# Report to OTRI: Breeding to protect plant health for Ontario's processing tomato industry, 2018 (CAP 0026)

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## Completion of project AIP-P119

During the first part of 2018 we completed several facets related to the previous OTRI funding breeding project.

### Breeding lines released in 2018

Twenty $F_7$ generation breeding lines, selected in fall 2017, were released in time for 2018 field planting. All of these lines were based on pedigrees started at AAFC-GPCRC, Harrow. Our focus remained on increasing genetic diversity in processing tomato and our current work attempts to combine backgrounds of multiple wild species as illustrated in Table 1. We also placed a high priority on selections with high natural tomato soluble solids and good fruit colour.

We released 20 breeding lines under a materials transfer agreement to one commercial seed company partner. An important objective of this project is to increase genetic diversity in processing tomatoes and the majority of the 20 lines released had at least one wild tomato species in the recent pedigree. Seventeen lines had *Solanum habrochaites* either alone or in combination with other wild species. *S. habrochaites* is an important source of genetic diversity since it is predominantly cross pollinated, and reasonably compatible with cultivated tomato. Two lines combined *S. habrochaites* with *S. pimpinellifolium* in the recent pedigrees and one line combined these two with *S. pennellii*. Seven lines combined *S. habrochaites* with *S. pennellii*. Two lines combined *S. habrochaites*, *S. peruvianum*, and *S. chilense* in their recent pedigrees, and one line combined these three species with *S. arcanum* to comprise four wild species in the recent pedigree.

While not a specific goal of this project, four of the lines exhibited high soluble solids, and one of these had a soluble solids level of 5.6 which was 0.7 units higher than the best commercial check. These lines represent important potential parents for hybrids used in the production of tomato paste.

Table 1. Number of breeding lines selected in 2018 with various tomato species in the recent pedigree

| Species in the recent pedigree | Number of lines released in 2018 |
|---|---|
| *Solanum habrochaites* | 4 |
| *S. habrochaites and S. pennellii* | 7 |

| Species in the recent pedigree | Number of lines released in 2018 |
|---|---|
| *S. habrochaites and S. pimpinellifolium* | 2 |
| *S. habrochaites, S. pimpinellifolium and S. pennellii* | 1 |
| *S. habrochaites, S. peruvianum and S. chilense* | 2 |
| *S. habrochaites, S. arcanum, S. peruvianum and S. pennellii* | 1 |

### Completion of microarray genotyping

We completed a second, large tomato genotyping job in early 2018 (288 lines on the Illumina 7,720 SNP microarray). These lines comprised several experiments. The largest subset of lines originated from a structured population (Recombinant Inbred Lines). The data from these lines will enable us to gain experience using a different set of analyses to answer questions about markers associated with traits of interest. The smaller subset of lines comprised breeding lines that will enable us to monitor our progress in increasing genetic diversity, to determine traits that might be present in our breeding lines, and to design future crosses.

## Background for new work in disease resistance breeding

In the 2018 intake of applications, OTRI was a successful applicant to the Canadian Agricultural Partnership Organizations and Collaborations Program administered through the Agricultural Adaptation Council. A 3-year project under the Protection and Assurance – Plant Health: Applied Research, Pilot Projects and Demonstrations category was developed.

The project is designed to build on the genetic diversity work in processing tomatoes that sets the Ridgetown breeding program apart from most others, and pivot towards more directed breeding for disease resistance.

Previous funding from OTRI has enabled the Ridgetown breeding program to gain experience using large numbers of SNP markers in microarrays to study large numbers of traits simultaneously. This new project enables development expertise in using smaller numbers of markers on a PCR platform, to focus on a few traits of specific interest. This work with a smaller number of markers is much less expensive and can become part of the routine screening tests used.

This project will enable us to develop marker protocols, make crosses combining resistances and begin making selections for resistance to verticillium, 2 races of fusarium, nematodes, and late blight. As an overarching goal, we will continue to work toward increasing genetic diversity in processing tomatoes. Adding the breeding for resistance to multiple diseases will increase the reach and impact of our work.

### Breeding field plots

Nine acres of breeding plots were established on a farm on Selton Line, northwest of Ridgetown.

There were 736 breeding lines from $F_2$ to $F_6$ generations planted (cf. 843 in 2017; 584 in 2016). The $F_6$ to $F_3$ generations originated partly from selections made at Ridgetown during fall 2017, and partly from selections made in 2013 but that were temporarily shelved. A total of 873 selections were made in fall

2018. Field selection work began on August 20 (2017 August 28; 2016 August 29) and was completed on September 21 (2017 September 28; 2016 Sept 22).

In Chatham-Kent rainfall was lacking in June and the early part of July, although plant development in our plots was good. Abundant rain was received from mid-July until the end of harvest. There were many days with very high temperatures. There was some cracking in some breeding lines due to the rainfall and so it was a good year to select for resistance to cracking. In recent past years we have enjoyed relatively warm, dry harvest seasons. In 2018 the frequent rains right through harvest resulted in high fruit rot pressure and allowed us to get an accurate sense of field-holding ability in this cohort of breeding lines.

## Nematode resistance breeding

We achieved the goal of growing over 20 $F_2$ populations combining nematode resistance with regionally adapted breeding lines and made 42 selections from within these lines. We have established these in the greenhouse for backcrossing to regionally adapted processing tomato lines over the winter. We will be completing the screening of these parent lines during the November 2018 to March 2019 period.

## Late blight resistance breeding

We completed our goal of establishing 20 lines with evidence of the presence of Ph-2 or Ph-3 late blight resistance genes (based on microarray marker studies previously funded by OTRI) in our summer greenhouse crossing block. We included an additional 9 breeding lines that showed evidence of late blight resistance based on their field responses in 2009. These 29 lines were used as parents to develop over 100 new pedigrees in the process of attempting to combine both Ph-2 and Ph-3 together. There is evidence that for good management of the available resistance to late blight, these two sources should be combined. We have completed the goal of establishing plants of these F1 hybrids produced in summer 2018 in the greenhouse now, to have F2 seed ready to plant in 2019.

## Tomato genotyping

Using funds from royalties we purchased an Applied Biosystems QuantStudio3, qPCR thermal cycler and detector. This equipment will enable us to implement routine molecular marker assisted selection. Our goal is to use it to develop breeding lines combining resistance to multiple diseases. Development of the protocols for the PCR assays and screening for nematode resistance are in-progress in anticipation of the March 2019 milestone for this activity.