



# Integrated Technologies for Efficient Breeding, Production, and Transplant Survival of Unique Ornamental Species

J. Alan Sullivan and Praveen Saxena

Department of Plant Agriculture  
University of Guelph, Canada



# Overall Objective

Selection of novel varieties and development of integrated plant production systems through tissue culture and to enhance early stage survival of transplants





# Specific Objectives

- Identify new species and develop novel germplasm that are adapted to drought and low nutrient environments
- Develop novel techniques to improve the survival and vigour of seedling and tissue culture plantlets transplants
- Optimize light quality, plant growth regulators and culture vessels/bioreactors for improving in vitro propagation
- Develop cryopreservation techniques to efficiently preserve important genotypes and ecotypes of rare, endangered and horticulturally important ornamental species



# Trial Gardens at Guelph, Milton (LO) and RBG: Success Despite Pandemic

- More than 300 Visitors
- Two Open Houses, 6 tours a day for Industry and Public
- Testing sites for new releases and our advanced selections
- Pollinator plant research site

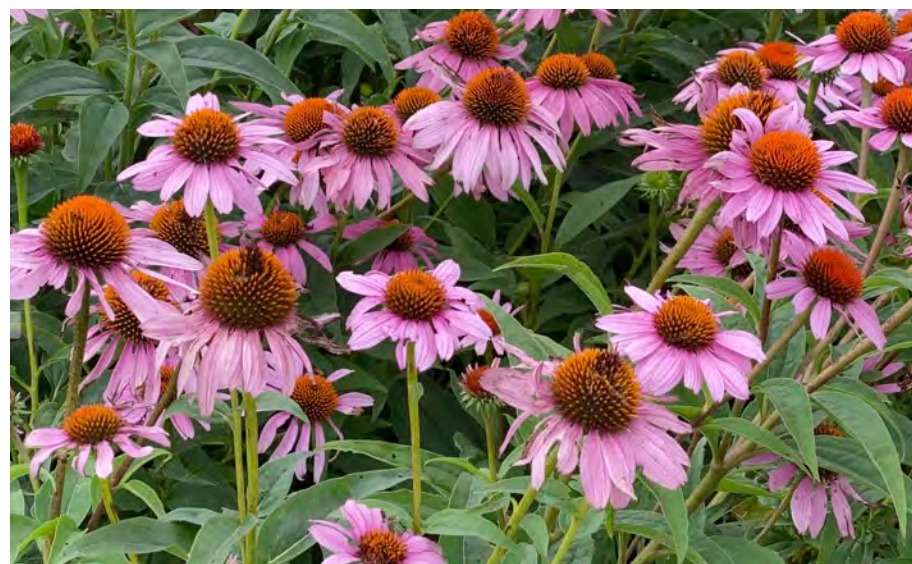


# 2020 Trial Garden, University of Guelph





# 2020 Trial Garden, University of Guelph





# 2020 Butterfly Garden, Landscape Ontario







Ornamental horticulture  
is the second largest sector of  
horticulture in Canada,  
based on gross farm receipts



Greenhouse flower & plant sales    \$1,556.7 Million  
Nursery stock sales and resales    \$643.5 Million

Greenhouse, nursery, and  
floriculture production is expected  
to increase by 2.5% per year  
between 2015 and 2025, which  
makes the 'industry second only to  
the 'grain and oilseed' industry







# Breeding Efforts – New Variety Development

Goals – Canadian native species and new varieties adapted to drought and low nutritional environments

## Ongoing studies:

*Liatris aspera*

*L. pycnostachyna*,

*Thermopsis caroliniana*

*Baptisia australis*

## Species new to this study:

*Lobelia cardinalis*

*L. siphilitica*

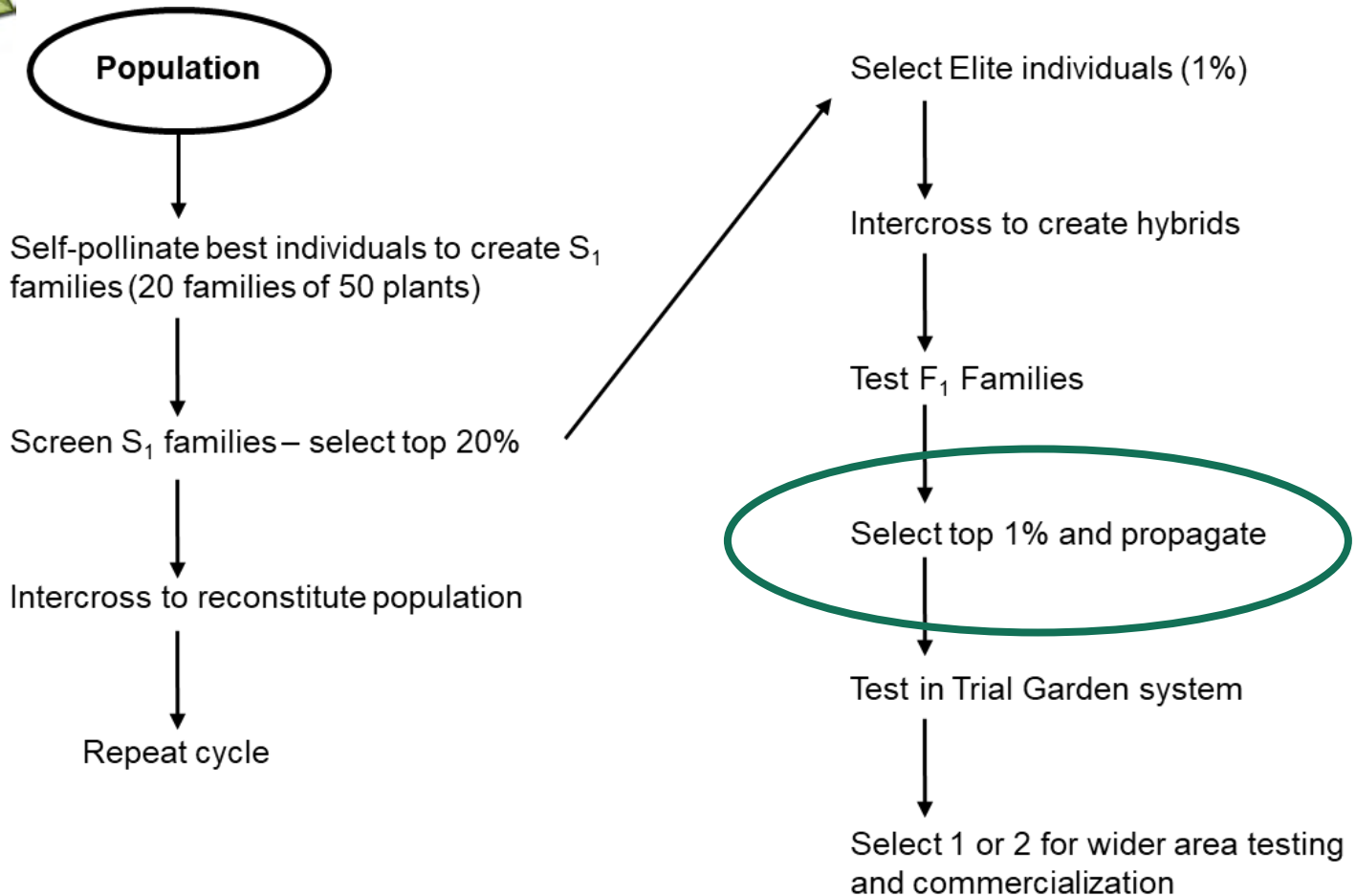
*Helenium autumnale*

*Physostegia virginiana*

*Allium cernuum*



# General Breeding Protocol







# Species currently in the program

*Liatris sp.*

*Baptisia australis*

*Thermopsis  
caroliniana*





# Species currently in the program

- Hairy Beardstongue (*Penstemon hirsutus*)  
Wild Bergamot (*Monarda fistulosa*)
- Spotted Bee Balm (*Monarda punctata*)
- Eastern Blue Star (*Amsonia tabernaemontana*)
- Eastern Red Columbine (*Aquilegia canadensis*)







Selection and testing underway in the greenhouse and field environment with low or no nutritional inputs

Screening in  
greenhouse  
and field  
trials





# Wildflower Breeding Stock Starting to Bloom after Being Removed from Vernalization Treatment – Feb.17/21

*Lupinus polyphyllus*  
(Large-Leaved Lupine)  
Left panel



*Aquilegia canadensis*  
(Eastern Red Columbine)  
Right panel





# Wildflower Breeding Stock Starting to Bloom after Being Removed from Vernalization Treatment – Feb.17/21

*Amsonia tabernaemontana*  
(Bluestar)  
Left panel



*Baptisia australis*  
(Wild Blue Indigo)  
Right panel





## Salt Exposure Treatments to Select Salt/Drought Tolerant Breeding Stock

Plants were watered with 10 mM NaCl solution and response was assessed as overall health and change in color and shape of the leaves

NaCl concentration was raised gradually to 60 mM





# Salt Exposure Treatments to Select Salt/Drought Tolerant Breeding Stock

*Aquilegia* seedlings resulting from 2020 crosses. Left panel

*Allium cernuum* seedlings resulting from 2020 crosses. Right panel







# Salt Exposure Treatments to Select Salt/Drought Tolerant Breeding Stock

*Baptisia* plants showing leaf injury after repeated exposure to 60mM NaCl (left panel)

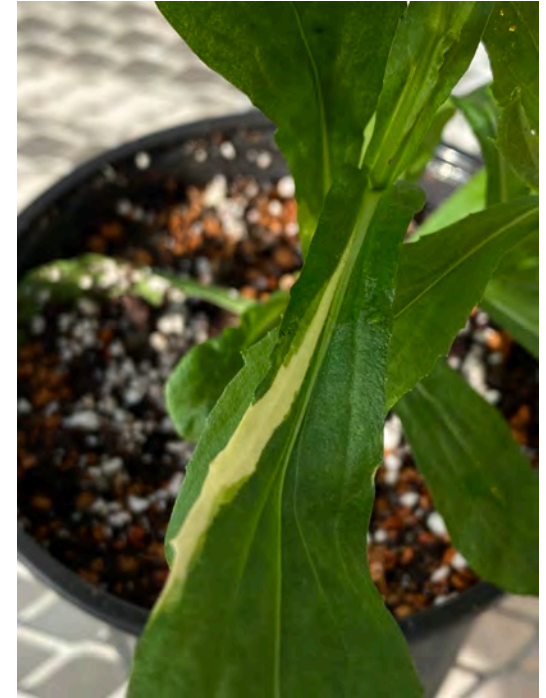
*Helenium* plants showing leaf injury after repeated exposure to 40mM NaCl (Right panel)





# Selection of Naturally Occurring Variegated Sport to be Propagated by Tissue Culture

*Helenium autumnale*  
Common Sneezeweed

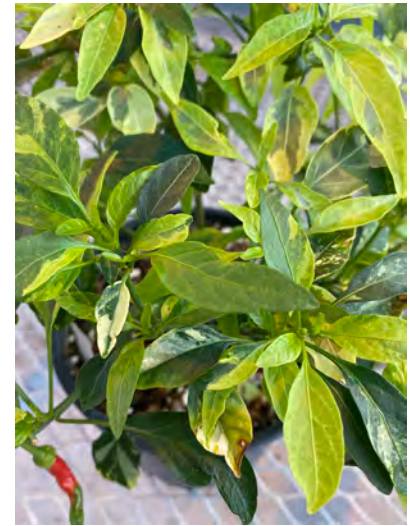






# Selection of Naturally Occurring Variegated Sport to be Propagated by Tissue Culture

Variegated  
mutation found in  
September 2020  
on a selection  
*Capsicum annuum*.  
Potential for  
combined  
ornamental and  
culinary  
applications.







# Unknown Species of Dianthus Found Growing Randomly Amongst Last Year's Trial Garden Plants

Unusual trailing habit with very small and simple flowers and an erratic blooming habit. Potential for crossing with other Dianthus species to improve bloom performance.





# Micropropagation Technology Development

Echinacea  
Lupin  
Roses  
Orchids  
Cardinal flower  
Native species  
Liatris  
Baptisia  
Chrysanthemum





# What is Micropropagation ?



Mass  
production of  
uniform  
plants from  
cultured cells,  
tissues, and  
organs

## Advantages of Micropropagation

Rapid, high volume,  
year-round  
production of  
uniform, vigorous,  
disease-free plants  
with minimal  
international  
restrictions



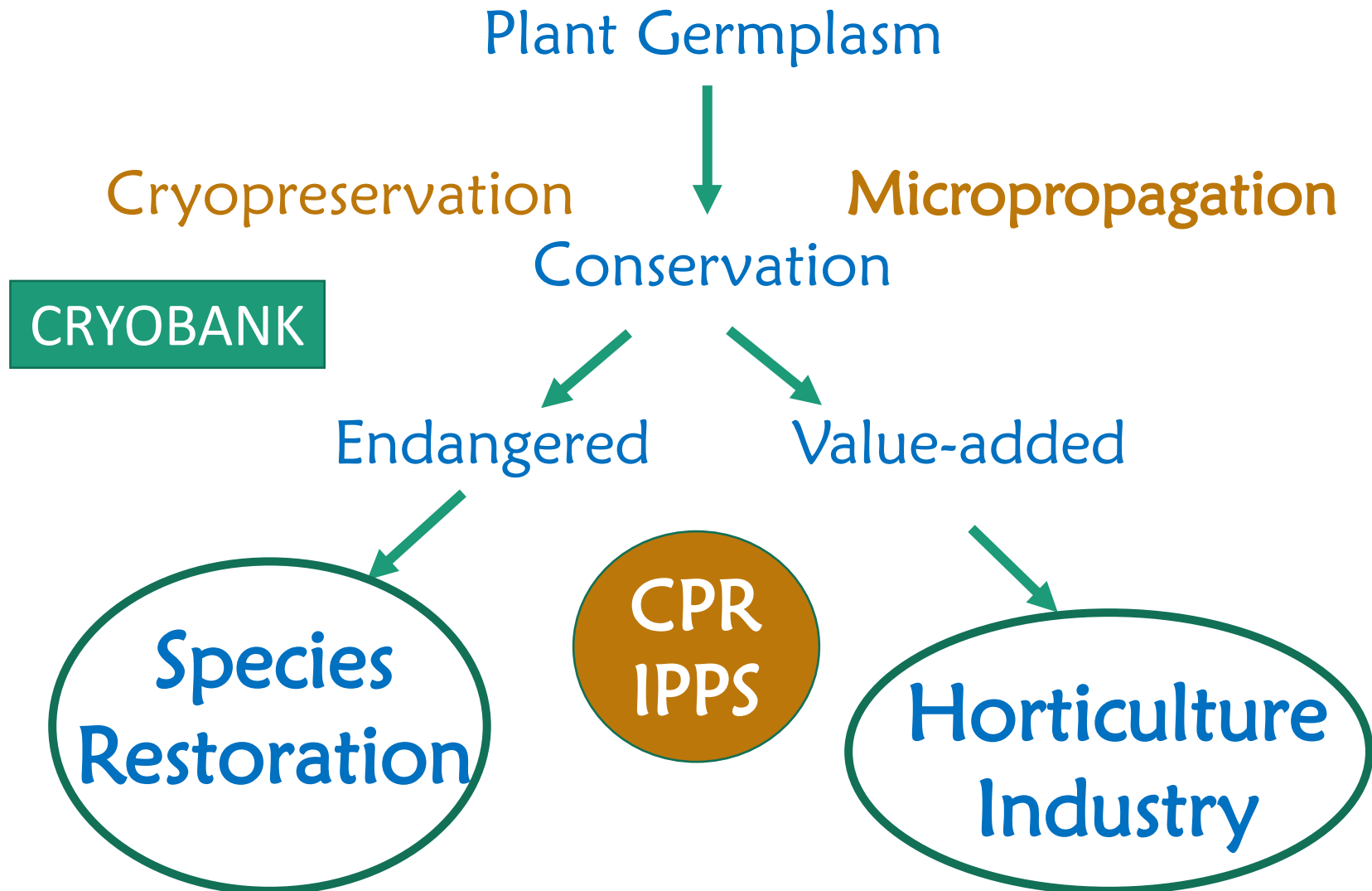


# Baptisia microplants propagated in controlled environments using “Micropropagation”





# GRIPP Conservation-Propagation-Redistribution (CPR) Model





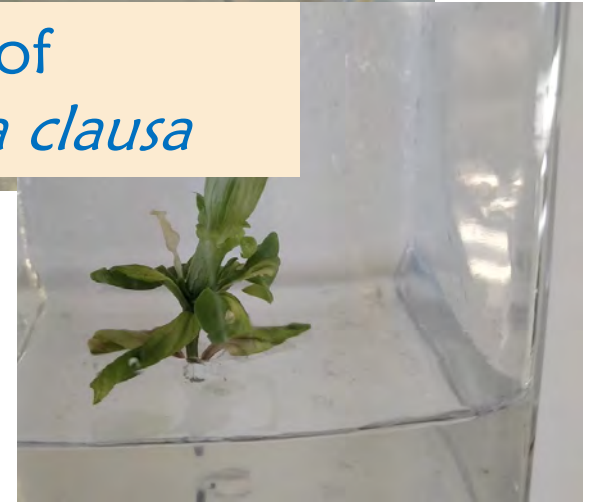
# In vitro culture initiation of different ornamental plant species



Shoot multiplication of  
Chrysanthemum



Variants of  
*Gentiana clausa*

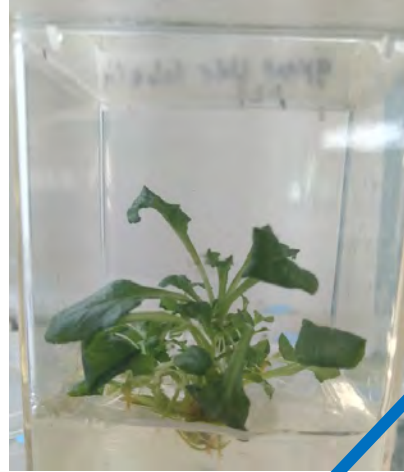






# In vitro culture of ornamental plant species provided by the Sixth Nations

*Lobelia siphilitica*



Flowering in vitro

*Lobelia cardinalis*





# Orchids micropropagation system established



Dendrobium sp.



Rhynchostylis sp.



Oncidium sp.



Vanda sp.







# In vitro culture initiation of different variegated plant species



*Impatiens walleriana* (variegated garden impatiens with red flower)



*Capsicum annuum* (variegated cayenne pepper)



*Helenium autumnale*  
Common Sneezeweed (one variegated leaf)





# Culture establishment and multiplication for variant *Baptisia australis*

Variant *Baptisia australis* with white floral keel vs Blue floral keel





# In vitro culture of a sport of Dianthus (species currently unknown) Trailing Dianthus





# Ornamental medicinal plants

Medical  
conditions

Infections  
Immunity  
Memory  
Diabetes  
Cancer  
Cardiac



*agronomy*

Holy  
Basil



Article

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

Mukund R. Shukla <sup>1</sup>, Annaliese Kibler <sup>1</sup>, Christina E. Turi <sup>1,2</sup>, Lauren A. E. Erland <sup>1,2</sup>, J. Alan Sullivan <sup>1</sup>, Susan J. Murch <sup>2</sup> and Praveen K. Saxena <sup>1,\*</sup>







Article

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

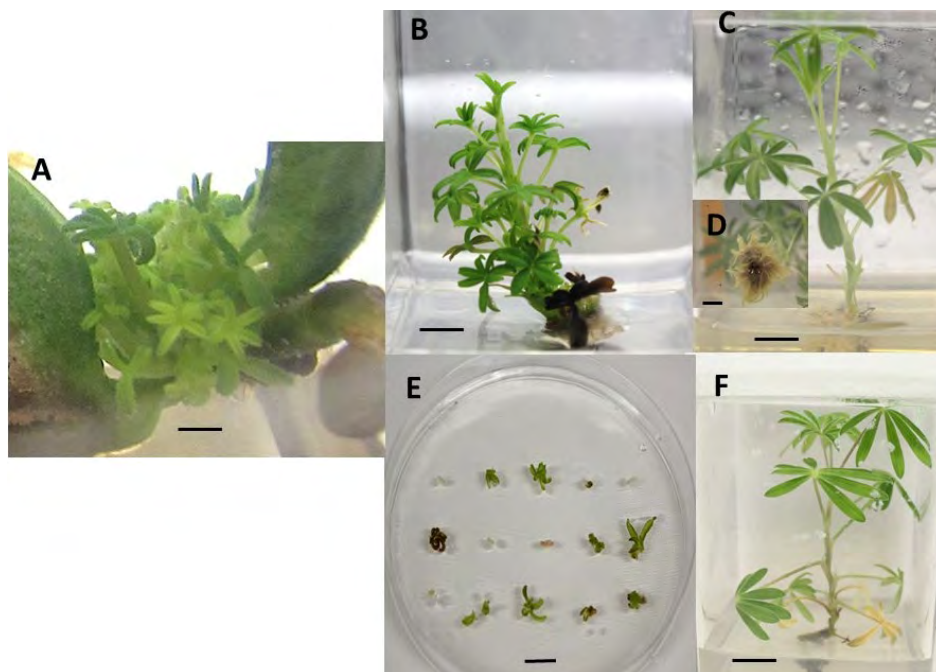
Elena V. Popova <sup>1,2</sup>, Mukund R. Shukla <sup>1</sup> , Terry McIntosh <sup>3</sup> and Praveen K. Saxena <sup>1,\*</sup> 

<sup>1</sup> Department of Plant Agriculture, Gosling Research Institute for Plant Preservation, University of Guelph, Guelph, ON N1G 2W1, Canada; elena\_aygol@hotmail.com (E.V.P.); mshukla@uoguelph.ca (M.R.S.)

<sup>2</sup> K.A. Timiryazev Institute of Plant Physiology of Russian Academy of Sciences, Moscow 127276, Russia

<sup>3</sup> Botany Department, University of British Columbia, Vancouver, BC V6T 1Z4, Canada; ttmcintosh@shaw.ca

Endangered  
plants of  
ornamental  
value





Summary: Despite COVID restrictions the selection of potential new introductions and micropropagation technology development progressed well





ONTARIO  
AGRICULTURAL COLLEGE  
DEPARTMENT OF PLANT AGRICULTURE

# Acknowledgements

Dr. Mukund Shukla

Dr. Wenlu Bi

Rodger Tschanz

Bob Nichols

Shuping Li

Kalisa Ramsahoi

*This project is part of the Accelerating Green Plant Innovation for Environmental and Economic Benefit Cluster and is funded by the Canadian Ornamental Horticulture Alliance (COHA-ACHO) and by the Government of Canada under the Canadian Agricultural Partnership's AgriScience Program.*

