Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Spring 2022

Activity title: Development of All-Male Asparagus Hybrids with Improved Traits

Name of Lead Researcher: David Wolyn, University of Guelph

Names of Collaborators and Institutions: Mary Ruth McDonald-University of Guelph, Travis Banks-Vinland Research and Innovation Center

Activity Objectives (as per approved workplan):

FY 2021-2022

(A) Breeding

- New breeding nursery established;
- New parents identified and make hybrid crosses;
- New hybrid trial established;
- Previous hybrid trials evaluated;
- Small quantities of seed for grower strip trials produced.

(B) Purple spot (Stemphyllium) pathology

- Analysis of field studies to determine association of purple spot levels in spears and fern completed.

(C) Winterhardiness – Seedling de-acclimation

- Second replicate experiment to assess dormancy and de-acclimation completed and analyzed.

(D) Purple spot (Stemphyllium) resistance mapping

- First replicate experiment to assess purple spot in segregating populations and mapping to determine genetic architecture conducted.

(E) Winterhardiness - transcriptomics

- RNA-sequencing analysis for second replicate experiment of acclimation/de-acclimation studies completed.

(F) Planting depth and density study

- First replicate year of yield data collection completed.

(G) QTL mapping- breeding traits

- First replicate year for phenotyping mapping populations and initial QTL analysis completed.

Research Progress to Date (use plain language, not to exceed 500 words):

(A) Breeding

All aspects of the breeding program progressed in the 2021/22 fiscal year including crosses to generate new parents and hybrids. New trials were planted in the spring of 2021 from crosses made in 2020. In 2021, several yield trials were evaluated, including two advanced and three preliminary. In the former trials, UG028 was improved 25-40% for marketable yield and up to 10% for percent marketable yield, compared to Guelph Millennium.
For hybrids in preliminary trials in the second and third years of harvest, marketable yield and percent marketable yield increased up to 37 and 22%, respectively, compared to Guelph Millennium.

(B) Purple spot (Stemphyllium) pathology

Purple spot was evaluated on spears in the spring, and foliage in the fall, to determine if levels of infection are correlated. A low correlation coefficient was estimated, $r<0.25$, suggesting a breeder must select for both traits separately, rather only one trait with the expectation of improving the other. Local isolates of the pathogen were collected at the Simcoe Research Station and efficacy of two currently registered fungicides and two new compounds will be tested.

(C) Winterhardiness – Seedling de-acclimation

Both experiments are in progress with results forthcoming.

(D) Purple spot (Stemphyllium) resistance mapping

A segregating mapping population was evaluated for levels of natural anthocyanin pigmentation, magnitude of pigment at Stemphyllium lesions, and lesion number. Variation for natural pigment intensity in scale leaves and pigment intensity at the site of lesions was observed, however, traits were not correlated. In addition, lesion number was not correlated with natural and pathogen-induced pigment intensity. Progress was made developing genetic maps with molecular markers and traits will be mapped in the future to determine genetic architecture.

(E) Winterhardiness – transcriptomics

Experiments were conducted with Guelph Millennium, an adapted winter-hardy cultivar, and UC157, an unadapted cultivar. RNA-sequencing determined differences in gene expression for the cultivars when levels of freezing tolerance differed. Differential expression was observed between the cultivars for 889 and 1213 genes in the fall and spring, respectively, identifying candidates involved in cold acclimation and deacclimation signaling pathways. The genes were grouped into functional categories, e.g. cell wall modification, membrane transport, hormone signaling, and provided insight into the processes involved in freezing tolerance. These results can be useful for developing strategies to enhance selection.

(F) Planting depth and density study

Based on the first year of data, increased density enhanced spear number and decreased diameter, while the opposite effects were observed with increased depth. Total yield was not affected by treatments due to compensation of spear number and diameter effects. Spear quality was not affected by treatments. The experiment will be harvested for the second year in 2022. A second replicate experiment will also be harvest for its first season.

(G) QTL mapping- breeding traits

Data for spear number and diameter (yield proxy), height of first branch from the ground (quality proxy), and foliar diseases were collected on over 200 plants in each of two mapping populations. Significant variation was found for all traits, suggesting quantitative trait loci (QTL) can be mapped.

DNA was extracted from 420 individuals and genotyping-by sequencing was conducted, revealing 3000 single nucleotide polymorphism loci in each population. These will next be used to identify QTL for breeding traits.

Extension Activities (presentations to growers, articles, poster presentations, etc.):

David Wolyn- Presentation
Asparagus Breeding
Asparagus Meeting Nov. 2 2021

Suman Parajuli – Presentation
Development of a purple spot disease screen
Asparagus Meeting Nov. 2, 2021

Arshdeep Singh Gill – Presentation
Transcriptomic analysis of winterhardiness
Asparagus Meeting Nov. 2, 2021

Brock Anderson – Presentation
Dormancy and winterhardiness in asparagus
Asparagus Meeting Nov. 2, 2021

Arshdeep Singh Gill – Poster
Transcriptomic analysis for freezing
tolerance among asparagus cultivars with
varying adaptation to southern Ontario
12th International Plant Cold Hardiness Seminar Dec. 3, 2021

Arshdeep Singh Gill – Poster
Transcriptomic analysis for freezing
tolerance among asparagus cultivars with
varying adaptation to southern Ontario
Corteva Agricultural Science Symposium Nov. 19 2021

Asparagus crop developed by U of G researchers decades ago continues to be a game changer for the industry
Dave Wolyn Interviewed by CTV for Web and TV story. June 10, 2021
https://kitchener.ctvnews.ca/asparagus-crop-developed-by-u-of-g-researchers-decades-ago-continues-to-be-a-game-changer-for-the-industry-1.5465167
https://kitchener.ctvnews.ca/asparagus-crop-developed-by-u-of-g-researchers-decades-ago-continues-to-be-a-game-changer-for-the-industry-1.5465167

U of G Asparagus Research Yielding Strong, Successful Varieties
Dave Wolyn interviewed for web story. July 13, 2021
https://news.uoguelph.ca/2021/07/u-of-g-asparagus-research-yielding-strong-successful-varieties/

COVID-19 Related Challenges:
COVID has significantly affect the mental health of the grad student working on objective (C) such that some experiments died in growth chambers and had to be reinitiated. The project is delayed significantly, and the student should complete the project before the grant ends next year. He is no longer receiving a stipend and will self-support.

The two mapping projects have been delayed as genomics lab access was limited during the past year. Consequently, mapping has not been completed at this time. DNA sequencing data has now been received from the contractor and mapping is in progress. Projects should be completed as originally planned.

Key Message(s):

- The development of new hybrids is progressing with promising candidates for further testing.
- Gene expression analysis as revealed physiological processes and genes that are important for freezing tolerance.
- Variation for purple spot lesion number and magnitude of pigment production was observed and mapping of these traits is proceeding.
- Variation for yield, quality and foliar disease was observed in two populations and mapping is in progress.

This project under the Canadian Agri-Science Cluster for Horticulture 3 is funded in part by the Government of Canada through the Canadian Agricultural Partnership's AgriScience Program, a federal, provincial, territorial initiative, with support from the Fruit and Vegetable Growers of Canada (formerly the Canadian Horticultural Council) and industry contributors.

CANADIAN AGRICULTURAL PARTNERSHIP
Innovate. Grow. Prosper.

FRUIT & VEGETABLE GROWERS OF CANADA | PRODUCTEURS DE FRUITS ET LÉGUMES DU CANADA

Canada