Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

2020-21 – Semi-Annual

Activity title:
Activity 9 - 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 and Travis Banks, Vineland Research and Innovation Center

Activity Objectives (as per approved workplan):
FY 2020-2021
(A) Breeding

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

(B) Purple spot (Stemphyllium) pathology

- Development of inoculation protocol and screen breeding lines for degrees of resistance to Stemphyllium under controlled environments and in the field completed;
- Relationships between resistance and timing and duration of stomata opening identified.

(C) Winterhardiness – Seedling de-acclimation

- First replicate experiment to assess dormancy and de-acclimation in germplasm in progress.

(D) Purple spot (Stemphyllium) resistance mapping

- Preliminary experiment to assess purple spot in segregating populations conducted and genotyping for mapping initiated.

(E) Winterhardiness - transcriptomics

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

Research Progress to Dates:
(A) Breeding
All aspects of the breeding program progressed in the 2020/21 fiscal year. Crosses for new hybrids (100) and germplasm development (50) were completed, and seed was collected from 75 superior male plants for supermale development.

All will be planted in the field in the spring of 2021. New trials were planted in the spring of 2020 from crosses made in 2019; these included 75 new hybrid combinations planted in preliminary trials, and 50 germplasm crosses planted in the breeding nursery. Seed was produced for five select, new hybrids for grower strip trials.
In 2020, several yield trials were evaluated, including two advanced and three preliminary. Advanced trials assess those hybrids identified as superior in preliminary trials. In the advanced assessments, several hybrids are showing commercialization potential, including UG028, UG030, and UG023. The best are improved approximately 9-23% for marketable yield and up to 15% for percent marketable yield (a measure of quality) compared to the standard, Guelph Millennium.
In preliminary trials, the first evaluation of new genetic combinations, several hybrids showed improved traits compared to the standard. The three trials evaluated were in the first, second and third full harvest seasons. For hybrids in the second and third years of harvest, improvements for marketable yield and percent marketable yield ranged 20-75% and 10-23%, respectively, compared to Guelph Millennium. For the newest preliminary trial in the first full harvest season, the best hybrid was improved 50% for yield and 15% for quality compared to the control; additional harvest years are necessary to validate the magnitude of the improvements.
Overall, the breeding program has been advanced with new parental selections and hybrids for evaluation, and the identification of new, improved hybrids compared to the standard, Guelph Millennium in both preliminary and advanced yield trials.

(B) Purple spot (Stemphyllium) pathology
Two years of field and controlled environment trials have been completed. Results comparing resistance among cultivars in the field and controlled environment were consistent when there were high levels of infection in the field.
Results under controlled environments showed that more infection takes place in the dark than under light conditions. This may be important in the field if spores land and germinate during the night. Initial results showed that resistance to the purple spot pathogen differed in the field and in the growth room. Further research showed that the results from the growth room were the same as in the field when there was high infection in the field. The high levels were associated with high rainfall in the 2- 3 days prior to disease assessment. In addition to long wetness periods associated with rainfall in the field, high soil moisture may result in open stomates, which increase the number of infections. Analysis of these results is continuing.
These insights will allow plant breeders to select for asparagus that will resist infection in the field and will allow growers to better understand weather conditions that will lead high levels of purple spot on asparagus in the field.

(C) Winterhardiness – Seedling de-acclimation
A growth room experiment initiated in the winter of 2020 was terminated due to covid-related issues. A new experiment was planted in the fall and is in progress.

(D) Purple spot (Stemphyllium) resistance mapping
In a preliminary experiment, a genetic mapping population was assessed for number of spear Stephyllium lesions from both natural infection in the field and from artificial inoculation in growth chamber assays. Natural levels of anthocyanin pigment in spear scale leaves and intensity of anthocyanins around Sttemphyllium lesions in the field were also determined. Variation was observed for all traits, indicating the mapping population will be useful for in-depth analyses that will be conducted in the 2021 and 2022 growing seasons. Plant tissue samples were collected for DNA extraction, which will lead to molecular marker analysis and trait mapping. The project will provide an understanding of how genetic variation affecting natural levels of anthocyanin in scale leaves relates to the intensity of pigment at a Stemphyllium spear lesion and disease level.

(E) Winterhardiness - transcriptomics
Two cultivars were sampled in the field at three dates for each of the fall and spring. RNA was extracted from crown tissue, and the LT50, or temperature at which 50% of plants die, was estimated. RNA sequencing is in progress to determine genes important for fall acclimation and the acquisition of freezing tolerance, and spring deacclimation accompanied by the loss of freezing tolerance. A second replicate experiment was planted in the field in 2020 for analysis in 2021.

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

David Wolyn, Asparagus Yield Data, oral presentation at Asparagus Research Meeting, University of Guelph, October 27, 2020

George Austin, Developing a bioassay and finding resistance to Stemphylium vesicarium in asparagus, oral presentation at Asparagus Research Meeting, University of Guelph, October 27, 2020

COVID-19 Related Challenges:

In March 2020 the University closed and access to research facilities was restricted for technical staff and grad students. Research in progress was allowed to continue with permission; if plants were actively growing, sampling could continue but access to labs was restricted. Consequently, no laboratory work progressed until the late July, when labs opened with restricted access, limiting the number of individuals in a laboratory at any one time. To access the genomics, common equipment, or tissue culture laboratories, individual requested access and managers allotted work times so all programs could access facilities equitably.

For field work, any plants in the ground were considered on-going research and could continue with permission and new plantings were also allowed with permission. Due to social distancing requirements at the Simcoe Research Station, one less summer student than desired was hired. All new plantings were completed as planned, however, yield trials in their first harvest season (2 wk harvest) were not conducted. Crosses were made for new hybrids and germplasm development using the available labor.

A new PHD student on the Purple Spot project was able to access the fields, however, the shut down and restricted interaction for the student with research staff in his first semester, created challenges for the development of the research project and collection of data. Preliminary data was collected, rather than a complete set as desired, and an additional year of study beyond original plans will be necessary.

A MSC student working on one project suffered some mental health issues during early stages of the pandemic, resulting in the termination of an on-going experiment, which has been replanted, delaying the overall project.

For the MSC student working on Stemphyllium, research trials progressed mostly as planned, despite restrictions of the number of people who could be in a lab or growth facility at one time.

Overall, most experiments proceeded to collect samples, but analysis of samples was delayed 4-5 months. In some cases research will be delayed one year. All new breeding trials were planted as planned, low priority trials were not harvested, and crossing proceeded with available labor.

Key Message(s):

Controlled environment assays are useful to determine asparagus cultivars that will be more resistant to purple spot under high disease pressure in the field. Long rainy periods and high soil moisture result in high levels of purple spot in the field because long wetness periods favour infection by the pathogen and associated opening of stomates as a result of high soil moisture also favours infection.

Asparagus breeding continues to produce improved hybrids in both preliminary and advanced trials. UG028 is a new hybrid with potential that can be advanced to pre-commercialization trials.

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