2020 OTRI FUNDING

	TITLE	RESEARCHER	$ AMOUNT FUNDED
1	Crop Tolerance Evaluations in Processing Tomatoes to Support Minor Use Herbicide Submissions (Robinson $5,000 - Nurse $3,000)	D Robinson / R. Nurse	$8,000
2	Problem Weed Control and Herbicide Tank Mix Interactions in Tomatoes (Robinson $5,000 - Nurse $3,000)	D. Robinson / R. Nurse	$8,000
3	Investigation into variables affecting tomato solids - labour	J. Zandstra	$10,000
4	Processing tomato cultivar trial, 2020	S. Loewen	$5,000
5	Scale Up Long-term Cover Crop Research: Soil Health Benefits to Plant Health and Human Health	L. VanEerd	$11,375
6	Evaluation of Oxidate 2.0 for transplant sanitation prior to shipping	C. Trueman	$4,000
7	Neonicotinoid alternative for Colorado potato beetle in tomatoes	C. Trueman	$4,250
8	Fungicide efficacy evaluations for early blight, Septoria leaf spot and anthracnose in processing tomatoes	C. Trueman	$4,000
Multi-Year Funding			
9	*Late blight surveillance and management - Part I (requested on a 3 year term at same levels) (Trueman $4,640 - Tomecek Agronomic Services $9,085)*	*C. Trueman/ Tomecek Agronomy*	*$9,085**
10	*Late blight surveillance and management - Part II (requested on a 3 year term at $5,000 initial year and $7,500 subsequent)*	*C. Trueman/ Tomecek Agronomy*	*$6,900***
11	*Breeding to protect plant health for Ontario's processing tomato industry (see note)*	*S. Loewen*	*$55,375*
		Total	***$125,985***

Trial 1: Weed Management with Authority, Prowl and Sencor Pre-transplant Tank Mixes

Objective: Determine whether adding Authority or Prowl to Sencor will improve residual control of broadleaf and grass weeds in tomatoes.

Materials & Methods:

Crop: *Tomato*
Variety: CC337
Planting rate: 11803 plants/ac
Row spacing: 1.5m

Planting date: May 27/20
Depth: 5 cm
Plant spacing: 45 cm

Design: Randomized Complete Block Design
Plot width: 1.5m
Reps: 4

Plot length: 10m

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 120 kg N/ha on May 26.

Soil Description:
Sand: 50% and 82%
Silt: 28% and 10%
Clay: 22% and 8%

OM: 4.1% and 2.8%
pH: 6.2 and 7.7
CEC 12.4 and 16.0

Texture: Sandy Clay Loam and Loamy Sand
Soil: Both in the Watford/Brady series

Application Information:

	A
APPLICATION DATE	MAY 26/20
TIME OF DAY	8:00 AM and 9:00AM
TIMING	PRE-T
AIR TEMP (c)	17 and 19
RH (%)	70 and 70
WIND SPEED (KPH)	6 and 8
SOIL TEMP (c)	20 and 23
CLOUD COVER (%)	0

Spray Equipment:
Application Method: CO2 Backpack
Nozzle Type: Air Induction
Nozzle Spacing: 50 cm (20")
Spray Volume: 200 L/ha (20 GAL/AC)

Pressure: 207 KPA (30 PSI)
Nozzle Size: ULD120-02
Boom Width: 1.5 m (60")

Table 1.1. Effect of Authority, Sandea and Sencor herbicide tank mix treatments on control of common ragweed (AMBEL), common lambsquarters (CHEAL) and large crabgrass (DIGSA).

TREATMENT	PERCENT CONTROL		
	AMBEL	CHEAL	DIGSA
AUTHORITY	30D	61B	25B
SENCOR	53C	90A	25B
PROWL	13D	28C	93A
AUTHORITY + SENCOR	75AB	88A	21B
AUTHORITY + PROWL	56C	75A	94A
SENCOR + PROWL	68B	94A	92A
AUTHORITY + SENCOR + PROWL	85A	98A	99A
LSD (P <0.05)	23	21	12

Note: Means followed by the same letter are not significantly different (P=0.05, LSD).

Table 1.2. Effect of Authority, Prowl and Sencor herbicide tank mix treatments on tomato injury at 7 and 28 days after treatment and marketable yield in the treated, weedfree sub-plots.

TREATMENT	VISUAL INJURY		YIELD
	7D	28D	(T/AC)
AUTHORITY	0C	0B	45A
SENCOR	0C	0B	44A
PROWL	1C	0B	42A
AUTHORITY + SENCOR	5B	0B	44A
AUTHORITY + PROWL	7AB	0B	44A
SENCOR + PROWL	4BC	0B	43A
AUTHORITY + SENCOR + PROWL	10A	4A	44A
LSD (P <0.05)	3	2	NS

Note 1: Means followed by the same letter are not significantly different (P=0.05, LSD).

Note 2: Marketable yield in the untreated, weedfree check was 45 T/ac

Conclusions: Two trials, each on a different soil type (ie. sandy clay loam and loamy sand), were conducted to determine differences in weed control and crop tolerance to two- and three-way tank mixtures of Authority, Sencor and Prowl. Despite the differences in soil type, data were similar enough in each trial to allow for them to be combined (ie. weed control and injury were similar in both trials).

The two-way tank mixes of Authority+Sencor, Authority+Prowl and Sencor+Prowl provided equivalent control of common ragweed and common lambsquarters to the three-way tank mix of Authority+Sencor+Prowl. Results of this study did show that postemergence broadleaf (especially of ragweed and triazine tolerant lambsquarters) control is necessary with these combinations of pre-transplant herbicides. Additionally, when Prowl H2O was not included, annual grass control would be necessary. None of the herbicides caused injury to tomato, and yields were similar to those in the weed-free check.

Trial 2: Tolerance of Tomatoes to Pre-Transplant Herbicides – Broadleaf Herbicides

Objectives:

1. Determine the efficacy and tolerance of tomato to Reflex and pethoxamid.

Crop: *Tomato*
Variety: CC337
Planting rate: 11803 plants/ac
Row spacing: 1.5m
Planting date: May 27/20
Depth: 5 cm
Plant spacing: 45 cm

Design: Randomized Complete Block Design
Plot width: 1.5m
Reps: 4
Plot length: 10m

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 120 kg N/ha on May 26.

Soil Description:
Sand: 50% and 82%
Silt: 28% and 10%
Clay: 22% and 8%
OM: 4.1% and 2.8%
pH: 6.2 and 7.7
CEC 12.4 and 16.0

Texture: Sandy Clay Loam and Loamy Sand
Soil: Both in the Watford/Brady series

Application Information:

	A
APPLICATION DATE	MAY 26/20
TIME OF DAY	10:00AM and 11:00AM
TIMING	PRE-T
AIR TEMP (c)	23 and 28
RH (%)	70 and 80
WIND SPEED (KPH)	6 and 11
SOIL TEMP (c)	20 and 23
CLOUD COVER (%)	0

Spray Equipment:
Application Method: CO2 Backpack
Nozzle Type: Air Induction
Nozzle Spacing: 50 cm (20")
Spray Volume: 200 L/ha (20 GAL/AC)
Pressure: 207 KPA (30 PSI)
Nozzle Size: ULD120-02
Boom Width: 1.5 m (60")

Table 2.1. Effect of herbicide treatment on tomato visual injury 7, 14 and 28 days after planting, plant dry weight 28 days after planting, and yield.

HERBICIDE	RATE	VISUAL INJURY 7D	14D	28D	DRY WT G	YIELD T/AC
1. Check (WEEDFREE)		0B	0B	0	98	43
2. REFLEX	400 ML/AC	1B	0B	0	96	46
3. REFLEX	800 ML/AC	2AB	3A	0	99	48
4. pethoxamid	1200 g/AC	2AB	0B	0	94	42
5. pethoxamid	2400 g/AC	3A	3A	0	102	42
LSD (P <0.05)		1	2	NS	NS	NS

Note: Means followed by the same letter are not significantly different (P=0.05, LSD).

Conclusions:

Two trials were established to determine tolerance of transplanted tomato to pre-transplant applications of Reflex and pethoxamid. There was very little injury other than some leaf distortion. Tomato showed excellent tolerance to both herbicides in both trials.

2020 Executive Summary

Dr. Rob Nurse (Robert.Nurse@Canada.ca)

Trial 1 – **Tolerance of processing tomato to Authority Supreme applied PRE.**
Research is required to identify herbicide options for the control of eastern black nightshade and for several herbicide resistant weed species. Authority Supreme is a pre-formulated tank-mix that contains the active ingredients sulfentrazone (group 14) and pyroxasulfone (group 15). This herbicide combination is labeled to control several annual grass and broadleaved weed species including eastern black nightshade, lambsquarters, pigweed, waterhemp and crabgrass. Currently, Authority Supreme is registered for use in field pea, chickpea, and soybean, but may have potential for registration in processing tomato because of known crop safety of the individual active ingredients. This trial specifically evaluated the application of Authority Supreme pre-emergence in processing tomatoes at doses ranging from 1/16 to 4x of the registered soybean dose. A dose response such as this will provide an estimate of the most appropriate dose that will not negatively reduce yield. Tomato injury was evaluated at 7, 14, and 21 days after tomato transplanting. Overall, tolerance of tomatoes was good to Authority Supreme; however there was some injury above 10% noted at the two highest (2x and 4x) doses tested. A regression analysis of tomato yield (% of weed-free control) vs herbicide dose was performed and demonstrated that yield was only decreased by more that 10% above the 2x dose. Therefore, these data suggest that Authority Supreme would be safe to apply at the currently registered soybean dose. This trial will be repeated in 2021.

Trial 2 – **Tolerance and weed control with the use of reduced doses of Treflan and Authority in processing tomatoes.**
The objective of this trial was to test the application of reduced rates of Treflan (group 3) and Authority (group 14) PPI and PRE in processing tomato. It was hypothesized that the lower Authority dose would reduce the chance of early season injury and the addition of Treflan would help to improve weed control. There were no injury concern with these treatments. The most prevalent weeds present in the trial were redroot pigweed, common lambsquarters, common ragweed and large crabgrass. As expected the control of common ragweed was poor, because it not labelled for either product. Control of common lambsquarters was also poor even when both products were tank-mixed. Control of redroot pigweed was acceptable only when both products were applied as a tank-mix. Weed control at 56 DAT was very poor for all treatments tested. Therefore, for this to be viable there will need to be a POST herbicide program combined. Yields in all treatments were reduced in comparison to the weed-free control.

Trial 3 – **Tolerance and weed control when Authority and pethoxamid are applied PRE in processing tomatoes.**
Pethoxamid is a new group 15 herbicide. Therefore, it's spectrum of weed control and mechanism of action is similar to Dual II Magnum. Authority is a group 14 herbicide that has recently been registered in processing tomato. This trial evaluates the efficacy of these products on several weed species when applied alone or in tank-mix with Authority. There were no crop injury concerns. Common lambsquarters, common ragweed and redroot pigweed were the most prevalent broadleaved weeds in the trial. Both Dual II Magnum and Authority provided >80% control of pigweed and lambsquarters while pethoxamid provided less than 50% control of when applied alone. Tank-mixes with Authority provided equal or better weed control comparatively. All products provided poor control of ragweed. By 56 DAT weed control was not maintained. Therefore, the use of these herbicides and tank-mixes would require a POST emergent application of another product to maintain weed control. This late season loss of weed control translated into yield losses across all treatments.

2020 Executive Summary

Dr. Rob Nurse (Robert.Nurse@Canada.ca)

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Progress Report – Investigations into Variables Affecting Tomato Solids. 2020 Season

Project Lead: John Zandstra† (jzandstr@uoguelph.ca)

Research Team: Sydney Boersma†, Kris McNaughton†, Darren Robinson†, Cheryl Trueman†, Steve Loewen†, Anne Verhallen‡, Laura Van Eerd†

†University of Guelph Ridgetown Campus, ‡OMAFRA

Introduction

Some processing tomato contracts in Ontario now include bonuses for higher than average Natural Tomato Soluble Solids (NTSS) and penalties for lower than average NTSS as an incentive for producers to produce more solids. This can be problematic as factors which influence solids and are controllable by tomato producers are not well understood. Other than high soil moisture levels close to maturity, which are known to depress NTSS levels, growers are unsure of practices to use to maintain high NTSS levels without affecting tonnage.

This project involved collecting a range of soil, plant, and weather variables from select locations in processing tomato fields, and harvesting fruit for NTSS determination. The resulting data set will be analyzed through Principal Component Analysis in an attempt to better understand production factors which influence NTSS and are controllable by tomato growers.

Materials and Methods

Due to natural field variability, as well as variability in NTSS levels within a load of tomatoes going to the processor, tomato fruit samples were taken by hand at small, specific locations within grower fields just prior to harvest. Harvest was conducted when at least 80% of the fruit was fully red ripe. Five (5) plants were harvested per location and the fruit was graded into 3 categories: red ripe + processing green, rots + grass green, and everything else, so total and marketable yields can be determined. From this, a subsample of red ripe fruit was forwarded to Steve Loewen's lab for analysis of Agtron, colour (L*,a*,b*), Hunter a, Hunter b, tomato sauce score, soluble solids. Soil samples and plant samples were taken in the immediate vicinity of the harvested plot; a complete soil health test will be completed which includes the parameters: organic matter, pH, buffer pH, phosphurous, potassium, magnesium, calcium, sodium, sulphur, boron, copper, manganese, iron, zinc, aluminum, Cation Exchange Capacity, % saturation of cations, potassium:magnesium ratio, electrical conductivity, %phosphorous, % aluminum, chlorine, Soltiva CO_2–C, PMN, Active C, Soil health index, NO_3-N and soil texture. Plant tissue was collected prior to harvest and analyzed for phosphorous, potassium, nitrogen, magnesium, zinc, manganese, calcium, copper, iron and boron. Disease and insect ratings were completed midsummer to avoid Ethrel (ripening agent) masking disease pressure at harvest. Weather Innovations Inc. will be providing weather data for each site (maximum, minimum temperature, heat units, precipitation). Our goal was to collect a minimum of 20 individual samples from 10 growers (200 samples total) each year throughout the harvest period. Growers who have a history of high and low solids will be included. Information collected from the growers included crop rotation, use of cover crops, fertility program, pest control program, source of plants (ie: greenhouse transplant grower), planting date, starter fertilizer, cultivation prior to planting and during crop development, and rate and timing of Ethrel. Overall, 200 leaf tissue and soil samples were collected, as well around 185 yield samples. Due to time constraints and changes in growers harvest schedules some samples were lost.

Soil and leaf samples have been analyzed by A&L Laboratories in London. Grower surveys are being revised to make it easier to complete as well as to provide data which is easier to analyze. We are now asking grower's permission to access their spray records so we can include this data in the analysis. Once these are completed, Principal Component Analysis will be completed with the all years of data.

Results

Results from the analysis of the previous 2 years show little relationship between the variables collected and NTSS. We are now including components of growers spray records, if permission has been granted, to include in the analysis. When harvesting the plots, we have also noticed different ways that the growth regulator Ethrel is being used, and wonder if this may have an influence on NTSS. Field trials were planned at the Ridgetown Campus in 2020 to evaluate this (timing of application relative to crop maturity) but was not completed due to Covid restrictions. This work is planned to begin in 2021.

Processing tomato cultivar trial, 2020

A report to Ontario Tomato Research Institute, 2020-11-01

Steve Loewen, University of Guelph Ridgetown Campus

Introduction:

Processing tomato cultivar trials were planned for the 2020 season as a follow-up to the 2019 trials. Planning was completed but requirements to limit exposure between research staff and industry cooperators at planting, and anticipated difficulties in harvest led to the discontinuation of the work.

Objectives:

The overall objective was to measure field performance of recently released processing tomato cultivars to assist processors in identifying hybrids that merit more extensive evaluation.

Methods:

To determine suitable entries for the trial, Ontario tomato processor representatives were contacted. Five companies provided lists of the cultivars they planned to grow in 2020. Seed companies were contacted to obtain seed of these entries and invited to submit additional entries. A list of 24 trial entries was compiled and seed was received for most of these.

A grower field site in Chatham township was arranged.

Based on many years of previous experience conducting cultivar trials in growers' fields the best results were obtained when the research team provided plants to the grower's planting crew on the grower's planting equipment.

Results

Since it was not possible to ensure compliance with pandemic precautions and University research policy, the trial was not planted. No research expenses were charged in relation to this project.

Scaling up: Long-term Impact of Cover Crops on the Production of Processing Tomatoes
Executive Summary 2020 to OTRI

Dr. Laura L. Van Eerd
University of Guelph, Ridgetown Campus
1-519-674-1500 x63644 lvaneerd@uoguelph.ca

Executive Summary:

Soil health is closely linked to soil function and crop productivity, which relates to plant health. Long-term fall planted cover crops significantly improved soil health in a cover crop experiment established in 2007 at the University of Guelph, Ridgetown Campus. Having previously quantified greater soil health and yields with cover crops (fall cereal rye, radish, mix of radish and rye, oat) compared to the no cover crop control, the objective of this study was to evaluate if these differences might translate to enhanced plant health. In addition to yield, we quantified plant health by evaluating processing tomato fruit quality (Steve Loewen), insect and disease incidence (Dr. Cheryl Trueman), and we will also assess fruit element content (SGS Canada Inc., Guelph, ON), and fruit phytochemical contents, antioxidant activities, and carotenoid contents (Dr. Rong Cao-AAFC, Guelph. ON).

The research trial was managed according to typical Ontario processing tomato production practices on a fertile, sandy loam soil with annual cover crops grown since 2007. Variety CC337 was planted on 26 May 2020 and harvested on 31 Aug. and 1 Sept. 2020. Ethrel® was not used so that we could observe any treatment impacts on maturity. In 2020, all cover crop treatments had numerically greater yields than the no cover treatment. Similarly, in previous years (2010, 2011, 2015, 2016, 2019), processing tomato **yields with cover crops were greater or as good as yields without cover crops**. In 2020, plants without N fertilizer had more defoliation and matured earlier (greater % red fruit at trial harvest) than those plants with preplant broadcast incorporated N fertilizer. It is not possible to differentiate if the defoliation was due to greater disease or natural plant senescence brought on by quicker maturity. The **no cover crop control had numerically more red fruits with anthracnose lesions** and a greater anthracnose disease index than all cover crops, however, this was not statistically significant. While one expects anthracnose to increase with crop maturity, the pathogen is soil borne and thus observed effects may reflect cover crop-induced benefits on plant health due to better soil health. The **incidence of bacterial speck and spot on fruit were very low, as was stink bug damage**. Treatments were not significant except for bacterial speck on fruit, where straw removed had a significantly greater percent fruit with bacterial speck compared to straw retained treatment. The fruit quality analysis (Agtron colour, pH and natural tomato soluble solids) indicated that all values were within acceptable ranges for commercial processing tomato requirements and the **cover crop treatments did not lower fruit quality**. Overall, it is evident that cover crop treatments did not negatively affect fruit yield, plant health nor fruit quality. A more thorough statistical analysis of both years is currently being completed.

Cheryl Trueman – RCUG
ctrueman@uoguelph.ca, 519-674-1500 x63646

2020 Research Report

Evaluation of Oxidate 2.0 for transplant sanitation prior to shipping

Prepared for Ontario Tomato Research Institute (OTRI)
November 27, 2020

Research Team:

- Cheryl Trueman, Ph.D., Assistant Professor, Dept of Plant Ag, Univ of G – Ridgetown Campus
- Phyllis May, Research Technician

Highlights/Summary:

- Bacterial spot (*Xanthomonas* spp.) is an economically important disease of tomatoes in Ontario. Due to a lack of effective biological and chemical controls and limited host resistance, bacterial spot management is challenging. The objective of the research was to evaluate the use of Oxidate 2.0 as a 'sanitizer' of outgoing tomato transplants prior to shipping.
- *Xanthomonas* spp. inoculated tomato plants were treated with Oxidate 2.0, and depending on experiment, the plants grown in either a greenhouse or field situation.
    - The Spring 2020 greenhouse trial was repeated in Fall 2020 due to contamination in the non-inoculated control. In the Fall trial, the incidence of seedlings with bacterial spot symptoms in inoculated and Oxidate 2.0 treatments was similar.
    - In the 2020 field trial, bacterial spot was observed 18 days after transplanting in the inoculated control, and 19 days in the Oxidate 2.0 treatment, which was not significantly different. This was similar to results in 2019, where there was no difference in the number of days to the first observation of symptoms among the inoculated control, non-inoculated control, and Oxidate 2.0 treatments.
- The results indicate that there is no benefit of applying Oxidate 2.0 prior to transplanting to delay the appearance of bacterial spot symptoms.

Cheryl Trueman – RCUG
ctrueman@uoguelph.ca, 519-674-1500 x63646

2020 Research Report

Neonicotinoid alternatives for in-furrow management of wireworms in tomato

Prepared for the Ontario Tomato Research Institute
October 19, 2020

Research Team:

- Cheryl Trueman, Ph.D., Assistant Professor, Department of Plant Agriculture, University of Guelph – Ridgetown Campus
- Phyllis May, Research Technician

Highlights/Summary:

- The objective was to evaluate the efficacy of in-furrow applications of Verimark (cyantraniliprole, group 28) for management of wireworm in tomatoes. This insecticide is a potential in-furrow alternativeto the neonicotinoid insecticide Admire (imidacloprid, group 4A), which will not be permitted for in-furrow applications at transplanting as of April 2021. Admire has traditionally been applied to manage Colorado potato beetle but is also reported to repel wireworms from feeding on recently transplanted tomato seedlings.
- The trial was completed at a commercial processing tomato site in Kent County. Wireworm sampling using pre-plant bait traps indicate populations (3.1 wireworms/trap) of the Eastern field wireworm (*Limonius agonus*) were above the general threshold guideline for vegetable crops suggested by OMAFRA (0.5-1.0 wireworms/trap). However, there were no differences among treatments for the incidence of wireworm feeding damage and the incidence of wireworm feeding damage was low.
- The low level of feeding damage may mean that the economic threshold for wireworm populations in bait traps is much higher than other vegetable crops. Alternatively, dry conditions during the growing season may have resulted in the insects moving down the soil profile, limiting feeding damage on tomatoes. Further investigation is required to better understand factors affecting the extent of wireworm feeding damage on tomato transplants and what level of stand loss is required for economic losses to occur. Since potential insecticide solutions for wireworm management are limited, integration of biological and cultural controls for wireworm management should also be considered.

Acknowledgements: Funding from the Ontario Tomato Research Institute and University of Guelph Ridgetown Campus. In-kind support from FMC Canada and the grower co-operator is appreciated. Thank you to Joe Tomecek for assistance in locating a commercial tomato field with wireworm pressure. Thank you to Dr. Jocelyn Smith for assistance in coordinating wireworm species identification and to Dr. Wim Van Heerk (AAFC-Agassiz) for completing wireworm species identification.

Report to OTRI: Breeding to protect plant health for Ontario's processing tomato industry, 2020 (CAP 0026)

S. Loewen, University of Guelph Ridgetown Campus, 2020-11-01

Description of the project

Since 2018, with the support of OTRI, the processing tomato breeding program at Ridgetown has moved to a greater focus on breeding for resistance to multiple diseases. There has been a trend for seed companies to require an expanded suite of resistances stacked in F_1 hybrid cultivars. The emergence of late blight as a risk earlier in the season and the constraints placed on the use of some control products suggest that genetic resistance to late blight is an important management strategy.

The primary goal of this project has been to begin incorporating a core set of resistance genes into all adapted lines in the breeding program. A secondary goal has been to gain experience using molecular markers as a routine tool for screening for disease resistance and to facilitate stacking resistance genes.

Specific project activities and outcomes to date, in Year 3 (2020)

COVID-19 had a significant impact on research trials in 2020

During research planning in March 2020 there was still a great deal unknown about SARS-CoV2 virus and the resulting COVID-19 disease. University of Guelph senior research administration placed a priority on the continuation of time-sensitive research projects (e.g. those involving seasonal crop field research) while balancing this with safety of staff. To achieve these goals, the tomato breeding effort was scaled back to permit safe working arrangements for staff and to minimize risk to the research program if the entire research team became ill with COVID-19 which might have required abandonment of the field research for the remainder of the season.

Five acres of breeding plots were established at a site on Kenesserie Road in Chatham-Kent in 2020. Ten acres would have been established in the absence of the pandemic.

Establish and advance nematode resistant breeding lines in the field

As a result of the molecular marker screening completed in Winter 2020, 27 F_4 generation lines, out of 33 selected in the field in Fall 2019, were identified as have resistance to nematodes. These were established in the field for Summer 2020. Selections were made in each of these lines in Fall 2020. In addition to nematode resistance, marker screening from Winter 2020 showed that we expect to find resistance to Verticillium 1 in all of these lines and resistance to Fusarium 2 in as many as 6 of these lines. An additional round of marker screening would permit confirmation of the results.

The nematode resistant backcross 1 F_2 generation (BC_1F_2) breeding lines were not planted in the field in 2020 and so achievement of project objectives related to this group has been delayed.

The work to date has resulted in taking nematode resistance from vintage lines, and from very old processing tomato cultivars and transferring that resistance into modern processing tomato background. The F_5 breeding lines lack the full complement of characteristics needed to merit release to co-operators. They will serve as a core group of parents for future crosses within the breeding program. It was an unexpected benefit that resistance to Fusarium 2 was found in some of these lines. The BC_1F_2 cohort should be an improvement on the F_5 group but further development has been delayed temporarily.

Establish late blight resistant selections in the greenhouse for backcrossing and establish resulting plants in the field

Selections, made in Fall 2019, with expected resistance to late blight, were established in the greenhouse during Winter 2020 and crosses were made to well-adapted parents. While seed was ready for field planning in Spring 2020, this material was held back to guard against risk of loss in the event of a pandemic-required shutdown of the field work.

Isolate DNA from 188 additional breeding lines to screen for disease resistance

It is important to have capacity in our own lab to extract DNA and assay PCR-based molecular markers and this project has allowed the development of that capacity and experience. Further to what was learned in Year 2 of this project, for routine screening of large numbers of lines, custom genotyping labs can do this work faster, and for much lower cost.

In Summer 2020 leaf tissue samples from 282 lines were sent to LGC Genomics for molecular marker screening. The lines chosen included: breeding lines released over the last 5 years, breeding lines sampled from some of the genetically diverse germplasm in the collection, and some older breeding lines released. The lines were assayed for markers associated with resistance to: Verticillium 1, Fusarium 2, Fusarium 3, nematodes, bacterial speck, tomato spotted wilt virus and late blight (*Ph-2* and *Ph-3*). Resistance was discovered for all the diseases on this list although for some (e.g., Fusarium 3, *Ph-2*, *Ph-3*) it was very rare. One breeding line had 4 resistances from the list stacked, and 8 lines had 3 resistances stacked. The discovery of resistance for Fusarium 3 is noteworthy, and it is highly desirable to repeat this test to verify the result. These lines represent important parents for further crossing to incorporate multiple resistances across the entire breeding program. While there has been limited direct selection for disease resistance prior to the start of this project, it was very positive to learn that resistances have been carried along in the background of many lines.

Other Ridgetown breeding program activities

Breeding lines released in 2020

Twenty F_7 generation breeding lines, selected in fall 2019, were released in time for 2020 field planting. There were 7 out of 20 that were based on pedigrees with an important contribution from *S. habrochaites* in the recent pedigree. Two out of the 20 had multiple wild species in the recent pedigree. Yield, early maturity, fruit colour, field-holding ability and elevated soluble solids were important factors in determining which lines would be released.

Breeding field plots

Five acres (explained under COVID-19 impact above) of breeding plots were established on a farm on Kenesserie Road northeast of Ridgetown. There were 495 breeding lines from F_2 to F_6 generations planted (893 in 2019, 736 in 2018; 843 in 2017) in addition to the 27 nematode resistance lines noted above.

Field planting started on May 27 and finished on June 5. Field selection began on August 25 (2019 August 29; 2018 August 20; 2017 August 28) and continued until September 29 (2019 October 10; 2018 September 21; 2017 September 28). Frost affecting the upper half of the crop canopy occurred on September 19. Field seed collection was completed October 20 on the semi-wild breeding lines.

Screening for tomato brown rugose fruit virus (ToBRFV) resistance

ToBRFV is a serious virus in greenhouse tomato production. A portion of the greenhouse production region in Ontario overlaps with the processing tomato production region presenting some risk for spread to the processing crop. Enza Zaden has reported finding a single gene conferring strong resistance although no details on the source of resistance have been given. At the invitation of J. Griffiths (AAFC-Vineland) plans have been made to have Ridgetown breeding lines screened to detect the presence of any resistance to ToBRFV that may be present in the collection. The presence of wild tomato species in the recent pedigrees of most breeding lines at Ridgetown, and the resulting genetic diversity suggests a measure of optimism for a positive result.