CANADIAN AGRISCIENCE CLUSTER FOR HORTICULTURE 4

Fruit and Vegetable Growers of Canada's Canadian AgriScience Cluster for Horticulture 4

Update to Industry for June 2024

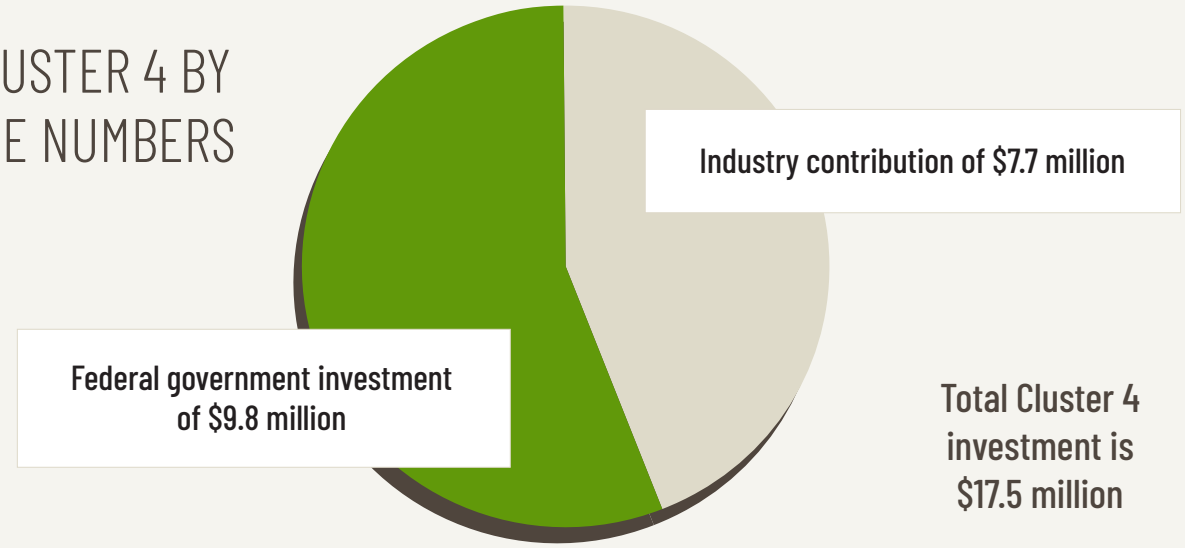
The Canadian AgriScience Cluster for Horticulture Cluster 4 is underway, with the first year of research activities having commenced in 2023. Spanning the years 2023 to 2028, Cluster 4 contains 10 research activities focused on the innovation, competitiveness and sustainability of Canada's fruit and vegetable industry.

Cluster 4 is addressing key challenges in the Canadian horticulture industry facing the production of apples, berries, field vegetables, greenhouse vegetables and potatoes. Through the 10 research activities, researchers plan to discover improved operational efficiency and sustainability for growers, target the reduction of on-farm chemical use, improve soil health, and identify more sustainable fruit and vegetable varieties for growers across the country.

This project is generously funded through the Canadian Agri-Science Cluster for Horticulture 4, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Sustainable Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada (FVGC), and industry contributors.

Over the next few years, researchers will share updates on their work through the FVGC website and its social media accounts. Research updates, including bi-annual knowledge transfer reports, will include current updates and early research findings.

CLUSTER 4 BY THE NUMBERS



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THE CLUSTER 4 RESEARCH ACTIVITIES:

ACTIVITY 4

Reducing losses from apple pests with alternative control strategies

LEAD RESEARCHER – Suzanne Blatt, research scientist in entomology with Agriculture and Agri-Food Canada at the Kentville Research and Development Centre

ACTIVITY 5

Apple crop load management: Enhancing thinning predictability and tree response through advancements in modelling, new precision thinning products and strategies, and technology

LEAD RESEARCHER – John A. Cline, professor of tree fruit physiology at the University of Guelph

ACTIVITY 6

Canadian Berry Trial Network

LEAD RESEARCHER – Beatrice Amyotte, research scientist for small fruit germplasm development with Agriculture and Agri-Food Canada at the Kentville Research and Development Centre

ACTIVITY 7

Increasing field vegetable yield and resilience to abiotic and biotic stresses through soil microbial engineering

LEAD RESEARCHER – Martin Filion, research scientist with Agriculture and Agri-Food Canada at the Saint-Jean-sur-Richelieu Research and Development Centre

ACTIVITY 8

Reduce risk strategies for cabbage maggot control

LEAD RESEARCHER – Renee Priya Prasad, associate professor and department head for agriculture at the University of the Fraser Valley

NOTE: Activities 1 to 3 are FVGC-led administrative activities including science coordination, knowledge transfer and impact assessment.

ACTIVITY 9

Developing a systems approach to pest management on greenhouse vegetable crops: mirid predator selection

LEAD RESEARCHER – Roselyne Labbé, research scientist in greenhouse entomology with Agriculture and Agri-Food Canada at the Harrow Research and Development Centre

ACTIVITY 10

Novel approaches for the management of tomato brown rugose fruit virus (ToBRFV)

LEAD RESEARCHER – Aiming Wang, research scientist with Agriculture and Agri-Food Canada at the London Research and Development Centre

ACTIVITY 11

National potato variety evaluation for sustainability, resilience and climate change

LEAD RESEARCHERS – Erica Fava, national potato variety trial coordinator and industry liaison; Jen McFarlane, soft fruits IPM coordinator and research coordinator with E.S. Cropconsult; and Katerina Jordan, associate professor at the University of Guelph

ACTIVITY 12

Regenerative and sustainable agriculture for climate change adaptation and carbon sequestration: rebuilding soil health and increasing crop productivity of Canadian potato production systems

LEAD RESEARCHER – Claudia Goyer, research scientist with Agriculture and Agri-Food Canada at the Fredericton Research and Development Centre

ACTIVITY 13

Positioning Canada's potato industry for improved sustainable production

LEAD RESEARCHER – Mario Tenuta, senior industrial research chair in 4R nutrient management and professor of soil ecology at the University of Manitoba

Reducing Losses from Apple Pests with Alternative Control Strategies

LEAD RESEARCHER

Suzanne Blatt
Research scientist in entomology with Agriculture and Agri-Food Canada at the Kentville Research and Development Centre

With ongoing reviews and deregistration of pesticides, growers are looking for ways to reduce their pesticide use to control pests in apple crops. In this research activity, which is a continuation of work done in Cluster 3, cultural, biological and sterile insect-release strategies for controlling bark beetles, leafrollers and apple maggots are being studied. Novel implementation of these strategies to target specific pests will provide additional options for insect pest control.

One goal of this research activity is to reduce pesticide use in apple production. Biocontrol agents will be used in conjunction with softer pesticides to reduce the potential for pesticide resistance development.

Researchers are looking into how changing the landscape around orchards may decrease bark beetle populations, leading to increased tree survival and lessening the need to replant parts of an orchard. They are also researching how sterile insect release for apple maggot control can complement management programs currently used by growers.

KEY TAKEAWAYS:

- Sterile insect release for apple maggots may complement current management programs, reducing annual pesticide use.
- Modifying landscapes around orchards may reduce bark beetle populations, increase the survival of trees and reduce the need to replant parts of the orchard.
- A biocontrol agent against leafrollers may complement the use of softer pesticide products, reducing the likelihood of resistance development and extending the registration life of sustainable products.
- Between September 2023 and March 2024, the research team was able to do sterile insect release of apple maggots with 19 different diets tested. Evidence of egg laying was found, with both eggs and live young maggots being removed from the apples. The best diet resulted in a pupation rate of 60 per cent when live maggots were added to the diet. The addition of eggs to the diet resulted in a lower success rate.

A cut open apple infected with apple maggot tunnels and larva.
Photo credit: Kim Hiltz

Apple maggots sitting on apples. Photo credit: Kim Hiltz

Apple Crop Load Management: Enhancing Thinning Predictability and Tree Response Through Advancements in Modelling, New Precision Thinning Products and Strategies, and Technology

LEAD RESEARCHER

John A. Cline
Professor of tree fruit physiology
at the University of Guelph

Fruit trees produce many flowers and fruits which need to be removed from the tree early in the spring for fruit to adequately size and to ensure the trees produce fruit the next year. This process, called thinning, is an orchard practice growers use to improve profitability and fruit quality. This research activity aims to thin flowers or fruits using special chemical thinners and new technologies.

The thinning practices used by growers currently can be imprecise and labour-intensive. Thinning creates up to 124 hours of work per hectare and accounts for 38 per cent of total labour costs annually (based on 2023 production and labour rates in Ontario).

This research activity will provide new strategies and product recommendations for apple crop load adjustment. This will lead to significant labour savings, improved fruit quality and a higher percentage of marketable fruit. Decision support systems will also be provided for producers to boost crop load management and explore artificial-intelligence-based computer vision systems for measuring key indicators of crop load, thus improving management outcomes.

This research activity will begin in 2024–25, with more information to come in the next report.

TOP: Fruits that have dropped to the ground naturally or in response to specialized chemicals early during fruit development.
ABOVE: A heavy crop load of Gala apples at harvest time, these apples are too small to market and sell for fresh market consumption.
Photo credits: John Cline

KEY TAKEAWAYS:

- Greater economic and environmental sustainability for fruit tree operations.
- Higher quality fruit production.
- Estimated labour savings of 25 per cent compared to hand-thinning.
- Increased orchard profitability by 10 per cent per hectare due to improved fruit quality.
- Better ability to estimate yields early in the growing season.
- Improved flowering and more consistent annual cropping.
- Recommendations for thinning apples using metamitron and 1-ACC, alone and in combination with 6-BA.
- Improved understanding of how chemical thinners impact labour savings, crop returns and risks of mummified fruit due to black rot fungal infections.
- Crop load optimization models for profitability maximization.
- Recommendations for using computer models to increase thinning efficacy and outcomes.

Canadian Berry Trial Network

LEAD RESEARCHER

Beatrice Amyotte
Research scientist for small fruit germplasm development with Agriculture and Agri-Food Canada at the Kentville Research and Development Centre

The Canadian Berry Trial Network (CBTN) is working to find better berry varieties to grow in Canada. This ongoing research activity from Cluster 3 is assessing the climatic adaptation, productivity and fruit quality of berry cultivars.

Variety trials of blueberry, raspberry and strawberry are happening in British Columbia, Ontario, Quebec and Nova Scotia. Through these trials, evidence-based recommendations are being made for new berry cultivars to grow in each province. Varieties are being tested from Canadian and international breeding programs.

During the first cycle of CBTN from 2019 to 2023, promising strawberry varieties were found for eastern Canadian fruit growers. The varieties had good adaptation and productivity. Nevertheless, significant differences were observed among all trialled berry varieties, which influenced the trial results; no single berry variety consistently yielded the highest results across all years and locations.

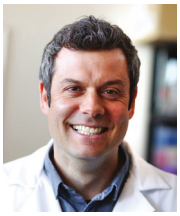
This cycle of the CBTN will see in-depth analysis of raspberry and blueberry varieties, employing the same methods used for strawberry varieties in the first cycle.

TOP: Strawberries at harvest time in Nova Scotia in 2022.
ABOVE: Strawberries in bloom in Nova Scotia in 2023 during the growing season.
Photo credits: Canadian Berry Trial Network

KEY TAKEAWAYS:

- The first cycle of CBTN had differing production seasons due to variations in general weather patterns and extreme weather events.
- Variety rankings changed annually, even within distinct trial locations, prompting a different approach to data analysis.
- Examination revealed some strawberry varieties with either average or above-average yields in at least two years and two locations, indicating potential resilience to climatic variation.
- Limited data prevented a similar analysis of raspberry and blueberry varieties in the first cycle, but the plan is to assess weather factors influencing yield in all three crops during this cycle.
- In the 2023 growing season, previously established trials of blueberry, raspberry and strawberry were studied for plant vigour, establishment and hardiness.
- A list of available varieties was developed and reviewed by provincial advisory panels for the 2024 growing season.

Increasing Field Vegetable Yield and Resilience to Abiotic and Biotic Stresses through Soil Microbial Engineering



LEAD RESEARCHER

Martin Filion
Research scientist with Agriculture and Agri-Food Canada at the Saint-Jean-sur-Richelieu Research and Development Centre

Through soil microbial engineering, this research activity is working to reduce the amount of chemical fertilizers and pesticides needed to produce vegetable crops. Soil-microbial-based engineering is being used to improve field vegetable yield, increase resilience to extreme weather events and plant diseases, and reduce fertilizer and pesticide inputs/runoff. New biological alternatives to chemical crop inputs will be provided through the research. This will help boost plant health and crop yields, and discover biofertilizers and biopesticides which are suitable for sustainable farming practices.

Emerging microbial-based technologies are being developed and reviewed to address crop-input-use efficiency. This research activity will support the development of new microbial inoculants and microbial-based inoculants to be used on vegetable crops instead of chemical fertilizers and pesticides.

KEY TAKEAWAYS:

- Develop novel microbial inoculants to reduce farm inputs without impacting yields.
- Make field vegetable yields better able to fight climate change effects and extreme weather events.
- Develop and transfer monitoring tools to support sustainable ag and integrated pest management (IPM).
- In the 2023–24 growing season, plant-growth-promoting rhizobacteria were found to increase lettuce yield by more than 15 per cent in both greenhouse and field conditions. Lettuce yields were maintained with 25 per cent less synthetic nitrogen fertilizer used, and some of these bacteria were also able to suppress growth of important pathogens impacting vegetables when tested under in-vitro conditions.

Reduce Risk Strategies for Cabbage Maggot Control

LEAD RESEARCHER

Renee Priya Prasad
Associate professor and department head for agriculture at the University of the Fraser Valley

Crucifers (crops in the cabbage family) provide a wealth of opportunities for Canadian vegetable growers, but they are under threat from cabbage root maggots. The cabbage root maggot is an insect pest that attacks all crucifer plants. The plant family includes cabbage, kale, broccoli, Brussels sprouts, cabbage, cauliflower, radishes, rutabagas and turnips. Cabbage root maggots feed on the roots of crucifer plants, potentially killing young plants or causing enough damage to root crops that they cannot be harvested.

This research activity, which is a continuation of previous research, will find new management tools, mainly insecticides, and strategies for how to use those insecticides with non-insecticide tools, so that growers will see decreased crop losses from cabbage root maggot. The plan is to get products registered for control of cabbage root maggots, giving growers more tools in their toolboxes to fight back against this pest.

Crucifers can become a major part of the Canadian vegetable industry moving forward if there are more ways to control cabbage root maggots. By growing crucifers, vegetable growers get a rotational crop option to accompany other vegetable crops such as potatoes. Crops in this plant family provide significant cash flow. In most areas of Canada, crucifers have been the first crops to start bringing in cash flow on a farm. The crucifer family has a lot of diversity in crops, allowing for numerous crop options to meet market demands and respond quickly to unpredictable growing seasons.

KEY TAKEAWAYS:

- Through this research activity there will be registrations of products (mainly insecticides) that will protect crucifers against cabbage root maggot.
- This research activity will give growers more options for rotational crops they can grow from within the cabbage family.
- Strong financial returns on crucifers for vegetable growers will be provided through this research activity.
- Field trials in the 2023 growing season showed promising results for transplant applications of up to four weeks post-treatment with the insecticides Cimegra and Verimark.
- Trials during the 2023 growing season showed there are multiple variables to be considered in future trial work. These include direct seed germination uniformity, transplant application methods and transplant tray dimensions.

Developing a Systems Approach to Pest Management on Greenhouse Vegetable Crops: Mirid Predator Selection

LEAD RESEARCHER

Roselyne Labbé
Research scientist in greenhouse entomology with Agriculture and Agri-Food Canada at the Harrow Research and Development Centre

Conventional pesticide use has climbed over the past 70 years, causing increased pest resistance to numerous chemical pesticide classes. To find new integrated pest-management strategies to protect greenhouse vegetable crops, a research team is studying three native North American mirid species: *D. discrepans*, *D. famelicus*, and *Macrolophus tenuicornis*. This builds upon a previous FVGC project where multiple new native predators with potential as commercial biocontrol agents were surveyed and collected.

The team is now conducting trials to compare the biological characteristics of select strains of these mirid species and rate their ability to manage greenhouse pests such as whitefly, spider mites and aphids. Through applying a selection approach, mirid strains can be developed to be tested on different vegetable crops to identify optimal environmental conditions needed for applying these predators successfully in Canadian commercial greenhouse settings.

To start, the team will develop novel open-rearing systems where the best bug strains and species will be put into optimized host plants. By doing this, growers should be provided with longer-term biological pest controls than are currently available. The research team expects that by creating open-rearing frameworks, growers will be able to more effectively apply a preventative and durable approach to fight back against pests. This will maximize biocontrol efficiency while lessening the need for the application of conventional agents and reducing crop losses from diverse greenhouse arthropod pests.

KEY TAKEAWAYS:

- Add to the development of a complete systems approach for applying and commercializing new native biocontrol organisms.
- Establish rates and schedules for introducing native biocontrol agents onto open-rearing systems.
- Develop best practices for applying open-rearing systems by identifying preferred host plants, supplemental foods and lights.
- Maximize the spreading of information about reducing crop losses and increasing returns to encourage growers to adopt new agents and open-rearing strategies in greenhouse vegetable crops.
- Aim to reduce losses from invasive species by applying a selective breeding and open-rearing approach to boost predator performance and persistence on crops.
- During the 2023–24 season significant progress was made in collecting mirids, with at least three species gathered, including *Dicyphus famelicus*, *Dicyphus discrepans* and a third mirid, *Nesidiocoris tenui*.
- Alternate species, including *D. discrepans* and *Macrolophus sp.*, will be collected during 2024–25 to include in surveys of alternate host plants.

Novel Approaches for the Management of Tomato Brown Rugose Fruit Virus (ToBRFV)

LEAD RESEARCHER

Aiming Wang
Research scientist with Agriculture and Agri-Food Canada at the London Research and Development Centre

Researchers are working to stop Tomato Brown Rugose Fruit Virus (ToBRFV) from threatening Canadian greenhouse tomatoes and peppers. This research activity, a continuation of previous federal research work after the discovery of ToBRFV in Canada, is studying the infection process and developing novel genetic resistance to ToBRFV.

Tomatoes are the primary host of ToBRFV. The viral pathogen has been recently identified and spreads rapidly. It can overcome genetic resistance to tobamoviruses, including the durable broad-spectrum resistance gene Tm-2². The virus is stable, easily transmissible and highly contagious. ToBRFV causes tomato yield losses of around 30 to 70 per cent.

ToBRFV is a regulated pathogen in many countries, including the United States, meaning it can be a threat to Canadian tomato exports. This research activity is focusing on understanding the ToBRFV infection process and developing novel genetic resistance to effectively control it in greenhouse vegetable crops.

KEY TAKEAWAYS:

- Genetic resistance is the most effective, economical and sustainable approach for controlling viral diseases. It is environmentally friendly, target-specific and offers reliable protection without additional labour or material costs during the growing season.
- Unlike resistance from wild tomatoes, which often requires multiple years of breeding efforts to transfer resistance into cultivated tomatoes, novel genetic resistance in elite cultivars can be readily accessible to tomato production.
- The use of genetic resistance provides immediate and accessible solutions for controlling viral diseases in cultivated tomato crops.
- During the 2023–24 crop year a tomato mutant population was developed with more than 10,000 plants screened. Promising lines showing resistance or tolerance to ToBRFV infection were found.
- Four full-length complementary infectious DNA clones of Ontario ToBRFV isolates were developed and found to be infectious on the model plant N. benthamiana and tomato.
- The Tm-2² gene and all ToBRFV genes were cloned. These clones will be used to understand why ToBRV can overcome Tm2²-conferred resistance.

A tomato plant infected with tomato brown rugose fruit virus (ToBRFV) in a greenhouse.
Photo credit: Aiming Wang

A tomato plant infected with tomato brown rugose fruit virus (ToBRFV).
Photo credit: Aiming Wang

National Potato Variety Evaluation for Sustainability, Resilience and Climate Change

LEAD RESEARCHERS

Erica Fava
National potato variety trial coordinator and industry liaison

Jen McFarlane
Soft fruits IPM coordinator and research coordinator with E.S. Cropconsult

Katerina Jordan
Associate professor at the University of Guelph

The national potato variety evaluation is an ongoing research activity that is working to find new potato varieties for growers across the country. The current phase of the research activity is evaluating yield, consistency across differing environments, food quality and economic viability of new potato varieties against consumer preferences and environmental sustainability.

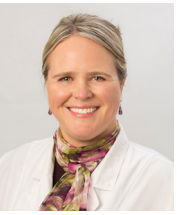
Previous research in Cluster 3 evaluating potato lines for Canadian production was focused on how to ensure marketability and competitiveness of new varieties compared to existing varieties. The new focus in this phase includes evaluating potato variety lines for resilience to extreme climate conditions, better nitrogen use efficiency, resistance to common diseases and expanding the marketable window for sales.

TOP: A potato variety trial at Elora, Ont.
ABOVE: An early chipping potato variety trial in Leamington, Ont.
Photo credits: Vanessa Currie

KEY TAKEAWAYS:

- The focus of the first phase of the variety trial is assessing the performance of Agriculture and Agri-Food Canada breeding lines.
- The second phase of the variety trial is evaluating the most promising lines from the first phase, along with varieties from other breeding programs, in regional field trials conducted by industry members.
- In the 2023–24 growing season, variety trials took place at eight sites across Canada.
- 160036-02 is a french-fry line five companies took for further evaluation in 2024. It yields and stores similar to the current standards, has good fry colour in storage, is resistant to common scab and is moderately resistant to Fusarium dry rot.
- CV15129-1 is a fresh-market line four companies took for further evaluation in 2024. It is a red creamer variety with moderate common scab resistance.
- F160025-03 is a fresh-market line two companies took for further evaluation in 2024. It has red skin and similar yields to standard varieties. It is resistant to PVX, golden nematode and Fusarium dry rot and has moderate common scab resistance.
- F160032-06 is a chip line five companies took for further evaluation in 2024; one company also decided to evaluate its potential in the United States. This selection has earlier maturity than standard varieties with similar yields and is resistant to PVX, with moderate common scab resistance.

Regenerative and Sustainable Agriculture for Climate Change Adaptation and Carbon Sequestration: Rebuilding Soil Health and Increasing Crop Productivity of Canadian Potato Production Systems



LEAD RESEARCHER

Claudia Goyer
Research scientist with Agriculture and Agri-Food Canada at the Fredericton Research and Development Centre

To ensure the long-term viability of agricultural operations, this research activity is using regenerative and sustainable agricultural practices (RSAPs) to study soil degradation and loss of biodiversity caused by intensive farming practices. Healthier soils are capable of supporting enhanced plant growth and higher crop yields.

RSAPs being studied include cover cropping, soil amendments and forages for livestock grazing. These practices will increase soil health through carbon sequestration, biodiversity and reductions in greenhouse gas emissions.

This research activity will provide a socio-economic study to understand the challenges and costs of implementing RSAPs. Knowledge, technologies and a support network are being supplied to help growers use sustainable practices effectively. Growers are collaborating with each other and experts. Trials are being conducted across diverse pedoclimatic conditions in Canada. A decision tool for growers to evaluate what RSAPs will work in their operations will be developed.

KEY TAKEAWAYS:

- Potato growers who will be evaluating RSAPs on their farms in Alberta, Manitoba, Ontario, Quebec, New Brunswick and Prince Edward Island were identified in 2023; growers in Manitoba and P.E.I. started trials.
- At McCain Foods Farm of the Future in New Brunswick during the 2023–24 growing season, two trials were planted and harvested. Soil, plant and greenhouse gas emission samples were taken during the growing season. Potato yields were measured. One potato field had three management zones laid out based on previous data, with soil samples collected to measure soil properties and potato yields.
- During the 2023 growing season, a field trial at the Agriculture and Agri-Food Canada Harrington Research Farm was in its second forage year. The above-ground biomass of the forages was measured, with the field plowed in the fall to incorporate the cover crops. It will be seeded to potatoes in 2024.
- Two trials in Quebec were planted to potatoes in 2023. In the fall, soil samples were collected to measure the baselines for physical, chemical and biological properties. Potato yields and soil-borne diseases were measured.
- A trial in Ontario was conducted during the 2023–24 growing season to investigate different cover crops and the use of fumigation

A group does soil sampling in a field under pasture at McCain Foods Farm of the Future in New Brunswick.
Photo credit: McCain Food's Farm of the Future

An experimental potato field design made by Stephanie Arnold with the University of Prince Edward Island for the research activity.
Photo credit: Stephanie Arnold with the University of Prince Edward Island

Positioning Canada's Potato Industry for Improved Sustainable Production

LEAD RESEARCHER

Mario Tenuta
Senior industrial research chair in 4R nutrient management and professor of soil ecology at the University of Manitoba

The sustainability of potato production in the future will depend on growers using nitrogen more efficiently and reducing losses to the environment. This research activity evaluates the use of nitrogen in the production of both fresh and processed potatoes, aiming to maintain standards and improve efficiency.

The research team will work to determine the environmental and agronomic performance indicators for fresh and processing potatoes in Canada. Emissions efficiency and nitrogen management practices on potato farms across the country are being studied. This research will find ways to ensure growers aren't regulated in nitrogen use, which would result in production decreases.

This research activity will begin in 2024–25, with more information to come in the next report.

KEY TAKEAWAYS:

- Developing environmental and agronomic performance indicators for improved nitrogen practices and management for fresh and processing potato production.
- Discovering how high-nitrogen use works on efficient potato varieties, which can reduce nitrous oxide emissions and improve agronomic performance.
- Determining the degree to which combined 4R nitrogen management practices can reduce nitrous oxide emissions and related environmental indicator performance.
- Determining what the potato crop needs when including nitrogen mineralization of soil to improve matching fertilizer nitrogen additions.
- Determining how further reductions in nitrous oxide emissions can combine or stack with potato genetics and 4R nitrogen management practices.
- Discovering if genetics and 4R nitrogen management practices can provide a greater return on investment for fertilizer nitrogen alone or in combination.

This project is generously funded through the Canadian Agri-Science Cluster for Horticulture 4, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Sustainable Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada, and industry contributors.

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