COHA CANADIAN ORNAMENTAL HORTICULTURE ALLIANCE

ACHO ALLIANCE CANADIENNE DE L'HORTICULTURE ORNEMENTALE

Research Clusters AgriScience Program:

Summary Report

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contents

Introduction

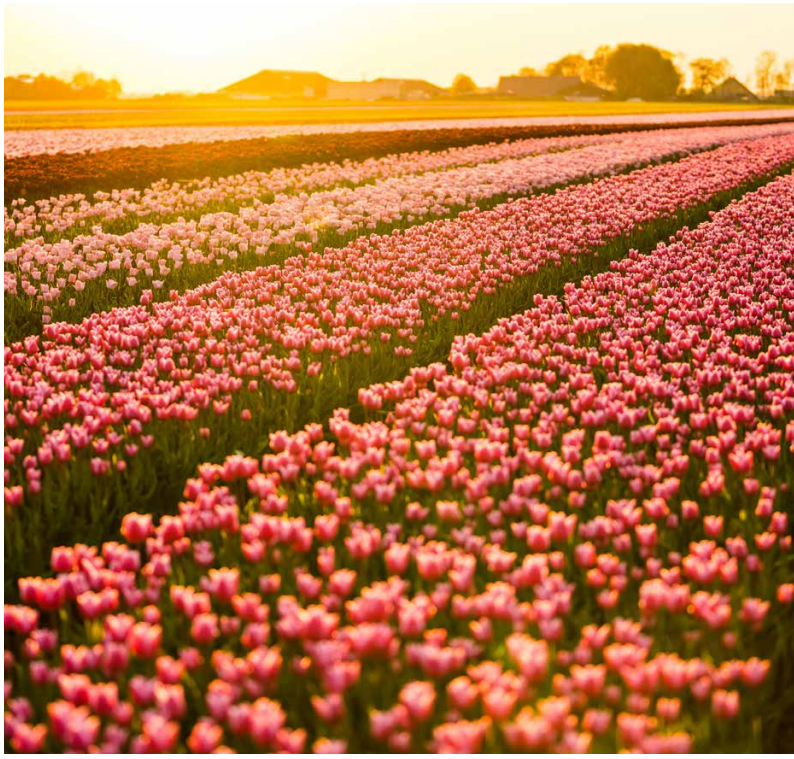
The Canadian Ornamental Horticulture Alliance (COHA) proudly represents Canada's vibrant and flourishing ornamental horticulture value chain. It is dedicated to **informing decision makers** about the economic and environmental importance of ornamental horticulture as part of Canadian agriculture. It provides a unified voice for public policy related to its sector's **competitiveness and new market opportunities**. It plays a key role in enhancing recognition of the value and benefits that ornamental horticulture products and services providers deliver to the Canadian economy and Canadians. COHA has a forward-thinking culture and is committed to **leading research and innovation** to enhance the application of science and technology in its sector. COHA's research clusters have played an integral role in how the Alliance continues to fulfil its mandate by supporting a strong research and innovation ecosystem where government, non-government organizations, industry, scientists, and academia can tackle current challenges as a team — sharing different perspectives, expertise, and resources.

The following is a high-level account of what COHA research clusters, in partnership with Agriculture and Agri-Food Canada (AAFC), have accomplished from 2008 to 2022, with a focus on most recent research activities and findings. Specifically, how its research outcomes and outputs have positively impacted the Canadian ornamental horticulture sector so far and how it plans to continue its efforts in research and innovation to benefit Canada.

Delivering on Promises to Government and Industry

COHA is a proactive alliance between the *Canadian Nursery Landscape Association (CNLA)*, *Québec Vert (QV)*, and the *Flowers Canada Growers (FCG)*. This alliance not only provides a unified voice, but also has a bird's eye view over the largest and most significant sector of horticulture and one of the most important agricultural sectors (in terms of farm gate sales, size, etc.) in Canada. Its reach spans the entire country. Therefore, COHA is best placed to stimulate collaboration and partnerships that aim to address sector challenges of a national scope as it continuously supports forward-looking research that is relevant and practical to the ornamental horticulture sector. This includes floriculture and greenhouses, nurseries, sod production, Christmas tree farms, and landscaping services — as well as their respective value chains. COHA continuously advances the Canadian ornamental horticulture sector through its research and innovation.

Since 2008, COHA's research program has successfully hosted three iterations of the AgriScience Program Cluster Component as part of its industry-driven and solution-oriented approach to support the Canadian ornamental horticulture sector, bringing together government, non-government organizations, industry, scientists, and academia to solve real-world, sector-specific problems. From its inception, COHA's research program has progressively increased the sector's research capacity, notably through setting research priorities, administering research funds, and applying on behalf of all three sector organizations for additional funding. This has increased engagement with new researchers and research groups, which in turn has led to an increased diversity of applicants and, ultimately, funded projects from research clusters 1 to 3.



As part of the funding agreements with AAFC, work plans were submitted for each research cluster, outlining priority research themes and projected outcomes that would benefit the sector — projecting advancements and solutions to enable the ornamental horticulture sector to continue innovating, growing, and prospering in the 21st century. From 2008 to the present day, COHA (via the AgriScience Program) has enabled research focused on issues of growing concern (such as economic and environmental sustainability, as well as climate change adaptation), including promising areas for the future (like expanding to new markets, using new technologies, and increasing overall efficiency in production). The sections below highlight outputs that are aligned with the originally proposed deliverables as achieved impacts on the sector.

First Research Cluster (2008 – 2013):

The Inception

The ornamental sector first participated in AAFC's AgriScience Program via COHA's research cluster in 2008 through a strategic partnership with the Vineland Research and Innovation Centre (VRIC). VRIC led this first research initiative, which aimed to advance solutions on extremely specific issues and challenges within the ornamental sector. This first research cluster gave way to 16 successful research projects, representing teamwork among Canadian academia and provincial/territorial government partnerships, including international collaboration. Research topics ranged from improved energy efficiencies and biological control agents to the application of pre- and post-harvest treatments to maintain product quality.

This first research cluster served as a steppingstone for COHA to strengthen its alliance with partnering organizations and enhance its research capacity across Canada. It also paved the way for ornamental horticulture research and innovation to gain momentum across academia and industry in collaboration with government.

For more information, please visit the Research Cluster 1 webpage.

Second Research Cluster (2013 – 2018):

Advancing Research and Innovation

Building upon the experience acquired while supporting the first research cluster, the second cluster program was managed and led by COHA, with administrative support from the Agricultural Adaptation Council (AAC). This research cluster was a coordinated effort of eight research projects aiming to:

1. Enhance competitiveness and increase sustainability
2. Grow the economy and expand the market

Research topics ranged from biological pest control to the exploration of new market opportunities. COHA research cluster projects were specifically designed to develop more efficient irrigation strategies, better fertilization advice, new plant species (representing new market opportunities), enhanced production techniques, and practical biocontrol strategies. COHA delivered on these items and empowered the sector to be:

- **More environmentally sustainable** via new irrigation systems that reduce water consumption, fertilization protocols that require less inputs and create less runoff and encouraging greater adoption of biological control agents (while reducing traditional pesticide use) by demonstrating their effectiveness and optimizing their use.
- **More competitive and profitable** by decreasing inputs needed to acquire the same yield and increasing market opportunities through new products with various planting applications.

For more information, please visit the Research Cluster 2 webpage.

Third Research Cluster (2018 – 2023):

Accelerating Green Plant Innovation for Environmental and Economic Benefit

This research cluster consisted of ten research projects, representing collaboration among Canadian academia, provincial/territorial governments, and industry, with a revived partnership with VRIC. Once again, it was led and managed by COHA with administrative support from CanLead Solutions — previously the Agricultural Adaptation Council (AAC). Priorities for the third cluster included:

1. Adapting to climate change
2. Enhancing environmental sustainability
3. Increasing competitiveness through productivity gains

Through this research cluster, COHA intended to develop cultivars and breeding lines that are better adapted to changes in climate (current and projected); efficiencies in the use of water, fertilizers, and biological controls; advancements in productivity and yield in relation to inputs; and approaches to utilize LED technology and new precision measuring devices. So far, through its research cluster partnerships and activities, COHA is successfully providing the industry with the means to be:

- **More adaptable in the face of climate change** by using new breeding techniques in ornamentals and turf to address pest and disease pressures, as well as extremes in temperature.
- **More environmentally sustainable** by using optimized nutrient delivery and water utilization systems that help reduce impacts on the environment.
- **More competitive** by using new protocols to enhance yields in relation to required inputs and by utilizing modern technologies to improve ornamental crop production, contributing to the competitiveness of producers and the sector.

Fact sheets and infographics summarizing the results of this most recent research cluster have been included in this document.

Impacting the Sector and Value Chain

Today, the Canadian ornamental horticulture sector is the fifth largest agricultural sector in Canada, with a value chain in sales and services of over $12.8 billion, employing over 220,000 Canadians and contributing to Canada's green economy. Nurturing a robust domestic research and innovation capacity is key to ensuring that Canada's ornamental horticulture sector can gain and maintain competitive advantages. Quickly evolving technologies, improved production, storage, transportation and marketing practices, mechanization, and new business models are all examples of areas where new scientific discoveries and innovative ideas can become successful business practices. Keeping up with rapid changes in demand from consumers for new varieties — especially low-maintenance species that survive well in more hostile environments — is a constant pressure for Canada's ornamental sector so that it can remain competitive and grow in both domestic and international markets, which includes adapting to a changing climate.

Canada aspires to be a leader in ornamental horticulture and has the potential to do so by cultivating its own advancements and innovations. If not, producers, farmers, and growers would have to resort to modifying and adapting research protocols and techniques developed in other countries to the Canadian context. Alternatively, for those who have the funds and expertise to do so, research would be conducted on individual farms and innovations would not be mobilized nationally. These approaches are not ideal for maintaining competitiveness in a global market or ensuring resiliency in the face of climate change. Unlike most other agricultural sectors in Canada, AAFC does not currently have research scientists, specialists, or research centres devoted to advancing the ornamental horticulture sector. This represents a gap in supporting Canada's

leadership in ornamental horticulture at an international scale. Without government financial support (like the AgriScience Program), research and innovation in Canadian ornamental horticulture would solely rely on partnerships between the scientific community and industry members to solve its problems and overcome its challenges in maintaining economic and environmental sustainability. Research would be conducted at a smaller scale and lack nationwide coordination.

With COHA research clusters being backed by industry partners, industry can be actively involved in research, thus enabling COHA to determine the best problems to work on that will have the greatest impacts — it's a win-win for the sector and its entire value chain! Some of the findings made and novel practices or technologies validated through COHA research have the potential to be applied within other agricultural sectors in Canada to promote economic and environmental sustainability more broadly. Thus far, COHA research clusters have not only accomplished their set research objectives (as per research work plans), they have also significantly contributed to the Canadian ornamental horticulture sector in other ways, namely to its **capacity to mobilize knowledge**, **competitiveness**, **resiliency**, **economic growth and viability**, and **environmental sustainability**. The following subsections briefly describe these impacts, with some key examples.

Knowledge mobilization

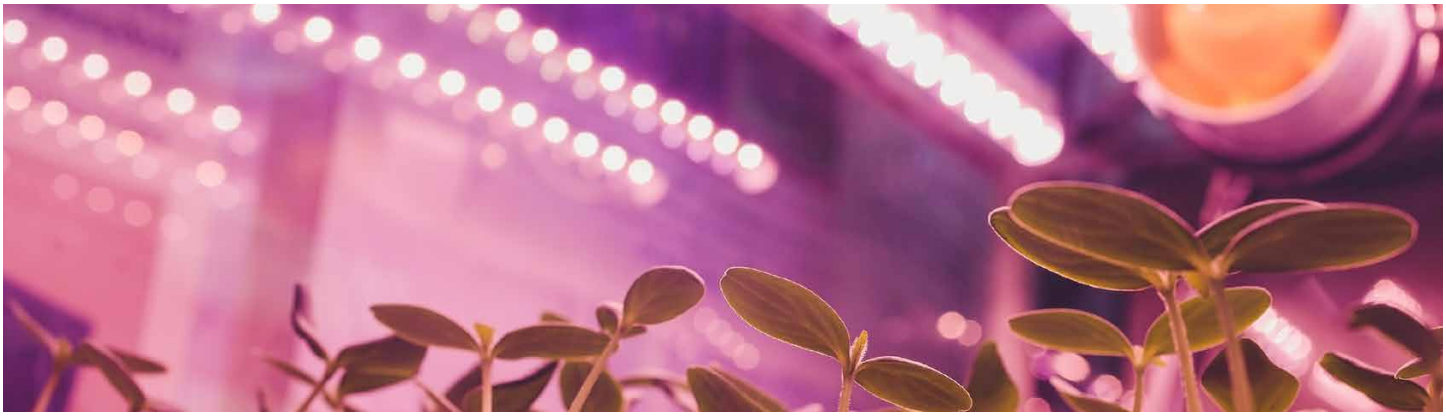
A key element of the AgriScience Program is communicating research results, both in terms of knowledge and technology, throughout the Canadian ornamental horticulture value chain, government, and the Canadian public. The COHA research cluster program has itself been an important platform to mobilize knowledge, as all three sector organizations (CNLA, QV, and FCG) closely collaborate. Consequently, these sector organizations have become more aware of the issues facing the sector from one coast to the other. The cluster structure has strengthened these partnerships and enhanced the transfer of information among COHA's members. Research clusters have thus enhanced the coordination of ornamental horticulture advancements. This subsection describes how COHA research clusters have been able to mobilize knowledge successfully and efficiently within the ornamental horticulture sector.

Empowering decision makers

One key component of knowledge mobilization is empowering both industry and policy decision makers with evidence to make informed decisions regarding practices and regulations. For example, COHA research cluster work was able to debunk the myth that high nitrate ratios produce smaller plants and that high ammonium ratios produce larger plants. This is valuable knowledge for producers and growers following traditional methods to help them adjust their nutrient and fertilization protocols accordingly. As another example, COHA research has shown that fertilized turf requires less water than unfertilized turf — contrary to past beliefs. Furthermore, properly maintained turfgrass has been shown to reduce runoff volume and phosphorus loss compared to unmaintained turf. This is critical information for government agencies and municipalities considering changes to bylaws that restrict the use of fertilizers on turfgrass to protect nearby water bodies. It is equally valuable to Canadian sod growers and turfgrass managers countering increased regulations in their regions.

Enhancing knowledge exchange pathways

COHA is also committed to maintaining and expanding existing knowledge exchange pathways within the sector. This includes having researchers continue to participate and present at relevant conferences (e.g., Canadian Greenhouse Conference) and publish in peer-reviewed scientific journals. Many researchers also host demonstrations on farms, which has been very successful at reaching growers. These avenues have been successful in informing extension specialists as part of their role in supporting producers to adopt new practices and technologies. COHA also hosts an Annual Research Webinar where all funded researchers present their latest findings. This 1-day event is recorded and posted to the COHA website, along with a French translation of the transcript. This allows for the presentations to be viewed and shared online. COHA hopes to expand its capacity to conduct broader sector analysis to gain information on the uptake of research cluster outputs — how producers/growers find out about COHA research findings and how these findings are being adopted, for instance. Growers usually rely heavily on field consultants, extension specialists, or private and/or government advisers to gain such knowledge. In many cases, producers engage directly with COHA research cluster primary investigators for assistance or advice in terms of translating research findings into practical applications. COHA research clusters have provided the means for Canadian research groups to develop relationships with businesses that are interested in funding research, like input suppliers, breeders, and various technology companies. COHA continues to foster these two-way relationships between the sector's research community and industry members as an essential knowledge exchange mechanism.



Creating accessible knowledge products

The latter scenario is not true for every new protocol or technology stemming from COHA research that is looking to be adopted. Some producers take it upon themselves to implement new protocols and technologies. For producers who want to educate themselves on innovative production ways, access to practical knowledge can be an obstacle. In fact, having access to peer-reviewed, practical information, and having it readily available and easily digestible is a major challenge in the ornamental horticulture sector. Producers can easily be bombarded with biased information that has not been independently verified, often coming from product manufacturers themselves. Sometimes, the issue might be that the research on certain topics is not yet published and available to the public. COHA research clusters have been able to equip the sector with evidence-based knowledge products and tools for making informed decisions.

Sector competitiveness

Ensuring the ornamental horticulture sector's competitiveness is essential, especially in a globalized market where competing American products are so easily available. Part of promoting competitiveness is ensuring that Canadian producers and growers are being practical and optimal in production. COHA research clusters have produced various recommendations for becoming more economical — allowing them to save money and increase efficiency! An example of this is a protocol for controlling weeds in turf that does not require using costly, conventional herbicides. It has also offered recommendations on the practicality of plant nutrient management. As examples, recommendations have been provided for nutrient management in limited bedding plant height, as well as optimized delivery of macronutrients (like magnesium and calcium) and micronutrients (like zinc and copper) using sub-irrigation and drip-irrigation. Such guidance is intended for producers and growers to update their production processes to maintain a competitive advantage.

Leveraging the latest technologies

Another way to enhance the sector's competitiveness is by ensuring that industry is utilizing available technologies to their full potential. There can be some reluctance to adopt certain technologies, especially if the equipment is complex or costly, and its benefits are not so evident. COHA research clusters have been instrumental in promoting the use of innovative technologies, as well as automation, to remain competitive. COHA research has led to a comprehensive list of water treatment technologies with specific and useful information to encourage immediate adoption. It has also validated existing technologies, such as CropAssist — an automated system for directly measuring greenhouse tomato growth and water use — to be used as a highly effective approach for ornamental plant production.

Enhancing risk management and sector resiliency

Beyond being practical and leveraging technology for optimal production, the sector must efficiently manage risks to remain resilient. Namely, pests are a huge source of revenue loss for the ornamental horticulture sector as they can rapidly cause a lot of damage to crops and are difficult to eliminate. COHA research clusters have offered ways for producers and growers to minimize profit loss due to common pests. For example, research led to new recommendations for growers to enhance aphid control, which is a major pest within greenhouse production. COHA research clusters have also provided better ways of controlling certain plant diseases and pathogens. Examples include successful pathogen suppression using vermicasting and pine bark as natural substrates, as well as some pre-and post-harvest treatments (like 1-methylcyclopropene) and antimicrobials for reducing disease in cut flowers. Notably, Dr. Rose Buitenhuis' work on evaluating changes in production practices, like implementing more sustainable production and pest control practices (including natural enemies, biopesticides and biostimulants), is a significant step forward in increasing plant health and production efficiency while effectively managing risks in floriculture crops in Canada.

Building capacity

The ornamental horticulture sector's resiliency also lies in building its capacity — encouraging, training, and empowering the next generation of producers and researchers in this field. COHA research clusters have successfully trained — and was a source of mentorship — for hundreds of students at various academic levels, exposing them to different facets of the sector and its value chain through problem solving, engaging with end-users, and exploring innovative solutions. Furthermore, COHA research clusters have been the foundation for some Canadian scientists to build a career in ornamental horticulture research. For example, Dr. Guillaume Grégoire first started as a researcher with COHA through the AgriScience Program and is now a full-time professor at Université Laval doing research for the ornamental horticulture sector.

Economic growth and viability

COHA is an alliance of three associations that each develop industry-driven research priorities and commitments. From 2008 to the present day, all three associations have increasingly devoted time and resources to envision the sector's future research needs. Having a high-profile funding program that involves all three partners boosted research visibility for producers across Canada. The success of the first research cluster led to greater interest and involvement by various stakeholders in the second (and third) cluster that were not initially involved, having had more awareness and acknowledgement of the research program. Also, from the first cluster proposal being written by VRIC to other clusters being solely led by COHA, a natural progression of leadership from industry occurred — where industry has become much more involved in the administration of the research program (the call for proposals, looking for feedback, and probing members on research priorities, etc.).

Increasing industry investments

This progression in leadership has come hand in hand with an increased investment from industry in COHA-led research over the years. The ornamental horticulture industry increasingly sees the value of research and innovation as shown by its progressive investment (cash and in-kind contributions) in COHA's research clusters from 2008 to 2018 — industry funding (cash and in-kind contributions) for Cluster 1 was $0.5 M, Cluster 2 was $1.6M, and Cluster 3 is $1.9M — with increased cash contributions for research clusters 2 and 3.

Although the number of funded research projects has not increased for the third research cluster, its projects have wider scope and larger impact. The industry has also been making longer-term investments to advance the ornamental horticulture sector in Canada. This is happening through sustainable commitments for research and innovation, such as the Memorial University of Newfoundland and Labrador Botanical Garden (MUNBG) investing in a tissue-culture lab to ramp up the numbers of perennials that can be trialed in nurseries. It is also happening through the commercialization of COHA research cluster products into the Canadian market, such as VRIC recently launching Crazee Mite (*Anystis baccarum*), a biocontrol game changer that was developed and validated through COHA research. The collaborative nature of the research clusters has also allowed for smaller businesses with limited funds — that did not anticipate being able to do research — to invest via COHA research clusters, alongside other small businesses, to investigate issues important to them.

Bringing new products to market

COHA research cluster activities empower the sector with ways to continue to grow and remain sustainable. COHA research clusters have contributed to the sector's economic growth by directly promoting new ornamental horticulture products to expand the sector's market. For example, new or underused native Canadian plants that have proven potential as low maintenance ornamental plants (e.g., Iceberg Alley willow made available in 2020); new or underutilized plants for green roof plantings that can have promising winter survivability, are low maintenance, and/or perform well in harsh conditions (e.g., urban areas); and three new biocontrol agents for Foxglove aphids (i.e., novel predatory mite, Met52 EC biopesticide, and pea protein biopesticide) brought to the commercialization stage by industry partners.

Environmental sustainability

While economically growing the sector, we need to find a balance regarding environmental impacts. There is increasing pressure to protect the environment and develop more sustainable ways to be productive and profitable in Canada, especially in the face of climate change and increasing environmental conversation efforts. COHA research clusters have empowered the sector with ways to enhance energy conservation, reduce water consumption and water quality impacts, improve fertilization practices, and deploy environmentally mindful pest management measures (that use less chemicals and utilize more biocontrols). The following subsection describes some examples to highlight these impacts on environmental sustainability.

Conserving energy

Energy efficiency work is an important way to become environmentally sustainable. COHA research clusters have contributed new ways of conserving energy during production. For instance, COHA research has shown up to 20% energy reduction via a new protocol that combines reduced nighttime temperature, morning carbon dioxide (CO_2) injections, and ventilation control, as well as new greenhouse heating and climate control strategies that conserve energy without sacrificing timely production and plant quality. More growers have moved to energy efficient lighting options and schedules as a result from Dr. Youbin Zheng's work on LED lights for ornamental crop production (Research Cluster 3). Although there are very promising findings for energy efficiency in the sector, the adoption of such energy conserving practices often demands a higher investment to put them into practice. Therefore, some of these new practices or technologies have not yet been broadly adopted by the sector. It may be an indication that supportive funding is required for implementation or simply that these larger changes to current practices take time. Such barriers can hopefully be overcome through additional funding and future partnerships targeted towards implementation.

Protecting water

Likewise, water irrigation and treatment systems can be a costly investment to make for producers. Therefore, broader adoption has been slower. Reducing water consumption and water quality impacts have been a focus of COHA research clusters. Keeping the challenges of implementation in mind, COHA has offered easier ways for industry to become more water conscious — by applying already existing technologies to the ornamental horticulture context, as well as ways to safely recycle water. As a first example, one COHA research cluster project brought forth a better way to manage water resources with reduced impact on the environment through precision irrigation that ensures that the right amount of water is given

to the right plant at the right time. The use of wireless tensiometers in nurseries is a prime example of how existing technologies can be applied to different settings and more readily implemented. Another example is Hybrid Treatment Systems, shown to be highly effective at removing plant growth regulators (PGRs) and pesticides from return irrigation water. Dr. Ann Huber's work is a significant step towards increasing safe recirculation of irrigation runoff in greenhouses and container nurseries by implementing efficient water recycling mechanisms. This research team also produced a demonstration video that shows how such a system can be put together to encourage its adoption.

The consumption of water is not the only environmental concern regarding the sector's impact on water resources. Water quality, especially related to fertilization practices, and the leaching of chemicals into nearby waterbodies, is of great concern. COHA research clusters have been able to identify best fertilization practices for different soil types, especially for high quality turfgrass, while minimizing nitrate losses through leaching. Some turf growers and managers have successfully reduced their fertilizer use based on these findings and recommendations. Specifically, Dr. Barry Shelp's work on optimizing nutrient delivery (Research Clusters 2 and 3) has been adopted by several growers in Canada.

Reducing the use of chemicals

Finally, the use of traditional chemicals for pest management is a growing worry for the environment and reducing their use has been at the forefront of research within the sector. COHA research clusters have largely increased the use of biocontrols as an environmentally friendly alternative and highly effective alternative to conventional pest management approaches in the sector. For example, research has led to the development of cost-effective best management practices for the seasonal use of predatory mites in greenhouses; evidence-based recommendations for an Integrated Pest Management (IPM) strategy against Foxglove aphids which significantly reduces the number of chemical sprays used; and greater knowledge of biocontrol agents for turf. Overall, biological control measures and practices developed through COHA research clusters have been widely adopted and implemented in production practices as pest control measures lend themselves to adoption more readily.

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Research Cluster 3:

Fact Sheets and Infographics

BETTER PRODUCTION PRACTICES FOR BETTER THRIPS CONTROL

Changing production practices to increase plant health and production efficiency in floriculture crops

Project Summary

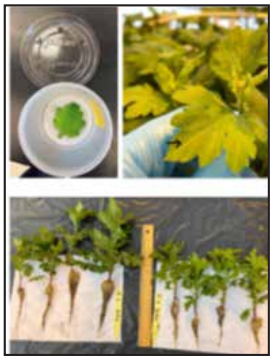
Pests, such as thrips, are a major problem for floriculture crops. Thrips are attracted to and perform better on plants that are high in nitrogen – one of the main ingredients in standard fertilizer. This project is looking at ways to reduce fertilizer use and make floriculture crops less susceptible to thrips infestations while avoiding impacts on plant growth. Research conducted so far confirmed that reduced fertilizer use can indeed lead to less thrips, but this effect is overshadowed by the effect of different chrysanthemum varieties. Also, a few biostimulant products were tested, but these could not compensate for reduced fertilizer use.

Growers need new ways to slow down pest population growth as well as increase the performance of biocontrols. This research investigates cutting dips to knock down pest populations for biocontrol agents to gain a kick-start. It is also exploring how plant resilience can be enhanced by optimizing plant nutrition to reduce pest population and using biocontrol agents to manage any residual pest population. Pests are attracted to plants based on their nutritional value. This is largely determined by the level of organic nitrogen in a plant. Nitrogen is one of the main ingredients in fertilizer. Reducing fertilizer use cuts input costs and could also make plants less susceptible to pests by lowering their nutritional value while increasing their internal defenses. The project also investigated whether biostimulants may be used to compensate for reductions in nutrients.

The objectives of this project were to:

- Eliminate or reduce thrips infestations on imported propagative material using cutting dips in reduced-risk insecticides
- Optimize fertilizer use (nutrients and biostimulants) to reduce thrips outbreaks and understand how fertilizer reductions impact biocontrol agents
- Validate how effective these new practices are by growing two crops from start to finish in commercial greenhouses

What you need to know



- High fertilizer use creates the perfect host plant – higher nutrients and lower plant natural defenses – for thrips infestations.
- Thrips' performance is highly variety dependent
- Reduced fertilizer rates affected plant quality. Tested biostimulants did not affect thrips and were not able to help chrysanthemums compensate for reduced nutrient input.

Watch a video presentation on this research project by clicking here. You can also watch a video about cutting dips here (1:01:17).

For more information, contact: **Dr. Rose Buitenhuis** rose.buitenhuis@vinelandresearch.com

Research Takeaways

- Dipping unrooted cuttings reduces pest populations and gives biocontrol agents a kick-start which increases the success of an IPM program
- Reducing fertilizer use leads to direct cost savings and may reduce thrips population growth
- Selecting resistant varieties is key

Read more about it

New Control Strategy for Thrips in Chrysanthemum

Bio-pesticides bloom in greenhouses

BETTER PRODUCTION PRACTICES FOR BETTER THRIPS CONTROL

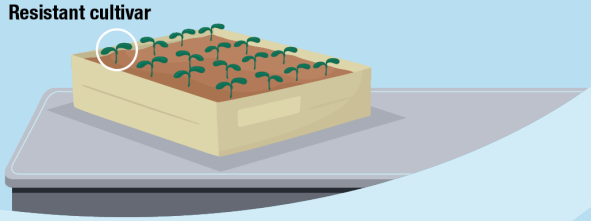
1 RESISTANT VARIETIES

Selecting resistant varieties is key.

Varieties with similar appearance are shown to have different susceptibility to thrips.

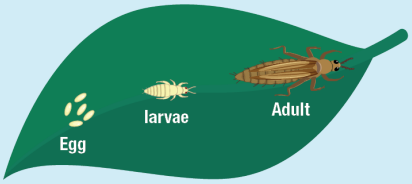
- Dipping cuttings can knock down pest populations and give biocontrol agents a kick-start.
- Reducing fertilizer is cost-effective and environmentally friendly, and can potentially help control thrips population growth.
- Tested biostimulants did not induce resistance to thrips in chrysanthemum nor did they help plants cope with reduced nutrients.
- Selecting resistant varieties is key as well as implementing a strong biocontrol program

Resistant cultivar

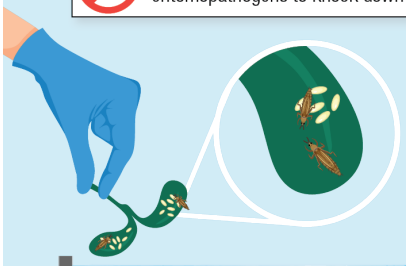


2 DIPPING INCOMING CUTTINGS

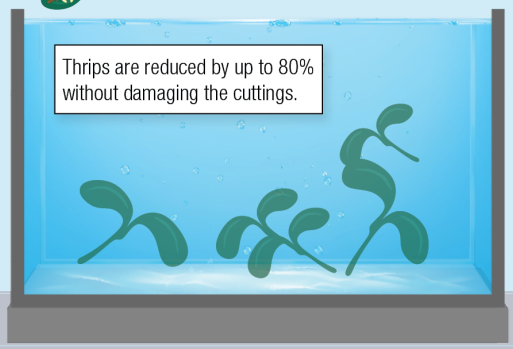
Life stages of thrips found on cuttings



Dip cuttings in products based on mineral oil or entomopathogens to knock down pest populations.



Assume that incoming cuttings already contain thrips.

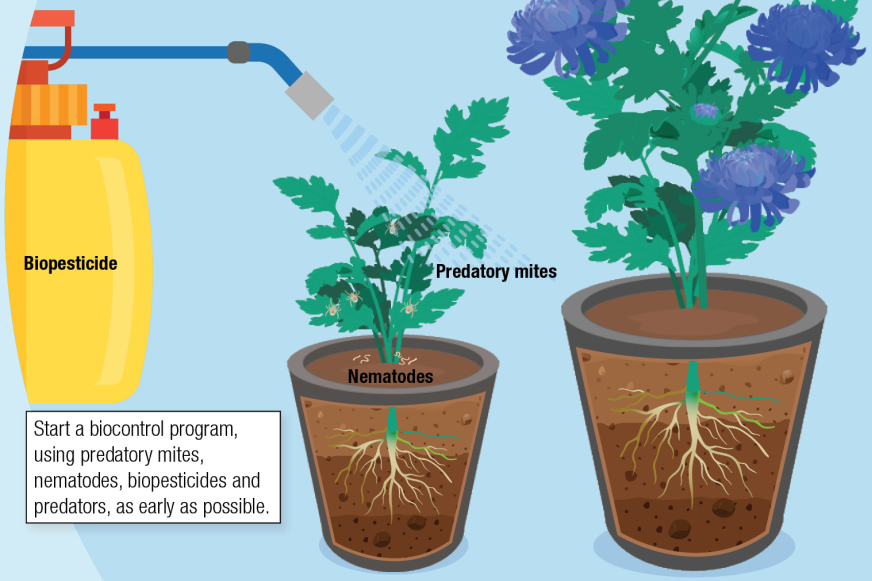


Thrips are reduced by up to 80% without damaging the cuttings.

3 REDUCE FERTILIZER IF POSSIBLE

More fertilizer means more nitrogen.

High fertilizer use creates the perfect host plant – higher nutrients and lower plant natural defenses – for thrips infestations.



Start a biocontrol program, using predatory mites, nematodes, biopesticides and predators, as early as possible.

X Biostimulants were tested; in chrysanthemum, they did not have any effect on thrips infestation nor did they help plants cope with reduced fertilizer.

The effect of chrysanthemum variety on thrips performance was stronger than the effect of fertilizer.

Advancing the sector through research.

For more information, contact:
Dr. Rose Buitenhuis rose.buitenhuis@vinelandresearch.com

LESS WATER AND HIGH-QUALITY PLANTS WITH PRECISION IRRIGATION

Irrigation efficiency in nurseries: Towards a more sustainable approach

Project Summary

Irrigation is one of the most important factors for nursery profitability. Yet, most growers base their decision making on visual appearance or pot weight. This project is looking to optimize irrigation management using wireless tensiometers combined with different automation strategies to develop recommendations and best practices for clustering plants in nurseries. Research conducted so far has shown 50% less water used with tensiometers with no effect on plant growth, confirming that automated irrigation can be used to produce high quality plants. While clustering according to water needs is an efficient approach to reduce water use, attention must be paid when pairing the plants as different species with the same overall water needs may not require the same amount of water at the same time during a season.

The way we water plants in a nursery is one of the most important factors for being profitable. Even so, nursery water management largely depends on personal judgment rather than precise measurements. Also, it is an added challenge to optimally water a wide variety of species with different water needs that are being grown together. It is essential for industry to move towards precision irrigation to help growers save on water and reduce their environmental impacts to meet regulations.

Researchers hope to identify different options that can be used by growers regardless of the equipment or resources available to them.

The objectives of this project were to:

- Improve irrigation management using wireless tensiometers
- Recommend best practices for grouping plant species based on their water needs
- Compare different automation strategies using tensiometers

Canada

What you need to know

By using precision irrigation in a nursery setting, you can:

- **Decrease water use by 50%** without affecting plant growth due to decreased water leaching and evapotranspiration
- **Deal with different watering needs** throughout a season – if two plants require the same amount of water during a season, they may not need it at the same time
- **Automate irrigation** either by using evapotranspiration prediction or new generation wireless tensiometers to produce high quality plants

Watch a presentation on this research project by clicking here.

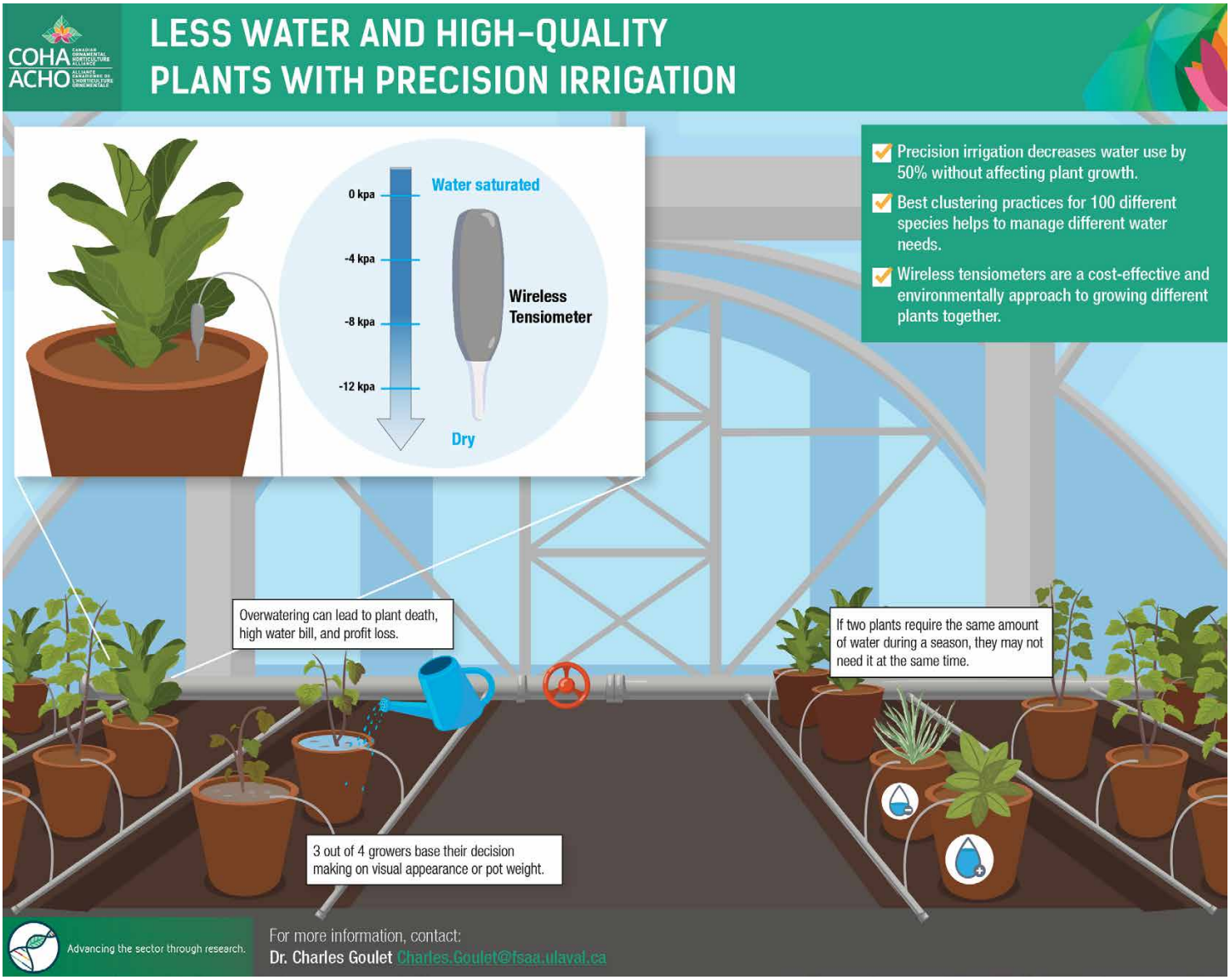
For more information, contact: **Dr. Charles Goulet** Charles.Goulet@fsaa.ulaval.ca

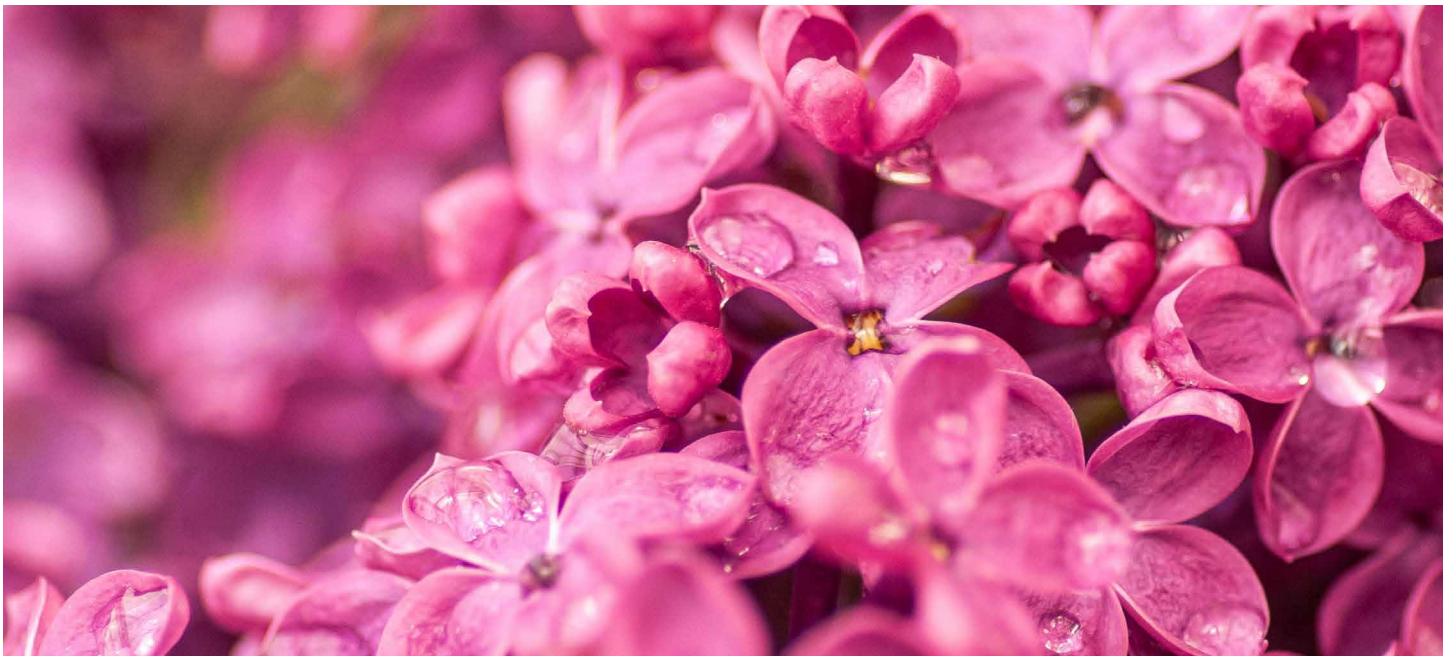
Research Takeaways

- Using tensiometers is very efficient
- Evapotranspiration-based irrigation is a great alternative
- 'Best clustering for 100 species' chart will be made available soon

Read more about it

Plantes ornementales – L'irrigation de précision en pépinière ; vers une approche plus durable [French Only]


COHA
ACHO
LESS WATER AND HIGH-QUALITY PLANTS WITH PRECISION IRRIGATION
Water saturated
0 kpa
-4 kpa
-8 kpa
-12 kpa
Wireless Tensiometer
Dry
Precision irrigation decreases water use by 50% without affecting plant growth.
Best clustering practices for 100 different species helps to manage different water needs.
Wireless tensiometers are a cost-effective and environmentally approach to growing different plants together.
Overwatering can lead to plant death, high water bill, and profit loss.
If two plants require the same amount of water during a season, they may not need it at the same time.
3 out of 4 growers base their decision making on visual appearance or pot weight.
Advancing the sector through research.
For more information, contact:
Dr. Charles Goulet Charles.Goulet@fsaa.ulaval.ca



HELPING TURF MANAGERS REDUCE FERTILIZER USE AND IMPACTS ON WATER

Optimizing turfgrass fertilization to reduce nitrate losses through leaching

Project Summary

Leaching of fertilizer nutrients into groundwater is a great concern for sod growers and turf managers. This project is looking at ways to improve fertilizer efficiency for turfgrass to reduce nitrate losses through leaching. Research conducted so far has shown that it is possible to maintain high quality turfgrass while reducing risks to water quality with minimal nitrate leaching. New protocols led to nitrate levels well below the Canadian standard for drinkable water.

Turf managers need to find ways of reducing the amount of nitrate losses while maintaining high quality turfgrass. The leaching of nitrates into groundwater is currently a major environmental downfall of sod production and turfgrass management. It is, however, possible to lessen impacts on water and be environmentally sustainable by optimizing the way fertilizer is used.

The aim of this research project is to improve fertilizer use for turfgrass to reduce nitrate-N losses through leaching. The objectives are to:

- Measure short-term and long-term nitrate losses from different fertilization strategies in different soils (loam, clay, and sand)
- Validate greenhouse results in an outdoor field trial

What you need to know

- It is possible to maintain a healthy lawn while reducing risk to nearby groundwater reserves
- New practices result in nitrogen levels well below the Canadian standard for drinkable water
- Best fertilization practices in loam, clay, and sand produce market standard high quality turfgrass

Watch a presentation on this research project by clicking here.

For more information, contact: **Dr. Guillaume Grégoire** guillaume.gregoire.1@ulaval.ca

Research Takeaways

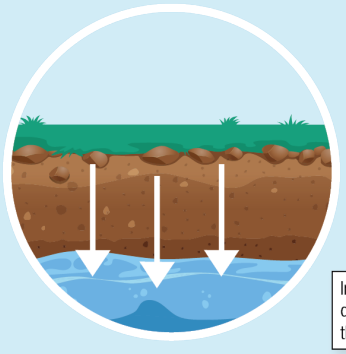
- Disturbing soil can lead to higher nitrate losses
- Not all nitrate sources are equal
- 150 kg of nitrate per hectare per year is sufficient to maintain high quality turfgrass

Read more about it

Reducing nitrate leaching losses from turfgrass fertilization of residential lawns

HELPING TURF MANAGERS REDUCE FERTILIZER USE AND IMPACTS ON WATER

- 150 kg of nitrate per hectare per year produces high quality turf
- Not all nitrate sources are equal and must be considered when choosing a fertilizer
- New fertilization practices are cost-effective and environmentally friendly



In moist soil, **PCFs** use temperature-controlled diffusion to regulate the release of nitrogen to match the plants needs and reduce nitrogen losses.

Polymer-coated fertilizers (PCFs)

Nitrogen stabilizers

Nitrogen stabilizers in fertilizer also help prevent losses by blocking parts of the nitrogen cycle that lead to nitrogen loss.

Not all nitrogen sources are the same. Polymer-coated fertilizers are more efficient than stabilized nitrogen.

Disturbing soil leads to higher nitrate loss.

Soil disruptions

Standard fertilization protocols call for > 150 kg of nitrate per hectare per year.

Standard Fertilization

Increased leaching

New fertilization protocol using 150 kg of nitrate per hectare per year produces market standard turf grass.

Optimal Fertilization

Loam

Clay

Sand

Mix

Nitrates

More leaching

Nitrates from fertilizers seep through the soil into nearby groundwater reserves which negatively impacts the environment.

Nitrogen levels are below the Canadian standard for drinkable water.

Nitrates

Less leaching

Cutting down on fertilization reduces the amount of nitrates that leach into nearby groundwater reserves.

Advancing the sector through research.

For more information, contact:
Dr. Guillaume Grégoire Guillaume.Gregoire@fsaa.ulaval.ca

INNOVATIONS FOR REMOVING CHEMICALS FROM RECYCLED GREENHOUSE WATER

Enabling recirculation with hybrid treatment systems

Project Summary

Water recycling has now become a necessity for lowering water consumption in greenhouses. Recycled water poses some risks and challenges. Recirculating water can contain residual nutrients, Plant Growth Regulators (PGRs), pesticides, and even pathogens that could contaminate crops. This project is looking at how well different media can remove common greenhouse chemicals from water to optimize the design of a Hybrid Treatment System (HTS) using woodchips, and a selection of mineral media including pea gravel, slag, wollastonite, and granular activated carbon (GAC) depending on grower requirements. Research conducted so far has shown that woodchips are almost as good as GAC for removing PGRs and many pesticides. Hydraulic retention time needs to be longer to remove pathogens compared to chemicals. Depending on the requirements, mineral cells can also be selected to remove chemicals and reoxygenate the water in a full system.

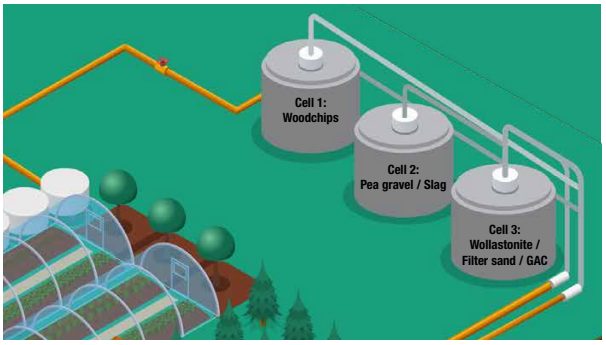
Current water restrictions and regulations are forcing greenhouse and nursery producers to lower their water consumption. A great way to better manage water use is by recycling water runoff. Using recycled water can be risky and measures need to be taken to ensure that the water is safe for reuse. Growers are particularly concerned about recirculating water containing Plant Growth Regulators (PGRs), pesticides, and pathogens which could contaminate and negatively affect crop production. Research is focused on improving the quality of recycled water using innovative ways to treat and safely recirculate water.

The objectives of this research project were to:

- Assess the ability of various media components of the Hybrid Treatment System (HTS) to remove common greenhouse PGRs and pesticides
- Optimize the sequence of media in the HTS design for the removal of PGRs and pesticides from greenhouse operational waters
- Improve the operational parameters of the current HTS design for removal of PGRs, pesticides, and pathogens

What you need to know

- Woodchip cells alone perform almost as well as the Granular Activated Carbon (GAC) – the "gold standard" for PGR and pesticide removal
- Hydraulic retention time for PGR removal is less than a day, but longer for removal of pathogens
- Mineral cells are important for other functions, such as re-oxygenation of the water or phosphorus removal, and should be included in a full treatment system



HTS media sequence examples:

Cell 1 = Woodchips
Cell 2 = Pea gravel / slag
Cell 3 = Wollastonite / filter sand / GAC

Watch a video presentation on this research project by clicking here.

For more information, contact: **Dr. Ann Huber** ahuber@srgresearch.ca

Research Takeaways

To design your own HTS, you must consider:

- Nutrients, plant pathogens, PGRs, and/or pesticides wanting to be removed
- Daily water volumes to be treated, including seasonal changes
- All water reuse volumes (indoor, outdoor, seasonal, plant stage, etc.) for proper water storage requirements for influent and effluent
- Outdoor space available for the treatment system
- The site's existing infrastructure (for collection, distribution, connection to facility computer control system, etc.)

Read more about it

Hybrid Treatment Systems for the treatment of horticultural production water

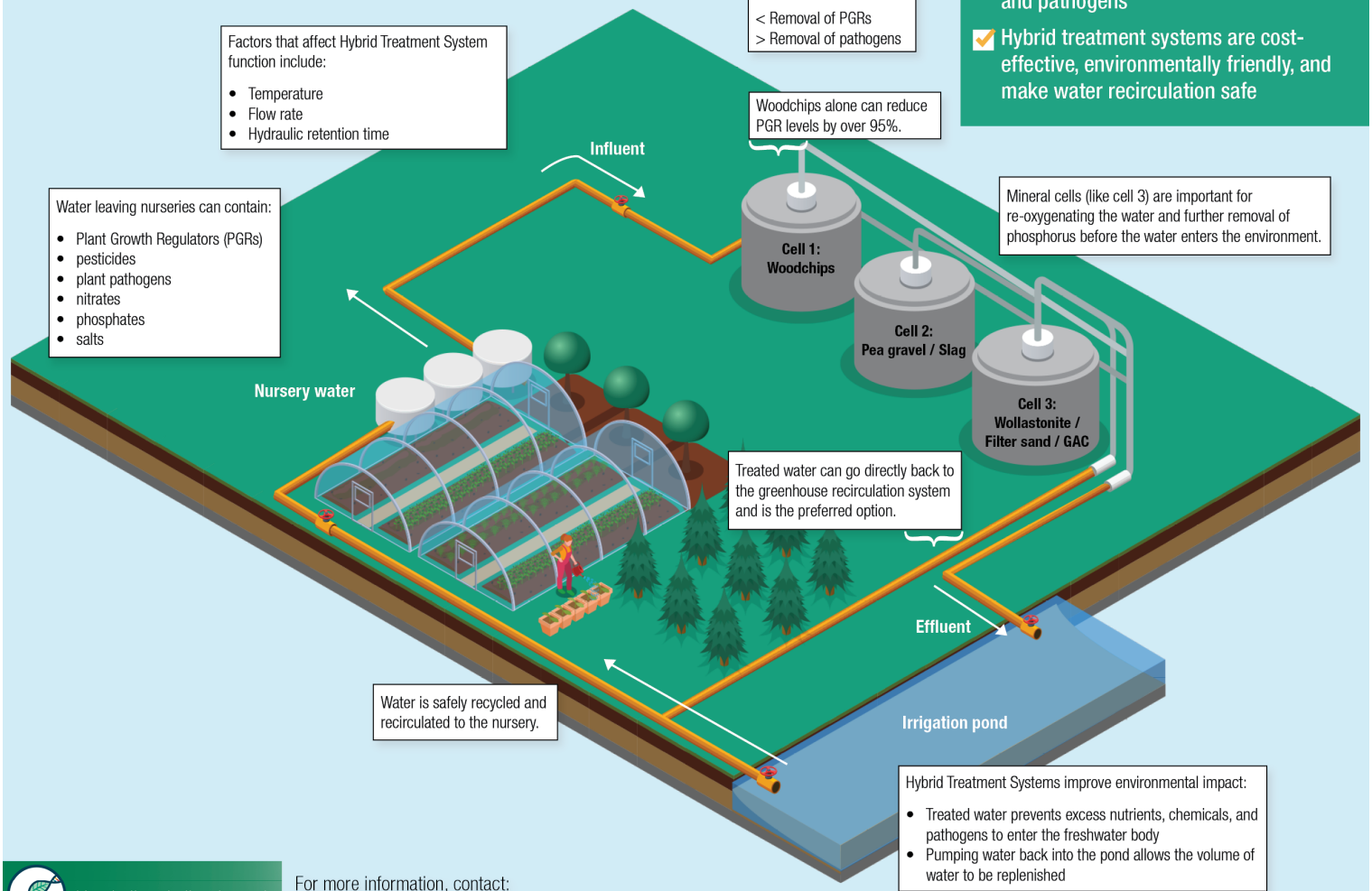
Water Treatment Guide for Greenhouses & Nurseries

Hybrid Treatment Systems show promise as an effective water filtration method for greenhouse and nursery growers

You can also watch an informational video on the function and benefits of Hybrid Treatment Systems here.

INNOVATIONS FOR REMOVING CHEMICALS FROM RECYCLED GREENHOUSE WATER

- Woodchips work almost as well as GAC for removing PGRs
- Multiple, sequential treatments are needed to properly remove chemicals and pathogens
- Hybrid treatment systems are cost-effective, environmentally friendly, and make water recirculation safe



Advancing the sector through research.

For more information, contact:
Dr. Ann Huber ahuber@srgresearch.ca

DOES THE TEMPERATURE WITHIN A PLANT AFFECT ITS GROWTH?

Temperatures within horticultural plants: Stems and Flowers – explaining rapid growth

Project Summary

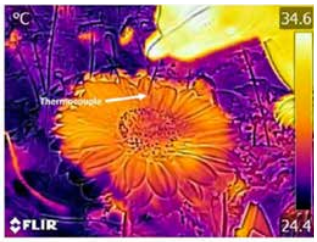
The role of climate and weather is well-understood for growth and productivity of horticultural crops, both outdoors and indoors. Thermal conditions that develop within plants (microthermal regimes) are poorly researched and understood. This project is reviewing and exploring temperature cycles within plants and looking at how they might be manipulated to enhance commercial value and decrease risks, like disease and pests. Research conducted so far shows that internal temperatures within plant structures (flowers, stems,s and fruits) are several degrees warmer than surrounding ambient air in sunny conditions – this phenomenon is known as a micro-greenhouse effect – and this is much more widespread and biodiverse than previously thought. Micro-greenhouse effects occur through plant pubescence and in enclosed spaces (like hollow buds, flowers, fruits, stems, and galls). These effects do not apply at night or under cloudy conditions. The micro-greenhouse effects can be explained through structure and function. The extent of the effects in flowers and stems of several floricultural species (Gerbera, Amaryllus, Narcissus, squash), fruits (ground cherry, black cumin, peppers, prickly cucumber, milkweed), and other hollow, translucent plant structures is still being investigated. Structure is probably important for understanding how heat should be re-assessed for crop growth, maturation, and productivity, especially with climate change.

The role of climate and weather is well-understood for growth and productivity of agricultural and horticultural crops, both outdoors and indoors. However, the subtleties of temperature within plants – known as microthermal regimes – remains largely unexplored. Gaining knowledge on the natural temperature cycles within plants shows great promise for manipulation during production to enhance commercial value and decrease risks, like disease and pests.

The objectives of this research project were to:

- Explore the anatomy and microscopic morphology of floral stems and flowers
- Understand how bettering the microclimate within plants affects growth, stem elongation, blooming and floral presentation
- Find out how to manipulate microclimates within stems and flowers to enhance commercial value

What you need to know



- Microthermal regimes within plants are a new area of research
- There is strong evidence of a micro greenhouse effect occurring in the hollow parts of Gerbera, Amaryllus, and Narcissus plants and in squash (stems, closed flowers, petioles)
- Temperature data analysis shows significant differences between stem temperature and air temperature – with the largest differences occurring during the daytime
- Manipulating microthermal regimes within plants could improve floriculture, aesthetics, as well as disease and pest control

Watch a presentation on this research project by clicking here.

For more information, contact: **Dr. Peter Kevan** pkevan@uoguelph.ca

Research Takeaways

- Micro-greenhouse effects occur through plant pubescence and in enclosed spaces (like hollow buds, flowers, fruits, stems, and galls).
- They have been explained through structure and function – known as "Heliocaminiform" structures which are widespread but hardly studied.
- These effects do not operate at night nor under cloudy conditions.

Read more about it

Exploring micrometeorology in plant stems and flowers

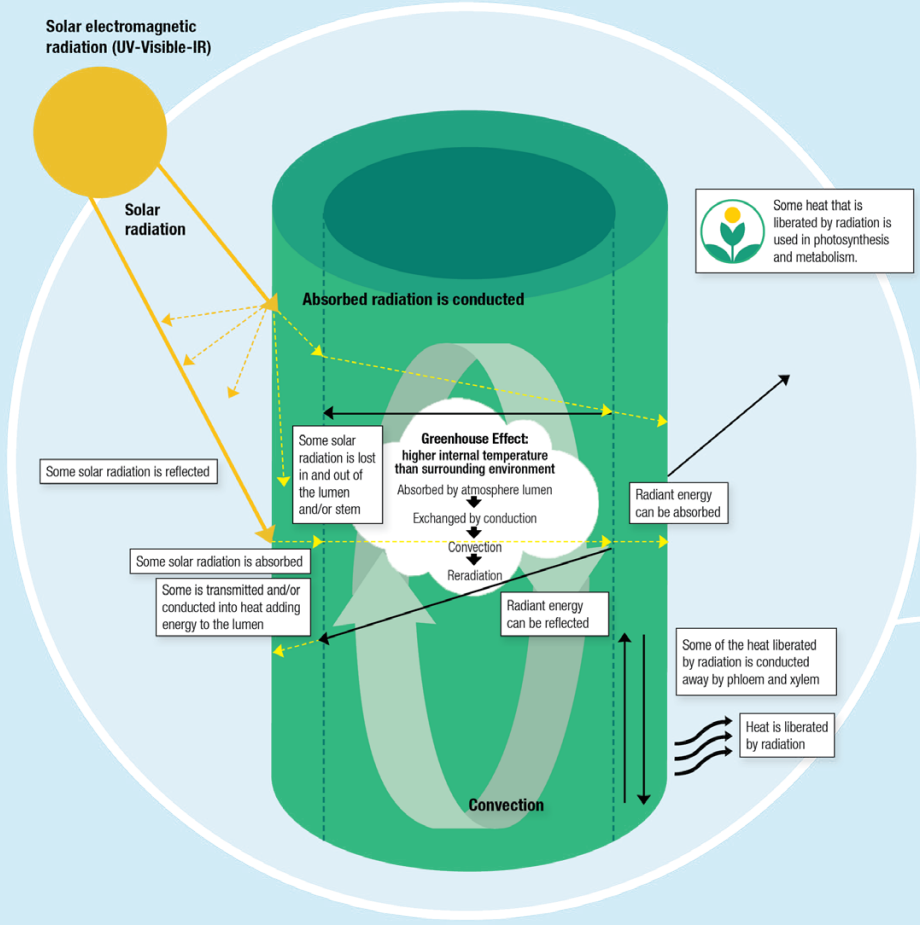
Understanding how temperatures within plants affect their growth

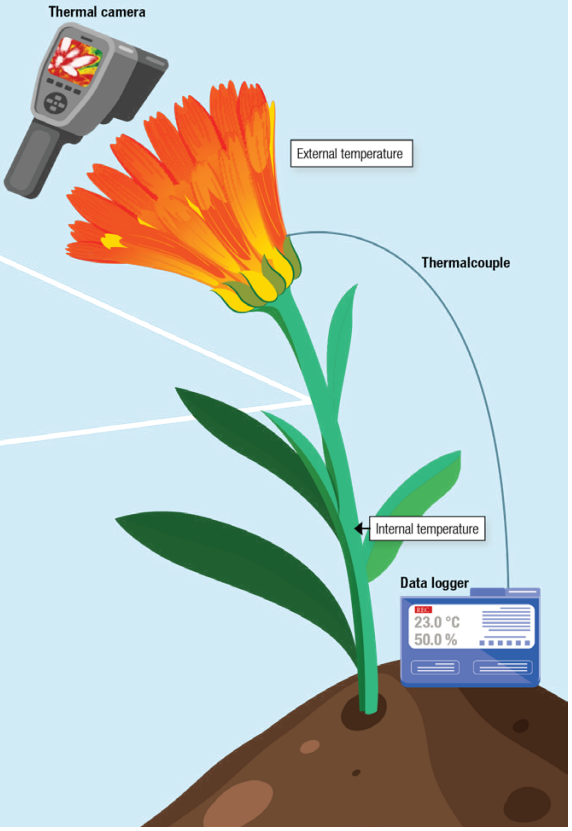
Secrets of the stalk: Regulating plant temperature from the inside out

DOES THE TEMPERATURE WITHIN A PLANT AFFECT ITS GROWTH?

HELIOCAMINIFORM MECHANISMS AND GREENHOUSE EFFECT

- Micro-greenhouse effects occur during plant pubescence and in enclosed spaces (like hollow buds, flowers, fruits, stems, and galls).
- They have been explained through structure and function – known as Heliocaminiform.
- Manipulating microthermal regimes within plants could improve floriculture, aesthetics, as well as disease and pest control.





Advancing the sector through research.

For more information, contact:
Dr. Peter Kevan pkevan@uoguelph.ca

GIVING CANADIAN SOD GROWERS A COMPETITIVE ADVANTAGE!

Integrating a genetic, agronomic, and economic approach to improving environmental adaptability and end use quality of creeping red fescue

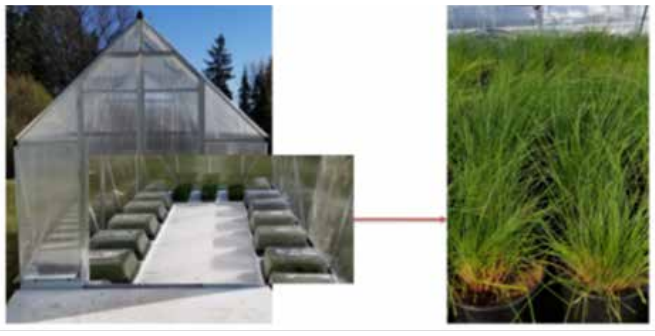
Project Summary

Creeping red fescue is a major export commodity for Canada. Currently, our seed production is lower than our main competitors. Research is focused on improving the global competitiveness of Canadian growers. This project is looking at ways for breeding creeping red fescue to become more resistant to disease and easily adaptable to different environments, how to improve seed productivity and quality, as well as the economics of changing the way we manage seed crops. One cycle of breeding selection has led to polycross seeds being used for a new cycle of selection.

Creeping red fescue is a grass that does well in cooler, shaded areas that requires little mowing as well as low input of fertilization and irrigation. Creeping red fescue is currently a $29 million per year export commodity. Canada competes with the U.S. and Denmark and is lower in seed productivity. This is making us less competitiveness in the international market. Creeping red fescue is often used in lawn mixtures for turf purposes around homes, buildings, and in parks. Research is geared towards improving how we breed and produce red fescue to gain beneficial management options and an economic advantage.

The objectives of this project were to:

- Breed creeping red fescue to be more resistant to disease and more adaptable in different environments
- Increase seed production and seed quality by regulating plant growth, nutrition, and better managing plant health
- Determine the economic profitability of these new ways to manage creeping red fescue seed crops



What you need to know

The project has completed one cycle of breeding selection leading to the production of polycross seeds and their regeneration for a new cycle of selection. Research is ongoing. Many areas were identified for future research, such as:

- Identifying genetic markers for disease tolerance, dark green coloration, fine leaves, and seed yield to improve the efficiency of the plant breeding
- Determining crop nutrient budget (uptake and losses) to improve nutrient management
- Tracking changes in soil health and gaseous emissions under different nutrient protocols
- Examining the effects of Plant Growth Regulators (PGRs) to induce plant dormancy, to suppress regrowth, and/or preserve the plants energy metabolism

Watch a video presentation on this research project by clicking here. Also, listen to a podcast by clicking here.

For more information, contact: **Dr. Nityananda Khanal** nityananda.khanal@agr.gc.ca

Research Takeaways

- There is a lack of locally adapted cultivar options
- Breeding was initiated in 2018 and will continue

Read more about it

Value of integrating perennial forage seed crops in annual cropping sequences

Integration of perennial forage seed crops for cropping systems resiliency in the Peace River region of western Canada

GIVING CANADIAN SOD GROWERS A COMPETITIVE ADVANTAGE!

Creeping red fescue is a widely used turf grass in the temperate and boreal regions of the world.

- There is a lack of locally adapted cultivar options in Canada
- One cycle of breeding selection in 2018 has led to polycross seeds being used for performance evaluation and new cycles of selection

ECONOMICS

- $29 million per year export commodity
- U.S. and Denmark are major competitors
- Analyze the economic benefit of new best practices

BREEDING

Selecting for genetic traits for:

- Disease resistance
- Adaptability to various environments
- Enhanced market value

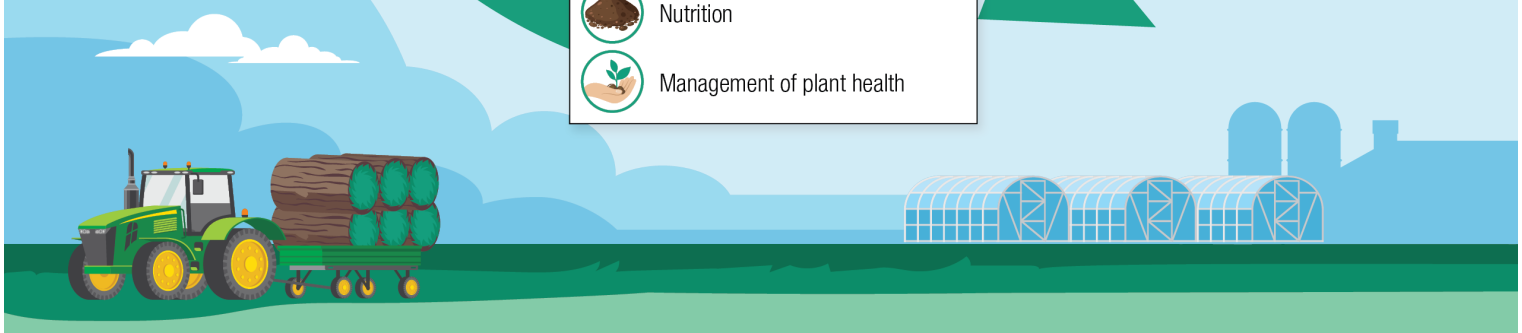
Areas for future research:

- Genetic markers for disease tolerance, dark green coloration, fine leaves, and seed yield for optimal efficiency of the plant population improvement
- Crop nutrient budgeting (uptake and losses) to improve nutrient management
- Soil health and gaseous emissions under different nutrient protocols
- Examining the effects of Plant Growth Regulators (PGRs) for plant dormancy, suppression of regrowth, and/or plant energy metabolism perservation

PRODUCTION

Seed production and quality through:

- Regulation of plant growth
- Nutrition
- Management of plant health



Advancing the sector through research.

For more information, contact:
Dr. Nityananda Khanal nityananda.khanal@agr.gc.ca

CUT NUTRIENT INPUTS WITH SUB-IRRIGATION AND DRIP-IRRIGATION

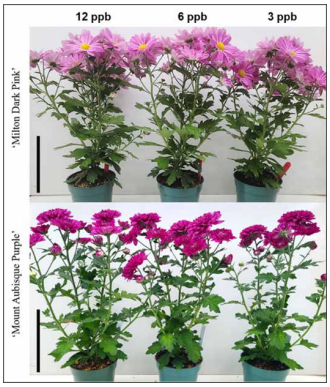
Optimizing nutrient delivery in greenhouse-grown potted chrysanthemums: Sub-irrigation and drip-irrigation systems

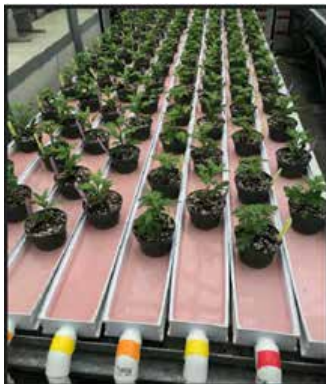
Project Summary

Growers are often looking for ways to improve nutrient delivery – to be more efficient with nutrient input without affecting plant growth or quality. This project optimized the delivery of both macro- and micronutrients to sub-irrigated and drip-irrigated potted chrysanthemums. Research demonstrated that the entire nutrient supply can be removed during flowering, without affecting plant and flower yield and quality at harvest. Subsequently, it was shown that the supply of individual nutrients during vegetative growth can be reduced by 75% or more based on industry standards using subirrigation without any negative effect. From this information, an optimized fertilizer protocol was designed and tested successfully with both sub-irrigation and drip-irrigation systems. This project improves timing and reduces fertilizer supply, reduces volume of nutrient-rich feedwater for treatment or discharge, and reduces environment risk, contributing to low-input floricultural operations. It is believed that this strategy can be applied to other greenhouse crops.

Growers need new ways to efficiently deliver nutrients to their crops to remain competitive. Nutrient use efficiency of modern cultivars of greenhouse-grown potted chrysanthemums can be improved by reducing nutrient supply during their vegetative growth, in combination with an interrupted supply during reproductive growth, without sacrificing plant yield and quality.

The objective of this project was to improve the delivery of both macro- and micronutrients using sub-irrigation and drip-irrigation for potted chrysanthemums.





What you need to know

Compared to industry standards, market-quality plants can be produced using sub-irrigation while reducing:

- Nitrogen, phosphorus, and potassium by 75 – 95%
- Calcium or magnesium by ~87.5%
- Zinc or copper by ~87.5%
- Manganese or iron by ~95%
- Boron or molybdenum by 75%

Watch a video presentation on this research project by clicking here.

For more information, contact: **Dr. Barry Shelp** bshelp@uoguelph.ca

Research Takeaways

- Timing is improved and fertilizer is reduced with sub-irrigation and drip-irrigation
- Directly reducing usage and cost of nutrients
- Minimizing the volume of nutrient-rich water discharged to be treated which improves environmental impact

Read more about it

Optimizing nutrient delivery in greenhouse-grown potted chrysanthemums

Another look at nutrient delivery for potted mums

Optimizing manganese and iron delivery for contrasting cultivars of subirrigated greenhouse-grown pot chrysanthemums

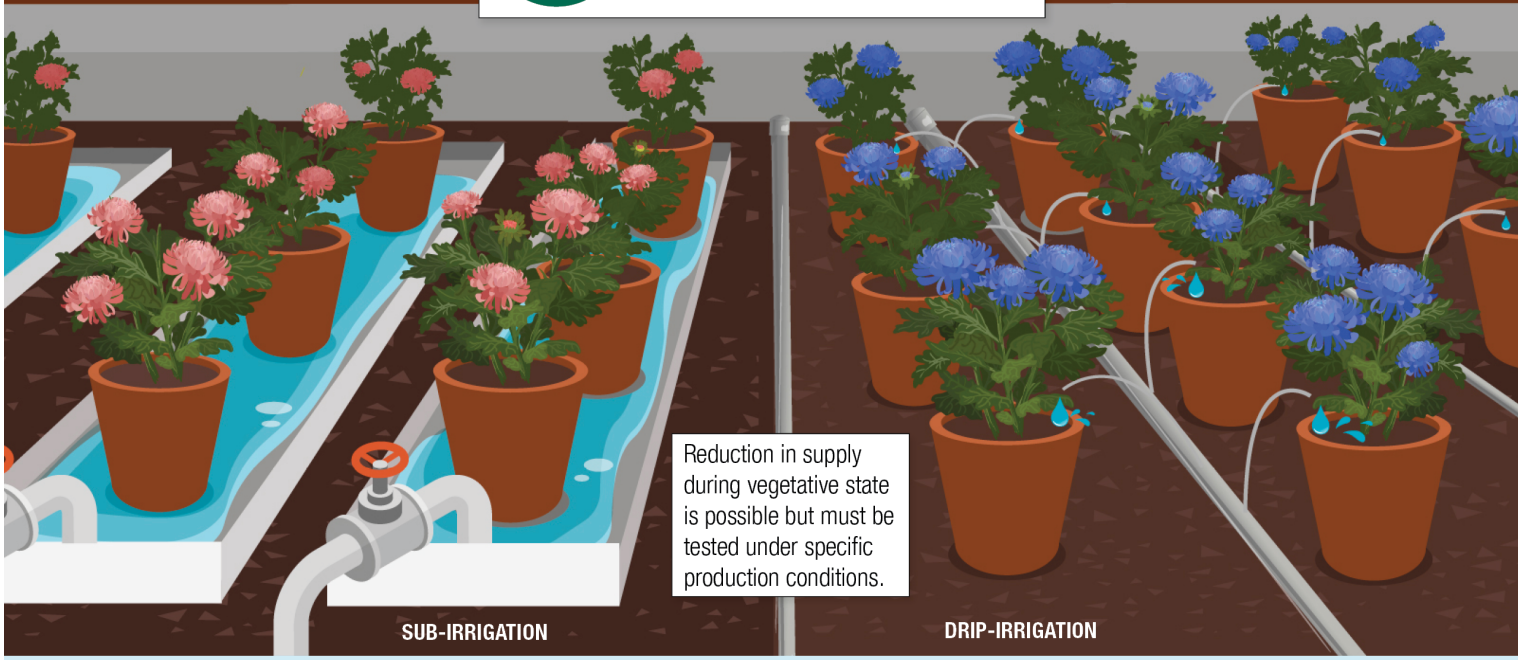
Ways to Optimize Nutrient Delivery in Garden Mums

CUT NUTRIENT INPUTS WITH SUB-IRRIGATION AND DRIP-IRRIGATION

The entire nutrient supply can be removed during flowering, and reduced prior to flowering without affecting plant and flower yield as well as quality.

- Improves timing and reduces fertilizer supply
- Reduces usage and cost of micro- and macronutrients
- Minimizes the volume and concentration of nutrient-rich water to be treated or discharged which improves environmental impact

75–95% less nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron, and molybdenum



Reduction in supply during vegetative state is possible but must be tested under specific production conditions.

Advancing the sector through research.

For more information, contact:
Dr. Barry Shelp bshelp@uoguelph.ca

NEW FLOWER VARIETIES THRIVE WITH LESS WATER AND LESS FERTILIZATION

Integrated techniques for efficient breeding, production, and transplant survival of unique ornamental species

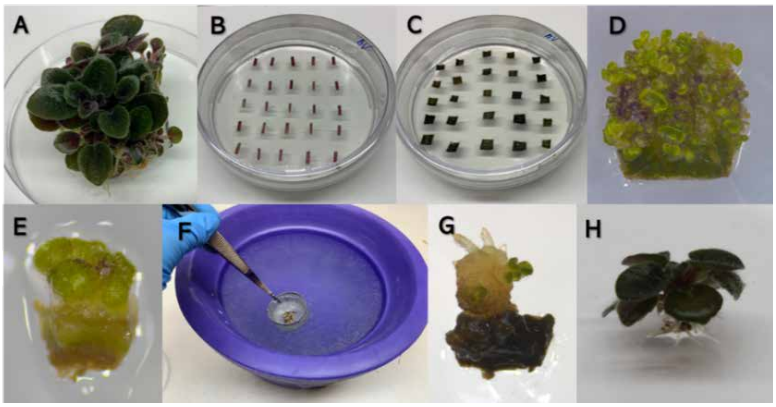
Project Summary

The ornamental horticulture sector needs to reduce its municipal water consumption and limit the use of fertilizers that cause pollution. It also needs to quickly produce cultivars for rapid commercialization and keep plants alive and healthy during this process. Research is focused on improving breeding, production, and transplantation. This project is looking to breed new varieties that are adapted to low water and nutrient environments. It is also using micropropagation for low-cost rapid production and cryopreservation for disease-free transplantation. Research conducted so far has successfully produced new selections that survives well with low water and low nutrients. Also, it has enhanced the way we use cryopreservation by adding melatonin and serotonin for better growth after clod stresses. A tissue culture protocol for rapid release is underway.

The ornamental horticulture sector has increasing needs for breeding, production, and transplant survival to remain competitive and sustainable. Specifically, producers need to **reduce their municipal water consumption** and **limit the use of fertilizers** that cause pollution, quickly produce cultivars for **rapid commercialization**, and keep plants alive and healthy during the process. We turn to research and innovation to fill these needs.

The objectives of this research project were to develop:

- New flower varieties that are adapted to low water and low nutrient inputs
- New techniques that improve the survival of seedlings and tissue culture plantlets for transplanting
- Tissue culture propagation systems that improve light quality, plant growth regulators, and culture vessels (like bioreactors)
- Cooling and freezing techniques to efficiently preserve rare, endangered, and horticulturally important ornamental species



What you need to know

For breeding:

- You can maintain genetic diversity while selecting for desired genetic traits by using a population breeding approach
- New selections that are adapted to low water and low nutrients were successfully produced

For producing:

- Micropropagation allows for rapid multiplication of disease-free and uniform plants at a very reasonable cost
- Tissue culture plants are easy and cost effective to ship
- A tissue culture protocol for speedy release will be provided to industry for rapid commercialization

For transplanting:

- A new approach developed in collaboration with *Gosling Research Institute for Plant Preservation (GRIPP)* enables transplants to survive and grow well both prior to and after cryopreservation
- Adding melatonin and serotonin enhances growth of plant tissues under tissue culture and cold stresses
- An enhanced cryotherapy protocol can be used to eliminate viruses in chrysanthemum and other potential ornamental plant species

Watch a video presentation on this research project by clicking here.

For more information, contact: **Dr. Alan Sullivan** asulliva@uoguelph.ca and Dr. **Praveen Saxena** psaxena@uoguelph.ca

Research Takeaways

Integrated Plant Production System (IPSS) is a complete system for commercial production of pathogen-free stock (medicinal, ornamental, and novelty) plants

- Home grown technology
- Reduces dependency on imported germplasm
- Minimizes the risk of pathogens
- Increases competitiveness in international market

Read more about it

Selling plants with a purpose: Greenhouse ornamentals for pollinator gardens

10 Trial Highlights to Watch For

In Vitro Technology in Plant Conservation: Relevance to Biocultural Diversity

Selection and Micropropagation of an Elite Melatonin Rich Tulsi (Ocimum sanctum L.) Germplasm Line

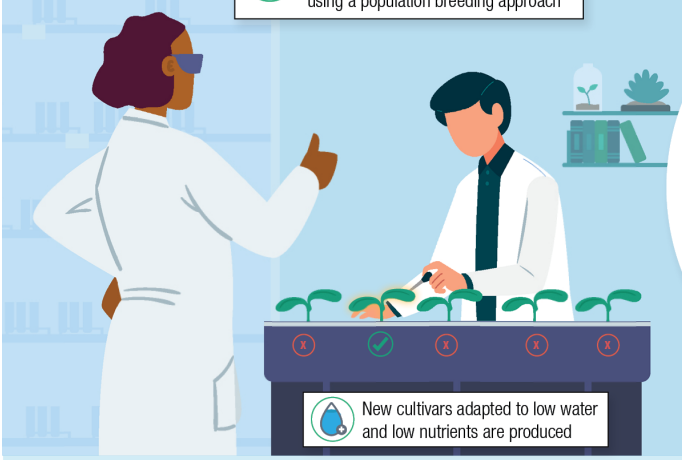
In Vitro and Cryobiotechnology Approaches to Safeguard Lupinus rivularis Douglas ex Lindl., an Endangered Plant in Canada

Utilizing high tech to bring native perennials to the marketplace

INTEGRATED PLANT PRODUCTION SYSTEMS

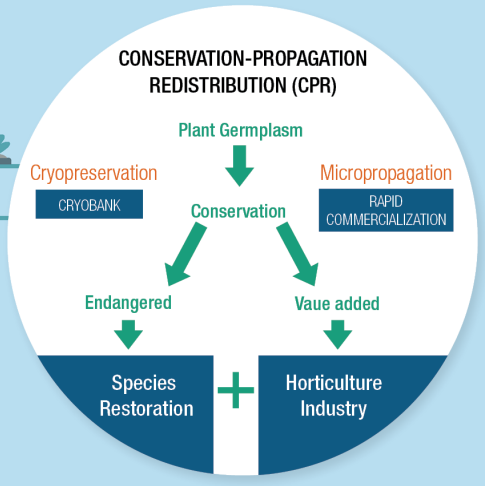
1 BREEDING

Maintain genetic diversity while selecting for desired genetic traits by using a population breeding approach



New cultivars adapted to low water and low nutrients are produced

CONSERVATION-PROPAGATION REDISTRIBUTION (CPR)



Integrated Plant Production Systems (IPPS):

- ☑ Use home grown technology
- ☑ Reduce dependency on imported germplasm
- ☑ Minimize the risk of pathogens by producing pathogen-free stock
- ☑ Increase competitiveness in an international market

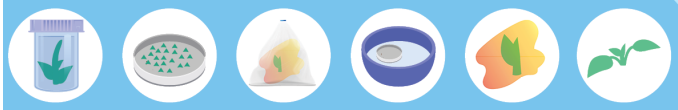
2 PRODUCTION

CRYOPRESERVATION

GRIPP Cryobank:

- Secure and cost effective storage of tissue at - 196° C
- Storage time is indefinite
- Reduced risk of contamination and genetic variation

Adding melatonin and serotonin enhances growth of plant tissues under tissue culture and cold stresses



Cryopreservation is used to eliminate viruses

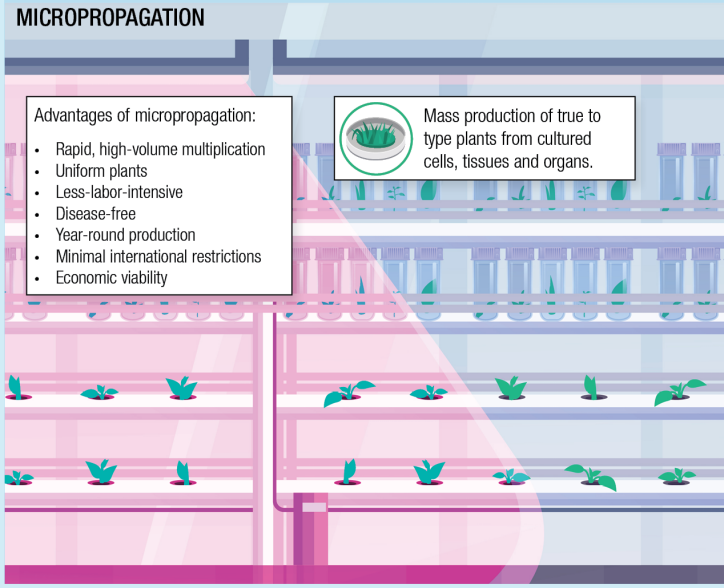
3 TRANSPLANTATION

MICROPROPAGATION

Advantages of micropropagation:

- Rapid, high-volume multiplication
- Uniform plants
- Less-labor-intensive
- Disease-free
- Year-round production
- Minimal international restrictions
- Economic viability

Mass production of true to type plants from cultured cells, tissues and organs.



Advancing the sector through research.

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IMPROVING IRRIGATION POND WATER QUALITY FOR REUSE

Minimizing horticultural impacts on surface water quality to encourage re-use through enhanced pond management

Project Summary

Recycling irrigation water can lead to poor water quality and excessive biological growth in ponds. This can mean poor quality water or expensive maintenance costs to clean out ponds and/or repair clogged intake filters for irrigation. Research was geared towards better management of irrigation ponds. This project evaluated in-pond technologies as well as pre-pond treatments to improve water quality. Research conducted so far has shown that preventing nutrients from reaching the pond is the most important practice, with a woodchip and slag hybrid treatment swale showing promise for preventing nutrient runoff. Where pond quality is compromised, covering ponds is successful at decreasing levels of phytoplankton while aeration is effective for breaking down organic matter.

The recycling of irrigation water can lead to excessive biological growth in irrigation ponds. This often results in poor water quality, the clogging of intake filters, and expensive maintenance costs. The sector requires a better understanding of the nutrients that are entering and held in irrigation ponds to better manage water quality. Research was focused on improving how we manage irrigation ponds to achieve higher water quality for reuse and to decrease the risk of nutrients leaving production systems.

The objective of this project was to evaluate and compare pond management tools to recommend improved pond management strategies. Both in-pond management technologies and pre-pond water treatments were explored.

What you need to know

In-pond management technologies that work:

- **Covering** ponds through physical shade barriers or plant coverings (like duckweed and hyacinths) decreases phytoplankton levels, particularly the amount of cyanobacteria (or 'blue-greens').
- **Aeration** is effective for breaking down organic matter. Although it causes high turbidity, intensive aeration helps to degrade organic material in sediments while maintaining low levels of chlorophyll and phycocyanin, without releasing high levels of soluble phosphorus.

Pre-pond water treatment design:

- The **woodchips** successfully removed nitrate-N and partially removed phosphorus
- The **slag** cell removed some phosphorus in the second year, although a longer retention time (i.e., increased volume of slag material) is required to fully remove phosphorus

Checkout this poster on Solutions for Pond Water Quality and watch a video presentation on this research project by clicking here.

For more information, contact: **Dr. Jeanine West** jwest@phytoserv.com

Research Takeaways

For new ponds:

- It is crucial to keep them clean from Day 1
- Hybrid Treatment Swales are a potential solution for managing N and P inputs from production runoff

For existing ponds:

- It is crucial to prevent additional nitrogen and phosphorus from entering
- Covering ponds and silos can help limit growth of phytoplankton
- Sediment disruption and degradation improves long-term water quality

Read more about it

New research project focuses on improving standards for effective pond management

IMPROVING IRRIGATION POND WATER QUALITY FOR REUSE

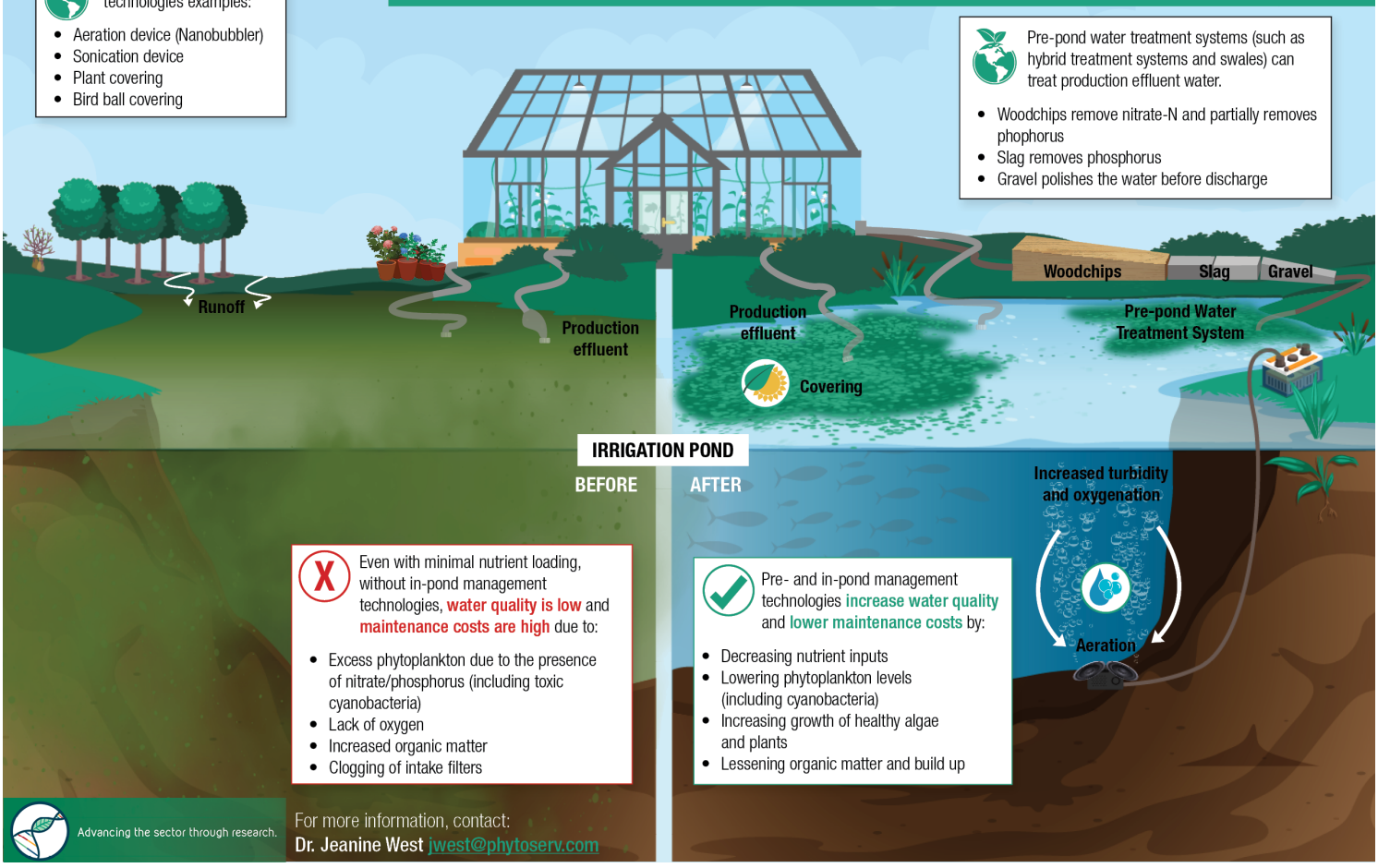
- Pre-pond technologies improve irrigation pond ecosystem health by preventing nutrients from reaching the pond in the first place
- Treating water using woodchips (including hybrid treatment swales) successfully removes nitrates, while other elements (such as phosphorus) can be removed using select mineral media
- In-pond technologies can help maintain pond health, and can prevent irrigation intake maintenance issues
- Coverings limit phytoplankton growth while aeration disrupts sediments and degrades organic matter, improving water quality long-term

In-pond management technologies examples:

- Aeration device (Nanobubbler)
- Sonication device
- Plant covering
- Bird ball covering

Pre-pond water treatment systems (such as hybrid treatment systems and swales) can treat production effluent water.

- Woodchips remove nitrate-N and partially removes phophorus
- Slag removes phosphorus
- Gravel polishes the water before discharge



Even with minimal nutrient loading, without in-pond management technologies, **water quality is low** and **maintenance costs are high** due to:

- Excess phytoplankton due to the presence of nitrate/phosphorus (including toxic cyanobacteria)
- Lack of oxygen
- Increased organic matter
- Clogging of intake filters

Pre- and in-pond management technologies **increase water quality** and **lower maintenance costs** by:

- Decreasing nutrient inputs
- Lowering phytoplankton levels (including cyanobacteria)
- Increasing growth of healthy algae and plants
- Lessening organic matter and build up

Advancing the sector through research.

For more information, contact:
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LEDs ARE MORE EFFICIENT AND LONGER-LASTING THAN CONVENTIONAL LIGHTING

Use of LEDs to improve ornamental crop production

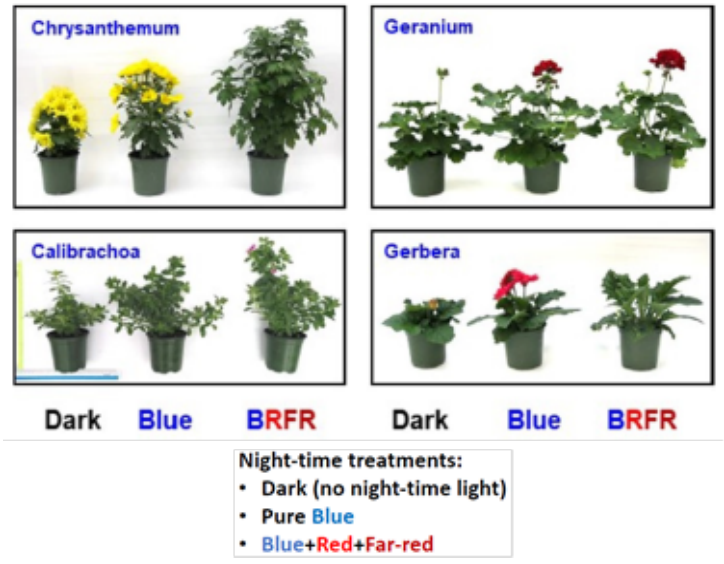
Project Summary

Light-Emitting Diodes (LEDs) have gained wide acceptance in greenhouse ornamental, vegetable, and indoor leafy green production. There is still much to learn on how best to use LED technologies for indoor plant propagation and production. Research was focused on validating the replacing of HPS conventional lighting with LED technology. This project was looking at how light conditions affect seed germination, how different light qualities impact stock plants, and how effective pre-finishing LED treatments are for making plants more robust for shipping. Research conducted so far has found that LEDs are more efficient than HPS. They last 2 – 4 times longer and allow for narrower fixture designs that cast less shadow when used in the greenhouse. Also, LED allows for more complex lighting functionalities to be used.

Converting electricity into heat is an expensive way to maintain temperatures in greenhouses. Light-Emitting Diodes (LEDs) have more recently gained wide acceptance in greenhouse ornamental, vegetable, and indoor leafy green production. There is still much to learn about how best to use LED technologies for plant propagation and production. Research aimed at determining how best to use LED technologies in ornamental crop propagation and production as well as find what factors contribute to shorter shelf life of potted ornamental plants and whether lighting and irrigation treatments prior to shipping can extend the shelf life of potted ornamental plants.

The objectives of this project were to:

- See how light conditions affect seed germination and performance
- Understand how different light qualities impact stock plants to optimize cutting uniformity
- Validate the replacing of HPS lighting with LEDs as supplemental lighting
- Investigate how effective pre-finishing LED treatments and irrigation strategies are for improving plant robustness during shipping



What you need to know

Compared to traditional HPS, LEDs are:

- 2 to 4 times longer in lifespans (with photon maintenance levels over 90%)
- More flexible in fixture shape and photon emission patterns which allows for longer, narrower fixture designs that cast smaller shadows
- LEDs allow for more sophisticated feedback-control algorithms to manage light intensity (made possible through the dimming function and duty-cycles with minimal negative effects) for saving energy and improving plant productivity
- LED technologies can provide different spectra or spectral combinations at different production stages to achieve different goals

Watch a presentation on this research project by clicking here.

For more information, contact: **Dr. Youbin Zheng** yzheng@uoguelph.ca

Research Takeaways

- High blue LED, UVA, and mild water stress did not extend shelf life of four potted plants
- Gerbera, kalanchoes, and miniature roses grown under LED were similar in quality as those grown under HPS
- Potted gerberas are particularly sensitive to water stress
- Shipping and retail conditions caused an immediate decline in plant quality
- Growers need to work more closely with retailers to keep plants well cared for

Read more about it

Dynamic versus Concurrent Lighting with Red and Blue Light-emitting Diodes as the Sole Light Source Can Potentially Improve Campanula Stock Plant Morphology for Cutting Production

Seed germination responses to low-level narrow-band light spectra for 14 ornamental plant genotypes

Growth and morphological responses of gerbera seedlings to narrow-band lights with different light spectral combinations as sole-source lighting in a controlled environment

Research Shines a Light on Greenhouse Plants

LEDs ARE MORE EFFICIENT AND LONGER-LASTING THAN CONVENTIONAL LIGHTING

COHA ACHO

1 PRODUCTION

Benefits of LED Lighting

- 2 - 4 times longer lifespan
- Flexible fixture shape and photon emission pattern
- Narrower fixture designs can cast less shadows
- Sophisticated feedback controls
- Stable lighting
- Adjustable lighting intensity and spectrum

High quality plants leave the production site

- ☑ Flowers grown under LED can have the same or better quality as those grown under HPS, yet LED is more cost-effective.
- ☑ Pre-treating flowers with high blue LED, UVA, or by using mild water stress did not extend shelf life.
- ☑ Growers need to work more closely with retailers to keep plants well cared for during shipping and in retail stores.

2 HOLDING AREA

For shipping, plants are packaged and placed in holding areas that often have:

- Low lighting
- Little to no watering
- Poor ventilation

Shipping and retail conditions cause rapid declines in plant quality

Advancing the sector through research.

For more information, contact:
Dr. Youbin Zheng yzheng@uoguelph.ca

3 POST-PRODUCTION

Water stress + Poor lighting = Lower shelf life & profit loss

Potted gerberas are particularly sensitive to water stress

COHA's Greener Horizon Strategy 2030: Research and Innovation

Greener Horizons 2030 is COHA's new strategy to address the Canadian ornamental sector's key priorities through the end of this decade. One of these priorities is research and innovation.

Ongoing innovation is imperative to building and maintaining an ongoing competitive advantage in a fast-changing sector such as horticulture.

Technology changes, improved production, storage, transportation and marketing practices, mechanization, climate change adaptation, and new business models are examples of areas where research and innovation activities can

be mobilized into innovative and successful business practices. New invasive pests are also a constant worry on the minds of ornamental primary producers as well as finding ways to improve plant hardiness and resistance to evolving disease risks.

In addition, keeping up with rapid changes in demand from the marketplace for new varieties and more sustainable production methods

is another ongoing pressure for Canada's ornamental sector to ensure it can remain competitive and grow in both domestic and international markets.

Largely due to the limited size of the Canadian market, both private and public investment

in Canadian-specific ornamental horticulture research and innovation is relatively limited. Opportunities for innovation specific to Canada

are rare because it is more difficult for innovators to earn a return on large investments in research and innovation. Many research activities often benefit the entire ornamental sector and not only a single firm. Among medium and smaller firms in the sector, it is often most cost-

effective to finance research activities through mechanisms such as Agriculture and Agri-Food Canada (AAFC)'s ornamental research cluster or other collective industry-government/industry-academia partnerships.

However, it is important to note that several larger businesses finance their research directly on issues that are very specific to them. Some of these firms undertake their own on-site research to address barriers for their company.

These operations would also greatly benefit from additional support to allow them to expand these research activities.

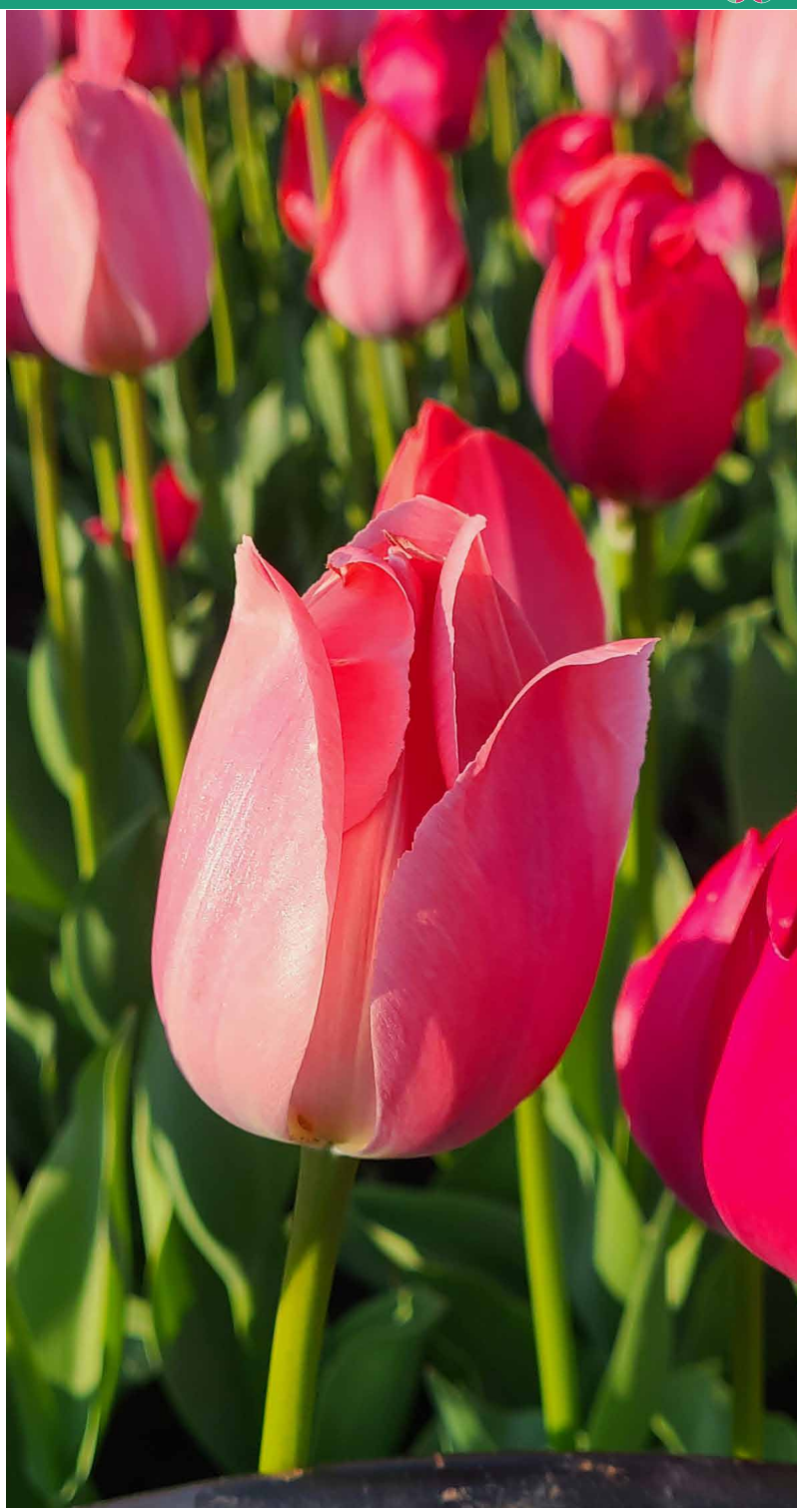
Primary Strategic Goal: The Canadian ornamental horticulture sector has access to all the required tools, technologies, and crop

protection materials available to be resilient and adaptable in the face of adversities including extreme weather events, climate change, invasive pests and diseases, along with major economic shocks and market fluctuations. Not only is

high-impact research undertaken to meet these requirements, but the sector has the means to communicate results broadly and mobilize this knowledge into the hands of those who need it to grow production, enhance profitability, and become more sustainable.

Key Objectives:

- Increased overall research and innovation capacity for the ornamental sector.
- Research and innovation that enable better productivity, operational capacity, and profitability (e.g., adoption of innovative technologies and automation, resiliency, disease, pest control, labour-related studies).
- Research and innovation that increases the sector's ability to grow markets by responding and adapting to evolving marketplace demands.
- Research and innovation that enables and demonstrates greater environmental sustainability for the sector (energy consumption, water, plastic use, green infrastructure) along with the ability to mitigate and adapt to climate change.



Moving Forward: COHA's Fourth Research Cluster

Previously, COHA set its own research themes in alignment with the AAFC AgriScience Program Priorities. This time, COHA has increased its engagement with industry members — a lesson learned from previous research clusters. This allows COHA members to directly voice their challenges and, in turn, for COHA researchers to tailor research projects to be solution oriented. In Spring and Summer 2022, COHA held virtual consultation sessions with its members across the country to determine future research and innovation needs. Overall, member participation throughout the Canadian value chain was high, with most provinces and all subsectors (greenhouses, nurseries, sod farms, and Christmas tree farms) being represented — another testament to COHA's research involvement stimulating the ornamental horticulture sector across Canada. The identified research needs were then matched to AAFC priority areas (while also bearing in mind The Guelph Statement priorities for agriculture and agri-food production moving forward). Building on the success of the first three research clusters, COHA's fourth research cluster priority themes are as follows:

1. **Environment and Climate Change:** Research and innovation to help the sector reduce greenhouse gas emissions, sequester carbon, reduce impacts on Canada's natural resources, mitigate and adapt to climate change, and improve biodiversity, while positioning producers to seize economic opportunities from evolving consumer demands. For example, research projects may include:

   - *Using plant functional traits to identify performance forbs and shrubs for carbon sequestration*
   - *Tree stress and nursery soil health — improving carbon storage at Canada's tree nurseries*
   - *Impact of soil health Best Management Practices (BMPs) on soil and water management in ornamental nurseries*
   - *Sustainable peat alternatives/extenders for horticultural media*

2. **Economic Growth:**
   Advancements to help build sector capacity and growth through productivity efficiencies, adoption of best practices, exploration of new and emerging technologies or products, reduction of waste, and innovative labour solutions. For example, research projects may include:

   - *Hardy roses for a changing climate*

3. **Sector Resilience:**
   Research and innovation to enhance sector resiliency to anticipate, mitigate, and respond to risks; protect and enhance plant health; contribute to the development and adoption of assurance systems; and enhance good mental health while fostering public trust in the sector and products. For example, research projects may include:

   - *Indoleamine mediated Crop Resilient Ornamentals Production systems*

COHA – Advancing the Sector through Research

For Canada to lead and prosper in ornamental horticulture, the sector must continue to foster its innovative and adaptive spirit among its producers, growers, and farmers. COHA's research program has become a critical means for planting the seed of modernization within the Canadian ornamental horticulture sector — leveraging new technologies and changing the way we produce and market ornamental products. COHA research clusters provide the means for government, industry, and academia to meaningfully collaborate to address sector challenges and needs within its value chain.

COHA's fourth research cluster will be focused on providing producers, growers, and farmers with ways to fight against the impacts of climate change, grow Canada's green economy, and maintain sector resiliency. COHA will continue to pollinate the country with cutting-edge, practical, and impactful knowledge to ensure that industry members from one coast to another are empowered to make the right decisions for their businesses. Through the AgriScience Program, COHA will continue to encourage ways of protecting the environment while growing the Canadian economy — providing sustainable and environmentally mindful ways to enhance production and maintain competitiveness.