Crop Diversification
2019 Annual Report

Canada Manitoba Crop Diversification Centre – Carberry, MB

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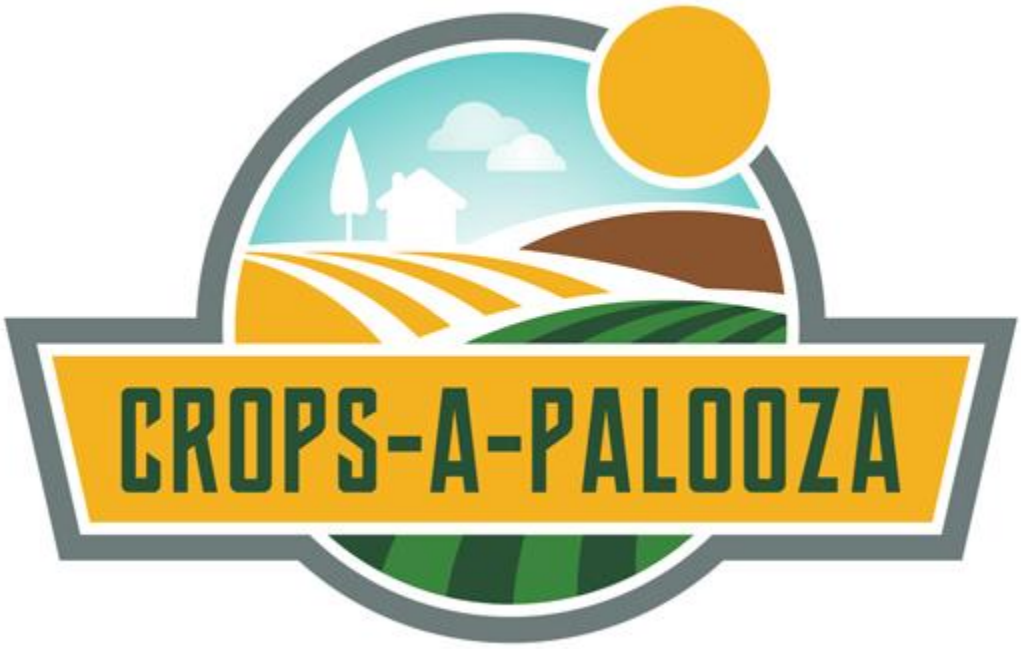

Crops-A-Palooza:

Crops-A-Palooza is a one day, in-field learning event featuring top-notch farmers, researchers and agronomy professionals all focused on ensuring you are equipped with the tools needed to grow the best crops possible. CMCDC hosted this event in Carberry with nine commodity groups in the 2019 planting year.

There were 18 stations including:

1. A Change in the Forecast
2. Cover Crops 101
3. What's new in Weed Technology
4. Managing Insect Pests
5. Value of Seed Treatments
6. How Deep are Your Roots?
7. Crack Open the Pod of MPSG Research and Resources
8. Maximizing Winter Wheat Yields with Proper Nutrition
9. What You Need to Know About Managing Your High Yielding Spring Wheat
10. Take a Stand with Canola Plant Populations
11. Show me the Money: Oilseed sunflower marketing options
12. Pushing Nitrogen Rates in Oats
13. Hemp Establishment
14. Space It Till You Make It
15. Every Day is Fry Day – From Potato to French Fry
16. Real Ag Live
17. Ag in the Classroom: Scavenger Hunt
18. Keep it Clean!

Industry Partners:

1. Keystone Potato producers Association
2. Manitoba Crop Variety Evaluation Team
3. Ducks Unlimited Canada
4. National Sunflowers Association of Canada
5. University of Manitoba
6. Manitoba Canola Growers Association
7. Canola Council of Canada
8. Manitoba Corn Growers Association
9. Manitoba Oat Growers Association
10. Manitoba Pulse & Soybean Growers
11. Manitoba Wheat and Barley Growers Association
12. Agriculture and Agri-Food Canada
13. Manitoba Agriculture & Resource Development.

A Change in the Forecast

Speakers:

Rotimi Ojo	*Manitoba Agriculture and Resource Development*
Nathon Kucherhan	*Environment Canada*
Ian Cook	*Enns Brothers*
Paul Bullock	*University of Manitoba*
Shawn Senko	*Canola Council of Canada*
Kris Kinnaird	*Farmer's Edge*

Objectives:

1. To spray or not to spray? That is the question.
2. Ag weather network delivers a better way to watch the weather.
3. Microclimate data in near real-time.

Collaborator: Manitoba Agriculture and Resource Development

Demonstration Summary:

Timi Ojo, agriculture meteorology specialist for Manitoba Agriculture and Resource Development, works with farmers to strategize where weather stations are needed and should be placed as part of the province's ag weather network to provide Manitoba growers with up-to-the-hour data. "We collaborate with farmers on where to place weather stations on their property so that there is very minimal disruption to the farm, while still capturing the most ideal information on what is happening on the field to help with daily operations." Ojo said there were 46 weather stations placed on farmers' properties in 2014; by the end of 2017, there were 109.

No one watches the weather more than a farmer and now Manitoba farmers have a better way to watch it. Manitoba's ag weather network has continued to expand over the past few years to give farmers important weather data so they can determine how best to take care of their crops. "Farmers intuitively watch the weather. It's in our DNA," said Harry Sotas, who farms grains and oilseeds just east of Birtle. Wind speed and direction, humidity, rainfall, soil moisture and temperature - all are monitored and reflected in the everyday practice of taking care of one's crops.

With this amount of growth, thanks in large part to funding support from the Growing Forward 2 initiative, Manitoba is becoming a leader in the development of emerging weather partnerships with industry. Philip Waldner is happy to have had a monitoring station placed on his land about a month ago. Waldner said he previously "used Starbuck or Portage to get information," both towns being approximately 30 to 40 km away from his farm in Rosedale. Now, he gathers data from the local weather station on his property. New weather stations benefit the

community by providing precise local weather conditions and keeping a historical record for the area, allowing for year over year comparison.

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Having access to data so close to the field, and in near real-time, gives growers an accurate look at what is taking place in the microclimate of their own farm. “Knowing the hourly wind direction and velocity on your property is critical,” said Sotas. “When spraying crops, it is important to have this information upfront to know if it is a good time to be spraying at all. You want to ensure that what you are spraying only goes where you intend it to go, and not potentially damage a neighbour’s crops or your own. Efficacy of the product is important. The weather station provides localized data to ensure conditions are right.”

Sotas says local information gives farmers confidence. It’s important to know humidity levels to gauge if it is a good time to harvest, soil temperatures for seeding and rainfall levels to help determine crop yield. “Any information you have, helps,” said Sotas. Aside from capturing statistics such as precipitation, wind velocity and humidity, as of late last year the new and updated weather stations around the province are testing soil moisture further down than what has been done in the past.

“Most weather monitoring stations do not have moisture probes and, if they do, they do not measure to the level of 50 and 100 cm down,” said Ojo. “This one element gives agriculturists a very good picture of the soil moisture status of the root system of their crops.” Another significant benefit to Manitoba growers is that the weather data is available on the Manitoba Agriculture website for all to see. “In just one month this spring, the current weather conditions page had 7,300 visits, making it one of the most visited areas of the website,” Ojo said.

When gauging the success of the project, Ojo is seeing the user base of the ag weather project expanding beyond its primary agricultural audience. “A federal agency that was looking into a crash contacted us because it occurred approximately two miles from the weather station. There was nothing else around that would give them any information regarding weather conditions at the time of the crash. They were able to use this data to investigate if weather was the cause. This station had only been installed about three months prior.”

Other users include the provincial flood forecasting group, fire prevention officials and the University of Manitoba. Farmers, however, remain the chief benefactors of the program, giving them access to data that is central to providing a healthy harvest for Manitobans.

Cover Crops 101

Speakers:

Yvonne Lawley	*University of Manitoba*
James Frey	*Parkland Crop Diversification Foundation, Roblin*
Elizabeth Karpinchik	*Tone Ag Consulting / Manitoba Organic Alliance*
Virginia Janzen	*University of Manitoba*

Objectives:

1. What do you want to accomplish with a cover crop?
2. How will you plant it and when?
3. What will follow the cover crop in your rotation?
4. Which cover crop will you plant?
5. How will you terminate your cover crop?

Collaborator: University of Manitoba, Parkland Crop Diversification Centre.

Demonstration Treatments:

1. Pea and oats (A very commonly used green manure)
2. Pea, oats, and specialty green manure blend (9 species in total)

Demonstration Summary:

Cover crops have gained their champions in Manitoba. The practice is cited among other alternative grazing strategies like bale or swath grazing to extend the grazing season and, arguably, improve soil, according to livestock and forage organizations. Manitoba Agriculture and Resource Development has also thrown support behind the practice, although the Ag Action Manitoba program funding cover crops excludes farmers grazing their own cattle.

Organizations such as the Manitoba Forage and Grassland Association commonly call on local producers who have embraced cover crops to tour their farms or speak at association-sponsored events. One such speaker, Clayton Robins, was recently chosen for a Canadian Forage and Grassland Association study for his work grazing energy-dense cover crop forages near Rivers. Not everyone's cover crop experience has matched up with that success, however. Manitoba's short growing season is a challenge, while the last few years of dry weather may have turned the tables on anyone trying to establish a cover crop.

Industry and government are both pushing Manitoba farmers to integrate cover crops, but not everyone has had good results if they've experimented rather than planned it all out. Industry and government are both pushing Manitoba farmers to integrate cover crops, but not

everyone has had good results if they've experimented rather than planned it all out. Farmers should know what they want to get out of a cover crop before starting the drill, Yvonne Lawley of the University of Manitoba said.

"We're hoping that cover crops are going to be a recipe (where) we just know what we need to follow — just give me the recipe. I'll do it. I'll have success on my farm — but really, cover crops are more like a game of cards where you're being dealt a hand and you have to respond to the field, the situation and even the growing season that you have," she said.

A farmer's goal will take much of the guesswork out of the decisions that come next, diversification specialist James Frey of the Parkland Crop Diversification Foundation said. "If you know that you've got an area that is prone to salinity, well that actually takes a lot of the questions out of choosing the right cover crop mix or when to plant it or how to terminate it because you know that your goal is salinity, specifically," he said.

The potential seeding window should be the next thing on the table, Lawley said. Seeding in early summer allows warm-season annuals time to grow, while farmers waiting until late summer could opt for cool-season crops and fall-seeded cover crops are best suited for winter annuals, farmers heard during Crops-A-Palooza last month in Carberry.

Farmers may plant in late May or early June if they want to dry out a wet field, Lawley said. Early-harvested crops present another obvious window, she added, although the busy harvest season might put a time crunch on planting cover crops. "Some people do that by planting the cover crops in the morning when you can't harvest, and others are trying to find people who can do that work for you," she said.

Some farmers may plan a mix around legumes, with the intent to add more long-term nitrogen to the soil, while others are planting for pollinators and have the length and timing of bloom periods in mind, speakers said in Carberry. Salinity, meanwhile, may mean more select plant options, since there is little benefit if crops don't grow well enough to draw down the water table or outcompete weeds like kochia or foxtail barley.

What's New in Weed Technology

Speakers:

Tom Wolf	*Agrimetrix – Research & Training*
Ian Epp	*Canola Council of Canada*
Dallas Mench	*Gaber Distributors - Pommier America, Inc*

Objectives:

How to use WEEDit for

1- Spot Spray
2- Dual Spray
3- Full Coverage

Collaborator: Agrimetrix – Research & Training

Demonstration Treatments:

1. Canola (Plot Dimensions = 5mX1.2m)
2. Wheat (Plot Dimensions = 5mX1.2m)
3. Soybeans (Plot Dimensions = 5mX1.2m)
4. Plot space (30mX30m) to run weed-it; tilled on June 24, 2019 (1-month prior to event)
5. Plot space (30mX30m) to run weed-it; tilled on July 10, 2019 (2 weeks prior to event)
6. Plot space (30mX30m) to run weed-it; tilled on July 17, 2019 (1 week prior to event)

Demonstration Summary:

The private sector was also involved in the displays, which included a sprayer demonstration. Sprayer expert and farmer favourite Tom Wolf, with Agrimetrix Research and Training, was on hand to promote a new spraying option. WEED-It, developed by Dutch company Rometron, is similar to other sprayer sensors, sensing green foliage and automatically turning sprayer nozzles off when no greenery is detected, allowing for less chemical use. WEED-It sensors, Wolf explained, can be retrofitted onto most farmers' existing sprayers for about $1,500/foot, depending on the length of the existing sprayer boom.

Tom Wolf of Sprayers 101 spoke about the possible in crop use of WEEDit, although the green on brown technology is largely used for burn off, since it doesn't differentiate between the green of a crop and green of the weeds. Jesper Voois, product specialist with Rometron, goes over the specs of the WEEDit system, how the spot sprayer is designed to only spray individual weeds – illustrated by using water-reactive paper next to weeds in a demonstration plot – and how much the system costs.

WEEDit is a selective spray system of sensors and pulse-width-modulated (PWM) spray nozzles that can sense plants and trigger the right amount of spray for the intended target. WEEDit achieves this by using sensors that emit a red light that return a near-infrared signal when striking chlorophyll. Spray nozzles located at 8-inch intervals along the boom are activated to spray the sensed plant. The system is designed to work at speeds of up to 24 kmh.

With PWM capability, the system allows a simultaneous broadcast spray of a low herbicide dose in the background, activating the full dose for larger weeds, ensuring that weeds too small to be detected receive a controlled dose. The ability to selectively spray green material has additional potential in desiccation and pre-harvest treatments.

“I’ve been watching both weed sensing and PWM with interest for over 20 years”, says Tom Wolf, co-owner of Agrimetrix. “I believe that this technology is part of agriculture’s future. It addresses many economic and agronomic needs of producers, while also advancing agriculture’s commitment to environmental protection.” In some provinces, WEEDit may be eligible for Canadian Agriculture Partnership (CAP) rebates.

Managing Insect Pests

Speakers:

Tyler Wist	*Agriculture and Agri-Food Canada*
Tharshi Nagalingam	*University of Manitoba*
Bryan Cassone	*Brandon University*
Vincent Hervet	*Agriculture and Agri-Food Canada*
Melanie Dubois	*Agriculture and Agri-Food Canada*
John Gavloski	*Manitoba Agriculture and Resource Development*
Crystal Almdal	*University of Manitoba*

Objectives:

Top Insect Concerns from 2019, Forecasts for 2020, and Management Tips.

Collaborator: Manitoba Agriculture and Resource Development

Demonstration Summary:

John is an entomologist with Manitoba Agriculture and Resource Development in Carman. He conducts monitoring programs for some of Manitoba's major insect pests and provides information on insects and insect management to farmers, agronomists and those working in the agriculture industry. John does numerous presentations and information updates for agronomists and farmers, and co-produces a weekly Manitoba Crop Pest Update during the spring and summer. He Presented at Crops-A-Palooza event to highlight top Insect concerns from 2019, forecasts for 2020, and provide management tips to the growers' community.

Flea Beetles:

Flea beetles can be quite noticeable on canola late in the summer, as can their feeding on the pods at times. Research at Agriculture and Agri-Food Canada in Saskatoon looked at how economical this late-summer feeding can be. The study concluded that: Flea beetle feeding on canola in late-summer is rarely an economic concern. Flea beetle feeding that occurs when seeds in lower pods of canola are at the green stage or beyond is unlikely to affect seed yields regardless of the infestation rate of flea beetles. Even when seeds are translucent to green, numbers higher than 100 flea beetles per plant, and for some cultivars higher than 350 per plant, may be necessary to cause significant yield reductions.

Once the canola becomes less palatable for the flea beetles or is being cut, these species of flea beetles will be on the move looking for other cruciferous host plants to feed on, including cruciferous garden vegetables and flowers, and can be hard to manage.

Soybean Aphid:

Still no soybean aphids found in Manitoba this year. We try to track when the first soybean aphids are found each year, so please let me (John Gavloski) know if you see any. At this point the risk of there being any economic problems should they be detected soon is low.

Grasshoppers:

Grasshoppers have been a concern in many crops, and as crops like cereals mature and become less attractive they are moving into other crops like canola, which may have been less attractive to them earlier in the season. With canola there is often an edge effect. So if you see grasshoppers at what seem to be high levels while entering a canola field, assess whether populations decline as you move into the field.

Pre-harvest intervals restrict insecticide options for grasshoppers late in the season. If insecticides are being considered for late season grasshopper control, note that pre-harvest interval is the time until the crop is swathed or cut.

Weeds:

Tall waterhemp sightings in the province are likely to increase over the next month as soybeans drop their leaves and the waterhemp plants begin to tower over the mature crop. When in doubt, please ask for help in verifying if plants are waterhemp, as these plants must be destroyed and equipment must be thoroughly cleaned before it leaves an area with a noxious weed to prevent spread. Scout fields before harvest to prevent seed spread in the field and beyond. The pictures below are green pigweed, not waterhemp and these are great examples of submitted photos that help with Noxious Weed surveillance in the province.

Value of Seed Treatments

Speakers:

Ted Labun	*Syngenta Canada*
Gregory Sekulic	*Canola Council of Canada*
Kevin Zaychuk	*20/20 Seed Labs Inc.*
Brett Graham	*Syngenta Canada*
Serena Klippenstein	*Manitoba Pulse & Soybean Growers*
Nathan Klassen	*Bayer Canada*
Rasine	*University of Manitoba*

Objectives:

To discuss the benefits of seed treatment on

1- Canola
2- Soybean
3- Wheat

Collaborator: Syngenta Canada

Demonstration Treatments:

1. Canola Fungicide CK @ 3 seedlings/ft² (30 seedlings/m²)
2. Canola Insecticide + Fungicide @ 3 Seedlings/ft² (30 seedling/m²)
3. Canola Fungicide CK @ 5 seedlings/ft² (50 seedlings/m²)
4. Canola Insecticide + Fungicide @ 5 Seedlings/ft² (50 seedlings/m²)
5. Full package protection (SR:5lbs an acre)
6. Westar (NO HERBICIDE), (SR: 5lbs an acre)
7. Westar BL seed treatment (no herbicide) (SR:5lbs an acre)
8. Soybean, untreated
9. Soybean, treated
10. Wheat, untreated
11. Wheat, treated

Demonstration Summary:

Some farmers consider seed treatments an insurance policy to try and ensure their crop has every opportunity to germinate and establish healthy plants. Others see them as another added cost they don't need, especially if they haven't had any serious disease issues for a while. Invariably though, once a farmer has had a disease problem costing a significant amount of yield, seed treatments become standard practice. As is often the case, it's "once bitten, twice shy" when it comes to seed treatments.

“A lot of people who don’t use seed treatments get away with it for a lot of years, and then suddenly have a problem where they have too much smut or they’ll get common root rot or take all root rot. They then realize they should maybe have applied a seed treatment,” says Harry Brook, a crop specialist with Alberta Agriculture and Forestry. “Seed treatments are a significant cost, so probably the best way to think them is as insurance, and it’s up to individual farmers to assess their risk based on their crop rotation, the conditions at seeding and how comfortable they are with the amount of risk that’s involved.”

Common root rot can be especially problematic because it affects most cereal crops. If farmers are growing another cereal crop this year, and had common root rot in the same field last year, they should certainly pencil in a seed treatment. Shorter crop rotations — such as wheat/canola — in general are at higher risk for disease problems.

“A longer, varied crop rotation means there is less chance of disease organisms building up,” says Brook. “With a short, minimally varied crop rotation we’re setting ourselves up for disease issues because the more we grow the same crop, the more opportunities there are for pathogens that attack that crop to multiply and flourish. That increases the risk of disease and crop failure, so it might be more advantageous to use seed treatments.” But for farmers who have a long rotation, and a smaller number of acres to seed — so they can allow time for the soil to warm up and become moist — a seed treatment may not pay every year.

Coping with smut and bunt used to be part of growing cereals on the Prairies, but fungicide seed treatments are now very effective in killing these pathogens. Invariably, says Brook, whenever he talks to farmers who have seen a lot of smut or bunt in their crops they haven’t bothered with a seed treatment. “The problem is if you are planting untreated seed with smut spores on the seed, you are going to get smut,” says Brook. “If you’ve never had smut and you’ve got very warm soils — around 7 C to 8 C and there’s good moisture so you can seed shallow, then the big advantage of disease prevention through a seed treatment is removed.”

Infections due to fusarium, including F. graminearum, are another big issue that cereal farmers seem to be dealing with on a regular basis. The first defence against this disease should always be using clean seed, says Pratisara Bajracharya, a pathologist with Manitoba Agriculture & Resource Development.

How Deep are your Roots

Speakers:

Curtis Cavers	*Agriculture and Agri-Food Canada*
Marla Riekman	*Manitoba Agriculture and Resource Development*
Jim Tokarchuk	*Soil Conservation Council of Canada*
Steve Crittenden	*Agriculture and Agri-Food Canada*

Objectives:

To demonstrate the crop rooting depths of

1- Soybean
2- Corn
3- Canola
4- Oats
5- Hemp
6- Sunflowers

Collaborator: Manitoba Agriculture and Resource Development

Demonstration Layout:

1. 2 rows of canola
2. 2 rows of beans
3. 2 rows of oats
4. 2 rows of sunflowers
5. 2rows of hemp
6. 2 rows of corn

Demonstration Summary:

Agriculture and Agri-Food Canada agronomist Curtis Cavers spent most of the day standing in a hole. Soil researchers had brought out a backhoe to provide an opportunity for farmers to get a good look at the soil profile, more than a metre down. The soil on the site happened to be well-drained, with no compacted layers. “This is as close to an ideal soil profile as you can get,” Cavers said. Visitors were reminded that soil profiles can vary greatly on a farm, or even within a field. The dark layer covering about six or seven inches at the top of the pit, Cavers said, “could be the old plow layer.”

Cavers said this pit was dug in an area with nice soil. “It’s a nice structure, it holds lots of moisture.” In late July, the soil was holding about eight to 10 inches of moisture. “The crop’s using about a third of an inch of water per day right now. That’s a month’s supply of

stored moisture when you get going." The pH of the soil in this particular spot, Cavers said, was about 6.0, because the spot is so well drained. In other areas of this same field, the pH varies, and do so other soil properties. "The biggest mistake you can make is to assume it's uniform," Cavers said.

Cavers was enthusiastic about this opportunity to show farmers the soil in this specific spot, but he was encouraging farmers to go home and take a good look at their own soil. "Remember what you see here so you can compare it." He hopes farmers will consider the soil profile they'd expect to see in a different situation, and think about how the soil profile matters to the growing plants.

Unless you're someone who has a soil pit dug on the farm, it's rare to see more than the top few inches of soil. But what exists below has a significant impact on what happens above, and the better we understand the characteristics of our soil, the better we can manage its potential and limitations. Marla Riekman, Manitoba Agriculture soil management specialist, showcased six different crops' rooting structures and showing off the layers of soil that feed a crop all growing season long at 2019 event of Crops-A-Palooza in Carberry, MB.

Despite total rainfall only around 77 per cent of normal for the region this year, crops were looking good due to the soil — a class one clay loam from the Ramada series. In this particular soil pit, farmers could view the rooting structures and depth of corn, hemp, sunflowers, soybeans, oats, and canola, and many were surprised by just how deep the roots of each of these crop types would go, Riekman says.

"When you can actually see that much space, and see the variability in the soil, and see the variability in the crop roots and how deep they are, people are pretty excited to be able to visualize it," adding it's not something farmers often get a chance to see. Visualizing soil structure, depth, and rooting patterns are very important, as the horizons and make-up of soil tell the history of how that soil was formed. That history informs how a soil will act under different conditions, what its water holding capacity might be, and even which nutrients may need to be applied in higher rates, various forms, or closer to the crop, depending on pH and soil structure.

Crack Open the Pod of MPSG Research and Resources

Speakers:

Cassandra Tkachuk	*Manitoba Pulse & Soybean Growers*
Ian Kirby	*Manitoba Pulse & Soybean Growers*
Laura Schmidt	*Manitoba Pulse & Soybean Growers*
Nate Ort	*University of Manitoba*

Objectives:

To discuss the initiatives and accomplishment of Manitoba Pulse & Soybean Growers regarding

1- Soybeans
2- Dry Beans
3- Field Peas
4- Faba Beans

Collaborator: Manitoba Pulse & Soybean Growers.

Demonstration Treatments:

1. Soybeans
2. Dry Beans
3. Field Peas
4. Faba Beans

Demonstration Summary:

At Crops-A-Palooza 2019 event, MPSG representatives briefed that investing in scientific research means MPSG can deliver on our mission to provide production knowledge and market development support to Manitoba pulse and soybean farmers. MPSG's board of directors have outlined a clear vision for MPSG's research investment in our strategic plan. As a core activity, 50–60% of the annual budget is allocated to funding a collaborative and focused Research and Production (R&P) program.

Research requires a network of professionals from various disciplines to explore the complexity of crops, production systems and market opportunities. MPSG's R&P strategy utilizes five approaches to address specific priorities with appropriate resources.

These studies create the foundation of our R&P program and represent the largest portion of the annual R&P budget. MPSG provides financial support to researchers from public institutions to investigate:

- Novel products, practices or technologies to improve soybean and pulse crop yield, quality, production efficiency or resiliency.
- Underlying mechanisms of crop behaviour (genomics, phenology, physiology) to improve crop performance.
- Environmental (abiotic) and pest (biotic) stresses and diagnostic tools to prevent or manage outbreaks.
- Pre-competitive processing or nutritional attributes to increase market demand.

Manitoba Pulse & Soybean Growers' website has been redesigned to make research results, On-Farm Network trial data and production information more accessible to Manitoba farmers. Production resources, such as the Dry Bean Growth Staging Guide, are continually being developed and/or updated using the most current research. Website visitors are now able to access all of MPSG's On-Farm Network data, ensuring farmers have the opportunity to put the program's applicable and relevant results to work on their farms. Farmers can search the entire Network and single-site reports by trial type, region and/or crop type.

A University of Manitoba master's student has found the major difference between growing soybeans in Ontario versus Manitoba is how long it takes to flower. "Soybean has traditionally been grown in Ontario, and as soybean acres expanded in Manitoba, we wanted to look at the difference in growth habit," says Nate Ort, who caught up with Real Agriculture at Crops-a-Palooza at Carberry, Manitoba. "We grew soybean in Ottawa and Carman for five years in each, and then we just looked at the differences."

Ort says the main difference the researchers found, was that flowering occurred much earlier in Ontario, likely largely due to temperature differences and differences in latitude. "Soybeans are very sensitive to day length, and this can delay time to flowering," says Ort, adding the difference of about 4 degrees in latitude equates to a difference of 50 minutes of daylight on the longest day of the year. Heat units also differ between the two locations.

"Ontario starts accumulating more heat every day than us, and then in terms of crop heat units…Ontario can be over 3000 crop heat units accumulated, where [Manitoba] would be probably under 2600/2700 crop heat units."

Maximizing Winter Wheat Yields with Proper Nutrition

Speakers:

Ken Gross	*Ducks Unlimited Canada*
Elmer Kaskiw	*Manitoba Agriculture and Resource Development*
Neil Ryan	*Ducks Unlimited Canada*
Edgar Hammermeister	*Western Ag Professional Agronomy*

Objectives:

Demonstrate a fertility program to achieve high yield winter wheat.

Collaborator: Ducks Unlimited Canada

Demonstration Treatments:

Main Plot – Variety
1. Gateway
2. Elevate
3. Wildfire

Subplot – Fertility
1. "Producer practice": 100 lbs of N; 30 lbs of P
2. "Balanced", High yield practice: Westernag recommendation, split app

Demonstration Summary:

There are great new winter wheats available to Manitoba farmers and more in the pipeline, says Ken Gross, an agronomist with Ducks Unlimited Canada and the Western Winter Wheat Initiative.

"(AAC) Gateway is my new favourite and I really like the way it looks," Gross told the Crop Talk Westman webinar Aug. 31. "It has very good protein. I think this is a real winner for Manitoba… because it is such a good variety and well suited for Manitoba. I think it is going to take a lot of the acres away from traditional (CDC) Falcon areas. It has a yield bump over Falcon. "I think you will see a lot more acres of Gateway in the future." Emerson is the most popular winter wheat in Manitoba with 134,000 acres covered by crop insurance this year, accounting for 65 per cent of the insured winter wheat acres. CDC Falcon is second with 12 per cent, followed by AAC Gateway at 10 per cent. But Gross predicts AAC Gateway will quickly gain ground. Emerson is popular because it's the only winter wheat rated "R" or resistant to fusarium head blight, which hit growers hard two years ago, he said.

"That scared a lot of guys and I don't blame them for wanting to find a variety that could provide protection against that," Gross said. "Emerson's winter hardiness is only (rated) 'good.' It is a taller variety. Although it is rated 'very good' for lodging I have seen it go down. The biggest gripe I have against Emerson, other than the height, is the fact that it doesn't quite have the same yield as Falcon." AAC Gateway's yield potential is two per cent above CDC Falcon. AAC Gateway is an inch taller than CDC Falcon. Both have the same winter hardiness rating — "fair."

They share the same a "very good" rating for resistance to lodging "good" for resistance to stem and leaf rust. However, AAC Gateway is a milling wheat and CDC Falcon is not. Gross said in Lethbridge, Alta. trials conducted this year, AAC Gateway's protein content was 13.8 per cent versus 12.3 and 11.5 per cent for Flourish and Radiant, respectively. Crop insurance data shows last year Emerson averaged 79 bushels an acre in Manitoba, versus 71 for AAC Gateway.

Pintail and Wildfire could also be popular in Manitoba, Gross said. Both have good winter hardiness so could be attractive to farmers farther north, where sometimes winterkill can be a problem with winter wheat. "It (Pintail) has got the highest winter hardiness of any winter wheat variety out there," he said. "When you are seeding an organic crop you usually don't have any residue to trap snow in the fall, so Pintail might be a pretty good option for you to look at under those circumstances. There are new winter wheat varieties with traits that can help you in different situations."

Wildfire appears to have great yield potential In Alberta. Developed by Agriculture and Agri-Food Canada wheat breeder Rob Graf at Lethbridge, Wildfire outyields Radiant and Moats by 15 per cent. Gross said it's unclear how Wildfire will yield in Manitoba. "Wildfire is the one I think will take over a lot of acres in the next few years," Gross said. "Wildfire is a little bit shorter than Emerson, but it still has a 'good' rating for fusarium. It has some of the good disease resistance that Manitoba producers are looking for. The only place it really falls down is on stem and leaf rust. It is not rated very well for that. But I think we can control that with fungicides because every producer I know always applies a fungicide at flag leaf and that should take care of that issue, but we will have to wait and see."

What You need to Know About Managing Your High Yielding Spring Wheat

Speakers:

Amy Mangin	*University of Manitoba*
Haider Abbas	*Manitoba Agriculture and Resource Development*
Steve Barron	*East Business Manager with Double Diamond Farm Supply*

Objectives:

To demonstrate the effect of fertility timing, fertility rates, and Plant Growth Regulators on protein contents and yield of wheat

Collaborator: University of Manitoba. Double Diamond Farm Supply.

Demonstration Treatments:

1. Standard rate of N for high yield (140 lb/ac)
2. Reduced rate of N (70 lb/ac)
3. Split N 70 (at seeding) + 70 (at flag leaf) lb/ac (Surface Broadcast)
4. Controlled Release N (40:100) urea: ESN blend
5. Standard rate of N for high yield (140 lb/ac) with Single application of PGR Moddus
6. Standard rate of N for high yield (140 lb/ac) with Single application of PGR Manipulator
7. Standard rate of N for high yield (140 lb/ac) with split application of PGR Manipulator

Demonstration Summary:

Plant growth regulators (PGRs) have become increasingly popular over the last few years. The Manitoba Wheat and Barley Growers Association (MWBGA) have been involved in numerous research projects focusing on PGRs and their potential to benefit Manitoba farmers. Like each farming operation, not all PGR products are alike. The functions of the products range which means there is a lot for farmers to learn about them.

Plant growth regulators (PGRs) are synthetic compounds that are foliar applied to crops and alter the hormonal activity to modify plant growth and development. Common cereal PGRs inhibit the synthesis of the hormone gibberellin, which results in decreased cell division and cell elongation in the stem. PGR's are used worldwide for several purposes but most commonly in cereal grain production to improve lodging resistance by shortening and strengthening plant stems. Lodging can cause severe yield loss in cereals if conditions are favorable (ie. med-high rainfall and high fertility). Yield loss is greatest in wheat when lodging occurs during grain fill following anthesis (14-21 days after FHB fungicide application timing).

PGRs vary in their best application timing. A big takeaway concerning PGR timing is the importance of closely monitoring the crops development. Growing conditions may increase or decrease plant development and targeted growth staging is extremely important for proper PGR usage. There are a few PGRs that can have a negative effect on yield if not applied at the correct growth stage. Chlormequat chloride (manipulator) has a wide application window, but the optimum timing would be when the wheat is at growth stage 30-32. This is when the main stem is beginning to elongate and the first node is approximately one inch above the ground.

Individual PGRs will have various optimum application timings but common PGRs used in cereals (Manipulator and Pallisade) have a wide application window, from 2-leaf to flag leaf. For greatest efficacy Manipulator should be applied at growth stage 31 (node 1 detectable) to growth stage 32 (2nd node detectable). Proper staging requires slicing of the stem length-wise to see node formation as nodes will not yet be swollen.

I would suggest that producers should expect yield increases or advantages such as increased protein in the wheat or increased efficiencies with harvest and straw management. However, it can be difficult to measure the ROI (return on investment) concerning harvest efficiencies. The manipulator work that I have personally been involved with has delivered higher wheat yields with the same protein as the check. The treated wheat protein did not increase but it also did not decrease with a higher yield, which might have been expected.

Research shows that when PGRs are applied at optimum timing there can be a small but significant yield increase (3-5 bu/ac) in a field with moderate to high yield potential. This yield increase is not a guarantee and research is underway to try understand what is driving yield responses to PGR applications. Every field deserves a profiling conversation concerning the PGR practice. I would suggest that cereals that are conductive to lodging are more likely to deliver an increased ROI over Varieties that stand well.

PGR applications will not always be justified. Growers should take into consideration the management history of the field in question and determine if it is high-risk for lodging. Fields that are pushing yield potential with large amounts of N fertilizer applications, history of manure applications and high seeding rates are most prone to lodging and will most likely benefit from a PGR application. It’s important to note that not every variety or species of cereal will respond the same to PGR applications, the reason for this is still being researched.

Take a Stand with Canola Plant Populations

Speakers:

Autumn Barnes	*Canola Council of Canada*
Angela Brackenreed	*Canola Council of Canada*
Dane Froese	*Manitoba Agriculture and Resource Development*
Wes Hildlebrand	*Enns Brothers*

Objectives:

1- To demonstrate the effect of different target plant populations of Canola
2- To demonstrate the effect of different row-spacing of Canola

Collaborator: Canola Council of Canada

Demonstration Treatments:

1. TSW = 3.5 g at 5 lb/ac
2. TSW = 6.5 g at 5 lb/ac
3. TR = 3 pl/ft^2; SR = 46 seeds/m^2; 12" row spacing
4. TR = 3 pl/ft^2; SR = 46 seeds/m^2; 24" row spacing
5. TR = 6 pl/ft^2; SR = 92 seeds/m^2; 12" row spacing
6. TR = 6 pl/ft^2; SR = 92 seeds/m^2; 24" row spacing
7. TSW = 5 g at 2 lb/ac; 12" row spacing
8. TSW = 5 g at 5 lb/ac; 12" row spacing

Demonstration Summary:

The good news is the hot, dry summer made sclerotinia somewhat scarce in canola fields this summer, but there was a minor downside — there weren't many examples to show farmers attending a sclerotinia control session at this year's Crops-A-Palooza, even in the inoculated demonstration plots at the Canada-Manitoba Crop Diversification Centre (CMCDC) here. But they still got plenty of useful information about managing the fungal disease which will no doubt return in future.

Canola Council of Canada agronomy specialist Nicole Philip was disappointed that she couldn't actually show the comparisons between sclerotinia-tolerant and susceptible varieties or the effect of fungicide application timing, but had some take-home messages for producers.

Take a number of counts throughout the field 20-25 days after seeding and assess whether the number of plants per square metre (or square foot) or plants per metre (or foot) of row match the target goal. If plant counts are not within reason given the seeding rate, look for causes and determine ways to improve the success rate. Stands with plant densities below 40 to 50 plants per square metre (4 to 5 per square foot) are unlikely to achieve the full yield potential that could be achieved with higher plant densities under the growing conditions for that season. However, they may still outperform reseeded crops in most cases, due to the ability of individual plants in thin stands to compensate with additional branching and pod production, and the typical trend to lower yields from later seeded crops.

Consider the calendar date when assessing whether to reseed. A thin stand of 20 plants per square metre (2 per square foot) in the last part of May or early June often will usually have greater yield and profit potential than if the same field is reseeded. Reseeding adds to production costs and the reseeded field will have a much shorter growing season (and yield potential) because it was seeded so late. However, if fields can be reseeded before the third week of May with good soil conditions for rapid emergence, reseeding may be profitable. (Canola growers are encouraged to discuss reseeding policies with their insurance carriers and seed company reps, and look at weather data for their region.).

An accurate average plant stand count will determine whether crop establishment measures achieved the target goal. How many plants did you expect based on the seeding rate? And is the plant stand in line with this expectation? Answers to these questions will help growers improve stand establishment practices for next year, and help with management decisions for the current crop. To do counts, use a 50 cm by 50 cm square or a hoop with an inside diameter of 56 cm. Both are the equivalent of 0.25 of a square metre. Count the number of plants inside the square or hoop, and multiply by 4 to get plants per square metre. (for plants per square foot use a one foot square or divide the plants per square metre by approximately 10).

Another method is to use a metre stick and count the seedlings per metre of row. Take that number and multiply by 100 then divide by the seed spacing in cm to get plants per square metre. For example, 25 plants per metre multiplied by 100 then divided by 25 cm (10” row spacing) is 100 plants per square metre (approximately 10 per square foot). For all methods, several counts per field are required to get a good average.

Fields should be monitored and walked starting 10 days after seeding if conditions are good, or 15 days if conditions are cool. If the plant stand is less than expected for the given seeding rate, seed size and estimated seedling survival, then check equipment settings, seed characteristics and field conditions to identify why the ideal plant population was not achieved. The cause or causes may relate to the seeding operation, such as inconsistent depth, excess fertilizer placement with seed, or mechanical issues. Frost, wind or flooding, insects or disease, or herbicide residues could also be factors. When stands are spotty and thin, careful management is required to preserve the plants present. More conservative thresholds may be warranted for insects, weeds and diseases.

Show Me the Money: Oilseed Sunflower Marketing Options

Speakers:

Darcelle Graham	*National Sunflower Association of Canada*
Daryl Rex	*National Sunflower Association of Canada*

Objectives:

Showcase marketing options for oilseed sunflowers; specifically for the birdfood, crush and dehull markets.

Collaborator: National Sunflower Association of Canada

Demonstration Treatment:

Variety Talon (8 rows wide, 10 m long with 0.75 m (~30 inch) row spacing

Demonstration Summary:

Manitoba's sunflower market is holding steady for the time being, with acres likely unchanged on the year despite shifts in the processing sector. Prices were holding steady, he said, but farmers had good yields in 2017, which should keep them interested in the crop. The full impact of the Spitz closure is unknown for now, but Rex noted the company will still require product – just in the U.S., rather than in Alberta. "It seems to be the core producers are staying in it," said Daryl Rex, research agronomist with the National Sunflower Association of Canada. Actual acreage in the spring will also depend on snowfall between now and April, he added.

"The market is moving sideways, with nothing dramatic at this stage to say if it's moving up or down," said Phil Van Bergen, assistant vice-president with Agri-Tel in Beausejour. Van Bergen said sunflowers were in the "middle of the road" when it comes to rankings of predicted profitability, with farmers who typically grow the crop likely keeping amounts similar to last year's in the rotation. The latest estimates from Agriculture and Agri-Food Canada forecast seeded Canadian sunflower area in 2018 at 64,000 acres, which would be unchanged from the previous year. The bulk of Canada's crop is grown in Manitoba.

Canada grew 58,000 tonnes of sunflowers in 2017-18 on very good yields, but a return to average yields would see production decline in 2018-19. New-crop prices are currently hovering around 23 cents per bushel for oilseed sunflowers, in line with spot prices. "Where that goes from here is hard to say," said Van Bergen. Higher-than-normal yields in 2017 left more unspoken-for sunflower seed in the marketplace than normal. Those uncontracted seeds are moving now, with producers looking to clear up bin space and move some supplies before road bans come into effect, Van Bergen said.

Pushing Nitrogen Rates in Oats

Speakers:

Jason Voogt	*Field to Field Ag*
Ingrid Kristanson	*Manitoba Agriculture and Resource Development*
Ramona Mohr	*Agriculture and Agri-Food Canada*

Objectives:

To demonstrate the effect of different fertility rates on plant stand and yield of oats.

Collaborator: Field to Field Ag

Demonstration Treatments:

1. No Nitrogen
2. N = 120 lb/A
3. N = 160 lb/A
4. N = 200 lb/A

Demonstration Summary:

Oats grow best in black and grey wooded soil zones that have higher moisture, but can grow on sandy loam to heavy clay soils as long as they have good drainage. To reduce disease pressure and optimize yields, oats should not be grown after cereals. The best rotational crops include canola, hay, soybeans and other legumes. Research has shown that canola grown on oat stubble has 24 per cent more yield, while canola on wheat and barley stubble increased yield by only 18 and 19 per cent, respectively. Corn isn't the best choice in rotation with oats because it increases the risk of some diseases and ties up N early in the growing season. That said, U.S. research has shown that sandwiching a year of oats between a corn/soybean rotation almost eliminates corn rootworm issues.

Earlier-seeded oats generally give increased yields and quality. In general, seeding by the middle of May in Western Canada gives optimum yield and quality. Ideal soil temperature for oats is above 5 ^{0}C. Seed treatments can be used to help prevent seed- and soil-borne diseases. In cool, wet growing conditions they can help prevent root rot. Seed treatments are recommended for hulless oats because they are more susceptible to seed diseases. The recommended seeding rate for oats in Western Canada is to achieve 20 to 30 plants per sq./ft. Growers should use the higher seeding rate of this range in high-moisture, high-fertility, late seeding and high wild-oat competition situations. Seeding rates can be calculated using thousand kernel weights (TKW) times survival percentage (the percentage of seeds expected to germinate and produce vigorous seedlings). Under normal growing conditions growers should expect 95 per cent germination, but in cold, wet soil, germination could be 90 to 93 per cent.

Growers should increase seeding rate of hulless oats because their fragile, thin seed covering can reduce germination.

The optimum seeding depth for oats is one to two inches — deep enough to reach soil moisture — and should not exceed three inches. Oats are usually seeded with a row spacing of 7.5 to 12 inches but research has shown that in no-till systems wider row spacing up to 14 inches does not affect plant numbers or tillering. Wider row spacing may result in increased wild oats and, in dry conditions, may cause harvest issues if there is not enough stubble to hold the swath off the ground.

Some research suggests that oat seed size may be important for competition with wild oats. A 2005 greenhouse study at the University of Saskatchewan showed that oats derived from large seed produced 17 per cent more biomass and 15 per cent more panicles (flower clusters) than plants derived from smaller seed regardless of genotype or wild oat competition.

Oats in a no-till situation remove fewer nutrients from the soil — except sulphur — than barley, wheat or canola. Nitrogen (N) is the most yield-limiting nutrient in oats and a soil test is recommended to determine the amount of N growers need to apply. Too much N reduces test weight and the percentage of plump kernels, and also increases lodging. Too little N reduces tillering and yield.

N requirement depends on moisture availability. Yield potential is higher with more moisture, and so a higher N rate is required to achieve optimum yield. A 100 bu./ac. oat crop generally requires 97 to 117 lbs./ac. N. Agriculture & Agri-Food Canada (AAFC) researchers at Brandon and Indian Head confirmed that under normal conditions optimal yields were achieved when soil plus applied N was at 89 lbs./ac., which is around 36 to 71 lbs./ac. of applied N, depending on the residual.

Hemp Establishment

Speakers:

Jeff Kostuik	*Hemp Genetics International*
Alden Braul	*Hemp Genetics International*

Objectives:

To demonstrate the impact of following treatments on plant stand of hemp:

1- Seeding Depth
2- Soil Compaction
3- Excess Moisture

Collaborator: Hemp Genetics International

Demonstration Summary:

1. Seeding depth - 0.75"
2. Seeding depth - 1.5"
3. Seeding depth - 2.5"
4. Soil compaction - no compaction
5. Soil compaction – 1 x compaction with mini land roller
6. Soil compaction – 2 x compaction with mini land roller
7. Excess moisture – no excess
8. Excess moisture – 3” prior to emergence

Demonstration Summary:

When it comes to growing hemp, one of the more top-of-mind risks for producers is crop establishment — how do I grow this crop, and what on earth do I do when it comes to harvesting it?

Jeff Kostuik, director of operations in central Canada and the U.S.for Hemp Genetics International (HGI), says that hemp — that’s been around since 1998 — has been a bit of a rollercoaster ride, as the markets have changed, and different parts of the plant have become available to sell. As the industry has changed and more varieties have become available, interest levels in the crop have soared. “As of August of last year, is when we as farmers became eligible to play in the game of CBD (cannabidiol) and flower. Previous to that, we could take the seed off the field, and we could take the stalk off the field, but all the flower material had to stay on the field. We were essentially missing out on what’s become a billion-dollar industry worldwide,” Kostuik explains to RealAgriculture’s Lyndsey Smith at Crops-A-Palooza in

Manitoba. For many that remember hemp in its early days, they remember when the plant would stand up to 12 feet tall in the field, which made harvest a very tricky process.

"Many of those varieties that came from eastern Europe and places across the pond were fibre crops predominately. As we became more knowledgeable with the nutritional benefits of hemp as a food product — thanks to the likes of Manitoba harvest and Fresh Hemp Foods that did a lot of that work with hemp oil — we now know that. And that's really what's been driving the industry. " To accommodate some of the changes in the industry, HGI has begun offering different seed varieties that allow for harvest to flow more efficiently.

"Our breeding program has essentially taken that two-foot large seed head, that was 12 feet in the air before, and have got it that much closer to the ground. So we essentially tried to shorten that crop to increase our harvest index per se, and to minimize combine issues. That along with learning the proper procedures — when to harvest, and what to look for — has really sort of enhanced the grain industry for sure in Canada." Now that farmers are able to harvest the whole plant, it has created some definite changes in what the harvest pass looks like.

"We're moving from harvesting the seed or the stalk, which is quite visible — we know how it is, we've got machinery and infrastructure in place to do that," says Kostuik. "Now, we've got really small hair-like structures, like the hair of a frogs back, where our CBD, our cannabinoids are located, how in the heck do we harvest those small hairs, and maintain quality, and maintain the actual percentage of CBD. So looking anywhere from chaff collecting, to round-baling the whole plant and extracting, to hand-harvesting, to a number of different methods. "The race essentially is to be the most efficient and cost-effective as possible."

Space It Till You Make It

Speakers:

Morgan Cott	*Manitoba Corn Growers Association*
Rigas Karamanos	*Koch Fertilizer Canada*
Lanny Gardiner	*University of Manitoba*
John Heard	*Manitoba Agriculture and Resource Development*

Objectives:

To demonstrate the impact of different plant populations, and row spacing

Collaborator: Manitoba Corn Growers Association

Demonstration Summary:

Corn can tolerate some variability in seed spacing. Yield is not significantly affected by small gaps as long as the proper seeding rate is delivered. Uniform seed distribution within the row should be the goal of the seeding operation. Therefore, producers should consider evaluating their planter performance to ensure uniformity of plant spacing.

A well-tuned planter operating at a reasonable speed should help to minimize non-uniformity of plant spacing within the row. Planting at high speeds with a poorly maintained planter can result in a large number of doubles (two-plant hills) and skips (missing plants). Doubles can result in barren stalks and skips can cause significant yield loss, both resulting in lost yield potential for the field. Producers can also do some crop scouting once the crop is up and growing to determine if plant spacing is acceptable.

Producers should also consider increasing their target plant populations. Studies at the University of Guelph suggests that at relatively high populations (28,000 to 36,000 plants per acre), populations with less uniform corn plant spacing have generally not yielded lower than plots with more precise planting. Simply put, higher population may compensate for sloppy spacing - but at the cost of more seed per acre.

Every Day is Fry Day – From Potato to French Fry

Speakers:

Zachary Frederick	Manitoba Horticulture Productivity Enhancement Centre
Lindsey Andronak	Agriculture and Agri-Food Canada

Objectives:

To demonstrate the best management practices for growing potatoes acceptable to the processing industry in Manitoba.

Collaborator: Manitoba Horticulture Productivity Enhancement Centre

Demonstration Summary:

Contrary to popular belief, potatoes are not a high-water use crop compared to many other crops. They only require 16-20 inches of water during the growing season, whereas other crops require at least 20 inches (wheat and canola) and up to 25 inches (corn). What makes irrigation so important to a potato crop is that potatoes are extremely sensitive to water stress. Therefore, growers must maintain soil moisture levels within a narrow range, and the exact range changes throughout the growing season.

The total amount of rainfall within the growing season is usually not adequate for Manitoba processing growers that are aiming for maximum yield potential and quality. In addition, concentrated rain events, with long gaps between rains. are not ideal for maximum yield and quality. Consequently, growers need to supplement the water needs of the crop through irrigation. Irrigation systems provide uniform amounts of water to the crop over the duration of the season that the grower can supply water to the system. Growers can determine the amount of water needed by the crop by determining soil moisture levels using various equipment, demonstrated in our plot as outlined below.

Six rows of Russet Burbank potatoes were planted to demonstrate potato growing practices with an emphasis on irrigation management. The plot was fertilized with 422 lbs of ESN per acre and 179 lbs of MAP per acre. All potatoes were treated with Potato ST fungicide and Titan insecticide as a seed treatment. Potatoes were hand weeded throughout the season irrigated as needed. Three different moisture monitoring systems were installed in the plot; Watermarks with sensors at 12 and 24 inches, a Decagon soil moisture and temperature logger with sensors at seed piece height, 15 cm and 30 cm, and an AquaSpy with moisture and EC sensors every two inches for 48 inches.

If improperly irrigated (either too much or too little), potatoes can exhibit poor growth and decreased yields. Tuber quality is often affected, the most obvious symptom being rot from

excess water. However, there are also numerous other external (cracking, malformation, enlarged lenticels) and internal (hollow heart, sugar ends, blackheart) that effect both fresh and processing quality.

Attendees were able to observe sensor setup, how readouts are performed, what the data looks like and how it is interpreted with each sensor. Attendees could also see how a linear irrigator is setup and run. Unexpected guests in the form of Colorado Potato Beetles and a bacterial disease called Blackleg also became part of the exhibit for the public to learn about what these pests and diseases look like and how they are managed. As a conclusion to each presentation, representatives from the J.R. Simplot Company offered fresh French fries to attendees.

Other Stations:

Real Ag Live

Speakers:

Shaun Haney	*RealAg Radio – RealAgriculture*
Toban Dyck	*Manitoba Pulse & Soybean Growers*
Jay Whetter	*Canola Council of Canada*

Objectives:

To make the Crops-A-Palooza audience informed with “What’s new in Agriculture” by playing podcast recording on speaker – 20 minutes scheduled interviews.

Collaborator: RealAg Radio – RealAgriculture

Kids Activity: Scavenger Hunt

Speakers:

Agriculture in the Classroom-Manitoba
Manitoba Pulse & Soybean Growers
Canola Council of Canada

Objectives:

To open a Kids Corner with a scavenger hunt around the site to make Crops-A-Palooza a family event.

Collaborator: Agriculture in the Classroom-Manitoba

Keep it Clean!

Speakers:

Heidi Dancho	*Canola Council of Canada*
Brenna Mahoney	*Cereals Canada*

Objectives:

1- To demonstrate the importance of washing your hands, clothes and footwear thoroughly before entering in to a farm area.
2- Regularly cleaning and disinfecting your equipment are essential to the prevention of disease on any farm.

Collaborator: Canola Council of Canada

Crop Diversification Trials 2019

Manitoba Crop Variety Evaluation (MCVET) Trials

CMCDC is one of the many contractors that are part of the MCVET program, which facilitates variety evaluations of many different crop types in this province. The purpose of the MCVET variety evaluation trials are to grow both familiar (check varieties) and new varieties side by side in a replicated manner in order to compare and contrast various variety characteristics such as yield, maturity, protein content, disease tolerance, and many others aspects.

During the 2019 planting year, CMCDC conducted MCVET trials on spring cereals (Winter Wheat, and Fall Rye) in Carberry. (See Table 1). From each MCVET site across the province, yearly data is collected, combined, and summarized in the 'Seed Manitoba' guide. Hard copies are available at most Manitoba Agriculture and Resource Development and Ag Industry Offices. Seed Manitoba guide and the websites www.seedinteractive.ca and www.seedmb.ca, provide valuable variety performance information for Manitoba farmers.

Table: 1

Crop type	# of plots	Site
Winter Wheat	24	Carberry
Fall Rye	15	Carberry
Total plots	39	

For MCVET trial results conducted by CMCDC, please see Seed Manitoba Guide or visit websites www.seedinteractive.ca or www.seedmb.ca.

Development of decision support tools for Fusarium Head Blight management in Western Canada

Project duration: September 2018 – August 2019

Objectives: To increase understanding of resulting Fusarium Head Blight (FHB) infection for spring and winter wheat, barley and durum based on the current model.

Collaborators: Manasah Mkhabela PhD., Research Associate University of Manitoba Soil Science

Results:

Grain samples were sent for Fusarium specific analysis, but no report for these results has yet been generated. CMCDC will post a link when this report is available. Average yields for the crops tested are shown in Fig. 1. The quality ratings for the crops are not included here.

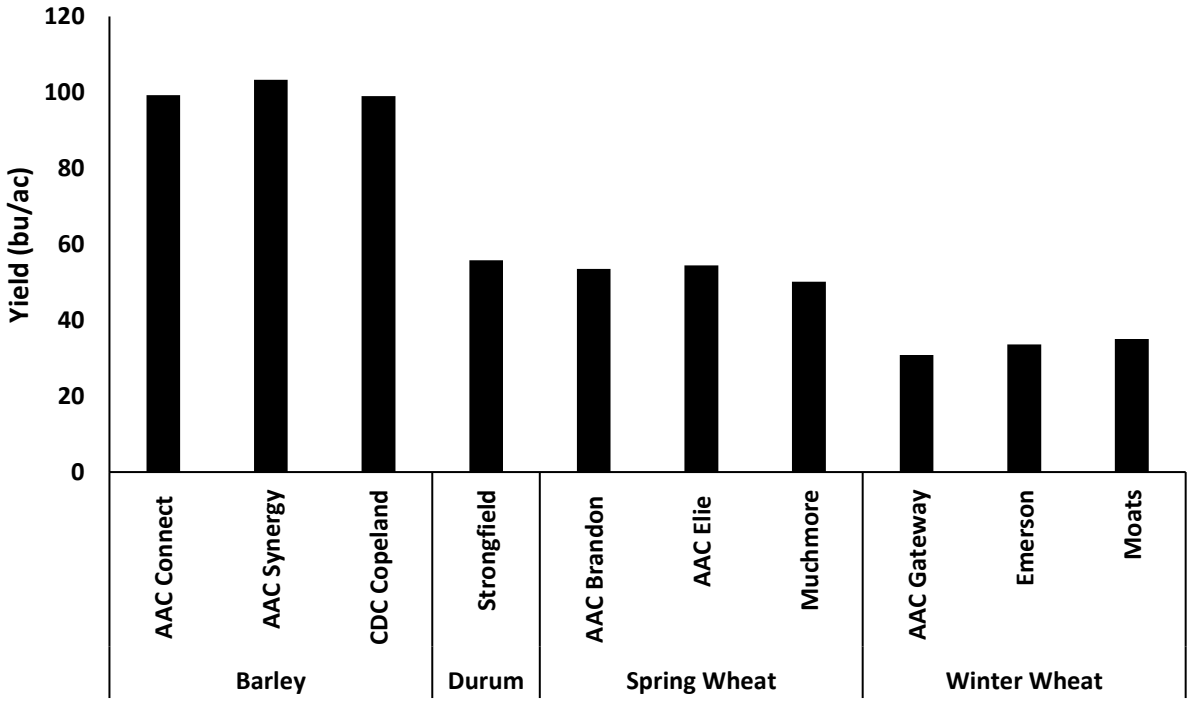


Fig. 1 Average yields for cereals tested

Background:

Farmers need improved decision-making tools in order to assess the local risk of Fusarium Head Blight (FHB). Better tools would improve judgement on whether or not to use fungicide and how to time application. The project recognizes that the current model for predicting the presence of FHB is insufficient and is gathering data across the province for different treatment plans using both known fusarium resistant and fusarium susceptible varieties. This project design centred on learning more about how spore density in the air at specific times of plant maturation affected FHB infection. The specific window of interest is during flowering and up to five days before flowering.

Materials & Methods:

Entries: 3 varieties for each winter wheat, spring wheat and barley; 1 variety for durum

Seeding: Winter Wheat seeded Sept 30 2018;
Barley, Spring Wheat and Durum seeded May 02, 2019

Harvest: August 21, 2019

Varieties: Winter Wheat: Moats, AAC Gateway and Emerson
Spring Wheat: AAC Elie; AAC Brandon and Muchmore
Barley: CDC Copeland; AAC Connect; and AAC Synergy
Durum: Springfield

Data collected	Date collected
Plant Counts:	Three leaf stage (and spring emergence for winter wheat)
Plant Staging:	Weekly staging beginning at late booting through late flowering
Spore Collection:	Beginning just before winter wheat flowering spanning five weeks and covering all cereals flowering
FHB sampling & rating:	18-21 days after flowering – Enumeration of FHB afflicted kernels per head in a given sample size of fifty heads per plot
Heights:	August 21
Yield:	August 21
Moisture:	August 21

Grain samples sent away to analyze for grading, fusarium species assessment, and mycotoxin analysis.

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

Evaluating yield potential of new winter wheat varieties

Project duration: September 2018 – August 2019

Objectives: Establishing a fertility program to achieve high yield winter wheat

Collaborators: Elmer Kaskiw, Ducks Unlimited Canada

Results:

Grain samples were sent for protein analysis, but no report for these results has yet been generated. CMCDC will post a link when this report is available.

Background:

In Western Canada, winter wheat is a high-yielding, profitable crop, and it is good practice to match your fertility rates with your yield goals. Managing the health of winter wheat is important for its success, and fertility is a key player in crop health. Nitrogen (N) fertility is an important consideration in winter wheat production, and can be one of the most challenging factors for producers planning winter wheat. Selecting the right source will help ensure your soil has a balanced supply of essential plant nutrients.

Performing annual soil tests and applying nutrients to meet crop requirements will assist in deciding on the right rate. Applying nutrients at the right time will ensure nutrient uptake when the demand is high. Lastly, the right place helps minimize the risk of loss while increasing the availability of nutrients to the crop. Ducks Unlimited Canada wanted to evaluate two practices: the “producer practice” with regards to fertility and a balanced “high yield practice”.

Materials & Methods:

Experimental Design:	Random Complete Block Design - Factorial
Entries:	6
Seeding:	October 25
Harvest:	August 20, 2019
Varieties:	Winter Wheat: Gateway, Elevate, Wildfire

Table 1: Treatments

Treatment	Fertility	Variety
Producer Practice	100% added in Spring	Elevate
Producer Practice	100% added in Spring	Gateway
Producer Practice	100% added in Spring	Wildfire
Balanced Practice	50%N added as ESN in Spring	Elevate
Balanced Practice	50%N added as ESN in Spring	Gateway
Balanced Practice	50%N added as ESN in Spring	Wildfire

Data collected **Date collected**

Heading Date: Jun 10 – Jun 14
Heights: At heading
Lodging: August 20
Yield: August 20
Moisture: August 20

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

Effect of residue management on growth, yield and quality of soybean

Project duration: May 2018 – August 2019

Objectives: To determine the effect of residue management on soybean planted in early versus later May

Collaborators: Ramona Mohr and Aaron Glenn (AAFC-Brandon)

Results:

Manitoba's soybean industry has grown rapidly over the past decade. The introduction of short-season cultivars has resulted in an expansion in production from traditional growing areas in the Red River Valley to shorter-season areas, leading to a record soybean acreage of 1.6 million acreas in 2016 (Statistics Canada 2016). Despite ongoing improvements in soybean genetics, soybean is inherently a cold-sensitive crop that can be prone to low-temperature damage in both the spring and the fall. As such, planting either too early or too late may pose a risk. Management practices that modify the micro-climate that soybeans are exposed to early in the growing season, and/or that give the crop a competitive advantage under stressful conditions, may help to create a set of conditions that are more conducive to soybean establishment, growth and yield and thereby potentially reduce production risk.

A series of small-plot and controlled environment studies were initiated in fall 2017 to better understand the effect of management on early-season temperature and moisture conditions and, in turn, on soybean establishment, growth, yield and quality. In 2019, early seeding increased yield at 2 of 3 sites, suggesting the potential benefit of early planting in a year like 2019 where spring frosts were not an issue, but where an early and cold fall delayed crop maturity and harvest. These results contrast with 2018 where planting date had no effect on yield. Residue management affected soybean yield only at Indian Head in 2019, with tall stubble enhancing yield in some cases, similar to the results at this site in 2018. These are preliminary results only from ongoing field trials.

Study 1: Effect of residue management and planting date on soybean (A. Glenn, C. Holzapfel, H. Abbas, R. Mohr)

A four-year study was initiated in 2017 near Brandon, MB (AAFC-Brandon), Carberry, MB (Canada-Manitoba Crop Diversification Centre), and Indian Head, SK (Indian Head Agricultural Research Foundation) to assess the effect of residue management practices on the following soybean crop. Treatments consisted of a factorial combination of six residue management treatments [fall-tilled; fall-burned; short stubble (+straw); tall stubble (+straw); short stubble (-straw); tall stubble (-straw)], and two soybean planting dates. A split plot design with four replicates was employed, with planting date assigned to main plots and residue treatments to subplots. Residue treatments were imposed on wheat (Brandon, Carberry) or canaryseed (Indian Head) stubble in fall 2017 and 2018, and these plots were planted to

soybean in 2018 and 2019, respectively. This will be repeated in 2019/20. Immediately after residue treatments were imposed, self-logging temperature sensors (Model DS1922L, iButton Temperature Logger) were installed at a 5 cm depth in each plot to monitor soil temperature until spring. In 2019, soybean (R2, 00.3, 2375 CHU) was planted into residue treatments in early or late May (May 9, 10, 14 and May 29, 23, 30 at Brandon, Carberry and Indian Head, respectively). Preliminary analysis of the 2019 data indicated no date x residue management interactions for the data presented, therefore main effects of data and residue management are reported herein.

Dry early season conditions and a wet, cool fall with early snowfall contributed to challenging growing season conditions for soybean in 2019. While soil temperature at planting was significantly lower for the early than late planting date at all sites, soil temperatures for the early planting date were near or above the recommended 10 C (Fig. 1a). Residue management influenced soil temperature only at Brandon, with higher temperatures measured in short stubble (-straw) and tall stubble (+/- straw) than in short stubble (+straw) treatments (Fig. 1a). Soil moisture at planting varied among sites and planting dates (Fig. 1b). Soil moisture was higher for the early than late planting date at Indian Head with the opposite evident at Brandon. Residue management had no effect on soil moisture at planting at Brandon or Indian Head; however, soil moisture was lower in the tilled than all other treatments at Carberry.

In 2019, seeding date had a marked effect on days to emergence (DTE). Early seeding increased DTE by an average of 5 to 13 days depending on site whereas, in cases where differences in DTE due to residue management were observed, differences among treatments often averaged only about 1 day (data not presented). While planting date and residue management influenced plant stand at both Carberry and Indian Head, average plant stands met or exceeded the provincial recommendation of 40 plants/m2 regardless of treatment (Fig. 1c).

In 2019, early planting increased soybean yield at Brandon and Indian Head (Fig. 1d). These findings demonstrate the potential benefit of early planting in a year like 2019 in which spring frosts were not an issue, but where an early and cold fall delayed crop maturity and harvest. These results contrast with 2018 where planting date had no effect on yield. Residue management affected soybean yield only at the Indian Head site in 2019 (Fig. 1d). Tall stubble resulted in a higher yield than either short stubble (+straw) or tilled treatments, with tall stubble (-straw) also producing higher yields than either the burn or short stubble (-straw) treatments. Tall stubble also out-yielded burn and short stubble (-straw) treatments at this site in 2018. It is interesting to note that, although residue management did not have a statistically significant effect on yield at Brandon (P=0.08) or Carberry (P=0.12) in 2019, contrast analysis identified higher yields in stubble treatments where straw was removed. This appeared to be associated with differences in plant stand at Carberry but not at Brandon.

Treatment had no effect on seed quality (protein, oil, seed weight, test weight) at Brandon or Carberry, except for test weight at Brandon which was higher for early than late seeding. At Indian Head, however, test weight, seed weight and %oil were higher with early planting, and were also influenced by residue management (data not presented).

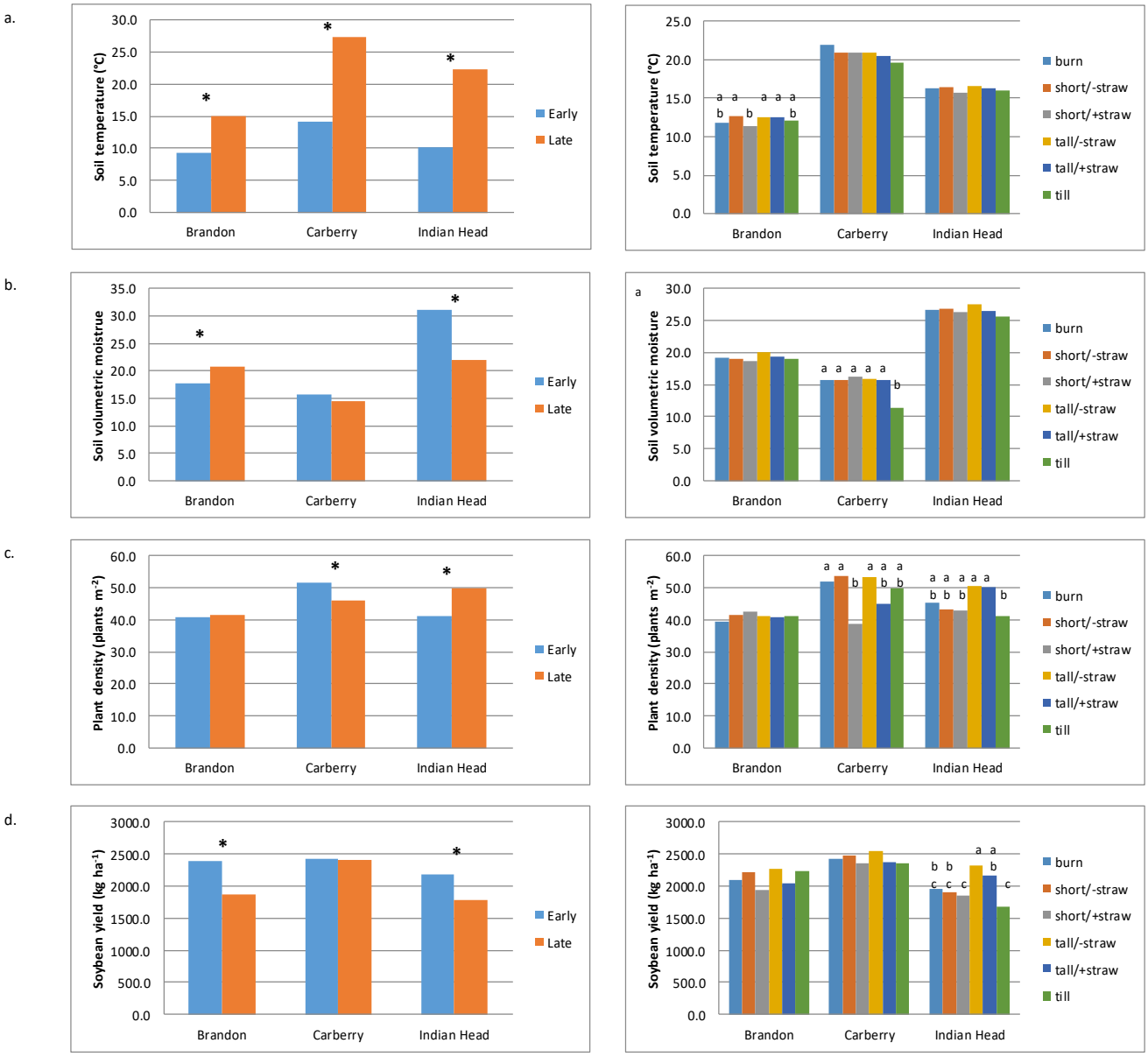


Figure 1. Effect of planting date (early vs late May) and preceding residue management (fall burn, short stubble with and without straw, tall stubble with and without straw, fall tillage) on soil temperature and moisture at soybean planting, and on soybean plant stand and yield, at Brandon, Carberry, and Indian Head in 2019. Reported values for planting date are averaged across residue management practices, and for residue management practices are averaged across planting dates. (*indicates that planting dates are significantly different within a given site. Residue management practices within a site that are denoted by the same letter are not significantly different from one another)

Fig 2. Residue management treatments established near Carberry, MB at time of iButton installation (left) and near Brandon, MB in late October 2017 (right).

Study 2: Temperature effects on soybean emergence under controlled conditions (D. Tomasiewicz, R. Mohr)

To complement the field studies, a series of controlled environment studies are ongoing to more closely assess temperature effects on early soybean development. Studies will be conducted during the winter over the duration of the project based on availability of the specialized controlled environment facility at AAFC-Saskatoon.

Preliminary testing of methodologies was done in 2017 to refine experimental protocols. Beginning in January 2018, a series of controlled environment studies have been conducted annually for several months each year to assess the effect of temperature and seed characteristics on soybean germination and emergence. In each case, a completely randomized design with three or four replicates are employed, and a range of temperature treatments are assessed. The effect of various factors including soybean size, seedlot, and conditions under which soybeans were produced is being investigated, with studies underway currently.

Background:

The Canadian prairies mark the northern fringe of soybean production in North America. Despite ongoing improvements in soybean genetics, soybean is inherently a cold-sensitive crop that requires a relatively long growing season. Frost, and near freezing temperatures in spring and fall can damage soybean. Early planting into cool and wet conditions can increase seedling disease and reduce plant stand (NDSU Extension Service 2010), with soil temperature acting together with soil moisture to affect establishment (Helms et al. 1996a; Helms et al. 1996b; Wuebker et al. 2001). Residue management practices may influence soil temperature as well as soil moisture, and thus potentially affect early-season growth.

Materials & Methods:

Experimental Design: Split plot design with four replications

Entries: 12

Seeding: May 10, 2019 (Date 1), May 23, 2019 (Date 2)

Harvest: October 08, 2019

Treatments

Main plots: two planting dates of soybean (May 10; May 25)

Sub-plots: Six spring wheat stubble treatments:

1. Short stubble with straw removed (15 cm standing stubble)
2. Short stubble with straw chopped & retained (15 cm standing stubble)
3. Tall stubble with straw removed (30 cm standing stubble)
4. Tall stubble with straw chopped & retained (30 cm standing stubble)
5. Fall-tilled wheat residue (straw chopped and returned prior to tillage)
6. Fall-burned wheat stubble (straw chopped and returned prior to burn)

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

Corn Variety Evaluation

Project duration: May 2019 – November 2019
Objectives: To develop and release early maturing cold tolerant corn inbreds.

Collaborators: Lana Reid Ph.D – AAFC Research Scientist Ottawa Research and Development Centre
Manitoba Corn Growers Association

Results:

This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team.

Background

The objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five Canadian provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada.

Project findings

These data were generated for AAFC; however, due to intellectual property issues pertaining to Plant Breeders' Rights, results for individual lines are not provided in this report. For more information on this variety trial

Materials & Methods

Experimental Design	Random Complete Block Design
Entries	30 varieties
Seeding	May 17, 2019
Harvest	November 01, 2019

Data collected	**Date collected**
% Emergence	Jun 03
Tasseling Date	Jul 02 – Aug 01
Silking Date	Jul 08 – Aug 19
Ear Formation	Jul 29 – Aug 26
Heights	Jul 30
Lodging	November 01, 2019
Yield	November 01, 2019
Moisture	November 01, 2019

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

Corn Parent Evaluation Nurseries

Project duration May 2018 – November 2018
Objectives To develop and release early maturing cold tolerant corn inbreds.

Collaborators Lana Reid Ph.D – AAFC Research Scientist Ottawa Research and Development Centre

Background

The objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five Canadian provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada.

Project findings

This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team.

Materials & Methods

Experimental Design	500 row observation nursery
Entries	500
Seeding	May 17, 2019
Harvest	September 27, 2019

Data collected	**Date collected**
Tasseling Date	Jul 02 – Aug 01
Silking Date	Jul 08 – Aug 19
Ear Formation	Jul 29 – Aug 26
Heights	Jul 30
Moisture	September 27
Yield	September 27

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

Corn Goss's Wilt Nurseries Evaluation

Project duration May 2018 – November 2018

Objectives Establishment of a Goss's Wilt nursery in MB.

Collaborators Lana Reid Ph.D – AAFC Research Scientist Ottawa Research and Development Centre

Background

Goss's wilt has been in Western Canada for only a few years, but plant pathologists, agronomists and breeders are already working to learn more about this corn disease and enhance management options for Prairie growers. Goss's wilt is caused by the bacterium Clavibacter michiganensis subspecies nebraskensis. "The bacteria overwinter on infected stubble, so the disease is a concern in fields with shorter corn rotations. But even in fields with longer rotations, it can be a problem because corn stubble is very mobile in the fall, blowing across the roadways and carrying the disease to new fields," Holly Derksen, field crop pathologist with Manitoba Agriculture, Food and Rural Development (MARD), says.

The disease usually occurs in a non-systemic form in which the pathogen infects the plant's foliage. "The bacterium enters the plant through a wound from hail or wind or sand blasting," Wilt Billing, DuPont Pioneer's area agronomist for central and eastern Manitoba, explains. "The infection usually appears on the upper canopy at first. Then with high humidity and rain splash, the disease moves very rapidly throughout the plant, usually from the top down."

The disease also has a systemic form where the bacteria infect the corn plant's vascular tissues. However, Billing and Derksen have not seen the systemic form in commercial corn fields in Manitoba. A relatively new disease, Goss's wilt was first identified in Nebraska in 1969. In the 1970s and early 1980s, the disease spread through Nebraska and into some surrounding states. Then very little disease occurred until about 2006 when Goss's wilt resurged and began spreading into new areas.

Billing notes, "Goss's is continuing to expand. In the U.S. it has moved right across most of the Corn Belt as far south as Louisiana. It moved into the southwestern edge of Michigan, so it has moved east of the Mississippi River." In Western Canada, the disease was first found in Manitoba in 2009 and in Alberta in 2013.

In Manitoba over the past five or six years, we've seen anything from an insignificant infection which doesn't have any yield loss all the way up to the most severe fields experiencing close to 50 to 60 per cent yield loss. So it can be very impactful," Billing says. The severity of the disease depends on weather conditions, the amount of inoculum in the field and the susceptibility of the hybrid to Goss's wilt. Fortunately, late summer conditions in Manitoba in 2014 didn't favour the disease. Billing says, "In 2014, we found the disease in many fields in mid

to late July. However, we had a dry spell during late July to early August, so the disease was really limited in its impact."

Managing Goss's wilt:

Symptoms of Goss's wilt may sometimes be confused with problems like drought, frost damage or sunscald, or with other diseases like Stewart's wilt or northern corn leaf blight. To identify Goss's wilt, Billing advises, "When you're walking through your corn field, look for greyish brown lesions with water-soaked margins. The telltale sign of Goss's wilt is the black freckling that shows up along the lesion edges. If you scout during drier conditions, you'll see that black freckling. If conditions are damp, like a heavy dew in the early morning, you'll sometimes see a glossy sheen on the lesion."

Derksen notes fungicides are not effective for controlling Goss's wilt because it is a bacterial disease. She has two main recommendations for managing the disease: "One is to lengthen your crop rotation. However, that may not always be enough to prevent the disease if neighbouring fields have Goss's wilt. The other key is to grow a resistant corn variety. At this time there isn't any third-party testing to compare varieties from different companies, but most companies have a range of tolerances to Goss's wilt, so you can check with your seed supplier for information."

Fig. 1 The bacterium enters the corn plant through a wound on a leaf and then spreads from there.

Project findings

This project is part of a long-term, multi-site study led by Lana Reid. Research findings will be made available by Lana Reid and team.

Materials & Methods

Experimental Design	100 row observation nursery
Entries	100
Seeding	May 17, 2019
Harvest	September 27, 2019

Data collected	**Date collected**
Tasseling Date	Jul 02 – Aug 01
Silking Date	Jul 08 – Aug 19
Ear Formation	Jul 29 – Aug 26
Heights	Jul 30
Moisture	September 27
Yield	September 27

Agronomic info

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.

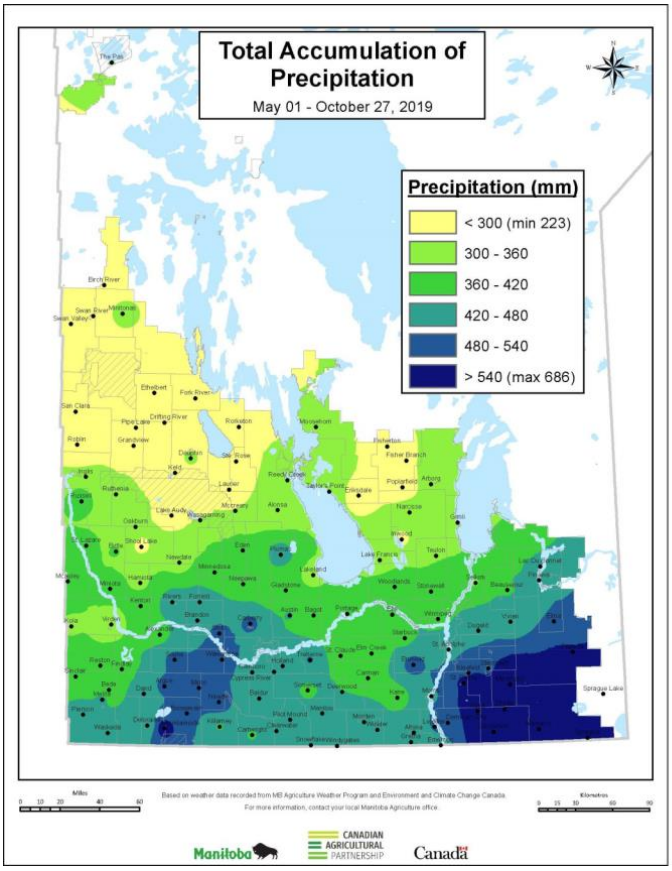
Sunflower Variety Performance Testing

The Manitoba Sunflower Variety Performance Trials (VPT) is organized and conducted by the National Sunflower Association of Canada (NSAC) in co-ordination with Manitoba Agriculture and Resource Develop-men. 2019 was the 13th year that the NSAC has coordinated the trials, which continue to serve as an important tool for sunflower growers with regional third-party performance data on various varieties. The hybrids tested in the trials are actively being pursued by sunflower breeding companies in Manitoba and may be in the experimental stage or registered under the Canadian Food Inspection Agency. In 2019, the NSAC coordinated the VPT at four locations across the province: Melita, Carberry, Dakota Plains and Stonewall.

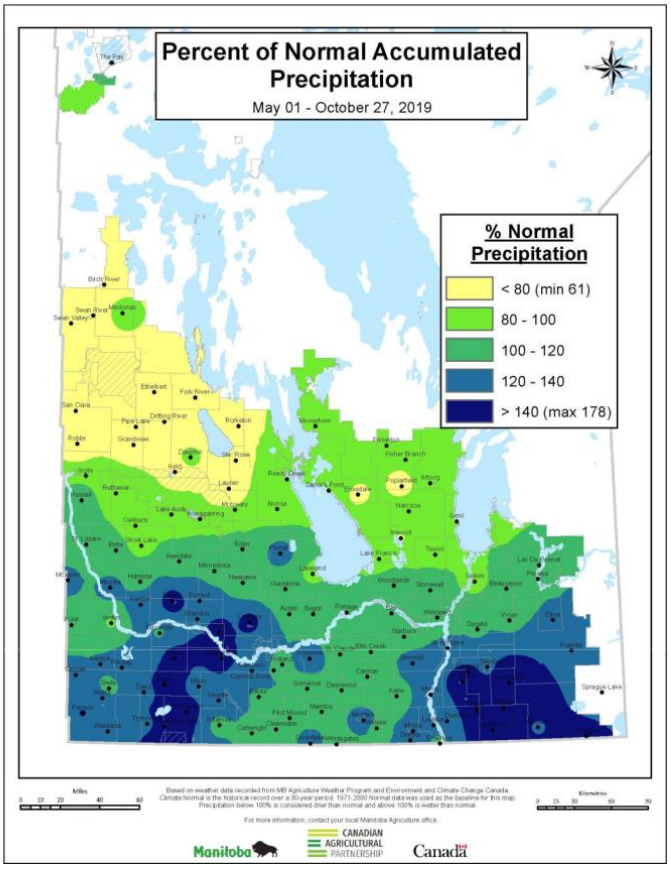
The 2019 growing season started off very dry resulting in delayed or difficult sunflower emergence. Dry conditions continued during July and August with below average rainfall until mid September. Disease was lower than normal, a consequence of the drier conditions early on. Late rains in September and an early snowstorm in October delayed harvest. Harvest had begun in September but continued into early November. Sunflower yields ranged across the province, rainfall dependent, with yields between 1800-3200 lbs. per acre reported with average to good quality. Much of the crop was harvested tough and needed to be dried.

These trials and results are made possible with your continued support through the sunflower check-off levy.
NSAC would like to acknowledge the producers who allow for the trials to be tested on their land.

Precipitation Data for 2019 (mm)



Precipitation Data for 2019 (% of Normal)



Confectionary Sunflower Variety Performance Testing

Comments:

These varieties were tested and data donated by the National Sunflower Association of Canada Inc. (NSAC) All sunflowers varieties listed are susceptible to sclerotinia and sunflower rust strains present in Manitoba.

Genetic resistance to verticillium wilt is rated as moderately susceptible to moderately resistant for all sunflower varieties presented.

Summary Table

Company	Hybrid	Genetic Traits [1]	Site Years	Yield % Check	Maturity (days to R9)	Height (inches)	2019 Seed Sizing (%) [2] >22/64	>20/64	<20/64
NuSeed America	6946 DMR	DM	25	100	0	0	41	30	26
NuSeed America	Panther DMR	DM	33	100	1	-3	55	26	14
Experimental lines being tested/proposed for registration in Canada									
NSAC	EX 43400	ExSun	2	82	-1	3	47	32	22
NSAC	EX 88647	ExSun	2	91	-3	3	70	23	7
	CHECK CHARACTERISTICS								
	6946 DMR		25 site years	3195 lb/ac	121 days	68 inches			

Site Comparisons:

			Carberry			
	Yield	Maturity*	2019 Seed Sizing (%) ²			Test Wt
Hybrid	(lb/ac)	(days to R9)	>22/64	>20/64	<20/64	(lb/bu A)
6946 DMR	3289	129	39	40	21	25.4
Panther DMR	3875	131	49	40	11	26.8
Experimental lines being tested/proposed for registration in Canada						
EX 43400	2714	127	25	40	36	25.4
EX 88647	3407	125	54	35	11	24.1
Site Average (lb/ac)	3321	128				25.4
CV%	6.96					
Sign Diff	No					
LSD (0.05)	--					
Planting Date	14-May					
Desiccation Date	--					
Harvest Date	22-Oct					

	Dakota Plains					
			2019 Seed Sizing (%) [2]			
Hybrid	Yield (lb/ac)	Maturity* (days to R9)	>22/64	>20/64	<20/64	Test Wt (lb/bu A)
6946 DMR	3519	128	67	23	10	24.0
Panther DMR	3167	129	71	20	9	23.4
Experimental lines being tested/proposed for registration in Canada						
EX 43400	2898	128	69	23	7	24.0
EX 88647	2821	126	87	11	3	23.7
Site Average (lb/ac)	3101	128				23.8
CV%	9.46					
Sign Diff	No					
LSD (0.05)	--					
Planting Date	28-May					
Desiccation Date	--					
Harvest Date	19-Oct					

Oilseed Sunflower Variety Performance Testing

Comments:

These varieties were tested and data donated by the National Sunflower Association of Canada Inc.

Oil Sunflower markets - include birdfood, oil crush and de-hull. Variety selection become more important when trying to capture de-hull markets. Choose varieties with better de-hull ratio, larger size and higher test weight. Environment will contribute greatly to final product.

Summary Table

Company	Variety	Herbicide/ Disease Tolerance	Site Years	YIELD % check	Maturity (days to R9)	Height (inches)	% Oil	Oil Type	Test Weight
NuSeed Americas	N4HM354 DMR	CL/DM	12	104	-1	-2	47.9	NS	34.3
NuSeed Americas	Talon	ExSun	15	97	-2	-4	45.2	NS	29.7
DuPont Pioneer	P63HE60	ExSun / DM	12	96	-2	0	46.9	HO	33.2
DuPont Pioneer	P63ME70	ExSun / DM	17	100	0	0	47.8	NS	31.0
DuPont Pioneer	P63ME80	ExSun / DM	15	94	1	0	49.8	NS	32.4
Experimental lines being tested/proposed for registration in Canada									
NuSeed Americas	N4HE302	ExSun	6	88	-2	3	44.5	HO	30.7
NuSeed Americas	N5LM307	CL	2	103	0	-8	39.4	CO	30.7
	CHECK CHARACTERISTICS								
	P63ME70		17 site years	3313 lb/ac	124 days	69 inches			

1 Genetic traits include CL = Clearfield tolerance; ExSun = Express tolerance; DM = Downy Mildew Resistance.

Site Comparisons

	Carberry			
Hybrid	**Yield (lb/ac)**	**Maturity* (days to R9)**	**Test Wt (lb/bu A)**	**Oil (%)**
N4HM354 DMR	2203	128	34.9	41.9
Talon	2426	122	32.3	41.1
P63HE60	2148	125	33.2	40.0
P63ME70	2115	129	31.5	42.7
Experimental lines being tested/proposed for registration in Canada				
N4HE302	2212	133	32.3	41.4
N5LM307	2110	129	32.4	37.0
Site Average (lb/ac)	2202	128	32.8	40.7
CV%	8.9			
Sign Diff	No			
LSD (0.05)	--			
Planting Date	14-May			
Desiccation Date	--			
Harvest Date	22-Oct			

	Dakota Plains			
Hybrid	**Yield (lb/ac)**	**Maturity* (days to R9)**	**Test Wt (lb/bu A)**	**Oil (%)**
N4HM354 DMR	3179	127	34.8	47.2
Talon	3302	128	29.8	44.8
P63HE60	3588	128	34.6	46.9
P63ME70	3374	128	31.3	48.2
Experimental lines being tested/proposed for registration in Canada				
N4HE302	3406	130	31.5	46.5
N5LM307	3549	128	29.1	40.7
Site Average (lb/ac)	3400	128	31.9	45.7
CV%	5.7			
Sign Diff	No			
LSD (0.05)	--			
Planting Date	28-May			
Desiccation Date	--			
Harvest Date	19-Oct			

*Physiological maturity for sunflowers is R9, where the bracts on the head are almost completely brown.

At Carberry, heads were clipped and dried artificially for stationary combining.

Development of Agronomic Practices for the Biofumigation Practices in the Central Manitoba

The Use of Mustards as a Biofumigant to Manage Verticillium Wilt of Potato in Manitoba

Principal investigators: Zachary Frederick and Haider Abbas

MHPEC technician: Jane Giesbrecht

CMCDC staff: Brian Baron, Beverly Mitchell and Alan Manns

Students: Jessica Kalyniuk, Olivia Gessner and Nicole Buurma

Funding sources:

Objective 1: [Haider Abbas] Funds provided by the Canadian Agricultural Partnership (CAP) for crop diversification at CMCDC

Objective 2: [Zachary Frederick] Funds generously provided to MHPEC by Simplot Canada II, McCain Foods, and the Keystone Potato Producers Association

The investigators wish to thank our grower cooperators for providing their time and land to evaluate the process of biofumigation and High Performance Seeds for providing the 'Caliente Rojo" mustard seed used in this experiment.

Abstract

Biofumigation describes the elimination or suppression of soilborne pests, pathogens and weeds by gases emitted from buried biomass from members of the Brassicaceae family (e.g., brown mustard, oriental mustard, radish, etc.). Biomass is pulverized and incorporated into moist soil to convert glucosinolates into degradation products such as isothiocyanates. The process has been developed and experimentally-validated as a control measure of Verticillium wilt of potato in the United States and Europe. However, the methods of growing the mustard crop and the effectiveness of the process to reduce Verticillium wilt in Manitoba have yet to be validated in regionally with all cultivars of mustards, especially with a specialty-type mustard bred for biofumigation called 'Caliente Rojo'. The project's overarching goal is to explore a way to economically manage Verticillium wilt of potato in Manitoba using a mustard crop as a biofumigant green manure to kill *Verticillium* propagules in soil and/or suppress the disease. More specifically, experiments were conducted to determine agronomic inputs to maximize

biomass of mustard cultivars ‘Andandte’, ‘Caliente Rojo’, and ‘Cutlass’. Additional studies examined field-scale mustard biofumigation to verify *Verticillium* CFU/g soil before biofumigating, mustard biomass at the time of biofumigation, and then the final *Verticillium* CFU/g one month after biofumigating. The conclusions of this project will scientifically reinforce growers’ efforts with evidence to effectively and economically manage Verticillium wilt of potato for their entire operations.

Objectives and Deliverables

1. [Haider Abbas] Characterize agronomic practices for mustard cultivars ‘Andandte’, ‘Caliente Rojo’, and ‘Cutlass’ necessary to achieve maximum biomass to theoretically maximize glucosinolate production.
    a. Practices to target: planting date (Mid July, Late July, Aug 1, Mid Aug), flea beetle control, minimum inputs (irrigation, N+S fertilization) needed to achieve max biomass, seedbed preparation (stubble type, chaff spreading, best seed-to-soil contact ratio)
    b. Deliverables
        i. Develop list of recommended and experimentally verified practices to successfully use mustard biofumigants as part of program to manage Verticillium wilt in Manitoba
        ii. Improve recommendations for the inevitable question of “does this process work with other mustards?”
        iii. Develop experimental evidence to make the call for Canada-bred mustards for biofumigation (if existing mustards will not suffice)

2. [Zack Frederick] Evaluate whether mustard biofumigation with “Caliente Rojo” reduces *Verticillium dahliae* soil CFU and/or Verticillium wilt of potato
    a. Deliverables
        i. Implement and validate the applicability of a real-time *Verticillium dahliae* quantification tool for soil testing
        ii. List approximate number of acres planted, and practices used to grow the crop
        iii. Individual grower will have comparison of numbers of Verticillium propagules at three timings: 1) before mustard biofumigation 2) one-month post-biofumigation and 3) post-potato production.
        iv. Disease ratings will occur in the potato rotation to document visual reduction of disease, possibly as response to Verticillium wilt
            1. Severity of Verticillium wilt symptoms
            2. Severity of black dot symptoms
            3. Severity of Rhizoctonia symptoms

v. Calculate cost of use for reduction in Verticillium CFU/g or Verticillium wilt

Methods

Objective 1

Pest Control:

When using mustard or any other crop as a biofumigant, it is important to know the targeted pest(s) and its life cycle. The biofumigant crop should be incorporated when the pest is present in the upper soil profile (15 to 20 cm).

Seeding Date:

Seeding date should be based on the targeted pest. Mustard should be seeded about 60 days before pest will be present in the field as mustard should be incorporated into the soil before seed production begins. Seeding date should be planned accordingly in order for the crop to have reached maximum biomass at time of incorporation. Depending on variety and growing conditions, it takes about 60 to 70 days to attain maximum biomass production.

Varieties:

Mustard comes in many varieties but not all are equally as effective when it comes to biofumigation. Some mustard varieties produce more glucosinolates compared to others. In fact, some varieties have been bred for the sole purpose of biofumigation, for example, the “Caliente”. Caliente grows quickly and is typically used in spring or late summer, bred specifically for biofumigation as it contains very high levels of glucosinolates. At CMCDC, we are testing all varieties i.e. Caliente Rojo, Cutlass, and Andante.

For The Best Results:

(i) **pH** of the soil should be above 5.5. If the field has a pH lower than 5.5 the biofumigation process might not be successful. For optimal results, the pH of soil should be as close to 7 as possible.

(ii) **Biomass and glucosinolates** are factors that are fundamental to the success of biofumigation.

(iii) **Fertilizer** Nitrogen is important to the production of biomass and sulfur is crucial for the production of glucosinolates. Nitrogen is applied depending on the field’s history. The rate of sulfur should be adjusted in relation to the chosen nitrogen rate in a 6:1 ratio. For example, if 100 lbs/ac of nitrogen is applied then the suggested amount of sulfur to be applied would be 17lbs/ac.

Soil Incorporation:

- The following considerations should be taken into account, when incorporating the mustard crop into the soil.
- Mustard crop should be incorporated into the soil before it has reached full bloom.
- Incorporation process should be done when soil has a good level of moisture. Do not incorporate mustard when the soil is dry.
- Mustard must be incorporated IMMEDIATELY after mowing, 80% of the fumigant gas will be released in the first 20 minutes after mowing.

After incorporation, the field should be rolled and packed to trap the fumigant gas in the soil. Finally, once the **incorporation process is complete**, leave the field undisturbed for 14 days to ensure that all the plant material can break down.

In the fall of 2018 growing season, fall rye (variety: Bono), and winter wheat (variety: wildfire) were seeded to produce stubble crop prior to mustard seeding. Plot area was 6 m^2 with a length of 5 m, and width of 1.2 m. After harvesting the top grain material of fall rye, and winter wheat crop, three different mustard varieties were seeded at two different dates with an interval of two weeks (July 26, and August 09), in the 2019 growing season. Herbicides and insecticides were applied when needed. All the other agronomic practices were carried out in accordance with standard mustard production guidelines.

Objective 2

The field-scale experiment had two components in two separate field years: the mustard biofumigant crop and the potato crop that followed.

Mustard biofumigant crop:

The grower provided the mustard cv “Caliente Rojo” seed, fertilizer, and water for seedlings. The grower seeded, watered, and raised the crop. The principal investigator will retrieve all relevant planting info from grower (date, depth, irrigation, fertility, conditions, stubble, texture, costs of inputs).

Fields were generally selected based on previous experience with Verticillium wilt for a field variability study from 2015-2019, although a few fields were selected because of grower willingness to test mustard biofumigation. The experiment was set up only in one quarter section of field to reduce soil variability between plots. A single field was the unit of replication. A quadrant of the field was selected for experimentation to reduce variability in soil conditions, and the exact area selected depended on the known distribution of *Verticillium* CFU from a previous field variability project (data can be retrieved from mbpotatoresarch.ca from the project by the same name). Each plot was 10m wide x 12m long, and four plots of biofumigated and four plots of non-biofumigated crop area were left bare per field (expecting to lose at least one because we may not know Verticillium distribution ahead of time).

Plots were geolocated for return to the plot after biofumigation, and the equipment recorded an average of 1-3 inches deviation at the time of sampling. A large plot size was selected to avoid the criticism that non-fumigated plots were in close enough proximity to be bio fumigated anyway. Strips of the field were to be bare for non-biofumigated strips. Some growers offered to not plant certain sections to create non-biofumigated strips, while other fields had bare spots created by hand after germination. Each plot (biofumigated and non) had two sampling points. The attempt was made to sample medium to high Verticillium areas and collect from center of the plot, with a few meters between sampling points. Each sampling point consists of two 0-10 cm composite samples. With eight strips per field and two sampling points a strip, there will be 16 sampling points per field. With four fields per year, that is 64 samples. There will be two collection dates (before biofumigation, three weeks after biofumigation) or 128 samples each year. For two years there will be a total of 256 samples. Verticillium counts were determined from 0-10 cm soil samples before biofumigation, just after the grower plants the mustard in late July. Biomass was recorded by harvesting all above-ground plant matter within one square meter from three random locations within a plot and immediately recording the weight in kilograms. Post-biofumigation sampling was done by returning to the same geolocated sampling points and sampling 0-10 cm one month after biofumigation, when biofumigant activity has ceased.

Manitoba Pest Surveillance Initiative (PSI) received eighty soil samples in small zip bags provided by MHPEC Inc. in 2019 for inoculum quantification. The original soil samples were ground to fine powder. Two sub-samples of 0.25g each were taken from each ground soil sample after it was well mixed between each sub-sampling. DNA was extracted from the sub-samples using DNeasy PowerSoil Kit (QIAGEN) following the manufacturer's instruction. Two extracted DNA samples were combined and mixed as the stock DNA to represent the original soil sample for the next step. The target DNA was amplified using the qPCR markers developed by Guillaume et al. (2011) for *V. dahliae*. A model was developed and validated based on the relation of the numbers of microsclerotia per gram soil and threshold cycle threshold (Ct) of DNA amplification. The both parties of PSI and MHPEC were satisfied the model validation and agreed to their application on the real soil samples. The model was MSVd = 4*10^(9.019 – 0.2721*Ct) for *V. dahliae*. The first assessment of the effectiveness of biofumigation will be through the comparison of microsclerotia pre and post biofumigation, using the biomass measurement as an approximate measurement for "dose".

Potato crop:

The final assessment for the effectiveness of biofumigation will be the reduction of Verticillium wilt in potato and/or the continued reduction of *V. dahliae* microsclerotia during the potato rotation that follows mustard. There will be one more verticillium testing date the following year after biofumigation on the potato rotation. There are 64 samples (eight strips x two points/strip X four fields) for three years, or 192 samples, making a total of 448 samples in

total for both the potato and mustard component of the field study. This sample from the potato rotation will be from the same geolocated plots as the mustard crop year and will be from 0-10 cm in depth. The *V. dahliae* from these soils will also be quantified using the same method as before. These samples will be collected in mid August, and a 10m row of potato plants over each sampling point will be rated for percentage wilt severity from 0-100%. If applicable, ratings for black dot, rhizoctonia, or other disease symptoms and signs will be rated for severity (0-100%).

Results:

Objective 1:

A significant flea beetles' infestation rate was observed throughout the grown season in the 2019 planting year. An area of 1 m^2 was harvested to analyze biomass production in each variety. In addition to CMCDC, 2 more local sites were selected to collect data points from off-site for observation purpose.

1). CMCDC On-site:

Fall Rye: Biomass production from all varieties was significantly different from each other. No sufficient biomass was generated in the Date 2 of Caliente Rojo, and Cutlass varieties due to the high infestation rate of flee beetles.

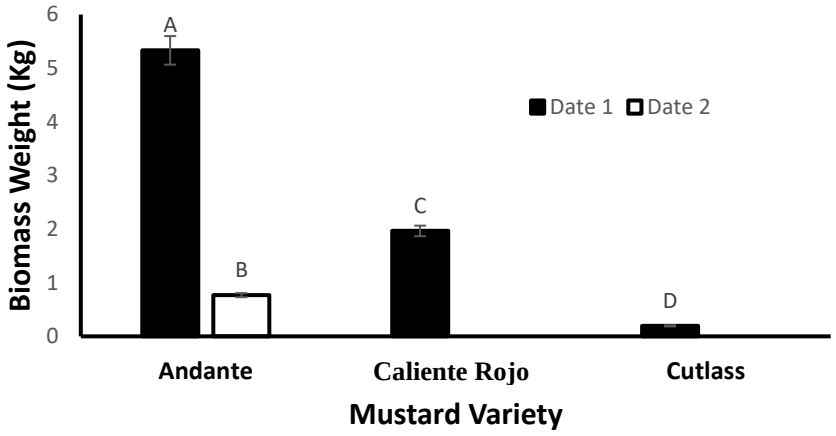


Fig. 1 Mustard verities seeded on Fall Rye (Variety: Bono) Stubbles

Winter Wheat: Biomass production of seeding Date 1 & 2 of Andante variety was significantly different from each other. No sufficient biomass was generated in the Date 1 & 2 of Caliente Rojo, and Cutlass varieties due to the high infestation rate of flee beetles.

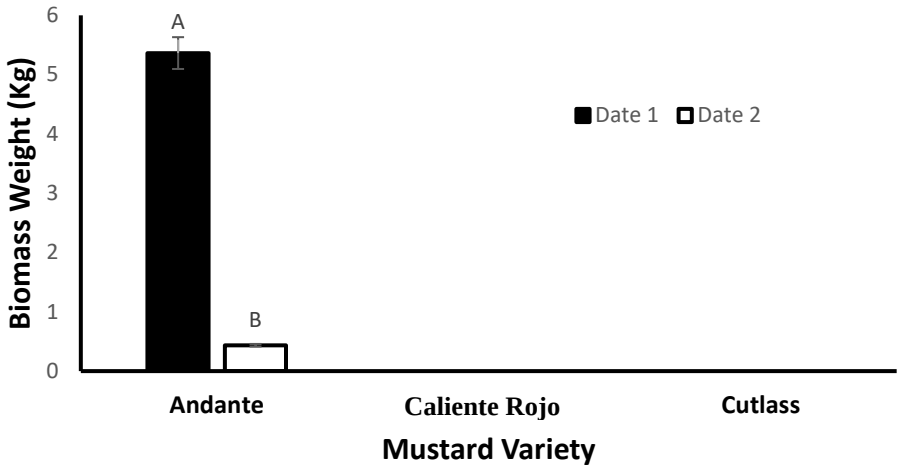
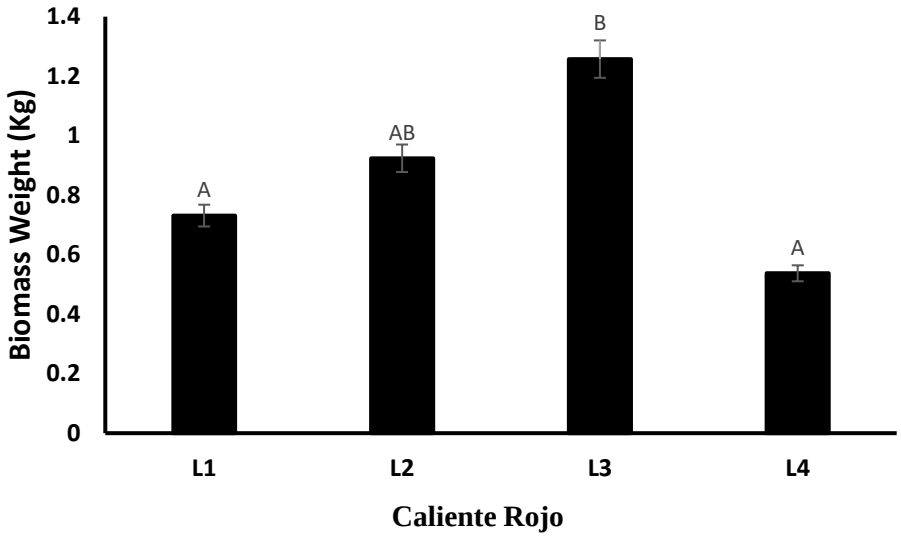


Fig. 2 Mustard verities seeded on Winter Wheat (Variety: Wildfire) Stubbles

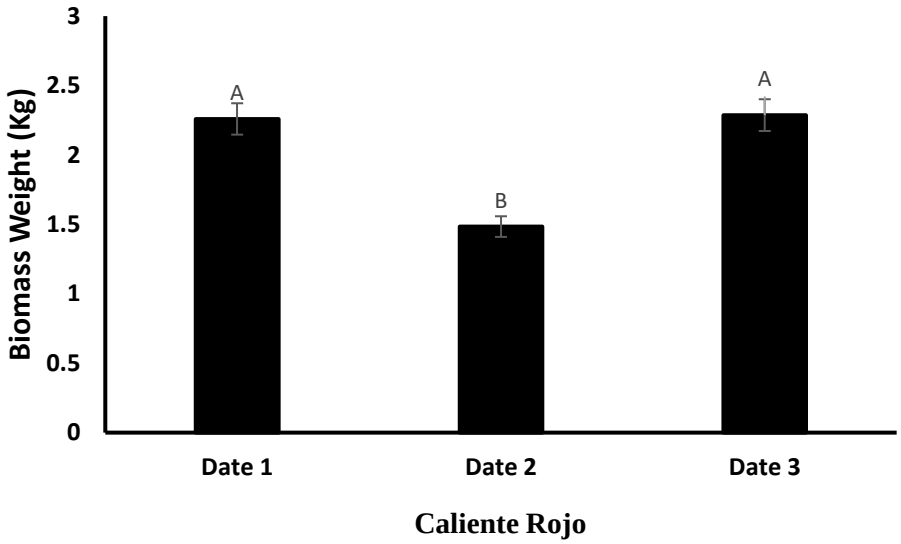
2). Field MB-3

Data was collected at 4 different sites (Locations 1-4) with same treatment but different land features.



3). Field MB-1

Mustard was seeded at 3 different dates. No significant difference in biomass production was observed in Date 1 and Date 3. However, Date 2 was significantly different from Date 1, and Date 3.



Objective 2

Four field sites were established in 2019 for study with one field site per grower cooperator. Two sites did not survive to biofumigate (MB-1 and MB-4) due to three feet of snow in mid September and extreme flea beetle pressure, respectively. MB-3 did not have sufficient growth to successfully biofumigate (average of 3-5 inches plant height). MB-2 was the only site with several feet of biomass with about 3-4 feet of mustard in wetter, high organic matter areas and 1-2 feet in the sand ridges (data not shown).

Designation	Planting Date	Biofumigation Date	Irrigation Status	Flea Beetle Damage	Cold Damage
MB-1	20-Jul	N/A	Irrigated	Moderate to destroyed	Did not survive
MB-2	29-May	23-Jul	Dryland	Minor	N/A
MB-3	01-Aug	28-Oct	Irrigated	Minor to moderate	Minor to moderate
MB-4	26-Jul	N/A	Irrigated	Did not survive	N/A

There was insufficient replication in the first year to provide a strong dataset for statistical analyses. At last two more years of study are planned to produce more robustly replicated data. *Verticillium dahliae* counts from fields that were not biofumigated in 2019 will not be shown to simplify the results.

Site MB-2 had sufficient accumulation of microsclerotia to possess Verticillium wilt hotspots of sufficient magnitude that the grower and consultant are aware of the disease. Established literature suggests that between 5-30 *V. dahliae* microsclerotia are required to infect a susceptible potato plant. The exact sites that were subject to biofumigation have been sampled annually since 2017, when the field was last in a potato crop. The areas assigned for plots have increased from approximately 136 to 360 microsclerotia from 2017 to 2018. A simple two tailed t-test would lead us to conclude there is a significant difference (P=0.0077) between the number of *V. dahliae* microsclerotia pre- and post-biofumigation, although the power is low because of inferior replication and tremendous variability in the response of microsclerotia count. Any appearance of a difference between the means for the non biofumigated plots is nonsignificant by the same test (P=0.6391) and would likely be the error associated with sampling. It also possible that the significance of the biofumigation treatment is more due to this same error as opposed to actual biofumigation.

This is where additional replication is necessary, and depending on the critiques of the community, additional proofs might be required.

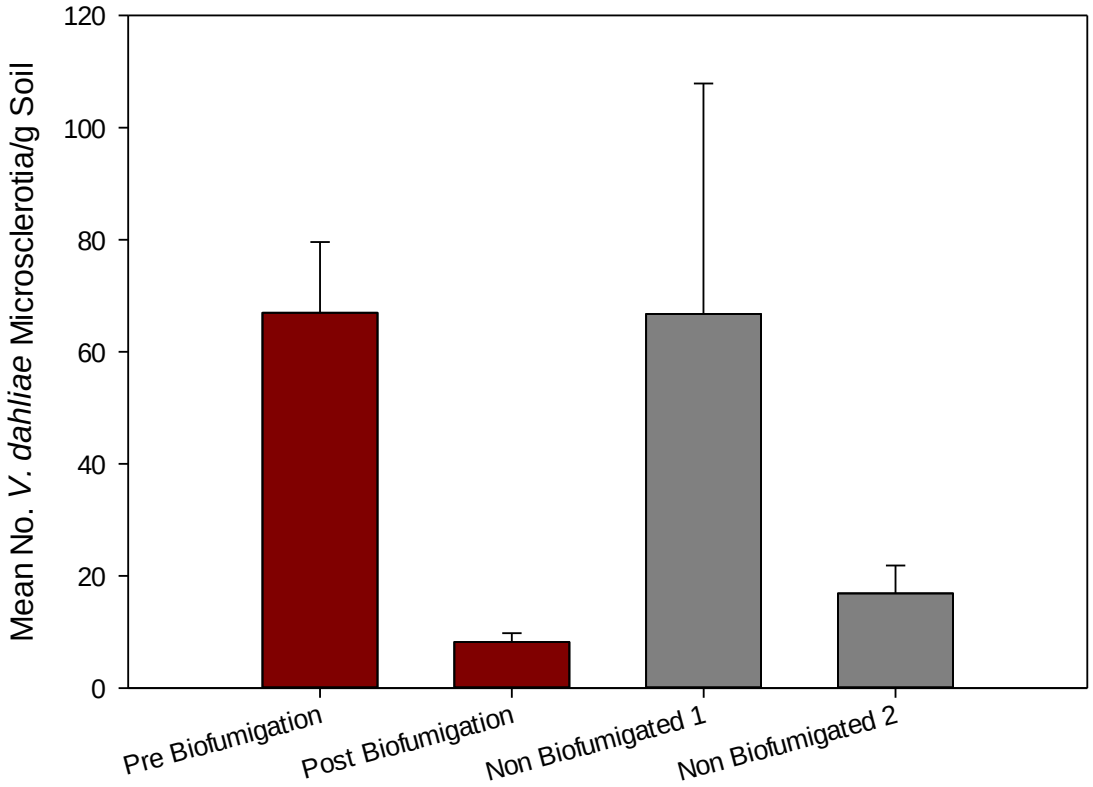


Fig 1. The comparison of *V. dahliae* microsclerotia observed for site MB-2 before and after biofumigation for plots subjected to biofumigation (red) and plots receiving no biofumigation (gray).

Site MB-3 had, on average, a low count of microsclerotia. Established literature suggests that between 5-30 *V. dahliae* microsclerotia are required to infect a susceptible potato plant. No samples from the pre-biofumigation set exceeded the minimum threshold required to cause disease, although the same was not true for the post-biofumigation samples (Fig. 2). Regardless of being over threshold, this field has lower Verticillium pressure than similar fields studied in Manitoba, where a *Verticillium* hotspot can have 200-300 microsclerotia in the same soil sample (data not shown). A simple two tailed t-test would lead us to conclude there is no significant difference (P=0.6395) between the number of *V. dahliae* microsclerotia pre- and post-biofumigation, although the power is low because of inferior replication. Any appearance of a difference between the means would likely be the error associated with sampling.

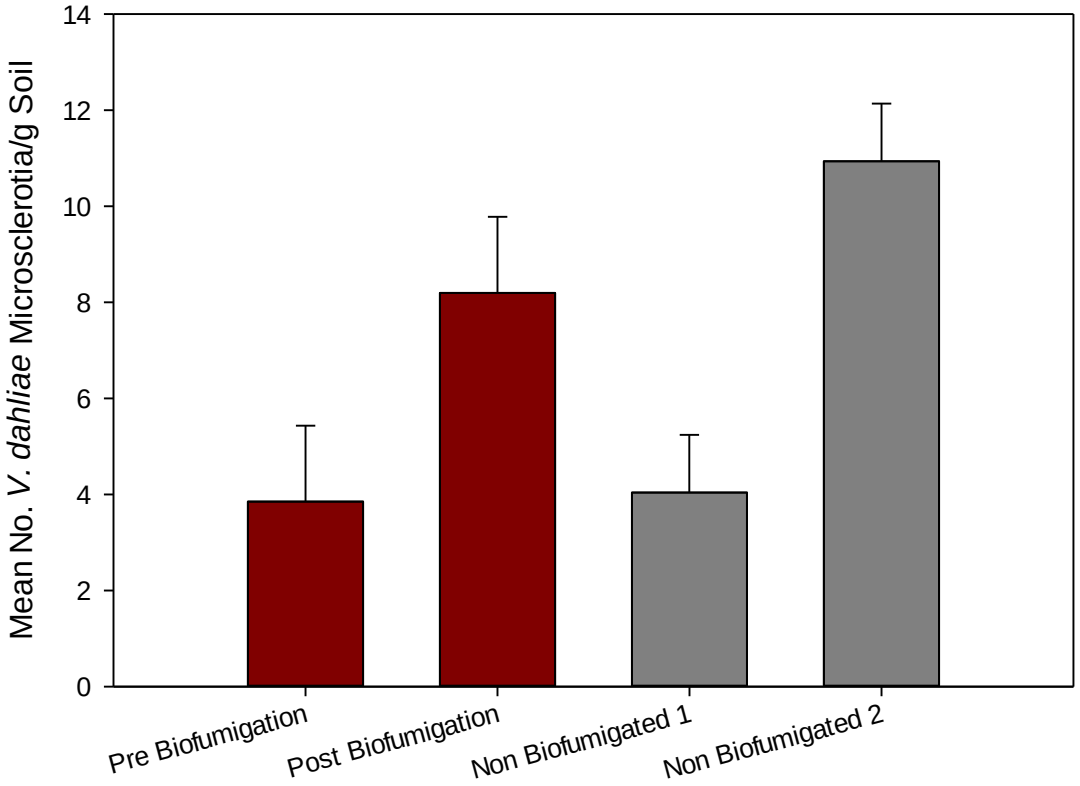


Fig 2. The comparison of *V. dahliae* microsclerotia observed for site MB-3 before and after biofumigation for plots subjected to biofumigation (red) and plots receiving no biofumigation (gray).

Conclusions

Objective 1

When managed properly mustard offers another tool to help growers control soilborne pests and diseases. It is important to strictly follow the outlined cultural practices to have any chance of success using mustard as a biofumigant. A high infestation rate of flea beetles was observed in the study areas which effected the capacity of biomass production of mustard varieties, highlighting a potential change that needs to be made for growing mustards in Manitoba. Proper chopping of plant material and soil incorporation is of utmost importance. Although mustard is a remarkable biofumigant, it could have other benefits that is expected from any other cover crop such as; prevention of soil erosion, recycling of soil nutrients, improved soil structure and maintaining soil organic matter. Interestingly, there are other crops that show

possible biofumigation effect such as but not limited to; buckwheat, pearl millet, Sorghum-Sudan grass, rape seed and oil seed radish. CMCDC will test the biomass production from the mustard varieties during the 2020 planting year again with more added treatments. For this purpose, crops of fall rye, and winter wheat were seeded as a stubble crop in the fall of 2019.

Objective 2

Although only two fields survived to biofumigate, useful observations were still gathered to add to the collection of information that the project leads have amassed so far. Superficially, it appears as if biofumigation did work to reduce *V. dahliae* microsclerotia in one field in 2019. More fields and years of study are necessary to assert if the biofumgiation process can achieve the objective to control Verticillium wilt of potato in Manitoba.

Additional anecdotal observations were also recorded in 2019. Chaff spreading is necessary on rye and wheat fields before seeding mustard because a thick mulch reduces soil to seed contact and reduces germination and growth, leading to mustard that is at the cotyledon stage after a month and a few inches tall after two months of growth. Flea beetle damage was severe in 2019, but markedly less so in fields that were not in Carberry or had stubble to protect mustard seedlings. Even a rigorous insecticide program did not afford the same protection as the presence of stubble. It was also surprising to see that a dryland field was so effective in 2019 to raise a mustard crop using only precipitation and two flea beetle insecticide treatments, granted a crop of rye was lost to plant the mustard in May. Growers and consultants have also expressed interest in whether mustard biofumigation has any control of powdery scab, can build organic matter, or can reduce wind erosion.

References

Bilodeau, G. J. et al. 2011. Development of an assay for rapid detection and quantification of *Verticillium dahliae* in soil. Phytopathology 102: 331-343.

Manitoba Mustard Biofumigantion Recommendations [2020]

Planting

PLANTING DATE

- Still the subject of ongoing research.
    - Original August planting date (with late October biofumigation) doesn't seem compatible with Manitoba's wet falls and extended potato harvests
    - 2020 experiment will focus on early June planting date with late August biofumigation date
        - Early June flea beetle damage expected to be less. Goal to have true leaves up before flea beetles begin to feed. Crucifer flea beetles thought to be more damaging than striped flea beetle in 2019.
        - Late August biofumigation date precedes bulk of potato harvest
- Seed treatment will be an ongoing area of experimentation in 2020. Seed treatment needed for flea beetle protection

DIRECT SEEDING

- Seeding rate between 6-10 lbs/ac depending on amount of residue
- Can be done in both heavy and light residue situations
- Makes for great seed to soil contact
- Caliente Brand seeds can be planted using main hopper or small seed attachment
- Drilling into dry soil and over circle tracks can be damaging to equipment. Cutting or filling tracks prior to planting helps

BROADCAST

- Seeding rate between 8-12 lbs/ac depending on amount of residue
- Use cheaper, dry fertilizer while simultaneously sowing
- After broadcasting, a pass with a undercutter, packer, harrow, or other tool will be required to ensure better seed to soil contact

FERTILIZER

- For maximum bio-fumigation potential, 120-150 units of available N are needed. Apply up to 90 units at seeding.
- Working in residue prior to planting may require more fertility due to nutrient tie-up
- For maximum growth, 25-30 units Sulphur are also recommended

PACKING

- Seed to soil contact critical, more is better
- Multiple packer types will work: Schmeiser/Ring Packer, Tire Packer/Roller, Coil Packer
- Harrows can also be used: Spring tooth Harrows, Rolling Harrows

- Vertical tillage/cutter tools can be utilized in heavy residue

GENERAL

- When growing a Biofumigant crop behind wheat or other grasses, the use of a grass herbicide is highly recommended because volunteer grains compete for water and nutrients
- Mustard is likely to be tolerant to salinity stress
- It is possible that mustard biofumigation reduces wind erosion, but this depends on wind speed, particle size, frequency of wind, and duration of winds.
- Allowing the plants to enter full bloom before biofumigation is not a bad thing – glucosinolate concentration is high in petals, levels in leaves won't drop until petal fall as the plant sheds older leaves. Don't let the plant get beyond petal fall before biofumigating.

IRRIGATION

- Shortly after seeding, multiple 1/4" shots of water are required to allow seeds to germinate
- In season, these bio-fumigant crops can use up to 2" or more per week
- When these plants are stressed for water, they will bolt and flower early (not what we want)

Incorporation

- The highest GL concentration is right at flowering, but these levels will hold for 2-3 weeks in cooler fall temps with adequate moisture
- As soon as flowers start dropping, so does the GL concentration
- For many areas, an August 5th planting date means middle to end of October for incorporation. This also avoids overlapping w/ harvest
- Ensure good soil moisture at incorporation to allow for rapid release of AITC's
- Extremely important to macerate plant tissue
    - Glucosinolate and enzyme are found in different parts of cell
    - Shredding thoroughly will allow for higher concentrations of AITC release and improved disease/pest/weed suppression
    - Flails tend to work better than mowers due to better mulching abilities.
    - Rears MFG makes a pul-flail that can be customized for more blades and higher arbor speeds, allowing for optimal AITC release
- **Flail the mustard – do not macerate plant tissue using any other way**
- We recommend residue is incorporated within 10-15 minutes of chopping. Sooner is better.
- Up to 80% of AITC can volatilize in the first 20 minutes after being chopped

- The most important rule for incorporating is to stay as close to the flail chopper as possible
- The use of a heavy offset disk or rototiller is recommended
- In extremely heavy residue, double disking is an option, but make second pass as close to first pass as possible
- Pull a heavy packer behind incorporation tool to seal soil
- If possible, a shot of water will help seal the soil surface

CAUTION

When planting directly after bio-fumigant incorporation, wait 10-14 days before planting

The AITC's released during bio-fumigation can be very phytotoxic

When planted too closely to incorporation, the AITC's have affected the germination of crops from corn and peas, to apples and potatoes

Good moisture at incorporation will speed up the release of AITC's

Flea beetle damage may be extreme without stubble protection. Foliar insecticides may be needed in certain situations, although exact thresholds have not been established.