2014 OTRI RESEARCH REPORT

	TITLE	RESEARCHER	$ AMOUNT FUNDED
1	Efficacy of copper alternatives on processing tomato transplants and field tomatoes, 2014	C. Trueman	$4,000
2	The development of pest management strategies for foliar disease and fruit rots in processing tomatoes, 2014	C. Trueman	$5,000
3	Disinfectants and other treatments as tools for reduction of X. gardneri populations in greenhouse transplants and delayed disease development in the field	C. Trueman	$5,000
4	Weed Control and Crop Tolerance Evaluations in Processing Tomatoes	D. Robinson	$5,000
		R. Nurse	$3,000
5	Herbicide-Fungicide Tank Mix Interactions in Tomatoes	D. Robinson	$5,000
		R. Nurse	$3,000
6	Long-term Cover Crop Research	L. VanEerd	$2,000
7	Processing Tomato Breeding Research	S. Loewen	$80,000 (approx.) (AIP funds half)

2014 Research Report: Pest management in Ontario processing tomatoes

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Key Findings / Summary of Results

Area 1: Bacterial spot management on transplants and in the field.

In all trials certain treatments resulted in reduction in incidence and severity of bacterial spot on either transplants or in the field (foliage and fruit), however, even treatments that resulted in disease reduction had significant amounts of disease. This is expected because these are inoculated trials, but this also reinforces that concept that the best way to manage bacterial spot is to limit introductions of the pathogen (*X. gardneri*) into the production system at all steps, since even a tiny population is capable of multiplying rapidly under the right environmental conditions.

Objective: Evaluate sole applications and combinations of products for protection of tomato transplants from bacterial spot on seedlings grown from infested seed. (p. 5-9)

Seedlings were grown from artificially infested seed and disease incidence in the trial was very high. Despite this, **treatments that included the Actigard seed treatment application had lower incidence and severity of bacterial spot up to 42 days after seeding**, when the trial was terminated. Combinations of the Actigard seed treatment with KleenGrow or Kocide 2000 foliar applications reduced the incidence of seedlings with bacterial spot symptoms up to 28 days after seeding, after which time it became very difficult to accurately measure disease incidence. **Applications of Kocide 2000, the current standard treatment in greenhouse tomato transplant production, had limited effect on reducing bacterial spot severity under these conditions of high disease pressure.** Actigard seed treatments had no negative effects on plant growth in this trial. Research should continue to evaluate the potential of Actigard seed treatments for management of bacterial spot.

Objective: Evaluate sole applications and combinations of products for reduction of epiphytic (leaf surface colonizing) populations of *Xanthomonas gardneri* on greenhouse transplants inoculated with symptomatic seedling, and assess subsequent symptom development in symptom-free seedlings transplanted to the field. (p. 10-22)

Actigard seed treatments combined with foliar applications of Kocide resulted in the **most consistent** reduction in bacterial spot both on transplants and in the early stages of disease development in the field. This combination was more effective than applications of Kocide only. Applications of KleenGrow, Actinovate, AEF1301, and Cyclone were not effective. Other findings and observations include:

- The ability of *X. gardneri* to spread in greenhouses was demonstrated by the fact that our non-inoculated control developed disease symptoms despite barriers that were installed to reduce or delay this from happening. The likely cause of contamination was overhead watering activities.
- It was interesting that **in all treatments**, including Kocide treatments where we found much lower levels of bacteria on the leaf surfaces of **asymptomatic seedlings** just before transplanting, **bacterial spot developed within two weeks of transplanting.**
    - The low level of bacteria isolated from Kocide treatments was somewhat surprising given that the Kocide treatment alone provided limited suppression of bacterial spot. Prior to her retirement Diane Cuppels collected some evidence for copper causing a 'viable but not culturable' state in *X. gardneri*, meaning that the presence of copper caused the

bacteria to not be detectable on media, but still alive and present. This is one possible explanation for the variation in populations observed in this study. This state has been reported in some other bacterial plant pathogens in other crop systems.

- The process of taking asymptomatic seedlings to the field to observe disease development was an interesting exercise.
    - We observed that the disease **established more quickly** in Rep 1 and Rep 2, **where rain fell immediately after transplanting.** Disease developed more slowly in Rep 3 and Rep 4 which experienced dry conditions after transplanting.
    - Disease in the field was initially **widespread but the level of infection on plants themselves was relatively low** (i.e. <5% leaves with symptoms in most cases). I hypothesize that in grower fields **bacterial spot may be present earlier in the growing season than growers may realize, then develop quickly after severe rain events, and become quite noticeable in late June and early to mid-July** (i.e. browning leaves visible from afar).
- Preliminary results from OSU (Sally Miller's lab) on the Xanthomonas-like bacteria we isolated from the tomato leaves show that 82% of the isolates were *X. gardneri*.
    - In doing this project, we also successful learned how to purify bacterial DNA in a laboratory setup by myself and Steve Loewen, in part using funds from Steve's royalties from tomato breeding line releases.
- There was **no effect of seed or seedling treatments on disease incidence on fruit or yield** but it is possible that **integration of more effective seedling treatments with other measures** such as greenhouse biosecurity, applications of chemical treatments in the field (see report on page 23), or other tools might result in a yield increase.
- Actigard seed treatments **reduced seedling biomass but this did not affect tomato yield.** There also a **slight but statistically significant reduction and delay in seedling emergence** observed with Actigard seed treatments. We are exploring this further this winter.

<u>Objective</u>: Evaluate the efficacy of copper alternatives for bacterial disease management in the field, including the influence of the addition of Bravo to Kocide for bacterial spot control. (p. 23-29)

Defoliation was **limited by applications of Kocide + Dithane and Kocide + Actigard**. Applications of these treatments **did not result in a significant yield increase** compared to the nontreated control, suggesting that these treatments applications may have **limited economic benefit. However, there was one important finding with regards to fruit yield and quality. Applications of Kocide + Dithane, Kocide + Bravo, and Kocide + Actigard reduced the number of tomatoes with 5 or more spots by 67 to 79% and overall disease severity on fruit by approximately 50%.** Although we did not specifically rate for peelability or surface defects in this trial, fruit with more spots are less likely to meet quality standards for whole pack tomatoes.

There was no indication that these treatments reduce spot severity on fruit in trials conducted in previous years at Ridgetown Campus. This year we used cultivar H5108 in our evaluations, whereas in the past H9909 was used. Although these results could be related to the environmental conditions in 2014, the range of environmental conditions in previous years (i.e. 2013 wet and warm, 2012 hot and dry, etc.) **suggest the reason is more likely a cultivar effect.** If this is true, a given spray program may be more or less effective depending on the cultivar grown.

There is increasing scrutiny by growers and others on the effectiveness of copper and mancozeb applications for reduction of bacterial spot severity in the field, particularly on foliage. Recent results from field trials at Ridgetown Campus have also not provided compelling evidence for the value of these applications. However, **the results from this trial suggest it may be valuable to assess one or more of these spray programs on a range cultivars used for whole pack to determine if there are benefits for some cultivars for tomato fruit processing quality abandoning this practice.**

Area 2: Management of early blight, anthracnose, and other fruit rots.

<u>Objective</u>: Evaluate the influence of fungicide selection and the timing of the last fungicide application on the incidence and severity of tomato fruit rots under normal and delayed-harvest conditions. (p. 30-35)

The results show **no benefit of continuing fungicide applications up to 14 or 7 days before harvest for management of fruit rots**, and this is consistent with 2013 results. Chlorothalonil applications will however act as a protectant fungicide for late blight, thus, **growers should consider late blight pressure in the region when deciding when to conclude fungicide applications** for the season. Both fungicide programs in the normal ripeness tomatoes increased yields compared to the control in 2014. Interestingly, tomato yield in Bravo treatments in the overripe tomatoes was also higher than the control in the overripe tomatoes where the Quadris alternating with Bravo program did not have the same effect. The reason for this is unclear.

The causal agent of anthracnose can infect green fruit, thus, fungicide applications during early stages of fruit development may be more critical than late-season fungicide applications. Infection of fruit by *Alternaria* spp. causing black mould occurs when fruit are ripe whereas infection by *Alternaria solani* (*Alternaria tomatophila*), which is also the causal agent of early blight, can occur on green or red fruit.

Severe levels of bacterial spot were present in the trial and expedited defoliation and fruit ripening. Many growers faced a similar situation this year, thus our trial was completed under conditions that closely mimicked those observed in the field. **This research should be repeated for at least one more year to confirm consistency of results.** Additional statistical analysis will include combining data from multiple years to examine the consistency of response in different environmental conditions.

<u>Objective:</u> Evaluate fungicides for fungal disease management under Ontario conditions. (p. 36-40)

Bacterial spot severity in the trial was very high and likely affected our ability to evaluate the fungicides for early blight. We inoculated twice for early blight but few symptoms were observed in the trial. The trial was established in a separate location on campus than our bacterial spot trials and measures were taken to prevent cross-contamination between the sites. The overall incidence of anthracnose in the trial was relatively low, compared to other years when we have observed differences among treatments. For example the incidence of anthracnose in the control in 2013 was 24% whereas this year it was 9%.

Appendix A: 2014 weather statement (p. 41)

EXECUTIVE SUMMARY – WEED CONTROL IN TOMATOES (2014)

BY: DARREN ROBINSON, RIDGETOWN CAMPUS, UNIVERSITY OF GUELPH

Interaction Between Actigard and Postemergence Herbicides in Tomato

Objective: Determine whether Actigard increases injury to tomato or reduces weed control of Prism, Pinnacle or Sandea (each tank mixed with a micro-rate of Sencor).

Conclusions: Actigard did not reduce control of redroot pigweed, common lambsquarters or eastern black nightshade when tank mixed with Prism, Pinnacle or Sandea. None of the tank mix combinations injured tomato or reduced tomato yield.

Weed Control and Tolerance of Tomato to POST Applications of Dual II Magnum + Sencor

Objective: Determine the effect of different rates of sequential POST applications of Dual II Magnum + Sencor on eastern black nightshade control and tomato tolerance.

Conclusions: The purpose of this study was to determine whether applying Dual + Sencor postemergence (POST) after an industry standard of Dual + Sencor (PPI) would significantly improve control of eastern black nightshade. Dual + Sencor (POST) did not improve control of common lambsquarters but did improve control of eastern black nightshade. Tomato yield was greater where Dual + Sencor POST (250 + 150 ml/ac) followed the industry standard.

Tolerance of Tomato to Preemergence Herbicides

Objective: This trial was established to determine tolerance of transplanted tomato to pre-transplant applications of Reflex, Prowl, Valtera and tank mixes with Dual II Magnum and Sencor.

Conclusions: This trial was established to determine tolerance of transplanted tomato to pre-transplant applications of Reflex, Prowl, Valtera and tank mixes with Dual II Magnum and Sencor. Treatments containing Valtera (alone or in tank mix) caused significant injury AND yield loss, as has been seen in previous years. Tomato showed excellent tolerance to Reflex and Prowl H2O. **Data were submitted to support a minor use submission for Prowl H20.**

Weed Management Strategies in Tomatoes with PRE Applications of Reflex and Sandea

1. Objective: Determine the efficacy and tolerance of tomato to tank mixes of Dual II Magnum + Sencor with Reflex or Sandea.

Conclusions: This trial was established to determine tolerance of transplanted tomato and control by to pre-transplant applications of Reflex or Sandea in tank mixes with Dual II Magnum and Sencor. Reflex did not give acceptable control of common lambsquarters and Sandea provided poor control of eastern black nightshade. The addition of Reflex to Dual II Magnum plus Sencor improved control of redroot pigweed and common lambsquarters. The addition of Sandea to Dual II Magnum plus Sencor improved control of redroot pigweed. Yields in the tank mixes reflected the increase in broadleaf weed control.

Do Copper Formulation and Addition of Dithane Affect Weed Control or Tomato Tolerance to Prism?

Objective: This trial was established to determine the effect of tank mixing a) Kocide or Parasol with Prism, or b) Dithane, with either Kocide or Parasol, and Prism on weed control and tolerance of transplanted tomato.

Conclusions: All of the tank mixes caused less than 5% visual injury to tomato. Kocide or Parasol alone or tank-mixed with Dithane did not reduce efficacy of Prism. The addition of either copper formulation or Dithane to Prism did not reduce weed control.

Dr. Rob Nurse
AAFC, Harrow

Executive Summary

The tomato variety CC337 was used in all trials.

Trial 1 – **Interaction between Actigard and POST herbicides.**
The herbicides tested were Prism (57 g/ac), Pinnacle (4.9 g/ac), and Permit (19.5 g/ac) all POST at cotyledon to 1-lf weeds. Sencor was also applied to each treatment POST in 3 micro rates of 0.15 L/ac for a total of 0.46 L/ac. There were no visual injury symptoms present in any of the treatments. Weed control was monitored in all plots. For the most common broadleaved species (lambsquarters, pigweed and nightshade) there was no negative impact when Actigard was used. Yield in the weed-free control did not differ from yields in any of the herbicide treatments.

Trial 2 – **Tolerance of processing tomato to Refine SG POST.**
Refine SG is a pre-mix of Pinnacle and another ALS inhibitor. Refine SG was applied at 16 and 32 g/ac. The resulting injury from this product was not acceptable and ranged from 33 to 75% in comparison to the untreated control. Yield was reduced by 8 to 17 Ton/ac, respectively in comparison to the weed-free control. These data are a summary of two field seasons.

Trial 3 – **Weed control and tolerance to POST applications of Dual and Sencor.**
In this trial Dual was applied POST in 2 split applications (10 and 14 days after transplanting) at a total dose of (0.11; 0.13, 0.16 and 0.18 L/ac). Sencor was applied at the same timing at (0.3 L/ac). Visual injury ratings were recorded 7, 14, and 28 days after herbicide application. There were no injury concerns in this trial. Weed control was also assessed at 28 and 56 DAT and there were no concerns with respect to reduced weed control for any of the species in the trial. Yield in the weed-free control did not differ from any of the Dual POST treatments.

Trial 4 – **Weed control and tolerance of tomato to Permit applied POST when tankmixed with Sencor, Prism, and Pinnacle.**
In this trial Permit was applied POST (cotyledon weeds) at 19.5 g/ac. When tankmixed with Sencor, Prism or Pinnacle weed control was equal to or better than if Sencor was applied alone. Similarly, yield in all tank-mix treatments did not differ from the weed-free controlor Sencor alone.

Trial 5 – **Weed management in tomatoes with PRE applications of Permit and Reflex.**
In this trial tolerance and weed control with Permit (19.5 g/ac) PRE + Sencor POST was compared to Sencor alone POST or Reflex (0.4 L/ac) PRE + Sencor POST. Weed control and yield did not differ among treatments or in comparison to the weed-free control

2014 Final Research Summary

<u>Executive Summary:</u> Long-term cover crop research.

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Objective #1: To assess the effect of 4 years of cover cropping on crop productivity and economics

Typically cover crop research has focused on planting the cover crop in the fall and studying effects in the following growing season. Although this approach is valid for first time cover crop users, many vegetable growers have been growing cover crops for many years. Therefore, evaluating the long-term impact of growing cover crops over multiple years (4+ yr) on vegetable crop production and soil health is necessary. In Trial #2, over the 4 year crop rotation (cover crop, sweet corn- cover crop, spring wheat-cover crop, tomatoes- cover crop, field corn-stover removed or retained) the impact of cover crops was assessed. All cover crops compared to the no-cover crop treatment showed 5.9% increase in crop yields and 6.6% increase in profit margins. Average profit margins were $104/ac with cover crops than without in this 4 year rotation. Recommend oilseed radish (alone or with rye) cover crop due to higher profit margins and yields

Objective #2: To assess the effect of cover crops on vegetable crop productivity as well as selected soil health parameters

In Trial #2, cover crops were grown in for 4 years prior to field corn and stover removal. Soil samples were collected in the spring after field corn stover removal. The removal of corn stover and cover crop did not have a significant effect on soil aggregation in spring 2012 and 2013. There was no cover crop and corn stover interaction. Since cover crops were not grown during the 2011-2012 autumn seasons, plant biomass inputs were minimal, thus contributing less to soil organic matter and likely minimizing soil aggregation and the ability to detect differences. This research indicates that tillage has a larger impact on aggregate stability than cover crop type or corn stover removal in this sandy loam soil with 3.8% OM.

In Trial #2, in a lab study, Corn stover break down was quicker or not different (based on high decomposition rate and low half-life) without cover crop residues than with cover crop residues. There was lower carbon dioxide release and lower active carbon breakdown in cover crop-corn stover treatments compared to the no cover control. Therefore, some cover crops may act to conserve soil organic carbon and matter. The mix of oilseed radish and cereal rye may be the most effective at conserving organic matter due to its low decomposition rate.

Objective #3: To assess the effect of cover crop planting date on crop productivity and N dynamics.

Although many Ontario vegetable growers have been using cover crops for many years, there are still questions as to "what is the best cover crop to use before sweet corn or snap beans. In Trial #1, in 2011-2014, the cover crops were planted in August or September and included 1) no cover crop, 2) oat (seeding rate 72 lb/ac), 3) fall rye (120 lb/ac), 4) oilseed radish (12 lb/ac), 5) forage pea (200 lb/ac), and 6) hairy vetch (25 lb/ac). The following year, the site was disked and cultivated prior to planting either processing snap beans (Festina) or sweet corn (Obsession). P and K fertilizer was applied to the entire trail area. Nitrogen fertilizer was applied to all sweet corn and snap bean plots except for the no cover crop and no N control plots. For snaps, 40 lb N/ac 27-0-0 was preplant broadcast applied and for sweet corn, 90 lb N/ac 28% liquid was knifed in at sidedress.

The planting time of the cover crops (either August or September) did not affect crop yield the following year. Growers do not need to switch cover crop type based on planting date but planting in mid-September does not give a lot of growth for oilseed radish and hairy vetch. Average sweet corn yield was 2.13 ton/ac higher with a cover crop than without a cover crop (i,e., no-cover with N compared to cover crop with N). Snap yield was 0.37 ton/ac higher with a cover crop than without a cover crop. The four year average snap bean yield was higher with cover crops oats compared to the no cover crop & no N control treatment (Figure 2). Overall, bean and corn yield with all cover crops tested were as good as or better than the no-cover treatment.

Using genomic tools to foster innovation and competitiveness in Canada's processing tomato industry: Tomato breeding research report to the Ontario Tomato Research Institute, November 2014.

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1. Brief review of program background

Between 1984 and 2002 at AAFC-GPCRC Harrow, modern cultivated varieties of tomato were hybridized with wild species of tomato. These crosses represent a source of new genetic variation to increase genetic diversity of breeding lines and Ontario processing tomato cultivars developed from them. Work at Ridgetown continues to focus on backcrossing and selection to combine this new genetic variation with commercially adapted traits for Ontario.

The OTRI succeeded in obtaining matching research funding from the Agriculture and Agri-Food Canada Agricultural Innovation Program to support this breeding effort. This project brings together two important goals. While continuing to support the work to increase genetic diversity in processing tomato lines adapted for Ontario production, this project enables the adoption of applied genomic technologies and breeding techniques to achieve this goal.

2. Summary of objectives

(a) To release between 15 and 20 breeding lines annually to private sector breeders. These breeding lines will be developed and selected based on field performance.

(b) To extend the harvest season by gathering data on earliness of individual breeding lines (date of 80% red ripe) and the ability of breeding lines to hold fruit quality once fruit are ripe (number of weeks fruit quality is retained following 80% red ripe maturity), to inform decisions for selection.

(c) To advance two projects on enhancing the nutritional value of processing tomatoes. The high pigment, and similar genes provide one strategy to significantly increase lycopene levels, but these genes are associated with several field production challenges. One gene (*Aft*) from *S. chilense* combined with another gene (*atv*) from *S. cheesmaniae* results in fruit with high levels of anthocyanins and these compounds also show promise for enhancing the nutritional benefits of tomatoes.

(d) To identify 20 breeding lines as candidates for genotyping to expand our knowledge base of how the genetic sequence affects field performance of lines developed in our program.

(e) To prepare datasets to enable us to investigate the genetic diversity represented in our breeding collection and to enable the implementation of genome wide selection as a breeding approach to augment our field selection approach.

3. Release of breeding lines

Twenty F_7 generation breeding lines, selected in fall 2013, were released in time for 2014 field planting. Most of these breeding lines built on the work done at AAFC-GPCRC, Harrow. One of our goals is to release breeding lines with different wild species in the recent pedigree as a way of increasing genetic diversity. The results of the recent cohort of lines are summarized in Table 1.

Table 1. Number of breeding lines released in 2014 with wild tomato species, either alone or in combination, in the recent pedigree.	
Species in the recent pedigree	Number of lines released in 2014
Solanum habrochaites (4 different accessions)	5
S. pennellii	1
S.pimpinellifolium, S. arcanum, S. peruvianum	1
S. arcanum, and S. peruvianum	1
A total of 20 breeding lines was released.	

4. Extending the harvest season: Maturity dates and field-holding ability

In 2014 we collected 80%-red-ripe maturity dates on all selections. When a selected plant reached 80% red-ripe maturity, we began counting the number of weeks that fruit quality held in the field. We had one selection that reached 80% red ripe maturity in 91 days after transplanting in 2014, and some of our still-unadapted lines that did not reach 80% red-ripe maturity prior to our October 10 cutoff date.

Out of 673 total selections, 6 selections held fruit quality in the field for 5 weeks, 92 selections held quality for 4 weeks and 227 selections held quality for 3 weeks. There was a trend for earlier maturing selections to hold quality for a long time and this may be due in part to the longer period of favourable weather remaining after early maturing lines reach 80% red-ripe maturity. We did observe that 41 late maturing selections held quality for 2 weeks.

5. Summary of field selections 2014

Nine acres of breeding plots were established on a farm on Selton Line, northwest of Ridgetown. There were 669 breeding lines from F_2 to F_6 generations planted (compared to 643 planted in 2013). The F_6 to F_3 generations originated partly from selections made at Ridgetown during fall 2013, and partly from selections made in 2012 but that were temporarily shelved. A total of 673 selections were made in fall 2014. Field selection work began on August 28 (approximately 1 week later than 2013) and was completed on October 2 (approximately 2 weeks later than 2013).

6. Enhancing the nutritional value of tomatoes I: Lycopene

We are continuing to work with high-pigment genes attempting to overcome some of the defects associated with these genes. They provide a means to increase lycopene and beta-carotene significantly compared to normal tomatoes. We now have F_6 generation lines with the high-pigment genes combined with mid-season maturity and acceptable yield. In one approach to this work we are conducting additional backcrossing to regionally adapted lines. In a second approach, we are intercrossing among high pigment breeding lines, where the development of each breeding line has been focussed on retaining the high pigment trait, but addressing a different individual defect associated with the trait. The goal in this second approach is to learn if we can make progress in addressing a combination of defects, by now combining the progress we've made on each defect separately.

7. Enhancing the nutritional value of tomatoes II: Anthocyanins

Among various traits we are working on, we continue to collaborate with Rong Cao and his team at AAFC-Guelph to develop high-anthocyanin processing tomatoes as a potential niche product with enhanced nutritional value. Our collaborations with the group at AAFC Guelph and Nanchang

University are focussed on understanding the potential benefits that anthocyanins from tomatoes may have on human health. Results from the most recently published study showed that anthocyanins from tomato were able to reduce inflammation in rats in a dose dependent way. Our work at Ridgetown is directed toward developing and improving the horticultural and processing characteristics of lines with high anthocyanins. The breeding lines we have developed so far are very high yielding with a compact plant habit. They need slightly larger fruit size and earlier maturity.

8. Adoption of applied genomics breeding tools I: Genotyping to expand the knowledge of our breeding collection

The work leading up to the publication of the tomato genome sequence in 2012 fostered the development of single nucleotide polymorphism microarrays ("SNiP chips"). For relatively low cost per data point, this tool allows rapid genetic sequencing of tomatoes. During the last 2 years, royalties from licenced breeding lines have been reinvested in the tomato breeding program to renovate a room on campus to create a small lab and equip it with the tools necessary to extract plant DNA. Now that this lab is ready, we will choose 20 breeding lines from among our collection for genotyping. These 20 will add to the genetic sequence information we have on 100 lines already. Our goal is to build this knowledge base over time to enable us to answer different kinds of questions. We will be able to assess how much genetic diversity is represented in our collection, compared to a North American panel of processing tomato cultivars and lines. This kind of information can guide the choice of parent lines when designing future crosses to help us accomplish our objectives in a more targeted way. Combining genetic sequence information with field performance data will enable us to use genetic sequencing as a tool to enhance our field selection work.

9. Adoption of applied genomics breeding tools II: Investigating the use of genome wide selection (GWS)

A relatively new breeding approach being discussed among plant breeders is genome wide selection (GWS). Very briefly GWS requires genetic sequence data on some breeding lines, and field performance data on these same breeding lines. This group of breeding lines is called the training population. By creating a mathematical model that accounts for the entire genetic sequence (not just a few markers) and relating this to field performance of important traits, we can then predict the breeding value of a line, for all important traits simultaneously. While the approach holds great promise to make breeding progress based on genetic sequence information, especially on traits that are difficult or expensive to measure, it also has some weaknesses. Direct measurement of the important traits in the field remains the most reliable way to make progress.

We already have genetic sequence information on 100 of our breeding lines courtesy of Dr. David Francis at OSU. In 2014 we completed the third year of a field trial measuring important traits on these 100 lines. We now have a full data set for a training population and we can begin to investigate the usefulness of GWS to augment our field selection program.

10. Plans for 2015

Our goals for the next year focus on following through on the work done in 2014. We anticipate releasing 20 more breeding lines for spring 2015, identifying 20 additional breeding lines for genotyping, and developing GWS models based on the data we have collected in our initial training population.

2015 OTRI Research

	Title	Researcher	$ Amount Funded
1	Investigating cultivar-dependent spray program response for bacterial spot management in the field	C. Trueman	$3,000
2	The influence of fungicide selection and timing of last fungicide application on tomato fruit rots	C. Trueman	$3,000
3	Managing plant-parasitic nematodes in tomatoes in Ontario - Stage 1	C. Trueman	$5,000
4	Early identification of bacterial spot in greenhouse tomato transplants using hyperspectral imaging	C. Trueman	$5,000
5	Weed Control and Crop Tolerance Evaluations in Processing Tomatoes	D. Robinson	$5,000
		R. Nurse	$3,000
6	Herbicide-Fungicide Tank Mix Interactions in Tomatoes	D. Robinson	$5,000
		R. Nurse	$3,000
8	Establishing phosphorous and potassium uptake and removal values for various processing vegetable crops	L. VanEerd	$1,190
10	Studies on Sumagic treated processing tomato transplants - field practices	J. Zandstra	$4,500
11	Studies on Sumagic treated processing tomato transplants - greenhouse practices	J. Zandstra	$4,500
12	Tomato Breeding ($80,000/year, federal AIP funding to cover half of this amount)	S. Loewen	$40,000
		Total	**$82,190**

Note: All Ontario tomato research is jointly funded by the board and Ontario tomato processors, with a contribution from the Ontario Tomato Seedling Growers.