, a correlational study of 60 million seeded acres of yield data in Alberta obtained from Agricultural Financial Services Corporation (AFSC) showed that counties in Alberta where fields tend to contain more non-crop areas also have slightly higher canola yields. One reason could be that non-crop areas often serve as hotspots for beneficial arthropods that spill over into canola fields, increasing the visitations to canola flowers. This evidence is in line with global literature that proximity to natural and semi natural spaces has a positive effect on the yield potential of cropland, at a landscape scale.

Phase II of this project is funded and underway. Phase II will take the landscape yield implication to a field-scale impact. Research will focus on sites across central and southern Alberta to measure yield and quality parameters of crop grown in proximity to these spaces.

Published articles

"Wild bee responses to cropland landscape complexity are temporally-variable and taxon-specific: Evidence from a highly replicated pseudo-experiment" Agriculture, Ecosystems and Environment, 2021, v322, 107652

"Non-crop sources of beneficial arthropods vary within-season across prairie agroecosystem" Agriculture, Ecosystems and Environment, 2021, v320, 107581

"Pothole wetlands provide reservoir habitat for native bees in prairie croplands" Biological Conservation, 2019; v232, pp. 43-50

"Landscape complexity is associated with crop yields across a large temperate grassland region" Agriculture, Ecosystems and Environment, 2020; v290, 106724

Diverse weed management can protect herbicide efficacy

KEY RESULT:

Effective herbicides remain a critical part of integrated weed management. Steps taken now to increase diversity in the management strategy, while herbicides are still effective, is crucial to maintaining control of weed populations in the long term.

PROJECT TITLE, PRINCIPAL INVESTIGATOR:
"Mitigating herbicide resistance – investigating novel integrated weed management systems" Breanne Tidemann, AAFC Lacombe

FUNDING:
Alberta Canola, Alberta Barley, SaskWheat, WGRF

Herbicide resistance is increasing in Western Canada and around the world. While herbicides are still mostly effective, ongoing research has tried to identify other tactics and systems to include in an integrated weed management (IWM) approach.

This five-year project builds on previous research conducted by AAFC research scientist Neil Harker, who looked at IWM tactics for wild oat. This project investigated similar tactics, added chaff collection as a harvest weed seed control option, and branched out to wild oat, wild buckwheat and locally-important broadleaf weeds at each location.

This study compared weed populations for treatments that included diverse crop rotations (canola-wheat, fababeans-barley-canola, peas-winter wheat-canola, silage barley-winter triticale-silage barley, silage barley-fall rye-canola, alfalfa-alfalfa-alfalfa), with and without herbicides (various combinations), typical or increased seeding rates, and with and without chaff collection.

In year one, trial areas were seeded to wheat at a 2x seeding rate, treated with zero herbicides, and seeded with weeds to allow populations to establish. The middle three years were given the above crop rotations. For the final year, trials areas were again seeded to wheat at a 2x seeding rate with zero herbicides.

Wild buckwheat populations were not significantly affected by any of the crop rotations or integrated weed management techniques tested on average across locations. It is likely that the twining/climbing nature of buckwheat allows it to be less affected by the IWM strategies used in this study, which rely heavily on increased competitiveness to affect weed populations. Effective IWM on species such as buckwheat and cleavers will require new techniques with better efficacy.

Wild oat results were not as promising as results from Neil Harker's previous IWM research on wild oat. Wild oat densities at most locations would be unacceptable in a commercial field. One possible source of variation between the Harker and Tidemann studies is the initial wild oat population when IWM strategies are implemented. It's possible that IWM strategies are less effective on high weed populations. This is an area that requires more research.

One clear result is that grass weeds, and in particular wild oat, tend to be more competitive than the broadleaf weeds. The lowest broadleaf weed biomass was recorded in some of the low diversity, no herbicide treatments. This is a side impact of high, and competitive, wild oat populations in these treatments, which reduced the size and impact of the broadleaf weeds.

Credit: CCC

Effective integrated weed management on wild buckwheat and other species will require new techniques with better efficacy.

The biggest conclusion drawn to date is that the IWM methods previously studied for wild oat control, including increased seeding rates and inclusion of a winter cereal or barley silage, may not always prove effective for wild oats or for other species. Researchers want to understand why control levels in this study were so much lower than those observed in the Harker et al. (2016) study. If, as the researchers currently suspect, initial wild oat densities at the implementation of the integrated weed management strategies significantly affect control, this could critically impact the way farmers adopt these strategies.

Early application of IWM could be key because waiting until resistance establishes (and densities increase) could result in management failure and loss of control.

Western Canadian farmers also need additional IWM tactics. IWM systems studied to date are not a solution to herbicide resistance. They can aid in management of the weeds, but increasing diversity in the management strategy early, while herbicides are still effective, is crucial to maintaining control of our weed populations long term.

Blackleg Disease Cycle

Leptosphaeria maculans

Learn about the blackleg cycle in the Blackleg chapter of the Diseases section at canolaencyclopedia.ca.

1 Spores Released

In the spring, ascospores are released from the infected stubble and infect plants through stomata and wounds.

2 Primary Infection

Cotyledons and young leaves exhibit lesions with pycnidia. See A below.

3 Secondary Infection

The pycnidia release pycnidiospores which spread disease to other leaves and plants via rain splash and wind. Secondary infection has less impact on blackleg severity.

4 Fungal Growth Towards Stem

During mid-season flowering, infection from cotyledons/ lower leaves spreads internally to the stem base. See B below.

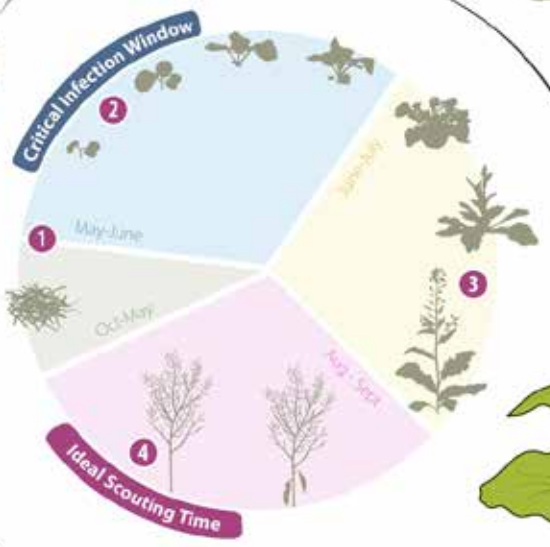
5 Stem Cankers and Plant Lodging

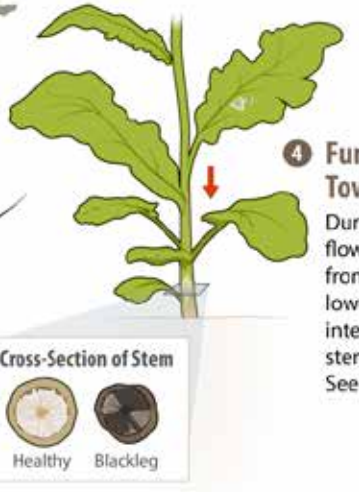
Lesions can cause root and stem cankers, which lead to lodging under severe infection. See C below.

6 Blackleg Survives on Residue

Fungus overwinters for 2+ years on infected canola stubble, primarily as mycelium pycnidia, and pseudothecia. See D below.

Crop rotation allows residue to decompose, reducing the inoculum available to infect the next crop. 2+ years





Scouting

The main blackleg disease scouting periods are:

1. prior to planting
2. cotyledon to two-leaf stage
3. flowering stage
4. ripening stage to post-harvest

Symptoms of blackleg disease in canola plants:

Early stages present as lesions with pycnidia (black specks) on the leaves.

The stem displays varying degrees of black, as seen in cross-section.

Late stages present with root and stem cankering (shrunken, pinched areas).

Pseudothecia and pycnidia can be seen on old canola stubble.

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NEW AND ONGOING PROJECTS

New studies launched in the past year are exploring biologicals for nitrogen fixation and insect management, phenology-based weed control, and new techniques to breed for blackleg resistance. Canola farmers across the Prairies fund many of these projects through their levy payments to SaskCanola, Alberta Canola and Manitoba Canola Growers. Some are funded through the Canola AgriScience Cluster, a partnership between Agriculture and Agri-Food Canada (AAFC) and the canola industry under the Canadian Agricultural Partnership (CAP).

NEW PROJECTS

FERTILITY MANAGEMENT

BIOLOGICAL NITROGEN FIXATION IN CANOLA

PRINCIPAL INVESTIGATOR: Alicia Ziemienowicz, Agriculture and Agri-Food Canada (AAFC) Lethbridge
FUNDING: Alberta Canola, Alberta Innovates, Western Grains Research Foundation (WGRF), Alberta's Results Driven Agriculture Research (RDAR)
OBJECTIVES: To generate canola with the trait of biological nitrogen fixation. This trait would allow crops to grow more efficiently in nitrogen-deficient soil, making them independent of nitrogen fertilizers.

INTEGRATED PEST MANAGEMENT

ENHANCE UNDERSTANDING OF CLEAVERS POPULATIONS IN WESTERN CANADA

PRINCIPAL INVESTIGATOR: Breanne Tidemann, AAFC Lacombe
FUNDING: Alberta Canola, SaskCanola, WGRF
OBJECTIVES: To look for cleavers biotypes on the Prairies based on emergence phenology, whorl/branch number, seed production, and seed weight. Evaluate emergence timing of cleavers populations. Screen for quinclorac resistance.

THE ROLE OF INSECT FEEDING AND PLANT DEFENSE RESPONSES IN ASTER YELLOWS DISEASE EPIDEMIOLOGY

PRINCIPAL INVESTIGATOR: Sean Prager, University of Saskatchewan
FUNDING: Alberta Canola, Manitoba Canola Growers
OBJECTIVES: To quantify the feeding behaviour of aster leafhoppers on different host plants and examine the relationship between feeding time and aster yellows phytoplasma.

INVESTIGATING INTERACTIONS OF ASCOSPORES AND PYCIDIOSPORES WITH BLACKLEG RESISTANCE IN CANOLA AND EFFICACY OF SEED APPLIED FUNGICIDES

PRINCIPAL INVESTIGATOR: Dilantha Fernando, University of Manitoba
FUNDING: SaskCanola
OBJECTIVES: To develop a protocol to efficiently produce ascospore and pycnidiospore inoculum with defined Avr profile for resistance screening. To assess interactions of inoculum types with blackleg resistance. To evaluate seed-applied fungicides.

INVESTIGATING THE ROLE OF PLANT HOSTS IN THE OUTBREAKS OF THE ASTER LEAFHOPPER VECTORED ASTER YELLOWS

PRINCIPAL INVESTIGATOR: Sean Prager, University of Saskatchewan
FUNDING: SaskCanola, WGRF
OBJECTIVES: To evaluate several crop and non-crop species commonly found in the Canadian Prairies as possible hosts for aster leafhopper development and/or phytoplasma infection.

PURIFYING GENOTYPES OF P. BRASSICAE AND DEVELOPING MARKERS LINKED TO RACES OF P. BRASSICAE COLLECTED IN WESTERN CANADA

PRINCIPAL INVESTIGATOR: Fengqun Yu, AAFC Saskatoon
FUNDING: SaskCanola, Manitoba Canola Growers, WGRF
OBJECTIVES: To develop markers linked to races of *P. brassicae* (the pathogen that causes clubroot), similar to the technology used for blackleg. First step is an efficient method to produce near pure genotype isolates (NPGI).

INSECTICIDE SUSCEPTIBILITY AND RESISTANCE MONITORING OF FLEA BEETLES IN CANOLA

PRINCIPAL INVESTIGATOR: Boyd Mori, University of Alberta
FUNDING: Alberta Canola, WGRF, RDAR
OBJECTIVES: To determine the susceptibility of the striped and crucifer flea beetle to various registered insecticides and investigate the mechanisms of insecticide tolerance.

This is an aster leafhopper, vector of aster yellows disease. Sean Prager from the University of Saskatchewan leads a study to evaluate several plant species to see if they can host aster leafhopper development and aster yellows phytoplasma.

STUDY OF THE EFFECTS OF BRASSICA ROOT ARCHITECTURE AND FERTILIZER APPLICATION ON CLUBROOT DISEASE SEVERITY

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, WGRF, RDAR
OBJECTIVES: To investigate the association between brassica root architecture and nitrogen treatments on clubroot severity and crop yield.

MANIPULATING WEED SEED PRODUCTION THROUGH PHENOLOGY-BASED WEED CONTROL

PRINCIPAL INVESTIGATOR: Charles Geddes, AAFC Lethbridge
FUNDING: Alberta Canola, Alberta Wheat Commission, SaskWheat, WGRF
OBJECTIVES: To improve our understanding of weed phenology in Western Canada, and use that information to develop strategies to reduce the amount of weed seed returned to the soil. This will help with herbicide-resistant weed management.

UNDERSTANDING FUSARIUM WILT AND ROOT ROT OF HYBRID CANOLA

PRINCIPAL INVESTIGATOR: Sheau-Fang Hwang, University of Alberta
FUNDING: Alberta Canola, RDAR
OBJECTIVES: To optimize cultural methods to control the fusarium pathogens causing seedling blight and root rot and wilt of canola.

EXPLORING FURTHER POSSIBILITIES AND ADVANCEMENTS OF USING BIO-CONTROL ENTOMOPATHOGENIC NEMATODES (EPNS)

PRINCIPAL INVESTIGATOR: Shabeg Briar, Olds College
FUNDING: Alberta Canola, RDAR
OBJECTIVES: To assess the management of root maggots and cutworms using commercially available entomopathogenic nematodes (EPNs); to identify and explore locally adapted virulent strains of EPNs.

INCORPORATION OF ABIOTIC AND BIOTIC FACTORS FOR DEVELOPMENT OF STAGE-STRUCTURED PREDICTIVE MODELS OF FLEA BEETLES

PRINCIPAL INVESTIGATOR: Maya Evenden, University of Alberta
FUNDING: Alberta Canola, RDAR
OBJECTIVES: To develop a weather-dependent, stage-structured deterministic developmental model for both flea beetle species and evaluate appropriate base temperature thresholds for predictions of flea beetles in canola.

PROMOTION OF WETLAND STEWARDSHIP BEST MANAGEMENT PRACTICES THROUGH A TARGETED WATER MONITORING PROJECT

PRINCIPAL INVESTIGATOR: Tony Ciarla, Millenium EMS Solutions
FUNDING: Alberta Canola and various other public and private funders
OBJECTIVES: To evaluate wetland management practices in mitigating the movement of crop protection products into wetlands and aquatic ecosystems. This will help ensure that farmers have access to crop protection tools by continuing to follow sound environmental stewardship.

GENETICS

USING AVIRULENCE MARKERS TO PREDICT THE PHENOTYPES OF CLUBROOT PATHOTYPES

PRINCIPAL INVESTIGATOR: Edel Pérez-López, Université Laval
FUNDING: Alberta Canola, Manitoba Canola Growers, WGRF
OBJECTIVES: To optimize a hydroponic bioassay to phenotype the interaction between canola and *P. brassicae*; to identify *P. brassicae* avirulence markers; to design and implement a multiplex PCR assay able to differentiate *P. brassicae* isolates.


Credit: Edel Pérez-López lab

A researcher works on a hydroponic bioassay to phenotype the interaction between canola and clubroot-causing P. brassicae pathogen. This part of Edel Pérez-López's new study at the Université Laval.

BUILDING BRIDGES TO SUCCESS - ACCESSING BRASSICA DIPLOID VARIATION FOR CANOLA IMPROVEMENT

PRINCIPAL INVESTIGATOR: Steve Robinson, AAFC Saskatoon
FUNDING: Alberta Canola, Manitoba Canola Growers, SaskCanola
OBJECTIVES: To test new technology for blackleg resistance breeding. Domesticated diploid bridging species in combination with targeted diploid germplasm will increase the efficiency to introduce and evaluate new resistance alleles into *B. napus*.

NEW CLUBROOT PATHOTYPES AND SECOND GENERATION RESISTANCE

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, SaskCanola, WGRF
OBJECTIVES: To evaluate the infectivity of the most important *P. brassicae* pathotypes on a suite of canola cultivars with second-generation resistance.


Credit: iStock.com/Nature

ONGOING PROJECTS

PLANT ESTABLISHMENT

UNDERSTANDING GRAIN PNEUMATIC CONVEYING IN SEEDING EQUIPMENT

PRINCIPAL INVESTIGATOR: Lorne Grieger, Prairie Agricultural Machinery Institute (PAMI)
FUNDING: SaskCanola, Ag Action Manitoba
OBJECTIVES: To look at factors in air seeder components that affect small seed distribution and viability, both in the field and in computer simulations.

HOW DOES IN-ROW SEED SPACING AND SPATIAL PATTERN AFFECT CANOLA YIELD?

PRINCIPAL INVESTIGATOR: Steve Shirtliffe, University of Saskatchewan
FUNDING: SaskCanola
OBJECTIVES: To determine the optimum distance canola plants should have from their neighbour, both within rows and between rows, so they can survive to produce maximum yield at existing seeding rates.

MANIPULATING AGRONOMIC FACTORS FOR OPTIMUM CANOLA HARVEST TIMING, PRODUCTIVITY AND CROP SEQUENCING.

PRINCIPAL INVESTIGATOR: Brian Beres, Agriculture and Agri-Food Canada (AAFC) Lethbridge
FUNDING: Canadian Agricultural Partnership (CAP)
OBJECTIVES: To look at the canola yield effect of seeding rates, hybrid maturity and harvest method.

FERTILITY MANAGEMENT

ENHANCING THE BENEFICIAL ROOT MICROBIOME IN CANADA

PRINCIPAL INVESTIGATOR: Chantal Hamel, AAFC Ottawa
FUNDING: CAP, Alberta Canola, SaskCanola, Manitoba Canola Growers, Western Grains Research Foundation (WGRF), NSERC
OBJECTIVES: To identify the prokaryotic community within the canola-specific root rhizosphere, and follow up to see how beneficial associative microorganisms could help to improve crop yield.

CANOLA FREQUENCY EFFECTS ON NUTRIENT TURNOVER AND ROOT-MICROBE INTERACTIONS

PRINCIPAL INVESTIGATOR: Tim Dumonceaux, AAFC Saskatoon
FUNDING: Alberta Canola, SaskCanola
OBJECTIVES: To better understand the effects of short canola rotations on soil nutrients and microbiology, this project examines root nutrient fluxes and plant, soil, and root-associated microbes using herbicide-resistant commercial varieties of canola.

OPTIMAL SOURCE, PLACEMENT AND APPLICATION TIMING FOR YIELD AND REDUCTION OF GREENHOUSE GAS FOOTPRINT FOR CANOLA

PRINCIPAL INVESTIGATOR: Mario Tenuta, University of Manitoba
FUNDING: Manitoba Canola Growers, SaskCanola
OBJECTIVES: To improve nitrogen use efficiency of fertilizer for canola production on light texture soils, looking at enhanced efficiency fertilizer products, placement and timing.

UNDERSTANDING CANOLA ROOT MORPHOLOGY AND MICROBIOMES IN RESPONSE TO SOIL PHOSPHORUS FERTILITY

PRINCIPAL INVESTIGATOR: Bobbi Helgason, University of Saskatchewan
FUNDING: SaskCanola
OBJECTIVES: To determine how canola root architecture and the root-associated microbiome impact the plant's ability to forage for phosphorus. This can help to develop strategies for overcoming phosphorus deficiency in canola production.

SKSIS-3: SYNERGIES AND SUSTAINABILITY FOR THE SASKATCHEWAN SOIL INFORMATION SYSTEM

PRINCIPAL INVESTIGATOR: Angela Bedard-Haughn, University of Saskatchewan
FUNDING: SaskCanola, WGRF, SaskWheat
OBJECTIVES: To enhance SKSIS by developing and integrating predictive soil mapping tools into SKSIS, and by creating a standalone SKSIS feature for efficient use in internet-deficient areas.

REVISING THE CROP NUTRIENT UPTAKE AND REMOVAL GUIDELINES FOR WESTERN CANADA

PRINCIPAL INVESTIGATOR: Fran Walley, University of Saskatchewan
FUNDING: WGRF, SaskCanola and other commodity groups
OBJECTIVES: To determine and revise estimates of the nutrient uptake and removal of crops commonly grown in western Canada, and to develop a user-friendly online and mobile app for determining nutrient uptake and removal estimates.

USING MODULATED ON-FARM RESPONSE SURFACE EXPERIMENTS (MORSE) TO DEVELOP EVIDENCE-BASED, AGRONOMIC RECOMMENDATIONS

PRINCIPAL INVESTIGATOR: Steve Shirtliffe, University of Saskatchewan
FUNDING: SaskCanola, Sask Wheat, WGRF
OBJECTIVES: To develop methodology that will allow crop input experiments to be performed using Modulated On-farm Response Surface Experiments, to refine image-based technology as a tool to assess crop response variables, including yield.

A researcher measures lodging-related parameters, helping AAFC's Bao-Luo Ma with a study to improve nitrogen use efficiency of canola.

ENHANCING THE SASKATCHEWAN SOIL HEALTH ASSESSMENT PROTOCOL – PHASE 2

PRINCIPAL INVESTIGATOR: Kate Congreves, University of Saskatchewan
FUNDING: SaskCanola, SaskWheat
OBJECTIVES: To build on the Saskatchewan Soil Health Testing Protocol so that it outputs soil zone-specific scores; to incorporate novel microbial measurements of soil health into the testing protocol; to explore early-indicators of soil health change.

SHINING LIGHT ON DIGITAL AGRICULTURE: LINKING SOIL NIR MEASUREMENTS, FERTILITY, AND CROP YIELDS

PRINCIPAL INVESTIGATOR: Derek Peak, University of Saskatchewan
FUNDING: SaskCanola, SaskWheat, Saskatchewan's Agriculture Development Fund (ADF)
OBJECTIVES: To use spectral sensing to produce spatially-resolved soil-based yield potential maps; and develop methodology to link field near infrared (NIR) data and laboratory analyses.

IMPACT OF PHOSPHORUS FERTILIZER FORMS ON NUTRITION OF WHEAT, PEA AND CANOLA, SOIL FATE AND LOSSES IN RUN-OFF WATER

PRINCIPAL INVESTIGATOR: Jeff Schoenau, University of Saskatchewan
FUNDING: SaskCanola, SaskWheat, SaskPulse, WGRF
OBJECTIVES: To assess how phosphorus fertilizer forms, placement, and rate affect crop responses, fate in the soil, and run-off losses in Saskatchewan soils.

IMPROVING NITROGEN USE EFFICIENCY AND SOIL SUSTAINABILITY IN CANOLA PRODUCTION ACROSS CANADA

PRINCIPAL INVESTIGATOR: Bao-luo Ma, AAFC Ottawa
FUNDING: CAP
OBJECTIVES: To assess and improve nitrogen use efficiency (NUE); to identify root architecture traits for efficient nitrogen acquisition; and to investigate how the soil microbiome responds to nitrogen management.

COLLECTING THE CARBON DATA NEEDED FOR CLIMATE-SMART AGRICULTURE IN SASKATCHEWAN

PRINCIPAL INVESTIGATOR: Kate Congreves, University of Saskatchewan
FUNDING: SaskCanola, SaskWheat, SaskOats, ADF
OBJECTIVES: To provide year-round measurements of greenhouse gas emissions from a representative cropping system in Saskatchewan; to assess 4R practices to minimize carbon footprints; to test if Saskatchewan cropping systems are a net carbon sink.

INTEGRATED PEST MANAGEMENT – DISEASE

EXPLORING NOVEL SEED-TREATMENT OPTIONS TO MITIGATE THE IMPACT OF BLACKLEG ON CANOLA

PRINCIPAL INVESTIGATOR: Gary Peng, AAFC Saskatoon
FUNDING: SaskCanola
OBJECTIVES: To assess the importance of blackleg infection from the soil, and investigate the conditions that affect the success of infection. The information will help understand the potential value of fungicide seed treatment for blackleg.

MONITORING THE RACE DYNAMICS OF LEPTOSPHAERIA MACULANS FOR EFFECTIVE DEPLOYMENT AND ROTATION OF RESISTANCE GENES FOR SUSTAINABLE MANAGEMENT OF BLACKLEG

PRINCIPAL INVESTIGATOR: Gary Peng, AAFC Saskatoon
FUNDING: SaskCanola, Alberta Canola, Manitoba Canola Growers
OBJECTIVES: To provide an up-to-date *L. maculans* race profile, which can be used to guide the deployment or rotation of canola cultivars carrying different R genes. To see how pathogen race changes in response to resistant cultivars over the years.

FINE-TUNING OF THE BLACKLEG YIELD LOSS MODEL IN CANOLA

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: CAP
OBJECTIVES: To refine and improve on an earlier yield loss model by using modern hybrid cultivars.

IMPROVING MANAGEMENT OF BLACKLEG ON CANOLA VIA BETTER FLEA BEETLE CONTROL AND EFFECTIVE FUNGICIDE SEED TREATMENT IN WESTERN CANADA

PRINCIPAL INVESTIGATOR: Gary Peng, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To assess potential connection between flea beetle feeding and blackleg infection, and whether foliar insecticide, blackleg-resistant cultivar and fungicide seed treatment can alleviate blackleg infection under different flea beetle feeding pressure.

DEVELOPING A ROBUST SYSTEM FOR EFFICIENT ASSESSMENT OF QUANTITATIVE RESISTANCE (QR) IN COMMERCIAL CANOLA VARIETIES FOR BLACKLEG MANAGEMENT

PRINCIPAL INVESTIGATOR: Gary Peng, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To explore a ddPCR-based protocol to measure quantitative resistance (QR) to blackleg in canola. Once developed and validated, this can quantify QR in canola cultivars and help screen QR traits in commercial canola breeding lines.

UNDERSTANDING THE CRITICAL INFECTION WINDOW THAT CAUSES BLACKLEG OF CANOLA IN WESTERN CANADA

PRINCIPAL INVESTIGATOR: Gary Peng, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To understand how quantitative resistance (QR) affects the success of stem infection via cotyledons or lower true leaves. The information may help fine-tune the timing of fungicide, including use of seed treatment.

MANAGING SMALL PATCHES OF CLUBROOT INFESTATION IN CANOLA FIELDS

PRINCIPAL INVESTIGATOR: Bruce Gossen, AAFC Saskatoon
FUNDING: Alberta Canola, SaskCanola, Manitoba Canola Growers
OBJECTIVES: To develop practical recommendations to manage small patches of clubroot. Includes lab studies of rotation crops and grass cover crops, field studies of liming and grasses, and tests to estimate resting spore numbers in soil.

INFLUENCE OF PH ON THE CLUBROOT PATHOGEN: ARE THERE pH-INSENSITIVE STRAINS?

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, SaskCanola, Manitoba Canola Growers
OBJECTIVES: To determine whether strains of the clubroot pathogen respond differentially to soil pH and whether pathogen strains can become adapted to high pH conditions.

CLUBROOT INOCULUM MANAGEMENT FOR SUSTAINABLE CANOLA PRODUCTION

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, Alberta Agriculture & Forestry
OBJECTIVES: To determine the spore population levels that are safe for the use of clubroot-resistant cultivars and develop a knowledge-based resistance deployment strategy.

A RAPID MOLECULAR ASSAY TO IDENTIFY PLASMODIOPHORA BRASSICAE PATHOTYPES FROM PLANT AND SOIL SAMPLES

PRINCIPAL INVESTIGATOR: Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, Alberta Agriculture & Forestry
OBJECTIVES: To generate an effective rapid molecular assay (PCR-based) to identify abundance and diversity of *P. brassicae* pathotypes in soil and plant samples; and to use genetic variability among pathotypes to identify genes of interest related to infection.

DEVELOPING SINGLE-SPORE ISOLATES OF PATHOTYPES OF PLASMODIOPHORA BRASSICAE

PRINCIPAL INVESTIGATOR: Bruce Gossen, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To develop techniques for isolating and whole-genome sequencing of single spores of *P. brassicae*, the pathogen that causes clubroot.

APPLICATION OF HYPERSPECTRAL IMAGING FOR DETECTION AND MAPPING OF SMALL PATCH CLUBROOT INFESTATIONS IN COMMERCIAL CANOLA FIELDS

PRINCIPAL INVESTIGATOR: David Halstead, Saskatchewan Polytechnic
FUNDING: SaskCanola, ADF
OBJECTIVES: To identify readily applied diagnostic features for remote imaging and mapping small clubroot patches and develop a diagnostic tool; to refine and validate diagnostic tool for identifying small patch clubroot infestations.

A PROTEOMICS-BASED APPROACH TOWARDS IDENTIFYING HOST AND PATHOGEN PROTEINS CRITICAL TO CLUBROOT ESTABLISHMENT IN CANOLA

PRINCIPAL INVESTIGATOR: Christopher Todd, University of Saskatchewan
FUNDING: WGRF, SaskCanola
OBJECTIVES: To identify *P. brassicae* effector proteins and to identify differentially expressed proteins in clubroot-susceptible and clubroot-resistant canola lines.

GENOME-WIDE FUNCTIONAL ANALYSIS OF PLASMODIOPHORA BRASSICAE EFFECTORS AND THE MANAGEMENT OF CLUBROOT DISEASE

PRINCIPAL INVESTIGATOR: Peta Bonham-Smith, University of Saskatchewan
FUNDING: SaskCanola, Saskatchewan Ministry of Agriculture
OBJECTIVES: To profile *P. brassicae* candidate effector proteins secreted by the clubroot pathogen during secondary infection, and identify their target plant proteins. Target protein mutants are potential sources of resistance to clubroot disease.

DEFINING POPULATIONS OF PLASMODIOPHORA BRASSICAE WITH NEAR ISOGENIC BRASSICA NAPUS LINES

PRINCIPAL INVESTIGATOR: Fengqun Yu, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To develop a set of near isogenic *B. napus* lines containing single clubroot-resistance genes, and to define the populations of *P. brassicae* with the newly developed near isogenic lines.

CLUBROOT PILLAR 3: HOST-PATHOGEN BIOLOGY AND INTERACTION

PRINCIPAL INVESTIGATOR: Bruce Gossen, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To examine factors that affect resting spore survival, germination and infection; to examine quantitative resistance to see if it might increase the durability of resistance genes; to evaluate strategies to maximize the durability of resistance.

BIOPESTICIDES AS A NOVEL MANAGEMENT STRATEGY FOR SCLEROTINIA IN CANOLA

PRINCIPAL INVESTIGATOR: Susan Boyetchko, AAFC Saskatoon
FUNDING: SaskCanola, Manitoba Canola Growers
OBJECTIVES: To screen and evaluate the biopesticide potential of selected bacterial strains that are indigenous to the Canadian Prairies and determine their ability to control disease development and growth of *Sclerotinia sclerotiorum* in canola.

RESISTANCE TO SCLEROTINIA SCLEROTIORUM EFFECTORS IN CANOLA.

PRINCIPAL INVESTIGATOR: Dwayne Hegedus, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To simplify the identification of *Brassica napus* canola lines with tolerance to sclerotinia stem rot.

DEVELOPMENT OF A BIOSENSOR FOR SCLEROTINIA STEM ROT DISEASE FORECASTING IN CANOLA

PRINCIPAL INVESTIGATOR: Xiujie (Susie) Li, InnoTech Alberta
FUNDING: CAP
OBJECTIVES: To develop an in-field real-time sensor to monitor plant disease pathogens, specifically the sclerotinia stem rot pathogens. The sensor would notify the farmer, via cell phone, when a disease outbreak is imminent.

IMPROVING THE MANAGEMENT OF SCLEROTINIA STEM ROT OF CANOLA USING FUNGICIDES AND BETTER RISK ASSESSMENT TOOLS

PRINCIPAL INVESTIGATOR: Kelly Turkington, AAFC Lacombe
FUNDING: CAP
OBJECTIVES: To study how the relationship between inoculum availability and environmental conditions before and during flowering impacts stem rot risk and fungicide response; to study how crop development and variability in flowering impact fungicide efficacy; to test fungicide application timing.

VERTICILLIUM STRIPE - THE DISEASE MANAGEMENT

PRINCIPAL INVESTIGATOR: Sheau-Fang Hwang and Stephen Strelkov, University of Alberta
FUNDING: Alberta Canola, SaskCanola, Manitoba Canola Growers
OBJECTIVES:
To determine the effects of growth stage and inoculation techniques on host infection, and to evaluate the effects of disease severity on plant growth and yield at different inoculum concentrations.


Credit: Dilantha Fernando

This is canola infected with verticillium disease. Dilantha Fernando at the University of Manitoba leads a study to identify and characterize Verticillium longisporum isolates from across the Prairies, and look for resistant canola lines.

VERTICILLIUM DISEASE ETIOLOGY AND NURSERY

PRINCIPAL INVESTIGATOR:
Dilantha Fernando, University of Manitoba
FUNDING: CAP
OBJECTIVES: To identify and characterize *Verticillium longisporum* isolates from across the Prairies; to investigate the longevity of micro-sclerotia in canola stems, and monitor pathogen movement in soil or through space; to look for resistant canola lines.

GENETICS AND GENOMICS OF BRASSICA-VERTICILLIUM INTERACTION

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To identify verticillium-resistant *B. napus* (canola) lines and to develop pathogen diagnostic tools.

INTEGRATED PEST MANAGEMENT – INSECTS

EVALUATING THE EFFECT OF CANOLA SEEDING RATE AND SEED SIZE SEEDED INTO WHEAT STUBBLE ON FLEA BEETLE DAMAGE AND POPULATION

PRINCIPAL INVESTIGATOR: María Angélica Ouellette, North Peace Applied Research Association
FUNDING: Alberta Canola
OBJECTIVES: To evaluate the impact of seeding rate, seed size, and seeding date on flea beetle damage - specifically for the North Peace region.

EFFECT OF HAIRINESS IN BRASSICA LINES ON THE ABUNDANCE, FEEDING AND OVIPOSITION BEHAVIOR OF FLEA BEETLES, DBM AND ASTER LEAFHOPPER

PRINCIPAL INVESTIGATOR: Chrystel Olivier, AAFC Saskatoon
FUNDING: SaskCanola, Alberta Canola
OBJECTIVES: To determine the effects of trichomes (hairs) on the feeding and/or egg-laying behaviour of three canola pests: striped flea beetle, diamondback moth (DBM) and aster leafhopper.

GENERATE KNOWLEDGE AND CONTROL STRATEGIES FOR THE POLLEN BEETLE BRASSICOGETHES VIRIDESCENS

PRINCIPAL INVESTIGATOR: Christine Noronha, AAFC Charlottetown
FUNDING: Alberta Canola, SaskCanola, Manitoba Canola Growers
OBJECTIVES: To establish economic thresholds for pollen beetle and continue the surveillance program in Western Canada to monitor the presence/absence of pollen beetles.

IDENTIFICATION AND ASSESSMENT OF THE ROLE OF NATURAL ENEMIES IN PEST (DIAMONDBACK MOTH) SUPPRESSION IN CANOLA

PRINCIPAL INVESTIGATOR: Maya Evenden and Sharavari Kulkarni, University of Alberta
FUNDING: Alberta Canola, SaskCanola
OBJECTIVES: To monitor natural enemies associated with diamondback moth (DBM); to understand relationships between DBM and its natural enemies and to develop dynamic action thresholds; and to understand factors that enhance parasitism.

MONITORING THE CANOLA FLOWER MIDGE WITHIN PHEROMONE-BAITED TRAPS

PRINCIPAL INVESTIGATOR: Boyd Mori, University of Alberta
FUNDING: WGRF, Alberta Canola, SaskCanola, Manitoba Canola Growers
OBJECTIVES: To develop a pheromone-monitoring tool for the canola flower midge and enhance our knowledge of the factors that contribute to its pest status.

CONTINUING TO WATCH THE WINDS: THE ORIGIN AND ARRIVAL OF MIGRANT ASTER LEAFHOPPERS AND DIAMONDBACK MOTHS

PRINCIPAL INVESTIGATOR: Tyler Wist, AAFC Saskatoon
FUNDING: SaskCanola, WGRF
OBJECTIVES: To pinpoint the southern origins of diamondback moth and aster leafhopper; to see if alfalfa could be a green bridge for aster yellows phytoplasma in Saskatchewan; to develop aster yellows risk index.

IDENTIFYING KEY PREDATORS AND THEIR ROLE IN CANOLA INSECT PEST SUPPRESSION.

PRINCIPAL INVESTIGATOR: Boyd Mori, University of Alberta
FUNDING: Alberta Canola, Manitoba Canola Growers, WGRF
OBJECTIVES: To identify the key natural enemies in the canola agroecosystem by detecting pest insect DNA in guts of predators, and to begin quantifying their pest suppression ability.

SURVEILLANCE NETWORKS FOR BENEFICIAL INSECTS II

PRINCIPAL INVESTIGATOR: Paul Galpern, University of Calgary
FUNDING: Alberta Canola, Manitoba Canola Growers
OBJECTIVES: To determine how far services extend from beneficial anthropod reservoirs and how much beneficial anthropod reservoirs contribute to canola yield by using precision agriculture.

INTEGRATED APPROACHES FOR FLEA BEETLE CONTROL II

PRINCIPAL INVESTIGATOR: Alejandro Costamagna, University of Manitoba
FUNDING: CAP
OBJECTIVES: To improve flea beetle management in general by studying the effect of plant density in flea beetle management, the effect of stem feeding damage, the role of natural enemies on flea beetle management, and regional predictive models for flea beetle abundance.

GENETIC RESOURCES FOR FLEA BEETLE RESISTANCE IN CANOLA

PRINCIPAL INVESTIGATOR: Dwayne Hegedus, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To investigate the complexity of the hairy trait and will provide canola breeders with hairy lines, and associated genetic markers, to allow its introduction into canola varieties.

BIOLOGICAL CONTROL OF CABBAGE SEEDPOD WEEVIL IN THE PRAIRIES.

PRINCIPAL INVESTIGATOR: Hector Carcamo, AAFC Lethbridge
FUNDING: CAP
OBJECTIVES: To assess the efficacy of *T. perfectus* in managing seedpod weevil in Quebec and its non-target effects in Eastern Canada. To document the species of weevils and parasitoids in cultivated and uncultivated habitats that could be affected directly or indirectly in the Prairies.

INTEGRATED PEST MANAGEMENT – WEEDS

HERBICIDE RESISTANT KOCHIA AND RUSSIAN THISTLE PRAIRIE SURVEYS

PRINCIPAL INVESTIGATOR: Julia Leeson, AAFC Saskatoon
FUNDING: WGRF, SaskCanola and other commodity groups
OBJECTIVES: To determine the distribution and abundance of glyphosate-resistant or auxinic-resistant kochia and other targeted weeds, including Russian thistle, waterhemp, and ragweed species in Manitoba, Saskatchewan and Alberta.

PRAIRIE WEED SURVEYS

PRINCIPAL INVESTIGATOR: Julia Leeson, AAFC Saskatoon
FUNDING: WGRF, SaskCanola, and other commodity groups
OBJECTIVES: "To complete the sixth set of weed surveys in the Prairie Provinces since the series of provincial surveys began in the mid-1970s. To summarize existing weed survey information and conduct a new series of general weed surveys.

INTEGRATED PEST MANAGEMENT – OTHER

IMPACT OF DROUGHT AND HEAT DURING FLOWERING ON CANOLA YIELD

PRINCIPAL INVESTIGATOR: Raju Soolanaya-kanahally, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To see how drought, heat and a combination of the two can affect canola seed yield, oil composition and carbon assimilation.

CHARACTERIZING TURBULENT SPRAY DEPOSITION FROM SELF-PROPELLED SPRAYERS

PRINCIPAL INVESTIGATOR: Tom Wolf, Agrimetrix Research & Training
FUNDING: SaskCanola, Alberta Canola
OBJECTIVES: To compare the uniformity of spray deposition for various commercial sprayers.

GENETICS

CONTRIBUTION OF INDIVIDUAL DEFENCE GENES TO SCLEROTINIA RESISTANCE IN CANOLA

PRINCIPAL INVESTIGATOR: Lone Buchwaldt, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To determine the contribution of lectin genes to sclerotinia resistance in canola, to determine the contributio of penetration-resistance genes to sclerotinia resistance in canola, and to determine the contribution of other candidate defense genes to sclerotinia resistance in canola.

PRESERVING HYBRID VIGOUR THROUGH A NOVEL APOMIXIS BREEDING STRATEGY IN BRASSICA CROPS

PRINCIPAL INVESTIGATOR: Tim Sharbel, University of Saskatchewan
FUNDING: SaskCanola, ADF

OBJECTIVES: To generate diploid, hybrid unbalanced apomictic boechera backcrosses; to transfer apomixis from these lines into sexual bridging species; to generate apomictic brassica crops via intergeneric crosses.

MODIFIED LIPID METABOLISM TO DELIVER IMPROVED LOW TEMPERATURE TOLERANCE IN BRASSICA NAPUS

PRINCIPAL INVESTIGATOR: Mark Smith, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To apply a targeted approach to identify new traits to confer improved low temperature tolerance in seedling canola.

ESTABLISHING TRANSGENE-FREE CRISPR/CAS9 BASED GENOME EDITING PLATFORM TO IMPROVE CANOLA RESISTANCE TO CLUBROOT

PRINCIPAL INVESTIGATOR: Wei Xiao, University of Saskatchewan
FUNDING: SaskCanola, ADF
OBJECTIVES: To establish transgene-free CRISPR/Cas9 based genome editing platform to support canola breeding programs, to identify novel clubroot resistance genes and create novel resistance allelic variants in elite canola germplasms.

INCREASING ABIOTIC (DROUGHT) AND BIOTIC (CLUBROOT) RESISTANCE IN BRASSICA SPECIES BY MODIFYING AUXIN RESPONSE

PRINCIPAL INVESTIGATOR: Jocelyn Ozga, University of Alberta
FUNDING: SaskCanola, Alberta Canola, NSERC
OBJECTIVES: To develop novel genetically-improved canola, using a biotechnological approach, that is more resistant to both biotic (clubroot disease) and abiotic (drought) stress.

IMPROVING HEAT AND DROUGHT RESISTANCE IN CANOLA THROUGH REGULATING DGAT1 ACTIVITY

PRINCIPAL INVESTIGATOR: Gavin Chen, University of Alberta
FUNDING: Alberta Canola
OBJECTIVES: To generate and evaluate canola lines with distinct modifications of DGAT1 enzyme under heat and drought stress and to identify additional candidate genes related to heat and drought stress. Diacylglycerol acyltransferase 1 (DGAT1) can increase tolerance to drought, heat or freezing stress in arabidopsis.

IDENTIFICATION AND EXPLOITATION OF GENOME STRUCTURAL VARIANTS FOR TRAIT IMPROVEMENT IN PRAIRIE CROPS

PRINCIPAL INVESTIGATOR: Andrew Sharpe, Global Institute for Food Security
FUNDING: SaskCanola, SaskWheat, Alberta Wheat, WGRF
OBJECTIVES: To develop canola and wheat pan-genome structural variant (PanSV) atlases; to develop high-throughput structural variant (SV) genotyping pipeline; to associate SVs with important agronomic traits.

ENHANCING YIELD AND BIOMASS IN CANOLA BY MODIFYING CARBOHYDRATE METABOLISM.

PRINCIPAL INVESTIGATOR: Michael Emes, University of Guelph
FUNDING: CAP
OBJECTIVES: When the endogenous leaf starch branching enzymes (SBEs) in arabidopsis are replaced with maize endosperm homologues, the result was a 250 per cent increase in seed oil per plant. Because canola is genetically close to arabidopsis, this study will look into a transfer of the above technology to canola.

PROTECTION OF CANOLA FROM PATHOGENIC FUNGI USING RNA INTERFERENCE TECHNOLOGIES

PRINCIPAL INVESTIGATOR: Steve Whyard, University of Manitoba
FUNDING: CAP
OBJECTIVES: To synthesize double-stranded RNA (dsRNA) and screen for fungicidal activity on sclerotinia stem rot and non-target effects, develop and test topical formulations, and assess the persistence of dsRNAs in the soil.

EXPLORING BRASSICA OLERACEA FOR RESISTANCE TO THE NEWLY EMERGED P. BRASSICAE PATHOTYPES

PRINCIPAL INVESTIGATOR: Habibur Rahman, University of Alberta
FUNDING: Alberta Canola, Alberta Agriculture & Forestry
OBJECTIVES: To introgress clubroot resistance genes from the cabbage/cauliflower-type plant species (*B. oleracea*) into Canadian canola, and develop molecular markers for these genes.

IMPROVEMENT OF THE CLUBROOT-RESISTANT CANOLA GERMPLASM OF CANOLA × RUTABAGA CROSS, AND FINE MAPPING OF THE RESISTANCE GENE

PRINCIPAL INVESTIGATOR: Habibur Rahman, University of Alberta
FUNDING: Alberta Canola, Alberta Innovates, Alberta Agriculture & Forestry
OBJECTIVES: To develop canola lines that carry the clubroot resistance gene of rutabaga, resulting in clubroot-resistant hybrid canola cultivars.

INTROGRESSION OF CLUBROOT RESISTANCE FROM B.RAPA INTO B.NAPUS CANOLA AND IDENTIFICATION OF MOLECULAR MARKERS FOR RESISTANCE

PRINCIPAL INVESTIGATOR: Habibur Rahman, University of Alberta
FUNDING: Alberta Canola, SaskCanola
OBJECTIVES: To introgress clubroot resistance (CR) from *B. rapa* to canola. The *B. rapa* germplasm used in this research carries resistance to pathotypes 3 and 3A. This could be a new source of resistance.

RE-SYNTHESIZING BRASSICA NAPUS WITH CLUBROOT RESISTANCE FROM C-GENOME

PRINCIPAL INVESTIGATOR: Fengqun Yu, AAFC Saskatoon
FUNDING: Alberta Canola, Alberta Innovates
OBJECTIVES: To generate new and unique germplasm and make it available to canola breeders to develop cultivars with broad spectrum of resistance to clubroot in Western Canada.

GENETIC DISSECTION OF THE RLM3-4-7-9 BLACKLEG R GENE CLUSTER AND KASP MARKER IMPROVEMENT.

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To identify the Rlm3, 4, 7, 9 genes for resistance against blackleg, develop allele specific markers *B. napus* donor lines for canola breeding and understand the function of these genes.

FROM FIELD TO THE GENOME. APPLICATION OF 3RD GENERATION SEQUENCING TO DIRECT GENOTYPING OF CANOLA PATHOGENS

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: Alberta Canola, SaskCanola
OBJECTIVES: To help canola growers with management of clubroot disease, researchers propose to develop a sensitive and rapid diagnostic tool to detect the presence of pathogen and determine the pathotypes present and the relative abundance.

OVERCOMING BLACKLEG DISEASE IN CANOLA THROUGH ESTABLISHMENT OF QUANTITATIVE RESISTANCE

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: SaskCanola
OBJECTIVES: To clone adult plant resistance (APR) genes against blackleg disease, to characterize the host pathways triggered by these genes, and to incorporate APR genes into commercial canola cultivars by marker-assisted breeding and gene editing.

DEVELOPING TOOLS FOR THE RAPID SCREENING OF CANOLA GERMPLASM FOR QUANTITATIVE RESISTANCE TO BLACKLEG DISEASE

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To optimize a protocol for identifying adult plant resistance (APR) to blackleg disease under controlled conditions and validate results in the field; to develop molecular markers associated with APR genes.

TO STANDARDIZE THE NOMANCLATURE OF BLACKLEG RESISTANCE GENES

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: Alberta Canola, SaskCanola
OBJECTIVES: To help in the international effort to locate new blackleg resistance genes, researchers need a universal protocol so they're not finding the same gene multiple times but giving it different names – which is happening.

DEVELOPING TOOLS FOR THE RAPID SCREENING OF CANOLA GERMPLASM FOR QUANTITATIVE RESISTANCE TO DISEASE

PRINCIPAL INVESTIGATOR: Hossein Borhan, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To develop a protocol to screen for quantitative resistance to blackleg in canola germplasm under controlled environmental conditions in growth chambers.

WEEDING OUT SECONDARY DORMANCY POTENTIAL FROM VOLUNTEER CANOLA

PRINCIPAL INVESTIGATOR: Sally Vail, AAFC Saskatoon
FUNDING: CAP
OBJECTIVES: To look for the genomic regions harbouring the genes controlling secondary dormancy in *Brassica napus*; to identify molecular markers to facilitate selection; to scan *B. napus* lines for lower secondary dormancy, perhaps identifying parent lines less likely to become volunteers.

PRE-BREEDING LINES COMBINING CANOLA QUALITY WITH SCLEROTINIA RESISTANCE, GOOD AGRONOMY AND GENOMIC DIVERSITY FROM PAK93

PRINCIPAL INVESTIGATOR: Sally Vail, AAFC Saskatoon
FUNDING: WGRF, Alberta Canola, Manitoba Canola Growers, SaskCanola
OBJECTIVES: To develop resistant pre-breeding lines that combine desirable traits in PAK93 with canola seed quality and shatter resistance from AAFC's elite lines; to form a consortium of breeding companies interested in funding final selection of pre-breeding lines.

ADDRESSING YIELD STABILITY DRIVERS OF CANOLA IN A CHANGING CLIMATE USING HIGH THROUGHPUT PHENOTYPING

PRINCIPAL INVESTIGATOR: Sally Vail, AAFC Saskatoon
FUNDING: WGRF, Manitoba Canola Growers, SaskCanola
OBJECTIVES: To fund field trials of the *B. napus* nested association mapping (NAM) germplasm resource in contrasting climatic environments. This will provide a sufficient datatset to test and apply phenotyping and selection techniques to improve canola yield stability.

MANIPULATING RECOMBINATION IN CROP POLYPLOIDS

PRINCIPAL INVESTIGATOR: Isobel Parkin, AAFC Saskatoon
FUNDING: SaskCanola, National Research Council (NRC), AAFC
OBJECTIVES: To identify homologues of gene candidates controlling homoeologous recombination in canola, wheat and *Camelina sativa*, to develop constructs for gene knock-outs using CRISPR technology.

IDENTIFYING THE OPTIMAL ROOT SYSTEM ARCHITECTURE (RSA) FOR BRASSICA CROPS

PRINCIPAL INVESTIGATOR: Isobel Parkin, AAFC Saskatoon
FUNDING: SaskCanola, ADF
OBJECTIVES: To understand the level of natural variation of root system architecture (RSA) for *Brassica napus*, to identify the regions of the genome contributing to variation in RSA and to assess the variation for improving nitrogen-use efficiency.

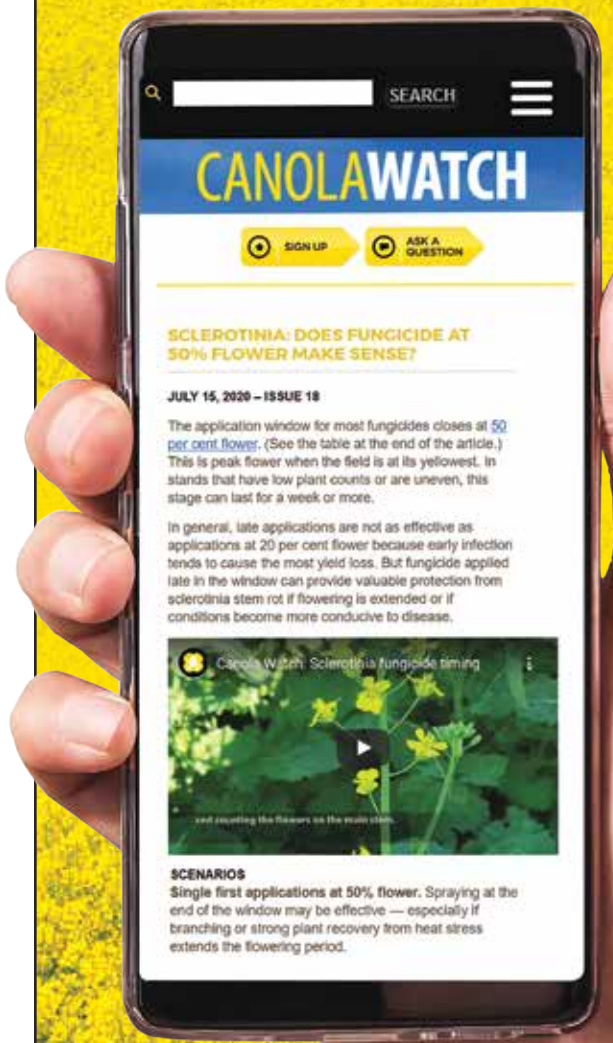
IDENTIFICATION AND GENETIC MAPPING OF NOVEL GENES FOR RESISTANCE TO BLACKLEG

PRINCIPAL INVESTIGATOR: Dilantha Fernando, University of Manitoba
FUNDING: SaskCanola, Alberta Canola
OBJECTIVES: To identify and map new sources of blackleg resistance.

IMPROVING BLACKLEG RESISTANCE DURABILITY THROUGH R-GENE ROTATION IN COMMERCIAL FIELDS

PRINCIPAL INVESTIGATOR: Dilantha Fernando, University of Manitoba
FUNDING: CAP
OBJECTIVES: To monitor blackleg incidence and severity in selected commercial fields with different R-gene rotations. This will develop empirical data of blackleg avirulence gene changes in the growers' fields in response to R-gene rotations.

CANOLAWATCH



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