2021 OTRI FUNDING

	TITLE	RESEARCHER	$ AMOUNT FUNDED
1	Weed Control Evaluations in Processing Tomatoes (Robinson $5,000 - Nurse $3,000)	D Robinson / R. Nurse	$8,000
2	Problem Weed Management in Processing Tomatoes (Robinson $5,000 - Nurse $3,000)	D. Robinson / R. Nurse	$8,000
3	Low and high rates of chlorothalonil for management of late blight in processing tomatoes	C. Trueman	$2,500
4	Processing Tomato Breeding Research	S. Loewen	(44,300 + 25% overhead) $55,375 total
5	Processing tomato cultivar trials, 2021	S. Loewen	$5,000
Postponed AND/OR Multi-Year Funding Agreed to – to be paid/done in 2021			
	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*	Postponed to 2021
	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*	Postponed to 2021
	Fungicide efficacy evaluations for early blight, Septoria leaf spot and anthracnose in processing tomatoes 1/00s	*C. Trueman*	*Postponed to 2021*

Project Title: Weed Control and Problem Weed Management in Processing Tomatoes

Research Agency: Ridgetown Campus, University of Guelph

Lead Investigator: Darren Robinson

Executive Summary:

The purpose of this research was to examine i) options for control of certain problem weeds in tomatoes (ie. eastern black nightshade, triazine-resistant lambsquarters and crabgrass), ii) to evaluate postemergence tank mixes for control of annual broadleaf weeds, and iii) to determine the applicability of tank mixing various preemergence (PRE) herbicides.

To meet the first objective of this work, 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.

Four studies were set up to determine the tolerance of tomatoes to different rate combinations of Sandea (between 14 and 28 g/ac), and either Prism (between 24 and 56 g/ac) or Sencor (120 and 180 ml/ac of Sencor L) applied POST to tomatoes. None of the tank mix combinations caused more than 10% injury, and they did not reduce plant dry weight (at late flower) or yield of tomato.

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-, three-, and four-way tank mixtures of Authority, Sencor, Prowl and Zidua. We also examined Authority Supreme, which is a combination of Authority and Zidua. We were not able to combine the two locations: **on the loamy sand**, there was significant injury when Zidua or Authority Supreme was included in tank mix with Prowl. The injury in these two treatments lead to a yield reduction, but yields tended to be less than other treatments. On the loam soil, none of the treatments lead to significant injury or yield loss in tomato.

Objectives:

1) To determine the best weed control option(s) for control of eastern black nightshade, triazine resistant lambsquarters and crabgrass.

2) To evaluate the effect of tank mixing Sencor, Prism or Pinnacle with Sandea for control of annual broadleaf weeds.

3) To evaluate effect of tank mixing Authority, Sencor, Dual II Magnum and Prowl H2O prior to transplanting for control of eastern blacknightshade.

TRIAL 1: TOLERANCE OF TOMATOES TO PRE-TRANSPLANT HERBICIDES – BROADLEAF HERBICIDES

Materials and Methods

Crop: *Tomato*
Variety: N3306 Planting date: May 18/21
Planting rate: 11803 plants/ac Depth: 5 cm
Row spacing: 1.5m Plant spacing: 45 cm

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

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 150 kg N/ha on May 12.

Soil Description:
Sand: 50% and 57% OM: 4.1% and 2.8%
Silt: 28% and 20% pH: 6.2 and 7.7
Clay: 22% and 22% CEC 12.4 and 16.0

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

Application Information:

	A
APPLICATION DATE	MAY 18/21
TIME OF DAY	6:00AM and 7:00AM
TIMING	PRE-T
AIR TEMP (c)	17 and 20
RH (%)	80 and 63
WIND SPEED (KPH)	6 and 3
SOIL TEMP (c)	15 and 15
CLOUD COVER (%)	0

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

Results:

Injury ratings were 1% or less, dry weights ranged from 86 to 91 g/plant, and yield ranged from 43 to 47 T/ac (Table 1.1). Plant dry weight and tomato yield were similar to the untreated check in all treatments.

Table 1.1. 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			DRY WT	YIELD
		7D	14D	28D	G	T/AC
1. Check (WEEDFREE)		0B	0	0	88	45
2. REFLEX	400 ML/AC	0B	0	0	86	44
3. REFLEX	800 ML/AC	1A	0	0	90	47
4. pethoxamid	1200 g/AC	0B	0	0	91	43
5. pethoxamid	2400 g/AC	0B	0	0	90	44
LSD (P <0.05)		1	NS	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.

TRIAL 2: TOLERANCE OF TOMATO TO POST APPLICATIONS OF SANDEA AND PRISM

Materials & Methods:

Crop: *Tomato*
Variety: N3306 Planting date: May 18/21
Planting rate: 11803 plants/ac Depth: 5 cm
Row spacing: 1.5m Plant spacing: 45 cm

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

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 150 kg N/ha on May 12.

Soil Description:
Sand: 50% and 57% OM: 4.1% and 2.8%
Silt: 28% and 20% pH: 6.2 and 7.7
Clay: 22% and 22% CEC 12.4 and 16.0

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

Application Information:

	A
APPLICATION DATE	JUN 8
TIME OF DAY	8:00 AM and 9:00 AM
TIMING	POST (21DAYS AFTER TRANSPLANTING)
AIR TEMP (c)	23 and 27
RH (%)	70 and 55
WIND SPEED (KPH)	4 and 8
SOIL TEMP (c)	26 and 29
CLOUD COVER (%)	0
CROP STAGE	9 LEAF

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

Results:

Injury ratings were all less than 10%, and tomato yields were all statistically similar to the untreated check (Table 2.1). Injury was 7, 8 and 9% at 7 days after treatments at the high rate of Sandea, where it was applied alone and with 24 or 56 g/ac of Prism. Yields ranged from 39 T/ac (Prism alone at 24 g/ac) to 47 T/ac (Sandea + Prism – 14 g/ac + 24 g/ac).

Table 2.1. Effect of different rates of Sandea plus Prism treatments on percent injury at 7 and 28 days after treatment (DAT) and tomato marketable yield (T/ac).

SANDEA RATE	PRISM RATE	PERCENT INJURY 7 DAT	28 DAT	Yield (T/ac)
14 G/AC	NA	1A	0A	42A
21 G/AC	NA	2A	2A	44A
28 G/AC	NA	7A	3A	40A
NA	24 G/AC	0A	0A	39A
NA	56 G/AC	3A	2A	43A
14 G/AC	24 G/AC	2A	1A	47A
21 G/AC	24 G/AC	4A	1A	42A
28 G/AC	24 G/AC	8A	1A	41A
14 G/AC	56 G/AC	3A	1A	43A
21 G/AC	56 G/AC	5A	2A	42A
28 G/AC	56 G/AC	9A	5A	44A
LSD (P <0.05)		NS	NS	NS

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

Conclusions: The purpose of this study was to determine the tolerance of tomatoes to different rate combinations of Sandea (between 14 and 28 g/ac) and Prism (between 24 and 56 g/ac) applied POST to tomatoes. None of the tank mix combinations caused commercially significant injury, nor did they reduce plant dry weight (at late flower) or yield of tomato. Tomato yield was 41 T/ac in the untreated weedfree check, and ranged from 39 to 47 T/ac among all treatments – none of which were significantly different than one another.

TRIAL 3: TOLERANCE OF TOMATO TO POST APPLICATIONS OF SANDEA AND SENCOR

Objective: Determine the effect of different rates of POST applications of Sandea + Sencor on tomato tolerance.

Materials & Methods:

Crop: *Tomato*
Variety: N3306 Planting date: May 18/21
Planting rate: 11803 plants/ac Depth: 5 cm
Row spacing: 1.5m Plant spacing: 45 cm

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

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 150 kg N/ha on May 12.

Soil Description:
Sand: 50% and 57% OM: 4.1% and 2.8%
Silt: 28% and 20% pH: 6.2 and 7.7
Clay: 22% and 22% CEC 12.4 and 16.0

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

Application Information:

	A
APPLICATION DATE	JUN 8
TIME OF DAY	8:00 AM and 9:00 AM
TIMING	POST (21DAYS AFTER TRANSPLANTING)
AIR TEMP (c)	23 and 27
RH (%)	70 and 55
WIND SPEED (KPH)	4 and 8
SOIL TEMP (c)	26 and 29
CLOUD COVER (%)	0
CROP STAGE	9 LEAF

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

Results:

Injury ratings were all less than 10%, and tomato yields were all statistically similar to the untreated check (Table 3.1). Injury was 6, 7 and 8% at 7 days after treatments at the high rate of Sandea, where it was applied alone and with 120 or 180 ml/ac of Sencor. Yields ranged from 40 T/ac (Sandea + Sencor at 14 g/ac + 180 ml/ac) to 49 T/ac (Sencor alone – 120 ml/ac).

Table 3.1. Effect of different rates of Sandea plus Sencor treatments on percent injury at 7 and 28 days after treatment (DAT) and tomato marketable yield (T/ac).

SANDEA RATE	SENCOR RATE	PERCENT INJURY 7 DAT	28 DAT	Yield (T/ac)
14 G/AC	NA	1A	0A	48A
21 G/AC	NA	2A	1A	46A
28 G/AC	NA	6A	3A	45A
NA	120 ML/AC	1A	1A	49A
NA	180 ML/AC	1A	0A	47A
14 G/AC	120 ML/AC	0A	0A	43A
21 G/AC	120 ML/AC	1A	0A	44A
28 G/AC	120 ML/AC	7A	4A	42A
14 G/AC	180 ML/AC	2A	0A	40A
21 G/AC	180 ML/AC	2A	2A	45A
28 G/AC	180 ML/AC	8A	5A	42A
LSD (P <0.05)		NS	NS	NS

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

Conclusions:

The purpose of this study was to determine the tolerance of tomatoes to different rate combinations of Sandea (between 14 and 28 g/ac) and Sencor micro-rates (between 120 and 180 ml/ac) applied POST to tomatoes. None of the tank mix combinations caused commercially significant injury, nor did they reduce plant dry weight (at late flower) or yield of tomato. Tomato yield was 45 T/ac in the untreated weedfree check, and ranged from 40 to 49 T/ac among all treatments – none of which were significantly different than one another.

TRIAL 4: WEED MANAGEMENT WITH AUTHORITY, PROWL AND SENCOR PRE-TRANSPLANT TANK MIXES

Materials & Methods:

Crop: *Tomato*
Variety: N3306 Planting date: May 18/21
Planting rate: 11803 plants/ac Depth: 5 cm
Row spacing: 1.5m Plant spacing: 45 cm

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

Field Preparation: Field was worked with an S-tine cultivator and fertilizer was applied at 150 kg N/ha on May 12.

Soil Description:
Sand: 50% and 57% OM: 4.1% and 2.8%
Silt: 28% and 20% pH: 6.2 and 7.7
Clay: 22% and 22% CEC 12.4 and 16.0

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

Application Information:

	A
APPLICATION DATE	MAY 18/21
TIME OF DAY	6:00AM and 7:00AM
TIMING	PRE-T
AIR TEMP (c)	17 and 20
RH (%)	80 and 63
WIND SPEED (KPH)	6 and 3
SOIL TEMP (c)	15 and 15
CLOUD COVER (%)	0

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

Results:
Injury was much greater in the experiment conducted on the loamy sand (Table 4.1) than the experiment on the loam soil (Table 4.2), so data were not combined for the analysis. Visual injury ranged from 1 to 3% among all treatments at 7 DAT, but was 4 to 15% at 28 DAT (Table 4.1). Yield ranged from 47 T/ac in the Dual + Sencor + Prowl treatment to 58 T/ac in the untreated, weed-free check. Tomato yields were equal to the untreated, weed-free check in the Authority, Dual + Sencor, Dual + Sencor + Prowl and Dual + Sencor + Authority + Prowl treatments. The tank mix of Dual + Authority + Prowl and Dual + Authority Supreme + Prowl treatments were 42 and 44 T/ac, respectively – both were less than the untreated, weed-free check.

On the loamy sand trial, visual injury in tomato was less than 3% and yields were similar to the untreated check in all treatments (Table 4.2).

Table 4.1. 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 – loamy sand soil.

TREATMENT	VISUAL INJURY		YIELD
	7D	28D	(T/AC)
UNTREATED	0A	0C	58A
AUTHORITY	3A	8B	53A
AUTHORITY SUP	2A	15A	49AB
DUAL + SENCOR	1A	5B	53A
DUAL + SENCOR + PROWL	1A	4B	47AB
DUAL + AUTHORITY + PROWL	3A	13A	42B
DUAL + AUTHORITY SUPREME + PROWL	3A	10A	44B
DUAL + SENCOR AUTHORITY + PROWL	3A	5A	48AB
LSD (P <0.05)	NS	5	8

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

Table 4.2. 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 – loam soil.

TREATMENT	VISUAL INJURY		YIELD
	7D	28D	(T/AC)
UNTREATED	0A	0A	43A
AUTHORITY	2A	0A	42A
AUTHORITY SUP	3A	0A	41A
DUAL + SENCOR	2A	3A	44A
DUAL + SENCOR + PROWL			
DUAL + AUTHORITY + PROWL	3A	1A	45A
DUAL + AUTHORITY SUPREME + PROWL	3A	3A	46A
DUAL + SENCOR AUTHORITY + PROWL	3A	3A	48A
LSD (P <0.05)	NS	NS	NS

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

Conclusions: Two trials, each on a different soil type (ie. 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. Data were not pooled across soil types. The tank mixes that included Authority or Authority Supreme with Prowl resulted in significant injury (>10%) and yield loss in the trial conducted on the loamy sand. There was not injury or yield loss in any treatments in the trial conducted on the loam soil.

2021 Harrow Processing Tomato Research Report

Dr. Robert Nurse

AAFC, Harrow

FOREWORD

The information contained in this report is a summary of the 2021 tomato weed research conducted at the Harrow Research and Development Centre, Agriculture and Agri-Food Canada. Included are summaries of site description variables, treatment lists outlining chemicals, rates, and timing of application as well as crop injury ratings, weed control ratings, and marketable crop yields.

Tomato transplanting went well in 2021. The trials received adequate precipitation within the first 2 weeks after herbicides were applied. This allowed for proper activation/movement through the soil profile of any pre-emergence herbicides. All tomato trials were successfully taken to yield.

Information regarding methods is summarized for each experiment. Any additional information required will be provided upon request. Weed ratings and crop injury are based on a 0 - 100 linear scale, where 0 represents no injury and 100 represents plant death. Individual weed species control was measure through destructive biomass collection and density counts.

Statistical analyses were conducted on crop injury, weed control ratings, and yield for each experiment where applicable. The least significant difference (LSD) was calculated whenever the F-test was significant at the 5% level.

Acknowledgment and thanks are extended to the chemical companies and producer organizations -specifically their representatives for supplying material, tomato transplants, and in-kind support. The Ontario Tomato Research Institute through The Ontario Processing Vegetable Growers is thanked for their financial assistance.

A sincere note of appreciation is extended to the technician, whose willingness and hard work has enabled the collection of these data and the assembly of this report.

Research Scientist:
Dr. Rob Nurse
Research Technician:
Elaine Lepp

Dr. R. E. Nurse
Agriculture and Agri-Food Canada
Greenhouse and Processing Crops Research Centre
2585 County Road 20
Harrow, ON
N0R 1G0
Tel: 519-738-1288
Fax: 519-738-2929
email: Robert.Nurse@Canada.ca

2021 Executive Summary

Dr. Rob Nurse (Robert.Nurse@agr.gc.ca)

The tomato variety H1301 was used in all trials.

Trial 1 – **Tolerance of processing tomato to PRE applications of Authority Supreme.**
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 1/32 to 16x 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 highest (2x to 16x) doses tested, especially at 3 weeks after application. A regression analysis of tomato yield (% of weed-free control) vs herbicide dose was performed and demonstrated that yield was only decreased by more than 10% at the 4x dose and above. Therefore, these data suggest that Authority Supreme would be safe to apply at the currently registered soybean dose.

Trial 2 – **Weed control and tolerance of processing tomatoes to PRE applications of Authority Supreme.**
This trial was conducted to complement the first trial by evaluating weed control provided by Authority supreme across a range of doses. This trial specifically evaluated the application of Authority Supreme pre-emergence in processing tomatoes at doses ranging from 1/32 to 16x 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 while still providing acceptable weed control. 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 highest (2x to 16x) doses tested, especially at 3 weeks after application. The most prominent weeds in the trial were large crabgrass, barnyardgrass, fall panicum, ladysthumb, velvetleaf, common ragweed, and common lambsquarters. Weed control was excellent in the trial unless the dose of the Authority Supreme dropped below a 0.25x dose. A regression analysis of tomato yield (% of weed-free control) vs herbicide dose was performed and demonstrated that yield was only decreased by more than 10% at the 4x dose and above. Therefore, these data suggest that Authority Supreme would provide acceptable weed control and be safe to apply at the currently registered soybean dose.

Trial 3 – **Weed control and tolerance of processing tomato to several 2 and 3 way herbicide combinations.**
In this trial Treflan or Prowl was applied with Dual II Magnum, Sencor, or Authority either PPI or PRE. There were no injury concerns for any of the treatments tested. The most common weeds in this trial were common lambsquarters, redroot pigweed, ladysthumb, fall panicum, large crabgrass and barnyardgrass. Weed control was excellent across all treatments, but were lower when each herbicide was applied alone. Yields were similar among all 2 and 3 way treatments, but were lower when either treflan or sencor were applied alone.

Trial 4. - **Weed control and tolerance of processing tomato to applications of Treflan and/or Prowl with shallow or deep incorporation.**

In this trial depth of incorporation was compared when Prowl H20 or Treflan were applied in processing tomato. For the purposes of this trial incorporation depth was set at either 2.5cm (1") or 10cm (4"). Prowl and Treflan were tankmixed with Dual II Magnum and incorporated and then followed by Authority PRE. None of the 2 or 3 way herbicide combinations or depth of incorporation had an impact on crop safety. The weed spectrum in the field consisted of large crabgrass, barnyardgrass, common lambsquarters, redroot pigweed, eastern black nightshade, common ragweed and velvetleaf. Although the majority of the trial was dominated by redroot pigweed and lambsquarters. Control of all species was excellent for all species across all treatments. Tomato yields did not differ from the Weed-free control for any of the herbicide treatment or by incorporation depth.

Table of Contents

Trial 1 – Tolerance of processing tomato to PRE applications of Authority Supreme.....7

Trial 2 - Weed control and tolerance of processing tomatoes to PRE applications of Authority Supreme. 9

Trial 3 – Weed control and tolerance of processing tomato to several 2 and 3 way herbicide combinations.....17

Trial 4 - Weed control and tolerance of processing tomato to applications of Treflan and/or Prowl with shallow or deep incorporation.....25

Agriculture and Agri-Food Canada Harrow

Authority Supreme Weedfree

Trial ID: 2120TOM1 Location: Harrow Trial Year: 2021
Protocol ID: 2120TOM1 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Crop Description

Crop 1: C LYPES Solanum lycopersicum Tomato **BBCH Scale:** BVSO
Entry Date: Oct-15-2021
Variety: Heinz 1301
Planting Date: Jun-10-2021
Rows per Plot: 2
Row Spacing: 1.5 m
Harvest Date: Oct-7-2021

Planting Rate: 30000 P/ha
Planting Method: TRANSP transplanted
Planting Equipment: MT transplanter, mechanical
Harvested Width: 1.5 m
Harvested Length: 8 m

Site and Design

Treated Plot Width: 1.5 m
Treated Plot Length: 8 m
Treated Plot Area: 12.0 m2 **Treatments:** 12
Replications: 4

Tillage Type: CONTIL conventional-till
Study Design: RACOBL Randomized Complete Block (RCB)

No.	Previous Crop	Year
1.	TRFPR	2020

Field Prep./Maintenance:

March 23-Spread 0-0-39-10.5 (sulphur)-5(Magnesium)-0.3(Boron) @ 336 kg/ha product.

June 7-Spread the bulk tomato fertilizer. Used a blend 15% Nitrogen, 10.1% Phosphorus, 6.4% Potassium, 0.3% Zinc, 9.4% Sulphur, 3.7% Calcium, 1.9% Magnesium, and 0.8% Manganese. Spread the fertilizer @ 890 kg/ha product (795 lbs/acre).

June 7-Worked the tomato area with the cultivator and packers east and west to incorporate the fertilizer.

June 9-Worked the tomato area, worked the west ½ of the trial with the 18' Kongsklide cultivator and packers 2" deep.

July 6-Side dressed the tomato trials with 28% UAN. Applied at 147 lbs/acre (150 kg/ha actual), 535 L/ha product.

July 15-Sprayed the tomato trial with CaliciMax @ 1.5 L/acre product at early fruit set.

July 27-Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

August 11- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

August 26- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

September 10- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

September 15-Sprayed the tomato trial with Ethrel (240 g/L) @ 6.4 L/ha for ripening of the fruit.

Soil Description

Description Name: G1+2
% Sand: 70 **% OM:** 2.9 **Texture:** SL sandy loam
% Silt: 20 **pH:** 6.5 **Soil Name:** Tuscola Fine Sandy Loam
% Clay: 10 **CEC:** 5.6

Weather Conditions

Closest Weather Station: HRDC weather station **Distance:** 0.5 km

Agriculture and Agri-Food Canada Harrow

Application Description

	A
Application Date	Jun-9-2021
Appl. Start Time	1:00 PM
Application Method	SPRAY
Application Timing	PRE
Application Placement	BROSOI
Appl. Entry Date	Oct-15-2021
Air Temperature Start, Stop	30.2, - C
% Relative Humidity Start, Stop	72.7, -
Wind Velocity+Dir. Start	7.1 KPH, S
Moisture 6 Hours after Appl.	0 mm

Crop Stage At Each Application

	A
Crop 1 Code, BBCH Scale	LYPES, BVSO

Application Equipment

	A
Appl. Equipment	3 nozzles
Equipment Type	BACCAI
Operation Pressure	275 kPa
Nozzle Model	ULD120-02
Nozzle Spacing	50 cm
Band Width	1.5 m
Boom Height	50 cm
Carrier	WATER
Application Amount	203 L/ha
Mix Overage	12.5 %
Mix Size	1.1 L
Propellant	COMCO2

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Description	Rate	Rate Unit	Other Rate	Other Rate Unit	Appl Timing	Appl Code
1	Weedfree										
2	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0	kg ai/ha	0	ml/ha	PRE	A
3	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0156	kg ai/ha	31.25	ml/ha	PRE	A
4	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0313	kg ai/ha	62.5	ml/ha	PRE	A
5	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0625	kg ai/ha	125	ml/ha	PRE	A
6	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.125	kg ai/ha	250	ml/ha	PRE	A
7	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.25	kg ai/ha	500	ml/ha	PRE	A
8	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.5	kg ai/ha	1000	ml/ha	PRE	A
9	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	1	kg ai/ha	2000	ml/ha	PRE	A
10	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	2	kg ai/ha	4000	ml/ha	PRE	A
11	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	4	kg ai/ha	8000	ml/ha	PRE	A
12	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	8	kg ai/ha	16000	ml/ha	PRE	A

Agriculture and Agri-Food Canada Harrow

Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Jun-17-2021	Jun-24-2021	Jul-2-2021	Oct-6-2021	Oct-6-2021
Rating Type	PHYGEN	PHYGEN	PHYGEN	YIELD	YIELD
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	%, 0, 100	T-US, -, -	T-MET, -, -
Trt-Eval Interval	8 DA-A	15 DA-A	23 DA-A	119 DA-A	119 DA-A
Trt No.					
1	0.0 c	0.0 d	0.0 d	45.1 a	101.1 a
2	0.0 c	0.0 d	0.0 d	39.9 a	89.5 a
3	0.0 c	0.0 d	0.0 d	41.9 a	93.8 a
4	0.0 c	0.0 d	0.0 d	36.8 a	82.6 a
5	0.0 c	0.0 d	0.0 d	32.5 a	72.9 a
6	0.0 c	0.0 d	26.3 c	37.4 a	83.9 a
7	0.0 c	3.8 d	30.0 c	35.9 a	80.4 a
8	0.0 c	17.5 d	53.8 b	27.1 a	60.8 a
9	0.0 c	48.8 c	78.8 a	32.5 a	72.8 a
10	2.5 c	67.5 b	100.0 a	5.9 b	13.1 b
11	8.8 b	88.8 a	100.0 a	1.2 b	2.6 b
12	20.0 a	97.5 a	100.0 a	0.0 b	0.0 b
LSD P=.05	2.71	13.47	16.92	13.17	29.53
Standard Deviation	1.88	9.36	11.76	9.15	20.50
CV	72.36	34.7	28.88	32.65	32.65
Grand Mean	2.60	26.98	40.73	28.01	62.80
Levene's F^	0.803	2.173	3.863	0.987	0.987
Levene's Prob(F)	0.636	0.039*	0.001*	0.477	0.477
Rank X2	.	.	.	.	.
P(Rank X2)	.	.	.	.	.
Skewness^	1.083*	1.2581*	-0.7264*	1.1957*	1.1957*
Kurtosis^	5.6913*	4.8534*	2.5478*	4.6345*	4.6345*
Replicate F	2.493	1.480	0.455	1.742	1.742
Replicate Prob(F)	0.0771	0.2380	0.7153	0.1781	0.1781
Treatment F	41.107	65.977	54.581	12.562	12.562
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001

Agriculture and Agri-Food Canada Harrow

Authority Supreme Weedy

Trial ID: 21TOM1 Location: Harrow Trial Year: 2021
Protocol ID: 21TOM1 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Crop Description

Crop 1: C LYPES Solanum lycopersicum Tomato **BBCH Scale:** BVSO
Entry Date: Oct-15-2021
Variety: Heinz 1301
Planting Date: Jun-10-2021
Rows per Plot: 2
Row Spacing: 1.5 m
Harvest Date: Oct-7-2021

Planting Rate: 30000 P/ha
Planting Method: TRANSP transplanted
Planting Equipment: MT transplanter, mechanical

Harvested Width: 1.5 m
Harvested Length: 8 m

Pest Description

Pest 1 Type: W **Code:** DIGSA Digitaria sanguinalis
Common Name: Large Crabgrass

Pest 2 Type: W **Code:** AMARE Amaranthus retroflexus
Common Name: Redroot Pigweed

Pest 3 Type: W **Code:** ABUTH Abutilon theophrasti
Common Name: Velvetleaf

Pest 4 Type: W **Code:** PANDI Panicum dichotomiflorum
Common Name: Fall Panicum

Pest 5 Type: W **Code:** AMBEL Ambrosia artemisiifolia
Common Name: Common Ragweed

Pest 6 Type: W **Code:** CHEAL Chenopodium album
Common Name: Lambsquarters

Pest 7 Type: W **Code:** ECHCG Echinochloa crus-galli
Common Name: Barnyardgrass

Pest 8 Type: W **Code:** POLPE Persicaria maculosa
Common Name: Ladysthumb

Pest 9 Type: W **Code:** SOLPT Solanum ptychanthum
Common Name: Eastern Black Nightshade

Pest10 Type: W **Code:** SETFA Setaria faberi
Common Name: Giant Foxtail

Pest11 Type: W **Code:** GASSS Galinsoga sp.
Common Name: Galinsoga

Pest12 Type: W **Code:** ERAME Eragrostis cilianensis
Common Name: Stinkgrass

Pest13 Type: W **Code:** SETPU Setaria helvola
Common Name: Yellow Foxtail

Site and Design

Treated Plot Width: 1.5 m
Treated Plot Length: 8 m
Treated Plot Area: 12.0 m2 **Treatments:** 13 **Tillage Type:** CONTIL conventional-till
Replications: 4 **Study Design:** RACOBL Randomized Complete Block (RCB)

No.	Previous Crop	Year
1.	TRFPR	2020

Agriculture and Agri-Food Canada Harrow

Field Prep./Maintenance:

March 23-Spread 0-0-39-10.5 (sulphur)-5(Magnesium)-0.3(Boron) @ 336 kg/ha product.

June 7-Spread the bulk tomato fertilizer. Used a blend 15% Nitrogen, 10.1% Phosphorus, 6.4% Potassium, 0.3% Zinc, 9.4% Sulphur, 3.7% Calcium, 1.9% Magnesium, and 0.8% Manganese. Spread the fertilizer @ 890 kg/ha product (795 lbs/acre).

June 7-Worked the tomato area with the cultivator and packers east and west to incorporate the fertilizer.

June 9-Worked the tomato area, worked the west ½ of the trial with the 18' Kongsklide cultivator and packers 2" deep.

July 6-Side dressed the tomato trials with 28% UAN. Applied at 147 lbs/acre (150 kg/ha actual), 535 L/ha product.

July 15-Sprayed the tomato trial with CaliciMax @ 1.5 L/acre product at early fruit set.

July 27-Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

August 11- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

August 26- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

September 10- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

September 15-Sprayed the tomato trial with Ethrel (240 g/L) @ 6.4 L/ha for ripening of the fruit.

Soil Description

Description Name: G1+2

% Sand:	70	**% OM:**	2.9	**Texture:**	SL sandy loam
% Silt:	20	**pH:**	6.5	**Soil Name:**	Tuscola Fine Sandy Loam
% Clay:	10	**CEC:**	5.6		

Weather Conditions

Closest Weather Station: HRDC weather station **Distance:** 0.5 km

Application Description

	A
Application Date	Jun-9-2021
Appl. Start Time	1:00 PM
Application Method	SPRAY
Application Timing	PRE
Application Placement	BROSOI
Appl. Entry Date	Oct-15-2021
Air Temperature Start, Stop	30.2, - C
% Relative Humidity Start, Stop	72.7, -
Wind Velocity+Dir. Start	7.1 KPH, S
Moisture 6 Hours after Appl.	0 MM

Application Equipment

	A
Appl. Equipment	3 nozzles
Equipment Type	BACCAI
Operation Pressure	275 kPa
Nozzle Model	ULD120-02
Nozzle Spacing	50 cm
Band Width	1.5 m
Boom Height	50 cm
Carrier	WATER
Application Amount	203 L/ha
Mix Overage	12.5 %
Mix Size	1.1 L
Propellant	COMCO2

ARM 2021.2 Trial Treatments

Agriculture and Agri-Food Canada Harrow

Authority Supreme Weedy

Trial ID: 21TOM1 Location: Harrow Trial Year: 2021
Protocol ID: 21TOM1 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Description	Rate	Rate Unit	Other Rate	Other Rate Unit	Appl Timing	Appl Code
1	Weedy										
2	Weedfree										
3	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0	kg ai/ha	0	ml/ha	PRE	A
4	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0156	kg ai/ha	31.2	ml/ha	PRE	A
5	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0313	kg ai/ha	62.5	ml/ha	PRE	A
6	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.0625	kg ai/ha	125	ml/ha	PRE	A
7	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.125	kg ai/ha	250	ml/ha	PRE	A
8	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.25	kg ai/ha	500	ml/ha	PRE	A
9	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	0.5	kg ai/ha	1000	ml/ha	PRE	A
10	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	1	kg ai/ha	2000	ml/ha	PRE	A
11	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	2	kg ai/ha	4000	ml/ha	PRE	A
12	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	4	kg ai/ha	8000	ml/ha	PRE	A
13	Authority Supreme	500	g/L	SC	pyroxasulfone+sulfentrazone	8	kg ai/ha	16000	ml/ha	PRE	A

Agriculture and Agri-Food Canada Harrow

Authority Supreme Weedy

Trial ID: 21TOM1 Location: Harrow Trial Year: 2021
Protocol ID: 21TOM1 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Pest Code				DIGSA	POLPE	ABUTH	ECHCG	AMBEL
Pest Name				Large Crabgrass	Ladysthumb	Velvetleaf	Barnyardgrass	Common Ragweed
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Jun-17-2021	Jun-24-2021	Jul-2-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021
Rating Type	PHYGEN	PHYGEN	PHYGEN	CONTRO	CONTRO	CONTRO	CONTRO	CONTRO
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100
Trt-Eval Interval	8 DA-A	15 DA-A	23 DA-A	28 DA-A	28 DA-A	28 DA-A	28 DA-A	28 DA-A
Trt No.								
1	0.0 c	0.0 e	0.0 e	0.0 c	0.0 c	0.0 b	0.0 c	0.0 b
2	0.0 c	0.0 e	0.0 e	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
3	0.0 c	0.0 e	0.0 e	12.5 c	35.0 b	62.5 a	12.5 c	62.5 a
4	0.0 c	0.0 e	0.0 e	38.8 b	68.8 a	87.5 a	38.8 b	75.0 a
5	0.0 c	0.0 e	0.0 e	73.8 a	100.0 a	100.0 a	70.0 a	87.5 a
6	0.0 c	0.0 e	2.5 e	91.7 a	100.0 a	99.7 a	90.9 a	93.8 a
7	0.0 c	0.0 e	2.5 e	81.3 a	100.0 a	87.5 a	83.8 a	100.0 a
8	0.0 c	0.0 e	30.0 d	93.8 a	100.0 a	75.0 a	97.5 a	100.0 a
9	0.0 c	18.8 d	45.0 c	97.5 a	100.0 a	100.0 a	100.0 a	100.0 a
10	1.3 c	53.8 c	75.0 b	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
11	2.5 c	81.3 b	97.5 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
12	10.0 b	98.8 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
13	16.3 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
LSD P=.05	4.97	6.79	12.57	22.47	25.61	32.54	24.53	27.39
Standard Deviation	3.46	4.74	8.76	15.65	17.84	22.66	17.09	19.08
CV	150.06	17.47	25.18	20.57	21.01	26.49	22.36	22.17
Grand Mean	2.31	27.12	34.81	76.10	84.90	85.55	76.42	86.06
Levene's F^	3.391	1.518	7.426	4.187	3.454	1.636	2.399	1.166
Levene's Prob(F)	0.002*	0.159	0.00*	0.00*	0.002*	0.122	0.02*	0.341
Rank X2	.	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.	.
Skewness^	-1.608*	2.0165*	0.1847	0.0958	-0.6349	-1.8228*	-0.2697	-1.1626*
Kurtosis^	12.2928*	12.5588*	7.3943*	1.9009*	7.4861*	6.1789*	1.2883	4.2393*
Replicate F	2.245	1.000	0.693	2.378	1.343	0.095	2.861	3.643
Replicate Prob(F)	0.0997	0.4040	0.5626	0.0864	0.2761	0.9621	0.0507	0.0219
Treatment F	8.412	297.671	96.847	20.591	12.822	6.248	17.616	8.882
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.
Missing data estimates are included in columns:Yates=4,5,6,7,8,9
^Calculated from residual.

Agriculture and Agri-Food Canada Harrow

Pest Code	CHEAL	DIGSA	DIGSA	AMARE	AMARE	ABUTH	ABUTH
Pest Name	Lambsquarters	Large Crabgrass	Large Crabgrass	Redroot Pigweed	Redroot Pigweed	Velvetleaf	Velvetleaf
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Jul-7-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	CONTRO	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	%, 0, 100	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -
Trt-Eval Interval	28 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A
Trt No.							
1	0.0 b	2.50 a	30.76 a	0.50 a	17.50 a	0.25 b	1.49 a
2	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a
3	62.5 a	1.25 a	8.34 a	0.50 a	39.25 a	1.50 a	43.75 a
4	75.0 a	1.25 a	11.00 a	0.75 a	44.00 a	0.75 ab	33.25 a
5	100.0 a	1.25 a	15.13 a	0.00 a	0.00 a	0.00 b	0.00 a
6	100.0 a	1.25 a	14.24 a	0.00 a	0.00 a	0.75 ab	34.00 a
7	100.0 a	1.75 a	36.00 a	0.00 a	0.00 a	0.50 b	42.50 a
8	100.0 a	1.75 a	29.50 a	0.00 a	0.00 a	0.25 b	5.50 a
9	100.0 a	1.25 a	5.00 a	0.00 a	0.00 a	0.00 b	0.00 a
10	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a
11	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a
12	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a
13	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a
LSD P=.05	26.92	1.696	26.356	0.492	34.463	0.660	38.213
Standard Deviation	18.75	1.183	18.378	0.343	24.031	0.460	26.646
CV	21.43	125.5	159.31	254.66	310.08	149.48	215.84
Grand Mean	87.50	0.942	11.536	0.135	7.750	0.308	12.345
Levene's F^	1.569	1.155	1.071	7.002	2.392	2.602	2.464
Levene's Prob(F)	0.143	0.348	0.41	0.00*	0.02*	0.012*	0.017*
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	-1.6095*	1.0378*	1.0194*	0.8181*	1.5627*	0.5395	1.3244*
Kurtosis^	7.0549*	2.2426*	2.7704*	4.9179*	6.4275*	0.6374	3.4983*
Replicate F	1.960	1.884	2.770	1.473	1.330	2.182	0.609
Replicate Prob(F)	0.1380	0.1498	0.0556	0.2383	0.2799	0.1071	0.6135
Treatment F	9.479	2.060	2.003	2.345	1.733	3.970	1.893
Treatment Prob(F)	0.0001	0.0469	0.0536	0.0241	0.1002	0.0006	0.0692

Means followed by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.
Missing data estimates are included in columns Yates=4,5,6,7,8,9
^Calculated from residual.

Agriculture and Agri-Food Canada Harrow

Pest Code	PANDI	PANDI	AMBEL	AMBEL	CHEAL	CHEAL	ECHCG
Pest Name	Fall Panicum	Fall Panicum	Common Ragweed	Common Ragweed	Lambsquarters	Lambsquarters	Barnyardgrass
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -
Trt-Eval Interval	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A
Trt No.							
1	3.00 a	59.75 a	1.25 a	7.25 a	0.50 a	42.53 a	0.00 a
2	0.00 b	0.00 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
3	2.50 ab	33.00 b	0.50 a	6.25 a	0.75 a	6.01 a	0.00 a
4	1.75 ab	27.75 b	0.75 a	13.75 a	0.75 a	40.00 a	0.25 a
5	1.75 ab	20.25 b	0.25 a	4.75 a	0.75 a	26.00 a	0.00 a
6	1.00 ab	16.50 b	0.75 a	18.69 a	0.00 a	0.00 a	0.00 a
7	1.50 ab	10.64 b	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a
8	0.50 b	5.10 b	0.25 a	7.25 a	0.00 a	0.00 a	0.00 a
9	0.25 b	6.75 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
10	0.00 b	0.00 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
11	0.00 b	0.00 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
12	0.00 b	0.00 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
13	0.00 b	0.00 b	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
LSD P=.05	1.548	25.335	1.029	16.269	0.964	52.360	0.285
Standard Deviation	1.080	17.666	0.718	11.345	0.672	36.512	0.199
CV	114.57	127.78	248.77	254.54	317.79	414.4	516.94
Grand Mean	0.942	13.826	0.288	4.457	0.212	8.811	0.038
Levene's F^	1.301	0.411	0.545	0.657	1.046	0.91	0.81
Levene's Prob(F)	0.257	0.95	0.871	0.781	0.429	0.546	0.639
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	0.0563	-0.1571	1.3235*	1.4676*	1.9297*	2.4391*	2.7764*
Kurtosis^	-0.2718	1.2796	3.1932*	3.8263*	6.4364*	8.4854*	11.9598*
Replicate F	5.516	4.983	4.021	3.086	0.723	0.355	0.649
Replicate Prob(F)	0.0032	0.0054	0.0145	0.0393	0.5446	0.7860	0.5889
Treatment F	3.830	4.070	1.282	1.157	1.000	0.778	0.892
Treatment Prob(F)	0.0009	0.0005	0.2707	0.3486	0.4685	0.6685	0.5629

Means followed by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.
Missing data estimates are included in columns:Yates=4,5,6,7,8,9
^Calculated from residual.

Agriculture and Agri-Food Canada Harrow

Pest Code	ECHCG	POLPE	POLPE	SOLPT	SOLPT	SETFA	SETFA
Pest Name	Barnyardgrass	Ladysthumb	Ladysthumb	Eastern Black N>	Eastern Black N>	Giant Foxtail	Giant Foxtail
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -
Trt-Eval Interval	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A
Trt No.							
1	0.00 a	0.25 a	0.78 a	0.25 b	4.00 a	0.00 a	0.00 a
2	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a	0.00 a	0.00 a
3	0.00 a	0.50 a	1.34 a	1.25 a	8.85 a	0.00 a	0.00 a
4	1.69 a	0.50 a	2.77 a	0.50 b	7.75 a	0.00 a	0.00 a
5	0.00 a	0.75 a	5.21 a	0.00 b	0.00 a	0.00 a	0.00 a
6	0.00 a	1.25 a	7.25 a	0.25 b	0.64 a	0.00 a	0.00 a
7	1.16 a	0.75 a	5.19 a	0.00 b	0.00 a	0.00 a	0.00 a
8	0.00 a	0.75 a	4.43 a	0.00 b	0.00 a	0.25 a	4.00 a
9	0.00 a	0.25 a	0.04 a	0.00 b	0.00 a	0.00 a	0.00 a
10	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a	0.00 a	0.00 a
11	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a	0.00 a	0.00 a
12	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a	0.00 a	0.00 a
13	0.00 a	0.00 a	0.00 a	0.00 b	0.00 a	0.00 a	0.00 a
LSD P=.05	1.655	0.797	6.128	0.620	6.203	0.199	3.182
Standard Deviation	1.154	0.556	4.273	0.432	4.325	0.139	2.219
CV	525.22	144.47	205.67	249.83	264.66	721.11	721.11
Grand Mean	0.220	0.385	2.078	0.173	1.634	0.019	0.308
Levene's F^	0.807	0.525	0.519	1.913	3.005	0.776	0.776
Levene's Prob(F)	0.641	0.885	0.89	0.063	0.005*	0.671	0.671
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	2.8905*	0.9873*	1.7982*	1.359*	1.4045*	3.7765*	3.7765*
Kurtosis^	13.6282*	2.347*	5.0567*	8.6794*	6.6421*	25.3468*	25.3468*
Replicate F	0.671	5.813	2.089	0.926	0.516	1.000	1.000
Replicate Prob(F)	0.5753	0.0024	0.1188	0.4382	0.6741	0.4040	0.4040
Treatment F	0.899	2.107	1.465	2.760	2.140	1.000	1.000
Treatment Prob(F)	0.5566	0.0420	0.1829	0.0092	0.0389	0.4685	0.4685

Means followed by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.
Missing data estimates are included in columns:Yates=4,5,6,7,8,9
^Calculated from residual.

Agriculture and Agri-Food Canada Harrow

Pest Code	GASSS	GASSS	ERAME	ERAME	SETPU	SETPU		
Pest Name	Galinsoga	Galinsoga	Stinkgrass	Stinkgrass	Yellow Foxtail	Yellow Foxtail		
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Oct-7-2021	Oct-7-2021
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	YIELD	YIELD
Rating Unit/Min/Max	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	T-US, -, -	T-MET, -, -
Trt-Eval Interval	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	62 DA-A	120 DA-A	120 DA-A
Trt No.								
1	0.75 a	1.14 a	0.25 a	2.55 a	0.00 a	0.00 a	23.5 ab	52.6 ab
2	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	41.9 a	93.9 a
3	0.50 a	0.52 a	1.00 a	0.89 a	0.00 a	0.00 a	25.9 ab	58.0 ab
4	1.50 a	3.00 a	0.25 a	0.09 a	0.25 a	0.88 a	19.6 b	43.9 b
5	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	32.3 ab	72.5 ab
6	0.25 a	0.13 a	0.25 a	0.10 a	0.00 a	0.00 a	30.3 ab	68.0 ab
7	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	38.0 ab	85.3 ab
8	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	38.6 ab	86.5 ab
9	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	38.6 ab	86.6 ab
10	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	25.0 ab	56.1 ab
11	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	6.3 c	14.1 c
12	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.0 c	0.0 c
13	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.0 c	0.0 c
LSD P=.05	1.291	2.459	0.631	2.049	0.199	0.703	12.86	28.84
Standard Deviation	0.900	1.715	0.440	1.429	0.139	0.490	8.97	20.11
CV	390.22	465.57	326.67	511.06	721.11	721.11	36.44	36.44
Grand Mean	0.231	0.368	0.135	0.280	0.019	0.068	24.62	55.18
Levene's F^	0.492	0.607	1.724	0.757	0.776	0.776	2.184	2.184
Levene's Prob(F)	0.907	0.823	0.099	0.689	0.671	0.671	0.033*	0.033*
Rank X2	.	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.	.
Skewness^	2.366*	2.984*	1.7927*	3.5405*	3.7765*	3.7765*	0.0118	0.0118
Kurtosis^	12.0755*	17.6793*	9.8674*	23.0696*	25.3468*	25.3468*	-0.6235	-0.6235
Replicate F	3.415	2.399	2.221	1.339	1.000	1.000	1.627	1.627
Replicate Prob(F)	0.0275	0.0839	0.1025	0.2770	0.4040	0.4040	0.2001	0.2001
Treatment F	1.000	1.000	1.641	1.032	1.000	1.000	10.516	10.516
Treatment Prob(F)	0.4685	0.4685	0.1236	0.4420	0.4685	0.4685	0.0001	0.0001

Means followed by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL
Missing data estimates are included in columns:Yates=4,5,6,7,8,9
^Calculated from residual.

Agriculture and Agri-Food Canada Harrow

Resistance management in processing tomatoes.

Trial ID: 21TOM2 Location: Harrow Trial Year: 2021
Protocol ID: 21TOM2 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Crop Description

Crop 1: C LYPES Solanum lycopersicum Tomato **BBCH Scale:** BVSO
Entry Date: Oct-15-2021
Variety: Heinz 1301
Planting Date: Jun-10-2021
Rows per Plot: 2
Row Spacing: 1.5 m
Harvest Date: Oct-7-2021

Planting Rate: 30000 P/ha
Planting Method: TRANSP transplanted
Planting Equipment: MT transplanter, mechanical

Harvested Width: 1.5 m
Harvested Length: 8 m

Pest Description

Pest 1 Type: W **Code:** DIGSA Digitaria sanguinalis
Common Name: Large Crabgrass

Pest 2 Type: W **Code:** AMARE Amaranthus retroflexus
Common Name: Redroot Pigweed

Pest 3 Type: W **Code:** ABUTH Abutilon theophrasti
Common Name: Velvetleaf

Pest 4 Type: W **Code:** PANDI Panicum dichotomiflorum
Common Name: Fall Panicum

Pest 5 Type: W **Code:** AMBEL Ambrosia artemisiifolia
Common Name: Common Ragweed

Pest 6 Type: W **Code:** CHEAL Chenopodium album
Common Name: Lambsquarters

Pest 7 Type: W **Code:** ECHCG Echinochloa crus-galli
Common Name: Barnyardgrass

Pest 8 Type: W **Code:** POLPE Persicaria maculosa
Common Name: Ladysthumb

Pest 9 Type: W **Code:** SOLPT Solanum ptychanthum
Common Name: Eastern Black Nightshade

Pest10 Type: W **Code:** GASSS Galinsoga sp.
Common Name: Galinsoga

Site and Design

Treated Plot Width: 1.5 m
Treated Plot Length: 8 m
Treated Plot Area: 12.0 m2 **Treatments:** 15 **Tillage Type:** CONTIL conventional-till
Replications: 4 **Study Design:** RACOBL Randomized Complete Block (RCB)

No.	Previous Crop	Year
1.	TRFPR	2020

Agriculture and Agri-Food Canada Harrow

Field Prep./Maintenance:

March 23-Spread 0-0-39-10.5 (sulphur)-5(Magnesium)-0.3(Boron) @ 336 kg/ha product.

June 7-Spread the bulk tomato fertilizer. Used a blend 15% Nitrogen, 10.1% Phosphorus, 6.4% Potassium, 0.3% Zinc, 9.4% Sulphur, 3.7% Calcium, 1.9% Magnesium, and 0.8% Manganese. Spread the fertilizer @ 890 kg/ha product (795 lbs/acre).

June 7-Worked the tomato area with the cultivator and packers east and west to incorporate the fertilizer.

June 9-Worked the tomato area, worked the west ½ of the trial with the 18' Kongsklide cultivator and packers 2" deep.

July 6-Side dressed the tomato trials with 28% UAN. Applied at 147 lbs/acre (150 kg/ha actual), 535 L/ha product.

July 15-Sprayed the tomato trial with CaliciMax @ 1.5 L/acre product at early fruit set.

July 27-Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

August 11- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

August 26- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

September 10- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

September 15-Sprayed the tomato trial with Ethrel (240 g/L) @ 6.4 L/ha for ripening of the fruit.

Soil Description

Description Name: G1+2

% Sand:	70	**% OM:**	2.9	**Texture:**	SL sandy loam
% Silt:	20	**pH:**	6.5	**Soil Name:**	Tuscola Fine Sandy Loam
% Clay:	10	**CEC:**	5.6		

Weather Conditions

Closest Weather Station: HRDC weather station **Distance:** 0.5 km

Application Description

	A	B
Application Date	Jun-8-2021	Jun-9-2021
Appl. Start Time	10:00 AM	1:00 PM
Application Method	SPRAY	SPRAY
Application Timing	PPI	PRE
Application Placement	BROSOI	BROSOI
Appl. Entry Date	Oct-15-2021	Oct-15-2021
Air Temperature Start, Stop	25, - C	30.2, - C
% Relative Humidity Start, Stop	83, -	72.7, -
Wind Velocity+Dir. Start	7 KPH, SW	7.1 KPH, S
Moisture 6 Hours after Appl.	0 mm	0 mm

Application Equipment

	A	B
Appl. Equipment	3 nozzles	3 nozzles
Equipment Type	BACCAI	BACCAI
Operation Pressure	275 kPa	275 kPa
Nozzle Model	ULD120-02	ULD120-02
Nozzle Spacing	50 cm	50 cm
Band Width	1.5 m	1.5 m
Boom Height	50 cm	50 cm
Carrier	WATER	WATER
Application Amount	203 L/ha	203 L/ha
Mix Overage	12.5 %	12.5 %
Mix Size	1.1 L	1.1 L
Propellant	COMCO2	COMCO2

ARM 2021.2 Site Description

Agriculture and Agri-Food Canada Harrow

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Description	Rate	Rate Unit	Other Rate	Other Rate Unit	Appl Timing	Appl Code
1	Weedy Check										
2	Weedfree Check										
3	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
4	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PPI	A
5	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
6	Prowl H20	240	g/L	MS	pendimethalin	1	kg ai/ha	4.17	l/ha	PRE	B
7	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
8	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PPI	A
	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
9	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
10	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PPI	A
	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
11	Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	2.4	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
12	Prowl H20	240	g/L	MS	pendimethalin	1	kg ai/ha	4.17	l/ha	PRE	B
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
13	Prowl H20	240	g/L	MS	pendimethalin	1	kg ai/ha	4.17	l/ha	PRE	B
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B
	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PRE	B
14	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
	Prowl H20	240	g/L	MS	pendimethalin	1	kg ai/ha	4.17	l/ha	PRE	B
15	Sencor 480	480	g/L	SL	metribuzin	0.24	kg ai/ha	0.5	l/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	1.75	l/ha	PPI	A
	Prowl H20	240	g/L	MS	pendimethalin	1	kg ai/ha	4.17	l/ha	PRE	B
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	0.292	l/ha	PRE	B

Agriculture and Agri-Food Canada Harrow

Pest Code				DIGSA	ECHCG	CHEAL	POLPE	ABUTH
Pest Name				Large Crabgrass	Barnyardgrass	Lambsquarters	Ladysthumb	Velvetleaf
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Jun-17-2021	Jun-24-2021	Jul-2-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021	Jul-7-2021
Rating Type	PHYGEN	PHYGEN	PHYGEN	CONTRO	CONTRO	CONTRO	CONTRO	CONTRO
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100
Trt-Eval Interval	9 DA-A	16 DA-A	24 DA-A	29 DA-A	29 DA-A	29 DA-A	29 DA-A	29 DA-A
Trt No.								
1	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b	0.0 c	0.0 b	0.0 b
2	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
3	0.0 a	0.0 a	0.0 a	95.0 a	82.5 a	75.0 b	75.0 a	87.5 a
4	0.0 a	0.0 a	0.0 a	91.3 a	91.3 a	100.0 a	100.0 a	100.0 a
5		0.0 a	0.0 a	88.8 a	88.8 a	95.0 a	92.5 a	95.0 a
6		0.0 a	0.0 a	86.3 a	90.0 a	100.0 a	87.5 a	100.0 a
7	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	98.8 a
8	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	98.8 a
9	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	97.5 a	100.0 a
10	1.3 a	0.0 a	0.0 a	95.0 a	95.0 a	100.0 a	100.0 a	100.0 a
11	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
12		0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
13		0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
14	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
15	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
LSD P=.05	1.09	.	.	9.19	12.09	11.11	14.78	9.70
Standard Deviation	0.75	0.00	0.00	6.44	8.47	7.79	10.36	6.80
CV	663.33	0.0	0.0	7.12	9.43	8.53	11.49	7.39
Grand Mean	0.11	0.00	0.00	90.42	89.83	91.33	90.17	92.00
Levene's F^	0.736	.	.	2.117	1.81	29.708	4.271	0.676
Levene's Prob(F)	0.686	.	.	0.029*	0.067	0.00*	0.00*	0.785
Rank X2	.	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.	.
Skewness^	3.4035*	.	.	-0.8951*	-1.3117*	-0.0965	-1.0913*	-3.2694*
Kurtosis^	20.6385*	.	.	2.3855*	4.891*	8.4052*	7.0627*	20.7156*
Replicate F	1.000	0.000	0.000	2.127	2.315	1.393	0.678	1.946
Replicate Prob(F)	0.4064	1.0000	1.0000	0.1112	0.0896	0.2583	0.5703	0.1369
Treatment F	1.000	0.000	0.000	62.455	36.165	44.874	25.012	56.985
Treatment Prob(F)	0.4654	1.0000	1.0000	0.0001	0.0001	0.0001	0.0001	0.0001

Agriculture and Agri-Food Canada Harrow

Pest Code	SOLPT	AMBEL	DIGSA	DIGSA	AMARE	AMARE
Pest Name	Eastern Black N>	Common Ragweed	Large Crabgrass	Large Crabgrass	Redroot Pigweed	Redroot Pigweed
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Jul-7-2021	Jul-7-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	CONTRO	CONTRO	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -
Trt-Eval Interval	29 DA-A	29 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A
Trt No.						
1	0.0 b	0.0 b	0.50 a	8.75 a	0.00 a	0.00 a
2	100.0 a	100.0 a	0.00 a	0.00 a	0.75 a	50.25 a
3	87.5 a	87.5 a	0.00 a	0.00 a	0.00 a	0.00 a
4	92.5 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a
5	95.0 a	92.5 a	1.00 a	8.45 a	0.00 a	0.00 a
6	97.5 a	100.0 a	0.25 a	0.66 a	0.00 a	0.00 a
7	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a
8	100.0 a	100.0 a	0.00 a	0.00 a	0.25 a	5.75 a
9	100.0 a	100.0 a	0.25 a	3.00 a	0.00 a	0.00 a
10	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a
11	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a
12	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a
13	100.0 a	100.0 a	0.25 a	4.50 a	0.25 a	4.75 a
14	100.0 a	100.0 a	0.75 a	1.68 a	0.50 a	36.00 a
15	100.0 a	100.0 a	0.50 a	1.75 a	0.00 a	0.00 a
LSD P=.05	10.67	9.66	0.870	8.501	0.724	46.418
Standard Deviation	7.47	6.77	0.609	5.957	0.507	32.528
CV	8.17	7.36	261.19	310.35	434.65	504.31
Grand Mean	91.50	92.00	0.233	1.920	0.117	6.450
Levene's F^	0.969	0.84	1.285	0.975	0.829	0.837
Levene's Prob(F)	0.498	0.624	0.254	0.493	0.635	0.627
Rank X2	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.
Skewness^	-2.7743*	-3.331*	1.5394*	2.2188*	2.7276*	3.058*
Kurtosis^	15.4437*	22.0059*	3.9833*	10.1552*	12.396*	15.4883*
Replicate F	1.064	1.650	1.256	1.604	0.583	0.655
Replicate Prob(F)	0.3746	0.1924	0.3016	0.2027	0.6293	0.5841
Treatment F	46.841	57.728	1.103	1.033	0.815	0.878
Treatment Prob(F)	0.0001	0.0001	0.3835	0.4418	0.6492	0.5862

Agriculture and Agri-Food Canada Harrow

Pest Code	ABUTH	ABUTH	PANDI	PANDI	AMBEL	AMBEL	CHEAL
Pest Name	Velvetleaf	Velvetleaf	Fall Panicum	Fall Panicum	Common Ragweed	Common Ragweed	Lambsquarters
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -
Trt-Eval Interval	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A
Trt No.							
1	0.00 a	0.00 a	0.25 a	2.00 a	0.00 a	0.00 a	0.00 a
2	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.50 a
3	0.00 a	0.00 a	0.00 a	0.00 a	0.50 a	16.50 a	0.50 a
4	0.25 a	5.50 a	0.00 a	0.00 a	0.50 a	6.75 a	1.50 a
5	0.25 a	15.50 a	0.50 a	4.18 a	0.50 a	1.11 a	0.00 a
6	0.00 a	0.00 a	0.25 a	2.38 a	0.25 a	0.79 a	0.00 a
7	0.25 a	11.25 a	0.25 a	6.04 a	0.00 a	0.00 a	0.00 a
8	0.25 a	1.20 a	0.25 a	3.25 a	0.00 a	0.00 a	1.00 a
9	0.00 a	0.00 a	0.25 a	7.00 a	1.00 a	19.50 a	0.00 a
10	0.00 a	0.00 a	0.50 a	8.00 a	0.00 a	0.00 a	0.00 a
11	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
12	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
13	0.00 a	0.00 a	0.25 a	5.92 a	0.00 a	0.00 a	0.75 a
14	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.50 a
15	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
LSD P=.05	0.355	13.873	0.535	9.210	0.926	19.505	1.160
Standard Deviation	0.249	9.722	0.375	6.454	0.649	13.669	0.813
CV	373.21	435.93	224.88	249.78	354.1	459.18	256.76
Grand Mean	0.067	2.230	0.167	2.584	0.183	2.977	0.317
Levene's F^	0.518	0.494	1.037	0.462	0.70	0.794	2.164
Levene's Prob(F)	0.91	0.924	0.437	0.941	0.762	0.67	0.026*
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	1.8069*	2.3455*	1.0294*	1.3024*	2.5489*	2.793*	1.0009*
Kurtosis^	4.5373*	10.5469*	0.7368	1.6604*	12.4937*	12.8419*	1.8665*
Replicate F	2.154	2.866	1.424	2.358	1.621	0.968	0.496
Replicate Prob(F)	0.1078	0.0479	0.2493	0.0853	0.1987	0.4170	0.6872
Treatment F	0.846	0.979	0.932	0.837	0.887	0.867	1.322
Treatment Prob(F)	0.6181	0.4898	0.5339	0.6276	0.5777	0.5973	0.2358

Agriculture and Agri-Food Canada Harrow

Pest Code	CHEAL	ECHCG	ECHCG	POLPE	POLPE	SOLPT	SOLPT
Pest Name	Lambsquarters	Barnyardgrass	Barnyardgrass	Ladysthumb	Ladysthumb	Eastern Black N>	Eastern Black N>
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021	Aug-10-2021
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -
Trt-Eval Interval	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A
Trt No.							
1	0.00 a	0.00 a	0.00 a	0.50 a	4.50 a	0.25 a	1.92 a
2	12.50 a	0.00 a	0.00 a	0.00 a	0.00 a	0.75 a	9.50 a
3	0.45 a	0.25 a	0.31 a	0.25 a	1.23 a	0.00 a	0.00 a
4	16.55 a	0.00 a	0.00 a	0.50 a	1.32 a	0.50 a	6.69 a
5	0.00 a	0.00 a	0.00 a	1.00 a	2.65 a	0.50 a	1.26 a
6	0.00 a	0.75 a	4.57 a	0.50 a	1.00 a	1.00 a	13.50 a
7	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a	8.25 a
8	33.50 a	0.50 a	9.00 a	0.25 a	0.33 a	0.25 a	0.93 a
9	0.00 a	0.00 a	0.00 a	0.25 a	0.27 a	0.00 a	0.00 a
10	0.00 a	0.00 a	0.00 a	0.50 a	8.50 a	0.00 a	0.00 a
11	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
12	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
13	6.00 a	0.25 a	1.75 a	0.00 a	0.00 a	0.75 a	7.75 a
14	5.00 a	0.75 a	8.87 a	0.00 a	0.00 a	1.50 a	21.00 a
15	0.00 a	0.00 a	0.00 a	0.25 a	0.75 a	0.25 a	3.25 a
LSD P=.05	19.910	0.656	8.573	0.868	6.436	1.360	18.736
Standard Deviation	13.953	0.459	6.007	0.608	4.511	0.953	13.129
CV	282.79	275.68	368.01	228.05	329.09	238.32	265.96
Grand Mean	4.934	0.167	1.632	0.267	1.371	0.400	4.937
Levene's F^	3.319	1.414	0.753	1.258	1.424	0.962	1.058
Levene's Prob(F)	0.001*	0.186	0.711	0.27	0.182	0.505	0.418
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	0.7215*	1.3844*	2.3093*	1.0487*	2.5755*	1.3766*	1.5713*
Kurtosis^	2.7755*	3.3527*	9.6754*	1.7371*	13.6053*	2.8636*	3.4496*
Replicate F	1.857	1.789	1.802	1.322	0.714	1.223	0.763
Replicate Prob(F)	0.1517	0.1638	0.1614	0.2800	0.5489	0.3133	0.5210
Treatment F	1.833	1.466	1.137	0.914	1.072	0.857	0.891
Treatment Prob(F)	0.0655	0.1667	0.3566	0.5513	0.4079	0.6075	0.5739

Agriculture and Agri-Food Canada Harrow

Pest Code	GASSS	GASSS		
Pest Name	Galinsoga	Galinsoga		
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato
Rating Date	Aug-10-2021	Aug-10-2021	Oct-7-2021	Oct-7-2021
Rating Type	BIOMAS	BIOMAS	YIELD	YIELD
Rating Unit/Min/Max	#/M2, -, -	G/M2, -, -	T-US, -, -	T-MET, -, -
Trt-Eval Interval	63 DA-A	63 DA-A	121 DA-A	121 DA-A
Trt No.				
1	0.00 a	0.00 a	24.2 b	54.2 b
2	0.00 a	0.00 a	36.9 ab	82.7 ab
3	0.00 a	0.00 a	22.3 b	50.0 b
4	1.25 a	0.68 a	23.1 b	51.8 b
5	0.25 a	0.35 a	31.1 ab	69.6 ab
6	0.25 a	0.26 a	34.0 ab	76.2 ab
7	0.00 a	0.00 a	34.9 ab	78.3 ab
8	0.00 a	0.00 a	30.0 ab	67.3 ab
9	0.00 a	0.00 a	37.6 ab	84.4 ab
10	0.00 a	0.00 a	27.9 ab	62.6 ab
11	0.25 a	1.44 a	42.3 ab	94.9 ab
12	0.00 a	0.00 a	39.1 ab	87.6 ab
13	0.00 a	0.00 a	45.1 a	101.1 a
14	0.00 a	0.00 a	37.0 ab	82.9 ab
15	0.00 a	0.00 a	47.6 a	106.7 a
LSD P=.05	0.756	1.182	11.74	26.31
Standard Deviation	0.530	0.829	8.23	18.44
CV	397.54	455.89	24.05	24.05
Grand Mean	0.133	0.182	34.21	76.69
Levene's F^	1.54	0.655	1.236	1.236
Levene's Prob(F)	0.136	0.804	0.285	0.285
Rank X2	.	.	.	.
P(Rank X2)	.	.	.	.
Skewness^	2.8046*	2.9778*	-0.5148	-0.5148
Kurtosis^	18.4423*	17.0982*	0.2138	0.2138
Replicate F	1.424	1.502	3.736	3.736
Replicate Prob(F)	0.2493	0.2279	0.0182	0.0182
Treatment F	1.508	0.926	3.579	3.579
Treatment Prob(F)	0.1502	0.5401	0.0007	0.0007

Agriculture and Agri-Food Canada Harrow

Tolerance and Weed Control using 2 and 3-way PPI and PRE tank mixes in processing tomatoes.

Trial ID: 21TOM3 Location: Harrow Trial Year: 2021
Protocol ID: 21TOM3 Investigator (Creator): Dr. R.E. Nurse
Study Director: E. Lepp

Crop Description

Crop 1: C LYPES Solanum lycopersicum Tomato
Entry Date: Oct-15-2021
Variety: Heinz 1301
Planting Date: Jun-10-2021
Rows per Plot: 2
Row Spacing: 1.5 m
Harvest Date: Oct-7-2021

Planting Rate: 30000 P/ha
Planting Method: TRANSP transplanted
Planting Equipment: MT transplanter, mechanical

Harvested Width: 1.5 m
Harvested Length: 8 m

Pest Description

Pest 1 Type: W **Code:** DIGSA Digitaria sanguinalis
Common Name: Large Crabgrass

Pest 2 Type: W **Code:** AMARE Amaranthus retroflexus
Common Name: Redroot Pigweed

Pest 3 Type: W **Code:** ABUTH Abutilon theophrasti
Common Name: Velvetleaf

Pest 4 Type: W **Code:** PANDI Panicum dichotomiflorum
Common Name: Fall Panicum

Pest 5 Type: W **Code:** CHEAL Chenopodium album
Common Name: Lambsquarters

Pest 6 Type: W **Code:** POLPE Persicaria maculosa
Common Name: Ladysthumb

Pest 7 Type: W **Code:** SOLPT Solanum ptychanthum
Common Name: Eastern Black Nightshade

Pest 8 Type: W **Code:** GASSS Galinsoga sp.
Common Name: Galinsoga

Pest 9 Type: W **Code:** ERAME Eragrostis cilianensis
Common Name: Stinkgrass

Site and Design

Treated Plot Width: 1.5 m
Treated Plot Length: 8 m
Treated Plot Area: 12.0 m2 **Treatments:** 16
Replications: 4

Tillage Type: CONTIL conventional-till
Study Design: RACOBL Randomized Complete Block (RCB)

No.	Previous Crop	Year
1.	TRFPR	2020

Agriculture and Agri-Food Canada Harrow

Field Prep./Maintenance:

March 23-Spread 0-0-39-10.5 (sulphur)-5(Magnesium)-0.3(Boron) @ 336 kg/ha product.

June 7-Spread the bulk tomato fertilizer. Used a blend 15% Nitrogen, 10.1% Phosphorus, 6.4% Potassium, 0.3% Zinc, 9.4% Sulphur, 3.7% Calcium, 1.9% Magnesium, and 0.8% Manganese. Spread the fertilizer @ 890 kg/ha product (795 lbs/acre).

June 7-Worked the tomato area with the cultivator and packers east and west to incorporate the fertilizer.

June 9-Worked 21TOM3 with the 10' three point hitch cultivator, half the treatments at 1" deep and the other half at 4" deep.

July 6-Side dressed the tomato trials with 28% UAN. Applied at 147 lbs/acre (150 kg/ha actual), 535 L/ha product.

July 15-Sprayed the tomato trial with CaliciMax @ 1.5 L/acre product at early fruit set.

July 27-Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

August 11- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

August 26- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 4.8 L/ha product for blight control.

September 10- Sprayed the tomato trial with Bravo ZN (500 g/L) @ 2.4 L/ha product for blight control.

September 15-Sprayed the tomato trial with Ethrel (240 g/L) @ 6.4 L/ha for ripening of the fruit.

Soil Description

Description Name: G1+2

% Sand:	70	**% OM:**	2.9	**Texture:**	SL sandy loam
% Silt:	20	**pH:**	6.5	**Soil Name:**	Tuscola Fine Sandy Loam
% Clay:	10	**CEC:**	5.6		

Weather Conditions

Closest Weather Station: HRDC weather station **Distance:** 0.5 km

Application Description

	A	B
Application Date	Jun-8-2021	Jun-9-2021
Appl. Start Time	10:00 AM	1:00 PM
Application Method	SPRAY	SPRAY
Application Timing	PPI	PRE
Application Placement	BROSOI	BROSOI
Appl. Entry Date	Oct-15-2021	Oct-15-2021
Air Temperature Start, Stop	25, - C	30.2, - C
% Relative Humidity Start, Stop	83, -	72.7, -
Wind Velocity+Dir. Start	7 KPH, SW	7.1 KPH, S
Moisture 6 Hours after Appl.	0 mm	0 MM

Application Equipment

	A	B
Appl. Equipment	3 nozzles	3 nozzles
Equipment Type	BACCAI	BACCAI
Operation Pressure	275 kPa	275 kPa
Nozzle Model	ULD120-02	ULD120-02
Nozzle Spacing	50 cm	50 cm
Band Width	1.5 m	1.5 m
Boom Height	50 cm	50 cm
Carrier	WATER	WATER
Application Amount	203 L/ha	203 L/ha
Mix Overage	12.5 %	12.5 %
Mix Size	1.1 L	1.1 L
Propellant	COMCO2	COMCO2

Agriculture and Agri-Food Canada Harrow

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Description	Rate	Rate Unit	Appl Timing	Appl Code
1	Shallow Incorporation Weedy				0.0156				
2	Shallow Incorporation Weedfree								
3	Shallow Incorporation Boundary	777	g/L	EC	s-metolachlor/metribuzin	1.943	kg ai/ha	PPI	A
4	Shallow Incorporation Prowl H20	240	g/L	MS	pendimethalin	1.0	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
5	Shallow Incorporation Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
6	Shallow Incorporation Prowl H20	240	g/L	L	pendimethalin	1.0	kg ai/ha	PPI	A
	Boundary	777	g/L	EC	s-metolachlor/metribuzin	1.943	kg ai/ha	PPI	A
7	Shallow Incorporation Prowl H20	240	g/L	MS	pendimethalin	1.0	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	PRE	B
8	Shallow Incorporation Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	PRE	B
9	Deep Incorporation Weedy								
10	Deep Incorporation Weedfree								
11	Deep Incorporation Boundary	777	g/L	EC	s-metolachlor/metribuzin	1.943	kg ai/ha	PPI	A
12	Deep Incorporation Prowl H20	240	g/L	MS	pendimethalin	1.0	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
13	Deep Incorporation Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
14	Deep Incorporation Prowl H20	240	g/L	L	pendimethalin	1.0	kg ai/ha	PPI	A
	Boundary	777	g/L	EC	s-metolachlor/metribuzin	1.943	kg ai/ha	PPI	A
15	Deep Incorporation Prowl H20	240	g/L	MS	pendimethalin	1.0	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	PRE	B
16	Deep Incorporation Treflan	480	g/L	EC	trifluralin	1.15	kg ai/ha	PPI	A
	Dual II Magnum	915	g/L	EC	s-metolachlor	1.6	kg ai/ha	PPI	A
	Authority	480	g/L	SL	sulfentrazone	0.14	kg ai/ha	PRE	B

Agriculture and Agri-Food Canada Harrow

Pest Code				DIGSA	ECHCG	CHEAL	AMARE	SOLPT
Pest Name				Large Crabgrass	Barnyardgrass	Lambsquarters	Redroot Pigweed	Eastern Black N>
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Type	PHYGEN	PHYGEN	PHYGEN	CONTRO	CONTRO	CONTRO	CONTRO	CONTRO
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100	%, 0, 100
Trt-Eval Interval	9 DA-A	16 DA-A	24 DA-A	29 DA-A	29 DA-A	29 DA-A	29 DA-A	29 DA-A
Trt No.								
1	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
2	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
3	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
4	0.0 a	0.0 a	0.0 a	97.5 a	100.0 a	97.5 a	100.0 a	100.0 a
5	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	95.0 a	100.0 a	97.5 a
6	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
7	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
8	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
9	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
10	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
11	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
12	0.0 a	0.0 a	0.0 a	97.5 a	100.0 a	100.0 a	100.0 a	97.5 a
13	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	95.0 a	100.0 a	95.0 a
14	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
15	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
16	0.0 a	0.0 a	0.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
LSD P=.05	.	.	.	2.43	.	5.01	.	4.31
Standard Deviation	0.00	0.00	0.00	1.71	0.00	3.52	0.00	3.03
CV	0.0	0.0	0.0	1.96	0.0	4.06	0.0	3.49
Grand Mean	0.00	0.00	0.00	87.19	87.50	86.72	87.50	86.88
Levene's F^	.	.	.	0.60	.	0.475	.	0.702
Levene's Prob(F)	.	.	.	0.86	.	0.942	.	0.77
Rank X2	.	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.	.
Skewness^	.	.	.	-2.6819*	.	-2.2247*	.	-2.7964*
Kurtosis^	.	.	.	12.3712*	.	8.9572*	.	14.0028*
Replicate F	0.000	0.000	0.000	2.143	0.000	3.151	0.000	1.364
Replicate Prob(F)	1.0000	1.0000	1.0000	0.1080	1.0000	0.0340	1.0000	0.2660
Treatment F	0.000	0.000	0.000	1589.572	0.000	370.748	0.000	502.727
Treatment Prob(F)	1.0000	1.0000	1.0000	0.0001	1.0000	0.0001	1.0000	0.0001

Agriculture and Agri-Food Canada Harrow

Pest Code	AMBEL	ABUTH	DIGSA	DIGSA	AMARE	AMARE	ABUTH
Pest Name	Common Ragweed	Velvetleaf	Large Crabgrass	Large Crabgrass	Redroot Pigweed	Redroot Pigweed	Velvetleaf
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Type	CONTRO	CONTRO	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	%, 0, 100	%, 0, 100	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -
Trt-Eval Interval	29 DA-A	29 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A
Trt No.							
1	0.0 b	0.0 b	1.00 a	7.09 a	0.75 a	54.00 a	0.00 a
2	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
3	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
4	100.0 a	100.0 a	0.25 a	1.75 a	0.50 a	10.50 a	0.00 a
5	100.0 a	100.0 a	0.25 a	0.71 a	0.50 a	19.25 a	0.00 a
6	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
7	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
8	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
9	0.0 b	0.0 b	1.50 a	5.27 a	0.75 a	48.96 a	0.25 a
10	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
11	100.0 a	100.0 a	0.25 a	1.39 a	0.00 a	0.00 a	0.00 a
12	100.0 a	100.0 a	0.00 a	0.00 a	0.25 a	1.06 a	0.00 a
13	100.0 a	100.0 a	0.25 a	6.00 a	0.25 a	0.21 a	0.00 a
14	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
15	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
16	100.0 a	100.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a
LSD P=.05	.	.	1.058	6.417	0.692	37.438	0.243
Standard Deviation	0.00	0.00	0.743	4.505	0.486	26.287	0.171
CV	0.0	0.0	339.45	324.47	259.15	313.93	546.5
Grand Mean	87.50	87.50	0.219	1.389	0.188	8.374	0.031
Levene's F^	.	.	1.758	1.558	1.165	3.372	0.60
Levene's Prob(F)	.	.	0.071	0.123	0.33	0.001*	0.86
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	.	.	2.4502*	2.0001*	1.3418*	1.3389*	2.6819*
Kurtosis^	.	.	13.1766*	8.2448*	4.1641*	6.363*	12.3712*
Replicate F	0.000	0.000	0.718	0.813	0.529	0.921	2.143
Replicate Prob(F)	1.0000	1.0000	0.5465	0.4935	0.6644	0.4386	0.1080
Treatment F	0.000	0.000	1.322	1.166	1.341	1.803	1.000
Treatment Prob(F)	1.0000	1.0000	0.2291	0.3313	0.2187	0.0645	0.4718

Agriculture and Agri-Food Canada Harrow

Pest Code	ABUTH	PANDI	PANDI	CHEAL	CHEAL	POLPE	POLPE	SOLPT
Pest Name	Velvetleaf	Fall Panicum	Fall Panicum	Lambsquarters	Lambsquarters	Ladysthumb	Ladysthumb	Eastern Black N>
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS
Rating Unit/Min/Max	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -
Trt-Eval Interval	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A
Trt No.								
1	0.00 a	0.00 a	0.00 a	1.50 a	34.25 a	0.25 a	0.88 a	1.25 a
2	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
3	0.00 a	0.25 a	10.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.50 a
4	0.00 a	0.25 a	4.12 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
5	0.00 a	0.25 a	1.86 a	1.75 a	54.97 a	1.00 a	3.31 a	0.75 a
6	0.00 a	0.00 a	0.00 a	0.17 a	0.63 a	0.13 a	0.43 a	0.25 a
7	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
8	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
9	14.25 a	0.50 a	3.08 a	1.75 a	39.25 a	0.75 a	3.13 a	1.25 a
10	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
11	0.00 a	0.00 a	0.00 a	0.25 a	3.25 a	0.00 a	0.00 a	0.00 a
12	0.00 a	0.00 a	0.00 a	0.25 a	1.15 a	0.25 a	2.52 a	0.00 a
13	0.00 a	0.25 a	8.75 a	0.75 a	4.83 a	0.00 a	0.00 a	0.00 a
14	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a
15	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
16	1.03 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
LSD P=.05	10.125	0.408	10.260	1.378	41.646	0.893	3.698	0.730
Standard Deviation	7.109	0.286	7.204	0.967	29.224	0.626	2.595	0.513
CV	744.56	305.34	414.52	240.84	338.03	421.56	404.46	193.01
Grand Mean	0.955	0.094	1.738	0.401	8.645	0.149	0.642	0.266
Levene's F^	0.815	1.356	0.927	2.253	1.12	0.565	0.633	0.982
Levene's Prob(F)	0.656	0.208	0.541	0.017*	0.366	0.886	0.832	0.488
Rank X2	.	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.	.
Skewness^	4.2384*	1.4102*	2.7845*	1.0982*	3.1752*	2.4392*	2.208*	0.6969*
Kurtosis^	32.0246*	3.0642*	12.2863*	4.0074*	21.0488*	11.0814*	7.5555*	3.1547*
Replicate F	1.154	1.271	0.452	2.135	0.314	2.698	1.981	3.705
Replicate Prob(F)	0.3376	0.2957	0.7172	0.1093	0.8153	0.0573	0.1307	0.0182
Treatment F	1.000	1.169	0.813	1.859	1.428	0.918	0.849	2.976
Treatment Prob(F)	0.4718	0.3288	0.6585	0.0561	0.1767	0.5519	0.6211	0.0024

Agriculture and Agri-Food Canada Harrow

Pest Code	SOLPT	GASSS	GASSS	ERAME	ERAME		
Pest Name	Eastern Black N>	Galinsoga	Galinsoga	Stinkgrass	Stinkgrass		
Crop Type, Code	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES	C, LYPES
Crop Name	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato
Rating Type	BIOMAS	BIOMAS	BIOMAS	BIOMAS	BIOMAS	YIELD	YIELD
Rating Unit/Min/Max	G/M2, -, -	#/M2, -, -	G/M2, -, -	#/M2, -, -	G/M2, -, -	T-US, -, -	T-MET, -, -
Trt-Eval Interval	63 DA-A	63 DA-A	63 DA-A	63 DA-A	63 DA-A	121 DA-A	121 DA-A
Trt No.							
1	14.62 a	0.50 a	0.49 a	0.25 a	0.75 a	31.0 a	69.6 a
2	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	41.9 a	93.9 a
3	7.50 a	0.00 a	0.00 a	0.00 a	0.00 a	39.7 a	88.9 a
4	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	37.0 a	82.8 a
5	9.40 a	0.25 a	0.03 a	0.00 a	0.00 a	30.6 a	68.7 a
6	1.05 a	0.00 a	0.00 a	0.00 a	0.00 a	37.5 a	84.1 a
7	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	43.1 a	96.7 a
8	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	38.9 a	87.2 a
9	12.13 a	0.00 a	0.00 a	0.00 a	0.00 a	29.9 a	67.0 a
10	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	39.5 a	88.5 a
11	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	41.0 a	91.9 a
12	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	43.5 a	97.4 a
13	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	38.7 a	86.7 a
14	4.53 a	0.00 a	0.00 a	0.00 a	0.00 a	44.5 a	99.8 a
15	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	44.2 a	99.0 a
16	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	43.9 a	98.5 a
LSD P=.05	9.222	0.402	0.350	0.178	0.534	11.37	25.50
Standard Deviation	6.475	0.282	0.246	0.125	0.375	7.99	17.90
CV	210.46	601.56	759.4	800.0	800.0	20.45	20.45
Grand Mean	3.077	0.047	0.032	0.016	0.047	39.05	87.55
Levene's F^	1.572	0.84	0.82	0.817	0.817	0.753	0.753
Levene's Prob(F)	0.118	0.63	0.651	0.655	0.655	0.719	0.719
Rank X2	.	.	.	.	.	.	.
P(Rank X2)	.	.	.	.	.	.	.
Skewness^	0.791*	3.5004*	4.2562*	4.2748*	4.2748*	-0.3504	-0.3504
Kurtosis^	2.7486*	21.4727*	32.1675*	32.3903*	32.3903*	-0.4246	-0.4246
Replicate F	2.646	0.721	0.960	1.000	1.000	2.874	2.874
Replicate Prob(F)	0.0604	0.5450	0.4198	0.4016	0.4016	0.0465	0.0465
Treatment F	2.389	0.930	0.990	1.000	1.000	1.483	1.483
Treatment Prob(F)	0.0124	0.5392	0.4812	0.4718	0.4718	0.1527	0.1527

2021 Executive Summary

Dr. Rob Nurse (Robert.Nurse@agr.gc.ca)

The tomato variety H1301 was used in all trials.

Trial 1 – **Tolerance of processing tomato to PRE applications of Authority Supreme.**
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 1/32 to 16x 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 highest (2x to 16x) doses tested, especially at 3 weeks after application. A regression analysis of tomato yield (% of weed-free control) vs herbicide dose was performed and demonstrated that yield was only decreased by more than 10% at the 4x dose and above. Therefore, these data suggest that Authority Supreme would be safe to apply at the currently registered soybean dose.

Trial 2 – **Weed control and tolerance of processing tomatoes to PRE applications of Authority Supreme.**
This trial was conducted to complement the first trial by evaluating weed control provided by Authority supreme across a range of doses. This trial specifically evaluated the application of Authority Supreme pre-emergence in processing tomatoes at doses ranging from 1/32 to 16x 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 while still providing acceptable weed control. 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 highest (2x to 16x) doses tested, especially at 3 weeks after application. The most prominent weeds in the trial were large crabgrass, barnyardgrass, fall panicum, ladysthumb, velvetleaf, common ragweed, and common lambsquarters. Weed control was excellent in the trial unless the dose of the Authority Supreme dropped below a 0.25x dose. A regression analysis of tomato yield (% of weed-free control) vs herbicide dose was performed and demonstrated that yield was only decreased by more than 10% at the 4x dose and above. Therefore, these data suggest that Authority Supreme would provide acceptable weed control and be safe to apply at the currently registered soybean dose.

Trial 3 – **Weed control and tolerance of processing tomato to several 2 and 3 way herbicide combinations.**
In this trial Treflan or Prowl was applied with Dual II Magnum, Sencor, or Authority either PPI or PRE. There were no injury concerns for any of the treatments tested. The most common weeds in this trial were common lambsquarters, redroot pigweed, ladysthumb, fall panicum, large crabgrass and

barnyardgrass. Weed control was excellent across all treatments, but were lower when each herbicide was applied alone. Yields were similar among all 2 and 3 way treatments, but were lower when either treflan or sencor were applied alone.

Trial 4. - **Weed control and tolerance of processing tomato to applications of Treflan and/or Prowl with shallow or deep incorporation.**
In this trial depth of incorporation was compared when Prowl H20 or Treflan were applied in processing tomato. For the purposes of this trial incorporation depth was set at either 2.5cm (1") or 10cm (4"). Prowl and Treflan were tankmixed with Dual II Magnum and incorporated and then followed by Authority PRE. None of the 2 or 3 way herbicide combinations or depth of incorporation had an impact on crop safety. The weed spectrum in the field consisted of large crabgrass, barnyardgrass, common lambsquarters, redroot pigweed, eastern black nightshade, common ragweed and velvetleaf. Although the majority of the trial was dominated by redroot pigweed and lambsquarters. Control of all species was excellent for all species across all treatments. Tomato yields did not differ from the Weed-free control for any of the herbicide treatment or by incorporation depth.

2021 Research Report

Low and high rates of chlorothalonil for management of late blight in processing tomatoes

Prepared for the Ontario Tomato Research Committee (OTRI)
November 1, 2021

Research Agency/Location: University of Guelph, Ridgetown Campus

Lead & Key Investigators:
- Cheryl Trueman, Ph.D., Assistant Prof, Dept of Plant Ag, Ridgetown Campus – Univ. of Guelph
- Kevin Dufton, Research Technician

Executive Summary:
- The objective of this research was to determine if current low and high label rates of chlorothalonil differ in efficacy against late blight in susceptible and partially resistant processing tomatoes.
- No late blight developed in the trial, so we were unable to collect data regarding the efficacy of low and high rates of chlorothalonil.

Funding:
- Ontario Tomato Research Institute, Ontario Agri-Food Innovation Alliance.
- We thank Heinz Seed for seed donation and crop protection companies for in-kind product donations.

TITLE: Low and high rates of chlorothalonil for management of late blight in processing tomatoes

OBJECTIVE: Determine if current low and high label rates of chlorothalonil differ in efficacy against late blight in susceptible and partially resistant processing tomatoes.

PEST(S): late blight (*Phytophthora infestans*)

MATERIALS: Bravo ZN (chlorothalonil 500g L^{-1})

METHODS: The trial was completed at Ridgetown Campus, University of Guelph. The trial was a 2 x 3 factorial arranged in a randomized complete block design with four replications. The first factor was host resistance to *P. infestans* ('TSH39', *+Ph-3*; 'TSH34', *-Ph-3*) and the second factor was fungicide treatments (no fungicide, Bravo ZN at 2.4 L/Ha, Bravo ZN at 4.0 L/Ha). Tomatoes were transplanted into twin rows on June 1 using a mechanical transplanter at a rate of 3 plants per metre. Each twin row was spaced 2 m apart. Each treatment plot was 7m long and consisted of one twin row. Applications were made using a hand-held CO_2 sprayer with nozzles ULD 120-03, and a water volume of 300 L Ha^{-1}. Treatments for Bravo Zn at 2.4 L/Ha were applied on an 8 to 10-day interval on Jun 23, Jul 1, 9, 19, 27, Aug 4, 13, 23 and 31, while treatments for Bravo ZN at 4.0 L/Ha were applied on a 14-day interval on Jun 23, Jul 7, 21, Aug 4, 19, and Sep 2. The trial was scouted for symptoms of late blight regularly throughout the season. Yield data was not collected because no late blight developed in the trial.

RESULTS & CONCLUSIONS: The efficacy of low rates of Bravo ZN for late blight management could not be determined, as no late blight was detected in the trial.

Project title:

Processing tomato breeding, 2021 to 2023: Report to OTRI for year 1 of 3.

Research Agency/location:

University of Guelph Ridgetown Campus

Lead and Key Investigators:

Steve Loewen, 2021-11-01

Description of the project

Over the long term, the processing tomato breeding program at Ridgetown has had a core objective of increasing genetic diversity in processing tomato breeding lines adapted for the Ontario production system and processing end-uses. Among essential traits such as yield, fruit colour, fruit size, fruit firmness and other characteristics necessary for Ontario, selection for increased earliness of maturity and lengthened field-holding ability of ripe fruit will be used to achieve incremental gains in length of harvest season. Selection to combine multiple genes for disease resistance, and work with a recently discovered trait on early fruit colouring will be pursued. It is expected that 15 advanced breeding lines will be available for release to private sector seed companies annually, for further development into cultivars.

Project term:

Start date: 2021-04-01

End date: 2024-03-31

Project activities up to November 1, 2021

Tomato breeding field plots

Eight acres of field breeding plots were established on rented land near Selton Line and Kenesserie Road in Chatham-Kent. Field transplanting began on May 27 and ended on June 11. There were 845 breeding lines from F6 to F2 generations grown out in 2021. Field selection work started on August 31 and was completed on October 4. There were 720 selections made in Fall 2021.

When making selections, the following traits were emphasized: yield, concentration of maturity, good fruit size, uniform fruit size, uniform fruit shape, good external fruit colour, uniform external fruit colour, fruit firmness, good shoulder colour (including absence of colour defects), small core, deep red internal colour, plant vigour, plant habit, disease resistance, general foliage health, early maturity.

As general observations for 2021, there was noticeably greater incidence of stinkbug damage compared to other years and it was a good year to select for field-holding ability of ripe fruit since disease pressure appeared to be higher than most other years.

Selection for extending the harvest season

For each field selection, the date on which it reached 80% red ripe was recorded in order to use the days from transplanting to harvest as a way to select for early maturity. The number of weeks that each

selection held fruit quality in the field, once it had reached 80% red ripe was also recorded. This allows for identification and retention of the lines with long field holding ability.

Given the heavy fruit disease pressure this fall, it was unexpected to find 8 selections that held fruit quality for 5 weeks and 468 selections that held fruit quality for 4 weeks. It may be evidence of the long-term benefits of selecting for long field holding ability in the parents used in developing new breeding lines. Since the breeding work uses lines with wild species in the recent pedigrees some breeding lines do not reach 80% red ripe within our growing season. At the other end of the range, in 2021 we identified 7 breeding lines that matured in fewer than 80 days (74 and 79) from transplanting to harvest. Pedigree V568 is a frequent parent in this group and may be a source of very early maturity. These lines will be monitored in subsequent years to determine if this is truly a genetic effect or if it is an environmental artifact of the 2021 season.

Release of breeding lines

While occurring prior to the start of the current project, as an output of the prior OTRI funded project, there were 20 breeding lines released in early March 2021 to commercial seed company partners in time for spring planting. Within the current project, decisions will be made to identify at least 15 breeding lines to release in winter 2022.

Stacking multiple disease resistances

The primary goal of the previously funded OTRI tomato breeding project was to begin incorporating an expanded list of disease resistance genes (including resistance to Fusarium 2, Fusarium 3, nematodes, Verticillium 1, TSWV, and late blight (Ph-2 and Ph-3)) in all breeding lines. While good initial progress was made, this is a long-term effort, and we have many breeding lines in our development pipeline with varying numbers of the desired complement of markers. We continued this work in 2021, placing a high priority on selecting lines, not only with the field characteristics described above, but also with multiple disease resistances.

This work was advanced further through our summer greenhouse crossing block of 32 parent lines, representing some lines with various combinations of at least 3 or 4 stacked resistances. Other parent lines had rare combinations of 2 resistance genes and others had rare-for-our-program single resistance genes. These were crossed to develop 148 new breeding lines combining these traits.

Developing breeding lines with multiple disease resistances has two benefits. Firstly, there is the direct benefit in ultimately having F1 hybrid cultivars with disease resistance. Secondly, there is the indirect benefit in expanding the reach and the impact of the investment and the effort in the Ridgetown breeding program since breeding lines with these multiple resistances are more likely to be used by commercial seed companies in developing new hybrids.

Early fruit colouring trait

A new trait called early fruit colouring was discovered at Ridgetown in 2005. The fruit begin to show some external colouring in response to exposure to sunlight while they are still immature, as evidenced by the fact that the gel has not yet formed around the seeds. It may be possible to blend some of these "less-green" fruit with ripe fruit to elevate the viscosity in the manufacture of tomato paste. The idea is that while a small percentage of normal green fruit is already blended with red tomatoes in making paste, this early fruit colouring might permit a higher percentage of these immature, presumably high-

pectin fruit to be blended in, thus possibly resulting in paste the same finished colour level but with even higher viscosity than is currently achieved.

A population of recombinant inbred lines (RILs) was developed previously for genetic study of this trait. In 2021, a sub-set of 19 of these RILs was grown out for evaluation as being suitable parents for incorporating this trait into commercially useful breeding lines.

Collaborative project screening for tomato brown rugose fruit virus (ToBRFV) resistance

The collaborative project with J. Griffiths (AAFC-Vineland) is ongoing. In winter 2021, seed of 530 Ridgetown breeding lines was sent for ToBRFV inoculation trials at 3 AAFC greenhouse facilities. The project has been subject to a number of delays due to COVID-19. As of October 14, 2021 inoculation and screening has started at an AAFC greenhouse in BC. A recent paper https://link.springer.com/article/10.1007/s41348-021-00535-x reported the results of a screening study with a Jordanian isolate of ToBRFV and resistance was found in *Solanum pimpinellifolium, S. habrochaites* and *S. chilense*. Since the Ridgetown breeding program has incorporated genetic diversity from many wild tomato species, including these 3, there is reason to be optimistic that resistance may be found in Ridgetown lines.

Natural tomato soluble solids (NTSS)

Measurements of NTSS (°Brix) were completed on 68 F6 generation field selections. This information is used to guide decisions on breeding lines to release and also to identify potential parent lines with high NTSS to use in the development of new breeding lines. It is expected that any gains in NTSS levels through breeding will be modest since soluble solids levels are influenced by so many factors. Despite this, NTSS levels are so important to the Ontario industry we continue to make them a factor in breeding decisions.

Project Title

Processing tomato cultivar trials, 2021

Research Agency/location

University of Guelph Ridgetown Campus

Lead and Key Investigators

Steve Loewen

Satinder Chopra

Executive summary

Processing tomato cultivar trials were conducted at two locations. At the "Ridgetown" site the trial evaluating cultivar performance was combined with a Pinnacle tolerance screening trial in a split-plot design. Cultivar performance was evaluated at a second site in Chatham Township. Cultivars recommended by processing company representatives were evaluated for field yield performance, fruit size and handling measurements, processing measurements and fruit quality measurements. In general, there was a great deal of variability in the field trials so that, while there were numerical differences, it was difficult to detect actual differences among cultivars in the yield grade categories measured. There were differences detected in fruit size, cracking, fruit size uniformity and fruit quality measurements. The results of the Pinnacle tolerance screening will be summarized in a separate report to follow.

Objective

The first objective was to measure the field, handling, peeling and fruit quality performance of new hybrids recently listed in seed company catalogues.

The second objective was to evaluate the lines for tolerance to Pinnacle herbicide.

Materials and Methodology

Cultivars

Ontario processing tomato company representatives were surveyed for the names of the hybrids of interest for the trial. Some seed was available on-hand from 2020, when the trial was planned but not planted out due to challenges presented by COVID-19 that year. Additional seed was received from seed companies. Seed quantities of some hybrids was limited and so a small number of hybrids did not appear in all trials. Transplants were grown in 200 cell plug trays in the greenhouses at Ridgetown Campus.

There were two cultivars considered as checks, H3406 and H5108. The old open-pollinated cultivar Ohio 7983 was included as a fill entry to make the number of trial entries a multiple of 3 to fit with commercial planting practices of using 3-row planters. In addition, we had abundant seed on hand.

Trial sites

Ridgetown site

One site was established in the same field as the processing tomato breeding plots near Selton Line and Kenesserie Road. This trial was set in the field on May 25, 2021, in an RCBD split-plot experimental design. Main plot treatment was cultivar and sub-plot treatment was unsprayed or sprayed 2x rate of Pinnacle. There were 3 replications and main plots (i.e., cultivars) were randomized in all 3 reps. Row spacing was 5 feet apart. Main plots were 36 feet long and planted in twin rows 22 inches apart and plants 18 inches apart within a row, to achieve a plant population of 11,616 plants per acre. Weeds were controlled by ppi Dual Magnum 2.1 L/ha and Sencor 0.33 kg/ha, cultivation and hoeing. Foliar and fruit diseases were controlled with sprays of Echo 720 (1.76 L/ha) and Bravo (2.58 L/ha). Later in the season Revus (0.66 L/ha plus surfactant) was used. This site received 31.2 inches of rainfall from May 25 to September 28.

Chatham Township site

A second trial site was established on a farm of Rob McKerrall in Chatham Township. The trial at this site was established on May 28, 2021, in an RCBD experimental design with 3 replications. There were no sub-plot treatments at this site. The trial was planted with the Ridgetown transplanter at the same row, twin-row and plant spacings as the Ridgetown site. PPI weed control was managed by the grower as was spraying for diseases.

Yield measurements

The plots at both sites were not sprayed with Ethrel in order to observe the natural sequence in maturity. At the Ridgetown site unsprayed sub-plots, and at the Chatham township site the plots, were harvested on 2 days each week, on the date closest to the time when 80% of the fruit were red ripe. Five plants, with no adjacent plants missing, were cut at soil level and the fruit were shaken by hand into a wheelbarrow. Fruit were sorted into red ripe, breakers, processing green, grass green and limited use/rots grade categories and the weight of fruit in each grade category was measured. An 11-quart basket of red ripe fruit was retained as a sample for fruit handling, peeling and quality evaluations.

Fruit handling measurements

From the 11-quart basket sample of red ripe fruit, a 3 kg sub-sample of fruit was weighed out for further evaluations. The number of fruit in this sub-sample was counted to measure average fruit size in grams. The fruit were dropped onto a concrete floor from a height of 4 feet. Only the fruit with cracks extending into the flesh were weighed and the results are reported as % cracking. The fruit with stems attached were counted and reported as percent of the total fruit number to estimate persistence of stem attachment. The uniformity of fruit size (i.e., diameter) was estimated on a weight basis by grading the fruit into 4 size categories using spaced steel bars. Size 1 was 1" or less, size 2 was greater than 1" and less than or equal to 1 1/2", size 3 was greater than 1 1/2"and less than or equal to 1 3/4" and size 4 was fruit diameter greater than 1 3/4".

Peeling and peeled colour measurements

After going through the handling evaluations described above, the 3 kg fruit samples are then peeled. The tomatoes were submerged in caustic potash (30% solution by weight) with Turgitol surfactant (0.3% by volume), at 102 +/- 1°C for 40 seconds. The sample was rinsed twice in water. The peels were removed mechanically. The peeled tomatoes were rinsed in water and drained and weighed. This

weight was expressed as percent of the initial sample weight and is reported as percent peeling recovery. After peeling, the tomatoes were sorted for colour, peels still attached, and blemishes. The percent of fruit that had no significant colour defects, and that peeled relatively easily were reported as percent cannable.

Fruit quality measurements

The remaining red ripe fruit from the 11-quart basket field sample were made into thin pulp and used for fruit quality measurements. Fruit were washed and dried and blended in a Waring Commercial blender, (with customized tomato blades) on medium speed, for 40 seconds, under vacuum. The juice sample was collected with a ladle through the sieve. Colour (Hunter a and Hunter b) was measured with a Konica-Minolta CR-410T chroma meter. The Hunter a/b ratio and Hunter Hue Angle were calculated. The pH of the juice was measured using a benchtop digital pH meter and natural tomato soluble solids (NTSS) was measured in degrees Brix using a Palette PR-101 digital refractometer.

Pinnacle tolerance screening

At the Ridgetown site (described above) one sub-plot within each cultivar main plot was sprayed with a 2x rate of Pinncle (thifensulfuron-methyl 50%) 3 weeks after transplanting (June 17).

Visual ratings of Pinnacle injury

Five days later (June 22) a first rater assessed the plants for symptoms of Pinnacle injury. On this same date a second rater also assessed the plants for symptoms of Pinnacle injury. The second rater rated the plants again 10 days after Pinnacle application to assess plant recovery.

Yield measurements and maturity

Plants in both unsprayed and sprayed sub-plots were harvested as described above for Yield Measurements. Samples of red ripe fruit were not retained for any further measurements for the pinnacle sprayed sub-plots.

Results/Conclusions

General comments about the yield results

While numerically different, none of the different yield grade categories or summed categories (Tables 1 and 4) were determined to be reliably different (based Analysis of Variance (ANOVA) and followed by Tukey's Honestly Significant Difference (HSD) tests). We propose two explanations for this. Firstly, there was a great deal of variability in the trial between replications. There may be several reasons behind this that are being scrutinized in preparation for future trials of this type. A second explanation follows in the next paragraph.

A note about the statistical methods used – and why our results are very conservative

There were some variables where a difference was detected between cultivars by ANOVA but they were not reported because they were not also detected by Tukey's HSD test at 0.05%. While there is some debate among statisticians as to why this happens, some believe it is related to the fact that ANOVA merely tests whether or not all means (e.g., the mean yield of red ripe fruit for each cultivar) are all equal or not. If the ANOVA test tells us that not all cultivar means are equal for a particular variable, then the question becomes, 'Which means are different from each other?' 'Which cultivars performed differently from each other?' Tukey's HSD is a very conservative test for separating the cultivar means,

of red ripe yield for example, or any of the other variables we measured. The way Tukey's HSD works is that it controls the experiment-wise error rate. In this case experiment-wise error rate refers to the number of comparisons between different cultivars we make. In an experiment with 22 cultivars there are 231 pairwise comparisons between all combinations of cultivars. As we make more and more comparisons, we increase our risk of saying two cultivars are different from each other, when in actual fact they're not really different. This is sometimes called a false-positive or a Type I error.

In summary, the methods that were used are among the most careful to avoid declaring a difference where no difference actually exists.

Ridgetown yield data (Table 1)

As noted above, while the means reported in the yield grade categories are numerically different in Table 1, we were unable to declare them actually difference because of the amount of variation in the trial. It may still be useful to look at the trends. The cultivars are arranged by the average days from transplanting to 80% red ripe and frequently it's more interesting to compare within maturity groupings.

Ridgetown fruit size and handling measurements (Table 2)

This table shows fruit size in grams, number of stems attached after harvest, and cracking. The percent of fruit with cracks after being subjected to our tests was quite high overall this year compared to previous years. This might be explained partly by fruit size and partly by the amount of rainfall we had.

The size1 through size 4 categories give some estimate of how uniform in size the fruit tend to be.

Ridgetown fruit quality measurements (Table 3)

In Table 3 the cultivars are again sequenced by maturity. The natural tomato soluble solids were lower overall this year compared to what we have measured in previous years. The fruit pH tended to be higher than usual this past year compared to previous years. A target pH is 4.3 for food safety and the values were well above that for many entries.

Chatham Township yield data (Table 4)

Like the comments for the Ridgetown location (see comments above), while there were numerical differences between the cultivars for yield grade categories measured, our very conservative approach, and variability in the site itself, did not permit us to detect any true or actual differences between yield. Again, the entries are arranged in sequence of maturity first by number of days from transplant to harvest and secondly, alphabetically within equivalent numbers of days. Overall, the yield at the Chatham Township site was much lower than the Ridgetown site. This site also had an earlier start and finish to the harvest season.

Chatham Township fruit size and handling measurements (Table 5)

The percent cracking tended to be high among some cultivars at this site, similar to what was observed at the Ridgetown site. CC337 was notable for extremely uniform fruit size with over 93 percent of the fruit falling in the Size 2 category. H1418 was next highest with 71 percent of fruit in the size 2 category. GEM 611 had almost 60 percent of the fruit in the size 4 category.

Chatham Township fruit quality measurements (Table 6)

Overall the fruit pH was lower than what was measured at the Ridgetown site, but it was still tending to be high compared to other years.

Pinnacle tolerance screening

The results for the Pinnacle tolerance screening will be summarized and interpreted in a second part to this report.

Acknowledgements

The support of the Ontario Tomato Research Institute, the seed companies, the processor representatives and Rob McKerrall are gratefully acknowledged.

Table 1. Processing tomato cultivar trial yield measurements, Ridgetown site, 2021.

Name	days	Red ripe	Breakers	Proc Grn	Grass Grn	Lim Use	Potential	Red + Breakers	Red + Breakers + Proc Grn	Red + Breakers + Proc Grn + Grass Grn
		tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre
H1014	99	40.9	6.9	2.6	3.8	3.6	57.7	47.7	50.3	54.1
H2206	102	33.5	3.4	0.7	0.9	5.4	44.0	36.9	37.6	38.6
HM7103	102	40.3	4.1	1.1	1.8	3.7	51.0	44.4	45.5	47.3
N3306	104	31.9	4.9	2.8	2.1	1.3	42.9	36.7	39.6	41.7
GEM 611	106	44.0	4.8	0.8	1.7	7.1	58.4	48.8	49.6	51.3
H1178	106	35.5	3.8	1.8	4.6	2.8	48.6	39.4	41.1	45.7
Ohio 7983	107	42.4	5.7	1.2	1.5	4.3	55.2	48.1	49.3	50.8
GEM 331	108	37.7	4.8	1.6	3.4	3.9	51.4	42.5	44.1	47.5
H5108	108	38.3	5.1	1.2	1.1	4.0	49.6	43.3	44.5	45.6
H1015	109	45.6	4.1	1.5	1.5	3.7	56.3	49.6	51.1	52.6
H1879	109	34.7	3.7	2.7	4.1	3.1	48.3	38.4	41.1	45.2
H1902	109	47.3	5.2	2.9	1.9	4.0	61.4	52.5	55.4	57.4
HM5900	109	25.8	2.9	0.8	0.8	4.7	34.9	28.7	29.5	30.3
HM9903	109	39.7	2.4	1.4	0.5	2.1	46.1	42.1	43.5	44.0
CC337	111	37.9	5.2	1.0	2.3	2.7	49.1	43.0	44.0	46.4
HM5369	111	36.8	3.0	0.7	0.7	2.6	43.7	39.7	40.4	41.1
AND4123	113	39.2	4.0	2.1	2.5	1.9	49.7	43.2	45.3	47.8
H1301	113	43.8	5.2	2.1	2.6	3.3	57.0	49.0	51.1	53.7
H1648	113	49.0	4.8	1.6	1.7	4.5	61.6	53.8	55.4	57.2
H3406	115	41.1	5.1	1.3	3.7	3.1	54.4	46.3	47.6	51.3
H1418	117	39.2	6.5	3.2	6.8	4.4	60.1	45.8	48.9	55.7
H9706	117	28.8	3.8	1.4	2.3	1.9	38.1	32.6	34.0	36.2
Tukey HSD at 5%	15	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Table 2. Processing tomato cultivar trial, fruit size, handling and peeling measurements, Ridgetown site, 2021.

Name	Days	Avg fr sz	Stems	Cracking	Size 1	Size 2	Size 3	Size 4
		grams	percent	percent	percent	percent	percent	percent
H1014	99	68.8	9.1	19.2	0.0	17.0	38.7	42.9
H2206	102	58.1	9.5	38.0	0.0	44.1	35.7	17.9
HM7103	102	80.7	3.5	25.6	0.0	12.0	32.0	54.8
N3306	104	65.9	2.1	20.8	0.0	47.4	38.7	13.3
GEM 611	106	75.2	0.8	23.3	0.0	11.3	30.1	57.8
H1178	106	77.2	13.2	29.8	0.0	19.4	41.0	39.0
Ohio 7983	107	70.5	0.7	38.7	0.0	33.9	47.0	19.0
GEM 331	108	68.2	1.5	21.8	0.0	22.3	25.1	51.7
H5108	108	72.2	5.5	29.7	0.0	21.0	37.5	41.2
H1015	109	76.3	13.5	35.5	0.0	14.7	45.8	39.1
H1879	109	74.6	4.1	30.0	0.0	20.4	47.0	32.4
H1902	109	75.8	13.4	37.2	0.0	21.7	49.4	28.7
HM5900	109	77.7	1.8	14.4	0.0	9.8	48.3	41.9
HM9903	109	83.4	0.0	35.4	0.0	11.3	42.3	46.3
CC337	111	57.1	1.2	31.8	0.0	72.6	13.4	13.8
HM5369	111	75.8	0.9	18.2	0.0	44.5	42.6	12.8
AND4123	113	78.0	6.8	17.0	0.0	12.9	31.7	50.6
H1301	113	59.7	12.4	27.3	0.0	57.0	41.0	1.4
H1648	113	88.1	5.9	32.5	0.0	19.3	28.3	51.9
H3406	115	65.6	2.2	35.4	0.0	35.0	47.9	16.8
H1418	117	65.6	12.2	11.0	0.3	43.7	40.5	15.0
H9706	117	67.6	6.5	16.6	0.0	33.1	43.0	24.1
Tukey HSD at 5%		13.5	ns	28.9	ns	42.3	34.5	44.7

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Table 3. Processing tomato cultivar trial, fruit quality measurements, Ridgetown site, 2021.					
Name	Days	Hunter a/b	Hue Angle	NTSS	pH
				Brix	
H1014	99	2.33	23.23	4.0	4.72
H2206	102	2.22	24.21	4.0	4.81
HM7103	102	2.36	22.95	4.3	4.71
N3306	104	2.42	22.48	3.9	4.77
GEM 611	106	2.42	22.42	3.7	4.60
H1178	106	2.56	21.37	4.5	4.71
Ohio 7983	107	2.35	23.04	4.0	4.59
GEM 331	108	2.46	22.11	4.2	4.66
HS108	108	2.31	23.49	3.9	4.59
H1015	109	2.55	21.40	4.2	4.62
H1879	109	2.69	20.41	4.8	4.64
H1902	109	2.52	21.64	4.4	4.69
HM5900	109	2.41	22.58	4.6	4.51
HM9903	109	2.49	21.87	4.3	4.63
CC337	111	2.49	21.93	4.0	4.77
HM5369	111	2.46	22.15	4.4	4.74
AND4123	113	2.60	21.03	4.2	4.49
H1301	113	1.90	31.09	3.5	4.81
H1648	113	2.70	20.31	4.2	4.70
H3406	115	2.56	21.37	4.5	4.66
H1418	117	2.68	20.45	4.4	4.59
H9706	117	2.44	22.34	3.9	4.66
Tukey HSD at 5%		0.64	ns	ns	ns

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Table 4. Processing tomato cultivar trial yield measurements, Chatham Township site, 2021.

Name	days	Red ripe	Breakers	Proc Grn	Grass Grn	Lim Use	Potential	Red + Breakers	Red + Breakers + Proc Grn	Red + Breakers + Proc Grn + Grass Grn
		tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre
H2206	95	20.4	3.6	0.6	0.5	2.3	27.5	24.0	24.6	25.1
Ohio 7983	95	18.4	2.3	0.5	0.3	5.8	27.3	20.6	21.2	21.5
GEM 611	97	31.7	3.9	1.0	1.9	2.0	40.6	35.7	36.7	38.6
H1014	97	28.4	2.6	0.5	0.6	1.6	33.7	31.0	31.5	32.1
HM9903	97	23.3	1.9	0.6	0.9	1.7	28.4	25.2	25.8	26.7
HM5900	100	26.3	2.2	0.3	0.7	3.5	33.0	28.5	28.8	29.5
HM7103	100	22.6	2.2	0.6	0.7	1.7	27.9	24.9	25.5	26.2
N3306	100	22.8	3.4	0.6	0.3	1.8	28.9	26.2	26.8	27.1
AND4123	102	27.9	2.9	0.6	0.7	3.0	35.2	30.9	31.4	32.2
H5108	102	25.8	2.6	1.3	0.9	2.1	32.6	28.4	29.7	30.6
GEM 331	102	31.3	3.7	1.2	2.1	1.5	39.8	35.0	36.2	38.3
H1879	102	30.1	2.0	0.5	0.6	3.3	36.5	32.1	32.6	33.2
HM5369	102	23.4	3.0	0.4	0.7	2.4	30.0	26.4	26.8	27.5
H1648	104	21.2	2.1	0.8	0.7	6.3	31.2	23.3	24.1	24.8
H1902	104	23.1	1.8	0.5	1.0	2.0	28.5	24.9	25.4	26.5
CC337	106	29.5	1.7	0.6	1.1	3.3	36.2	31.2	31.8	32.9
H1178	106	27.8	2.5	1.0	1.6	1.8	34.7	30.3	31.3	32.9
H1301	106	29.9	1.7	0.2	0.2	1.5	33.5	31.6	31.8	32.0
H1418	106	25.1	3.3	1.2	2.3	1.0	33.0	28.4	29.6	31.9
H3406	108	32.2	1.4	0.4	0.3	1.7	36.0	33.6	34.0	34.3
H9706	108	32.8	4.0	2.1	3.1	1.2	43.3	36.8	38.9	42.0
Tukey HSD at 5%	9.8	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Table 5. Processing tomato cultivar trial, fruit size, handling and peeling measurements, Chatham Township site, 2021.

Name	Days	Avg fr sz	Stems	Cracking	Size 1	Size 2	Size 3	Size 4
		grams	percent	percent	percent	percent	percent	percent
H2206	95	52.6	5.3	41.6	0.1	34.4	37.8	26.5
Ohio 7983	95	66.2	4.8	36.3	0.1	27.5	41.0	30.4
GEM 611	97	72.3	2.4	37.5	0.0	13.0	24.9	59.6
H1014	97	61.8	12.9	28.4	2.2	44.7	34.8	19.8
HM9903	97	74.7	3.3	17.3	0.0	13.7	39.3	57.6
HM5900	100	75.8	1.7	21.8	0.0	11.5	26.8	61.5
HM7103	100	69.0	3.0	28.2	0.0	22.5	32.4	44.4
N3306	100	63.2	2.7	15.2	0.4	48.8	33.0	17.3
AND4123	102	77.8	9.9	27.9	0.0	13.3	33.0	53.3
HS108	102	61.6	2.4	18.8	2.5	30.9	39.5	25.8
GEM 331	102	64.1	2.8	24.3	0.0	30.9	36.2	32.9
H1879	102	67.6	2.3	37.9	0.0	28.0	41.2	30.5
HM5369	102	65.6	1.4	5.9	7.1	45.6	35.9	17.4
H1648	104	84.9	7.2	30.4	0.0	24.6	28.7	46.4
H1902	104	61.1	8.8	24.9	0.1	47.8	35.5	15.3
CC337	106	46.5	4.0	23.5	2.6	93.8	3.2	0.0
H1178	106	65.7	8.1	44.8	0.0	50.1	34.8	14.7
H1301	106	54.6	6.7	40.8	0.0	62.7	30.0	7.5
H1418	106	54.6	6.7	18.8	0.4	71.0	21.4	6.5
H3406	108	60.7	4.1	43.8	0.0	54.4	34.8	10.4
H9706	108	69.2	4.6	45.3	0.0	34.5	40.3	25.0
Tukey HSD at 5%		21.7	ns	31.1	ns	38.9	29.9	46.3

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Table 6. Processing tomato cultivar trial, fruit quality measurements, Chatham Township site, 2021.

Name	Days	Hunter a/b	Hue Angle	NTSS	pH
				Brix	
H2206	95	2.09	25.54	4.1	4.35
Ohio 7983	95	2.14	25.00	3.7	4.34
GEM 611	97	2.37	22.89	3.8	4.48
H1014	97	2.34	23.24	4.1	4.63
HM9903	97	2.53	21.58	4.5	4.40
HM5900	100	2.37	22.87	4.5	4.46
HM7103	100	2.32	23.30	4.4	4.41
N3306	100	2.28	23.69	4.2	4.67
AND4123	102	2.40	22.65	4.6	4.42
HS108	102	2.26	23.84	4.1	4.33
GEM 331	102	2.28	23.68	3.8	4.62
H1879	102	2.56	21.41	4.5	4.47
HM5369	102	2.32	23.33	4.3	4.49
H1648	104	2.56	21.43	4.4	4.31
H1902	104	2.78	20.30	4.4	4.62
CC337	106	2.46	22.16	4.4	4.71
H1178	106	2.51	21.71	4.3	4.53
H1301	106	2.26	23.87	4.3	4.40
H1418	106	2.58	21.22	4.9	4.33
H3406	108	2.42	22.48	4.3	4.55
H9706	108	2.41	22.57	4.0	4.50
Tukey HSD at 5%		0.48	3.38	0.61	ns

Means are based on fruit samples from 5 plants harvested in each of 3 replications. Entries are arranged by days from transplant to harvest and then alphabetically. Tukey HSD at 5% is the minimum significant difference.

Project Title

Processing tomato cultivar trials Part 2: screening for Pinnacle tolerance, 2021

Research Agency/location

University of Guelph Ridgetown Campus

Lead and Key Investigators

Steve Loewen

Satinder Chopra

Executive summary

A split plot RCBD experimental design, with unsprayed and sprayed with a 2x rate of Pinnacle was used to investigate differences in processing tomato cultivar tolerance to Pinnacle herbicide. The interactions between cultivar and Pinnacle treatment were not significantly different on yield data. Visual ratings of Pinnacle injury symptoms on plants 5 days after spraying, by 2 different raters revealed some differences among the entries. There is evidence that AND4123, H1014, H1418, H1879 and H2206 are susceptible to injury from Pinnacle. H5108 and HM9903 probably susceptible since they perform similarly to N1069 which is a known susceptible check in the trial.

Objective

The main objective of this project was to measure the field, handling, peeling and fruit quality performance of new hybrids recently listed in seed company catalogues. The results of that work are presented in a separate report.

The second objective was to evaluate the lines for tolerance to Pinnacle herbicide. These results are reported here.

Materials and Methodology

Cultivars

The cultivars used were the same as for the cultivar trial with minor differences. Seed quantities were limited for H1902 and H1015 and so these entries were not planted in Pinnacle-sprayed subplots. N1069 and N1480e were added for the Pinnacle tolerance trial as check cultivars based on their known reaction to Pinnacle exposure. Previous work by Darren Robinson and others identified N1069 as showing significant visual injury from Pinnacle exposure and N1480e as being resistant to all rates of Pinnacle tested.

Transplants were grown in 200 cell plug trays in the greenhouses at Ridgetown Campus.

Trial site

The trial site and experimental setup is reproduced here from the first report for convenience. The trial was established in the same field as the processing tomato breeding plots near Selton Line and Kenesserie Road. Transplants were set in the field on May 25, 2021, in an RCBD split-plot experimental

design. Main plot treatment was cultivar and sub-plot treatment was unsprayed or sprayed 2x rate of Pinnacle. There were 3 replications and main plots (i.e., cultivars) were randomized in all 3 reps. Row spacing was 5 feet apart. Main plots were 36 feet long and planted in twin rows 22 inches apart and plants 18 inches apart within a row, to achieve a plant population of 11,616 plants per acre. Weeds were controlled by ppi Dual Magnum 2.1 L/ha and Sencor 0.33 kg/ha, cultivation and hoeing. Foliar and fruit diseases were controlled with sprays of Echo 720 (1.76 L/ha) and Bravo (2.58 L/ha). Later in the season Revus (0.66 L/ha plus surfactant) was used. This site received 31.2 inches of rainfall from May 25 to September 28.

Pinnacle application

One sub-plot within each cultivar main plot was sprayed with a 2x rate of Pinncle (thifensulfuron-methyl 50%) 3 weeks after transplanting (June 17).

Visual ratings of Pinnacle injury

Five days later (June 22) a first rater assessed the plants for symptoms of Pinnacle injury. On this same date a second rater also assessed the plants for symptoms of Pinnacle injury. The second rater rated the plants again 10 days after Pinnacle application to assess plant recovery.

Yield measurements and maturity

Plants in both unsprayed and sprayed sub-plots were harvested Yield Measurements. The plots were not sprayed with Ethrel in order to observe the natural sequence in maturity. Sub-plots were harvested on 2 days each week, on the date closest to the time when 80% of the fruit were red ripe. Five plants, with no adjacent plants missing, were cut at soil level and the fruit were shaken by hand into a wheelbarrow. Fruit were sorted into red ripe, breakers, processing green, grass green and limited use/rots grade categories and the weight of fruit in each grade category was measured.

Results/Conclusions

Yield results (Table 1)

In this experiment where the goal is to determine if a tomato cultivar is tolerant to Pinnacle or not, the most interesting response to observe is the interaction between cultivar (= entry in Table 1) and Pinnacle treatment (unsprayed or sprayed). If the interaction is determined to be truly different and not merely numerically different (which is usually an artifact of random variation in experimental conditions), then we would conclude that a cultivar behaves differently if it is exposed to Pinnacle than if it is not exposed. This should identify the Pinnacle-sensitive cultivars. On the other hand, if the interaction is not truly different or not significantly different, then the cultivars would be said to be insensitive to 2X rate of Pinnacle exposure used in this trial.

The 2021 results showed that none of the interactions between cultivar and Pinnacle treatment were significant for the yield grade categories measured. This would suggest that, based on evidence from yield measurements at the end of the season, all the cultivars evaluated in 2021 were tolerant to Pinnacle. It is also possible that if there were some cultivars sensitive to Pinnacle injury, the effect was masked by the end of the season in this trial in 2021. This is similar to what was discovered in a comparable trial in 2019 although some of the cultivars tested were different.

Incidence of visual injury ratings for all symptoms (Table 2)

Five days after spraying subplots with a 2x rate of Pinnacle, the plants in each sprayed subplot were rated for visual symptoms of Pinnacle injury on a scale of 0 to 5, where 0 = completely resistant, no evidence of any symptoms; 1 = probably resistant, uncertain or very slight amount of yellowing of meristems; 2 = possibly resistant, very slight cupping of leaflets, very slight yellowing of meristems; 3 = intermediate, slight yellowing, slight cupping of leaflets; 4 = probably susceptible, clear yellowing of leaflets, cupping of leaflets; 5 = clearly susceptible, epinasty of leaves, usually yellowing of meristems and leaflets, often necrosis on recently emerged leaflets.

Since these were category ratings rather than evenly spaced, continuous quantities, for each cultivar, the number of each rating category was counted (Table 2). Since there were 3 replications in the trial, the maximum number of ratings for each cultivar is 3. These ratings were done by rater 1.

The results of this assessment suggest that AND4123, H1014, H1418, H1879, and H2206 are susceptible to Pinnacle injury visible 5 days after spraying. H5108, HM9903 and N1069 are also probably susceptible although the evidence is not as strong. As noted above N1069 was found to be susceptible in work by other researchers. The results are not shown but the ratings suggested that there may have been a mixup in the seedlot of H1178 since, in two of the replications there were some plants that were clearly susceptible even though the majority were not. These results should be approached with caution since they are based on a single trial site and a single growing season.

Incidence of visual ratings for leaflet epinasty (drooping) (Table 3)

Table 3 summarizes the visual ratings for epinasty or leaflet drooping separate from the other symptoms. These results were completed by rater 2 and based on leaflet drooping alone AND4123, H1014, H1418, H1879, H2206, HM9903 appear to show the most severe response to Pinnacle. Again, N1069 is also probably susceptible but not as clearly as these others. These results are consistent with the results of the combined ratings in Table 2.

Incidence of visual ratings for chlorosis (Table 4)

The visual ratings for chlorosis or yellowing, usually of the growing point and most recently emerged leaves, are summarized in Table 4. These results were completed by rater 2. H1014, H1301, H1418, H2206, H5108 and HM9903 showed the most severe chlorosis in response to Pinnacle exposure. H1301 was not identified in any of the other ratings as likely being susceptible. AND4123 is likely susceptible based on this scoring but not as clearly as it showed in the other evaluations.

Incidence of visual ratings for canopy growth (Tables 5 and 6)

Finally, Table 5 shows a summary of the ratings of plant canopy vigour or plant canopy growth for the 3 replications of unsprayed and Pinnacle sprayed plots, at 5 days after spraying with Pinnacle. Table 6 shows the same ratings except they were done 10 days after spraying. The objective was to discover if any differences in rate of recovery from exposure to Pinnacle could be detected. Again, these observations were taken by rater 2.

From Table 5 AND4123, H1014, H1418, H1879, H2206, H5108, HM9903 and N1069 show evidence of the biggest differences in plant canopy vigour between unsprayed and Pinnacle sprayed subplots at 5 days after spraying. These results are mostly consistent with the combined and separate Pinnacle injury ratings above.

Caution is recommended when interpreting Table 6. The results are less clear and this is congruent with the yield results measured at the end of the season where the differences can become difficult to detect.

Summary

Based on a range of rating methods, used by two different raters, there is some consistency in the results. There is evidence that AND4123, H1014, H1418, H1879 and H2206 are susceptible to injury from Pinnacle. H5108 and HM9903 probably susceptible since they perform similarly to N1069 which is a known susceptible. The response of H1301 is unclear. It is important to remember that these results are based on a single site, and a single season of data.

Acknowledgements

The support of the Ontario Tomato Research Institute, the seed companies and the processor representatives is gratefully acknowledged.

Table 1. Mean number of days from transplant to harvest and yield grade categories for unsprayed and Pinnacle-sprayed plots for each cultivar, 2021.

Entry	unsprayed or sprayed Pinnacle	days	Red ripe	Breakers	Proc Grn	Grass Grn	Limited Use / rots	Potential yield
			tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre
AND4123	unsprayed	113	39.2	4.0	2.1	2.5	1.9	49.7
AND4123	Pinnacle	123	28.3	5.0	2.6	1.6	4.7	42.2
CC337	unsprayed	111	37.9	5.2	1.0	2.3	2.7	49.1
CC337	Pinnacle	113	40.8	3.2	1.4	1.2	0.8	47.4
GEM 331	unsprayed	108	37.7	4.8	1.6	3.4	3.9	51.4
GEM 331	Pinnacle	115	35.4	2.4	0.8	1.8	4.8	45.3
GEM 611	unsprayed	106	44.0	4.8	0.8	1.7	7.1	58.4
GEM 611	Pinnacle	109	39.6	5.1	1.7	2.0	4.7	53.0
H1014	unsprayed	99	40.9	6.9	2.6	3.8	3.6	57.7
H1014	Pinnacle	111	40.5	5.2	3.1	3.1	5.5	57.4
H1178	unsprayed	106	35.5	3.8	1.8	4.6	2.8	48.6
H1178	Pinnacle	109	33.0	3.8	1.6	6.0	2.3	46.7
H1301	unsprayed	113	43.8	5.2	2.1	2.6	3.3	57.0
H1301	Pinnacle	117	46.0	4.1	1.0	2.7	4.5	58.4
H1418	unsprayed	117	39.2	6.5	3.2	6.8	4.4	60.1
H1418	Pinnacle	119	41.4	2.8	1.1	1.3	3.3	49.9
H1648	unsprayed	113	49.0	4.8	1.6	1.7	4.5	61.6
H1648	Pinnacle	113	33.6	8.0	3.3	3.1	2.2	50.2
H1879	unsprayed	109	34.7	3.7	2.7	4.1	3.1	48.3
H1879	Pinnacle	121	31.9	2.6	1.1	0.8	6.2	42.6
H2206	unsprayed	102	33.5	3.4	0.7	0.9	5.4	44.0
H2206	Pinnacle	109	25.7	3.7	1.2	0.4	2.2	33.2
H3406	unsprayed	115	41.1	5.1	1.3	3.7	3.1	54.4
H3406	Pinnacle	117	45.0	4.9	3.0	6.7	2.1	61.6
H5108	unsprayed	108	38.3	5.1	1.2	1.1	4.0	49.6
H5108	Pinnacle	113	27.2	4.0	1.2	0.8	2.8	36.0
H9706	unsprayed	117	28.8	3.8	1.4	2.3	1.9	38.1
H9706	Pinnacle	117	35.8	4.5	1.4	1.9	1.5	45.1
HM5369	unsprayed	111	36.8	3.0	0.7	0.7	2.6	43.7
HM5369	Pinnacle	111	40.1	3.8	0.6	0.1	2.4	47.0
HM5900	unsprayed	109	25.8	2.9	0.8	0.8	4.7	34.9
HM5900	Pinnacle	111	31.1	3.7	0.9	1.1	3.1	39.9
HM7103	unsprayed	102	40.3	4.1	1.1	1.8	3.7	51.0
HM7103	Pinnacle	113	37.8	1.5	0.4	0.5	2.9	43.1
HM9903	unsprayed	109	39.7	2.4	1.4	0.5	2.1	46.1
HM9903	Pinnacle	113	41.8	3.0	1.4	1.6	2.2	50.0
N1069	unsprayed	102	40.3	1.9	0.5	0.6	4.8	48.1
N1069	Pinnacle	109	32.2	3.1	0.8	0.3	3.3	39.6
N1480e	unsprayed	102	37.6	4.2	1.9	3.6	2.3	49.7
N1480e	Pinnacle	111	42.2	3.4	1.1	1.4	3.9	52.0
N3306	unsprayed	104	31.9	4.9	2.8	2.1	1.3	42.9
N3306	Pinnacle	109	27.8	2.9	0.4	0.4	1.7	33.2
Ohio 7983	unsprayed	107	42.4	5.7	1.2	1.5	4.3	55.2
Ohio 7983	Pinnacle	113	32.9	7.2	1.6	2.2	4.8	48.7
main plot (entry)		$p < 0.001$	ns	ns	ns	$p < 0.01$	ns	$p < 0.01$
subplot (unsprayed or sprayed)		$p < 0.0001$	ns	ns	ns	ns	ns	$p < 0.02$
interaction (entry x pinnacle treatment)		ns	ns	ns	ns	ns	ns	ns

Means are based on 3 replications. Entries are arranged alphabetically by name.

Table 2. Incidence of visual ratings for Pinnacle-sprayed subplots, 5 days after spraying, pooled over 3 replications, 2021.

	Categories of visual injury in response to 2x rate of Pinnacle					
Entry	0 completely resistant	1 probably resistant	2 possibly resistant	3 intermediate	4 probably susceptible	5 clearly susceptible
AND4123						3
CC337	2	1				
GEM 331		2		1		
GEM 611				3		
H1014						3
H1178			2	1		
H1301				3		
H1418						3
H1648		1	2			
H1879						3
H2206						3
H3406				3		
H5108				1		2
H9706		2			1	
HM5369		1	1	1		
HM5900	1	1		1		
HM7103	1		1			1
HM9903					1	2
N1069					1	2
N1480e				2	1	
N3306		1		2		
Ohio 7983						3

Visual injury rating scale: 0 = completely resistant, no evidence of any symptoms; 1 = probably resistant, uncertain or very slight amount of yellowing of meristems; 2 = possibly resistant, very slight cupping of leaflets, very slight yellowing of meristems; 3 = intermediate, slight yellowing, slight cupping of leaflets; 4 = probably susceptible, clear yellowing of leaflets, cupping of leaflets; 5 = clearly susceptible, epinasty of leaves, usually yellowing of meristems and leaflets, often necrosis on recently emerged leaflets

Table 3. Incidence of visual ratings of leaflet epinasty (drooping) for Pinnacle-sprayed subplots, 5 days after spraying, pooled over 3 replications, 2021.

	Categories of leaflet epinasty in response to 2x rate of Pinnacle									
Entry	0 no epinasty	1	2	3	4	5	6	7	8	9 severe epinasty
AND4123					1		1	1		
CC337	3									
GEM 331	3									
GEM 611	3									
H1014									3	
H1178	3									
H1301	3									
H1418					1				2	
H1648	3									
H1879								3		
H2206								1	2	
H3406	3									
H5108			1			1	1			
H9706	3									
HM5369	2	1								
HM5900	3									
HM7103	2			1						
HM9903									3	
N1069	1						1		1	
N1480e	3									
N3306	3									
Ohio 7983							1	1	1	

Table 4. Incidence of visual ratings of chlorosis (yellowing) for Pinnacle-sprayed subplots, 5 days after spraying, pooled over 3 replications, 2021.

	Categories of leaflet chlorosis in response to 2x rate of Pinnacle									
Entry	0 normal green	1	2	3	4	5	6	7	8	9 severe chlorosis
AND4123					2	1				
CC337	3									
GEM331	3									
GEM611	2		1							
H1014						1	2			
H1178	3									
H1301				1		1	1			
H1418					1		2			
H1648	3									
H1879	2					1				
H2206							2	1		
H3406	3									
H5108							2	1		
H9706	1			2						
HM5369	3									
HM5900	3									
HM7103	2							1		
HM9903					1	1	1			
N1069	1		1		1					
N1480e	3									
N3306	3									
Ohio 7983							2	1		

Table 5. Incidence of visual ratings of plant canopy growth for unsprayed and Pinnacle-sprayed subplots, 5 days after spraying, pooled over 3 replications, 2021.

		Categories of plant canopy growth									
Entry		9 very good	8	7	6	5	4	3	2	1	0 severe damage
AND4123	unsprayed		1	2							
AND4123	Pinnacle				2	1					
CC337	unsprayed		1	1	1						
CC337	Pinnacle		1	1	1						
GEM 331	unsprayed	1		2							
GEM 331	Pinnacle	1		1	1						
GEM 611	unsprayed	1	1	1							
GEM 611	Pinnacle		1	2							
H1014	unsprayed	1	1	1							
H1014	Pinnacle			1	1	1					
H1178	unsprayed	1	1	1							
H1178	Pinnacle		2	1							
H1301	unsprayed		2	1							
H1301	Pinnacle			2	1						
H1418	unsprayed		2	1							
H1418	Pinnacle				2	1					
H1648	unsprayed		3								
H1648	Pinnacle		2	1							
H1879	unsprayed	1	1	1							
H1879	Pinnacle			1	1	1					
H2206	unsprayed		2	1							
H2206	Pinnacle				1	1	1				
H3406	unsprayed		1	2							
H3406	Pinnacle		1	2							
H5108	unsprayed		1		2						
H5108	Pinnacle					2	1				
H9706	unsprayed			3							
H9706	Pinnacle			2	1						
HM5369	unsprayed		3								
HM5369	Pinnacle			3							
HM5900	unsprayed			1	2						
HM5900	Pinnacle			1	1	1					
HM7103	unsprayed	1	1	1							
HM7103	Pinnacle	1		1	1						
HM9903	unsprayed			3							
HM9903	Pinnacle				1	1	1				
N1069	unsprayed		3								
N1069	Pinnacle		1		1	1					
N1480e	unsprayed			3							
N1480e	Pinnacle		1	2							
N3306	unsprayed		1	2							
N3306	Pinnacle			2	1						
Ohio 7983	unsprayed			3							
Ohio 7983	Pinnacle				1		2				

Table 6. Incidence of visual ratings of plant canopy growth for unsprayed and Pinnacle-sprayed subplots, 10 days after spraying, pooled over 3 replications, 2021.

		Categories of plant canopy growth									
Entry		9 very good	8	7	6	5	4	3	2	1	0 severe damage
AND4123	unsprayed	1	1			1					
AND4123	Pinnacle		1	1	1						
CC337	unsprayed	2	1								
CC337	Pinnacle		2	1							
GEM 331	unsprayed	1	1	1							
GEM 331	Pinnacle	1		2							
GEM 611	unsprayed	2	1								
GEM 611	Pinnacle		1	2							
H1014	unsprayed		2	1							
H1014	Pinnacle			1	2						
H1178	unsprayed	2		1							
H1178	Pinnacle	1	1	1							
H1301	unsprayed	2	1								
H1301	Pinnacle	1	1	1							
H1418	unsprayed	2	1								
H1418	Pinnacle		1	2							
H1648	unsprayed	3									
H1648	Pinnacle	1	2								
H1879	unsprayed	2	1								
H1879	Pinnacle		2			1					
H2206	unsprayed	2		1							
H2206	Pinnacle			3							
H3406	unsprayed	2	1								
H3406	Pinnacle	2				1					
H5108	unsprayed	1	1		1						
H5108	Pinnacle		2	1							
H9706	unsprayed		3								
H9706	Pinnacle		3								
HM5369	unsprayed	2		1							
HM5369	Pinnacle	1		2							
HM5900	unsprayed		3								
HM5900	Pinnacle		3								
HM7103	unsprayed	3									
HM7103	Pinnacle	1		2							
HM9903	unsprayed	2	1								
HM9903	Pinnacle	1	1			1					
N1069	unsprayed	3									
N1069	Pinnacle		1	2							
N1480e	unsprayed	3									
N1480e	Pinnacle		2		1						
N3306	unsprayed	1	2								
N3306	Pinnacle		3								
Ohio 7983	unsprayed	2			1						
Ohio 7983	Pinnacle			2		1					

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

2021 Research Report

Title: Enhancing Late Blight Surveillance and Management in Tomatoes – Annual Report YEAR 2

Prepared for the Ontario Tomato Research Committee (OTRI)
October 15, 2021

Research Agency/Location: University of Guelph, Ridgetown Campus

Lead and Key Investigators:

- Cheryl Trueman, Ph.D., Assistant Professor, Dept of Plant Ag, U of G – Ridgetown (lead)
- Joe Tomecek, Tomecek Agronomic Services
- Genevieve Marchand, Ph.D., Research Scientist, Agriculture and Agri-Food Canada, Harrow
- Yaima Arocha-Rosete, Ph.D., Kristine White, Sporometrics
- Herve Van der Heyden, Phytodata
- Amanda Tracey, OMAFRA
- Kevin Dufton, Research Technician

Study	Page
Comparison of spore trap technology for *Phytophthora infestans* surveillance	3-6
Validation of fungicide programs for late blight based on pathogen surveillance	7-11

Executive Summary:

- The objectives of this research are: a) compare the efficacy of the Spornado passive spore trap and the Rotorod active spore trap for early capture of *P. infestans* sporangia from the air, causal agent of late blight, in one of the Ontario processing tomato production regions, and b) conduct a field trial to validate the use of spore trapping versus current methods used to identify high-risk late blight periods and modify fungicide programs. The spore traps tested were established in eight locations in Kent County. This is the second year of research in a three-year project. Research was delay in 2020 due to the COVID-19 pandemic and resumed in 2021. This report focusses on results from the 2021 season.
- Late blight symptoms were first detected in the Great Lakes region (Ontario, Michigan, Ohio) on August 10. Despite the positive detection in the Great Lakes region, no symptoms were reported within the study region of Chatham-Kent.
- The Spornado first detected the presence of *P. infestans* on July 12. The positive identification occurred about three weeks after the BliteCast forecasting system first recommended protectant fungicide applications for late blight. Thus, using the Spornado would have reduced fungicide use and saved producers the cost of applying the more specific late blight fungicides earlier in the season. However, it would have increased fungicide use and cost compared to the current method of applying high-risk fungicides when symptoms are reported in the Great Lakes Region. The positive detection on July 12 was the only detection at the 3m height for the entire season.
- The Rotorod first detected *P. infestans* on July 22, 10 days later than the Spornado trap. Thus, using the Rotorod would also have reduced fungicide use and saved producers the cost of applying the more specific late blight fungicides earlier in the season. This year, as in 2019, we used a threshold of 10 sporangia m^3 to initiate fungicide applications using the Rotorod traps. Sporangia counts did not exceed the threshold at any point this season, nor

during the 2019 season. Using this approach, fungicide use was reduced further than any other high-risk threshold, including the current method of waiting until late blight symptoms are reported in the Great Lakes Region. Positive detections from the Rotorod traps occurred at three sampling intervals with only one instance of multiple traps at different locations detecting *P. infestans* sporangia.

- Results from 2021 mirrored 2019 as both the Spornado and Rotorod traps had positive detections of *P. infestans* by the mid-point of the season. Moreover, the threshold of 10 sporangia m^3 for the Rotorod trap was not exceeded and late blight symptoms were absent from the trials at the end of the production season in both years.
- Field trials were conducted again at Ridgetown and Cedar Springs. The trials were assessed for defoliation weekly beginning July 26, with the final assessment occurring on September 13. No late blight symptoms were observed, which was similar to 2019. Defoliation (%) was largely due to foliar bacterial disease. Yield data was not collected due to the absence of late blight symptoms.
- We intended to test the SporeCam in 2021 but due to circumstance outside our control it was unavailable. We were recently contacted by Syngenta Canada the SporeCam. They are testing the technology in various locations next year and we will work with them to try and host a SporeCam at no cost to us/this project.
- In place of the SporeCam, additional Spornado and Rotorod traps were installed in 2021 at four of the eight sites. These traps were installed at a lower height (1m) compared to the standard height (3m). The results from the lower traps will be compared to the higher traps and was not used to trigger treatments in the fungicide validation part of the project. Two of the four lower traps had positive detections of *P. infestans* this season, with the first occurring on July 22. There was no instance of the 1m and 3m trap having positive detections during the same sampling interval.
- Regular updates regarding spore trap detections were posted on ONvegetables.com as requested by OTRI. It should be noted that although we reported positive detections, as observed in 2019 and 2021, positive detections alone do not always mean that late blight will develop.

Funding:

- Ontario Tomato Research Institute
- Ontario Agri-Food Innovation Alliance
- Fresh Vegetable Growers of Ontario
- In kind support from: Sporometrics, Weather Innovations Inc

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

TITLE: Comparison of spore trap technology for *Phytophthora infestans* surveillance, 2021

PEST(S): late blight (*Phytophthora infestans*)

MATERIALS: Sporometrics passive spore traps 'Spornado', Rotorod

OBJECTIVE: Compare the efficacy of the Spornado passive spore trap and the Rotorod active spore trap for early capture of *P. infestans* sporangia from the air, causal agent of late blight, in one Ontario processing tomato production region.

METHODS: Spornado passive spore traps (Figure 1) and Rotorod active spore traps (Figure 2) were situated at the edge of eight commercial processing tomato fields near Ridgetown (PI-01), Cedar Springs (PI-02), Chatham (PI-03), Erieau (PI-04), Dover (PI-05), Wallaceburg (PI-06), Dresden (PI-07), and Eberts (PI-08), Ontario. Traps were setup along field edges as close as possible to the tomato crop without interfering with spray applications and other field work. Traps were installed on a metal pole 2.9 m high at all sites. At four sites, and additional set of traps was setup at a height of 1.0 m. Data collection from the 3m and 1m Spornado and Rotorod traps began June 7 and Jun 28 respectively. Spornado traps function when air moves passively through a removable cassette with a fine mesh filter. Conversely, Rotorod traps have a consistent volume of air passing through or over the area collecting spores. Rotorod traps were set to operate from 6:00 to 15:00, alternating between 10 minutes on and 10 minutes off. The cassettes and glass rods for the Spornado and Rotorod traps, respectively, were changed twice a week, placed individually in a plastic bag to avoid cross-contamination, and shipped by overnight courier for same-day detection of *P. infestans* DNA using quantitative PCR. Spornado cassettes were shipped to Sporometrics while Rotorod rods were sent to Phytodata. The final cassettes or rods for each spore trap were collected on Aug 30. Based on the DNA copy number qPCR limit of detection (LOD) for Spornado traps, results for *P. infestans* identification were expressed as positive (*P. infestans* DNA detected, ≥LOD) /negative (*P. infestans* DNA not detected, >LOD). Identification from Rotorod traps was provided as sporangia per m^3. Sentinel tomato plots, consisting of late blight susceptible cultivars, were also established at the Ridgetown, Cedar Springs, and Dresden locations to visually determine the presence of *P. infestans* and were a minimum of 100 m^2 in size.

RESULTS: Unfortunately, there were a few issues with the Rotorod spore traps this summer. On several occasions, motors responsible for rotating the rods malfunctioned. Moreover, one site needed to have the computer that runs the program replaced. In each instance it is unclear how long the Rotorod traps functioned properly during the sampling interval. The malfunction was not noticed until the beginning of the next sampling interval, as the traps would be observed functioning after fresh rods were installed.

For traps placed at 3 m above ground, the first positive results for *P. infestans* in the Spornado occurred on July 12 (sampling period July 8-12) at 1 of 8 sites, and this was the only positive Spornado detection all season (Table 1). The first documented sporangia count from a Rotorod trap occurred on July 22 (sampling period July 19-22) at 1 of 8 sites. During the entire sampling period there were no instances when both traps detected *P. infestans* sporangia during the same sampling interval. Moreover, only on the final sampling interval did more than one Rotorod trap have a positive detection during the same sampling period. Sporangia counts from positive Rotorod detections were 6/m^3 on July 22 at PI-03 (Chatham), 0.4/m^3 on July 29 at PI-06 (Wallaceburg) and 1/m^3 on August 30 at PI-03, PI-04 (Erieau), PI-06 and PI-08 (Eberts).

For traps placed at 1 m above ground only the Spornado at PI-01 (Ridgetown) and PI-02 (Cedar Springs) had positive detections; these were on July 22. There were no detections in any 1m Rotorods and Spornados at PI-05 (Dover) and PI-

07 (Dresden). There was no instance of a positive detection of *P. infestans* in both the 3m and 1m during the same sampling interval at any site.

Despite identifying the presence of *P. infestans* on July 12 and 22 with the Spornado and Rotorod traps, respectively, no late blight symptoms were observed on any of the sentinel tomato plants, nor was late blight reported in the Chatham-Kent growing region during the sampling period. Late blight was identified in field tomatoes in Norfolk County on August 10. The lack of late blight symptoms on tomatoes was surprising as the environmental conditions were conducive for infection by *P. infestans* throughout much of the summer.

CONCLUSIONS: The traps first detected the presence of *P. infestans* mid- to late July; the 12th (Spornado) and 22nd (Rotorod). Detection of *P. infestans* sporangia occurred approximately two to three weeks later than when BliteCast would have recommended the first late blight fungicide treatment, which was on June 21 at Cedar Springs and June 30 at Ridgetown (DSV of 18 reached, see field trial report 'Validation of fungicide programs for late blight based on pathogen surveillance' for further information). While sporangia were detected by the Rotorod, counts were not sufficient to trigger the application of high-risk late blight fungicides in the 10 sporangia/m^3 treatment. Use of either spore trap would have delayed the application of high-risk late blight fungicides, resulting in savings of input costs for growers and reducing pesticide use compared to BliteCast, but not compared to the quantitative Rotorod threshold or symptom detection within the Great Lakes Region. Additional research is required to validate spore traps as a decision support tool compared to other methods to determine high risk periods for late blight, particularly because late blight symptoms did not develop during the sampling period this year.

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

Figure 1. Spornado passive spore trap (right) Rotorod active spore trap (left) placed at 3 m and 1 m above the soil line at the Dover (PI-05) sampling location, 2021.

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

Table 1. Results for the presence of P. infestans sporangia in Spornado and Rotorod spore traps located near Ridgetown (PI-01), Cedar Springs (PI-02), Chatham (PI-03), Erieau (PI-04), Dover (PI-05), Wallaceburg (PI-06), Dresden (PI-07) and Eberts (PI-08), Ontario, 2021.

		June[c]						July[c]									August[c]								
ID[a]	Trap[b]	10	14	17	21	24	28	1	5	8	12	15	19	22	26	29	2	5	9	12	16	19	23	26	30
PI-01	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S1	-	-	-	-		-	-	-	-	-	-	-	+	-	+	+	-	-						
	R	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R1						-	-	-	-	-	-	-	-	-	-	-	-	-						
PI-02	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S1	-	-	-	-		-	-	-	-	-	-	-	+	-	-	-	-	-						
	R	-		-	-	-	-	-	-	-	-	- *	-	-	-	-	-	-	-	-	-	-	-	-	-
	R1						-	-	-	-	-	-													
PI-03	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	-		-	-	- *	-	-	-	-	-	-	-	+ (6)	-	-	-	-	-	-	-	-	-	-	+ (1)
PI-04	S	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+ (1)
PI-05	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S1	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-						
	R	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R1						-	-	-	-	-	-	-	-	-	-	-	-	-						
PI-06	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	-		-	-	-	-		-	-	-	-	-	-	+ (0.4)	-	-	-	-	-	-	-	- *	-	+ (1)
PI-07	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S1	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-						
	R	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R1						-	-	-	-	-	-	-	-	-	-	-	-	-						
PI-08	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	-		- *	-	-	-	-	-	-	-	- *	-	-	-	-	-	- *		-	-	-	-	-	+ (1)

[a] Trap locations were Ridgetown (PI-01), Cedar Springs (PI-02), South Chatham (PI-03), Ericau (PI-04), Dover (PI-05), Wallaceburg (PI-06), Dresden (PI-07), and Egberts (PI-08). [b] Cassettes or rods were collected two times a week. S = 3 m Spornado, S1 = 1m Spornado, R = 3 m Rotorod, R1 = 1m Rotorod. [c] Empty cells represent missing data. Number in parentheses represent sporangia m3. A '+' indicates detection of P. infestans and '-' indicates no detection of P. infestans * Instances where duration of proper Rotorod function is unknown because unit was not functioning when rods where changed.

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

TITLE: Validation of fungicide programs for late blight based on pathogen surveillance, 2021

PEST(S): late blight (*Phytophthora infestans*)

MATERIALS: Bravo ZN (chlorothalonil 500g L^{-1}), Quadris Flowable (azoxystrobin 250 g L^{-1}), Aprovia Top (benzovindiflupyr ('Solatenol') 100 g L^{-1}, difenoconazole 117 g L^{-1}), Orondis Ultra (oxathiapiprolin 30 g L^{-1}, mandipropamid 250 g L^{-1}), Torrent (cyazofamid 400 g L^{-1}), Tanos (famoxadone 25%, cymoxanil 25%), Revus (mandipropamid 250 g L^{-1})

OBJECTIVES: Evaluate the use of disease forecasting and spore trapping to identify high-risk late blight periods and modify fungicide programs compared to current methods.

EQUIPMENT/FORECASTING SYSTEMS: Spornado passive spore trap (Sporometrics), Rotorod (Phytodata), BliteCast (as per Krause, 1975)

METHODS: The trial was completed at Ridgetown Campus, University of Guelph. Two tomato cultivars, 'TSH39' and 'TSH34', were used to identify differences between host resistance to *P. infestans*. TSH39 has host resistance to *+Ph-3* while TSH34 is susceptible to *–Ph-2*, and *-Ph-3*, both cultivars have similar maturity dates. Tomatoes were transplanted into twin rows on June 1 at Ridgetown and June 8 at Cedar Springs using a mechanical transplanter at a rate of 3 plants per metre. Each twin row was spaced 2 m apart. Each treatment plot was 7m long and consisted of one twin row. Transplanted between each plot twin row was a guard row, cultivar TSH39, to ensure treatment separation. The trial was designed as a 2 x 10 factorial with four replications. Factor A was the trigger initiating the application of high-risk fungicides for late blight management and factor B was the host resistance to *P. infestans*. The triggers tested were: late blight symptoms reported on tomato or potato in Ontario, Michigan, or Ohio, a Spornado positive finding for *P. infestans* at any trap location, a Rotorod positive finding for *P. infestans* at any trap location, a Rotorod sporangia count of 10 per m^3 or greater at any trap location, the accumulation of a DSV value of 18 from BliteCast, BliteCast DSV value of 18 and a positive Spornado result, BliteCast DSV value of 18 and a Rotorod sporangia count of 10 per m^3 or greater and BliteCast DSV value of 18 and a positive Rotorod result. In addition to the triggers there was also a non-treated control and a control that was only sprayed with fungicides applied during low *P. infestans* periods. Trap locations were those outlined in the previous study 'Comparison of spore trap technology for *Phytophthora infestans* surveillance'; Ridgetown, Cedar Springs, Eberts, Chatham, Erieau, Dover, Wallaceburg, and Dresden, Ontario. BliteCast was calculated by Weather Innovations Inc. using weather data collected at Ridgetown Campus according to the parameters of Krause (1975). A threshold of 18 DSV used to initiate a change in fungicide program. Except for the non-treated control, each treatment was sprayed with a standard, low-risk fungicide *P. infestans* management program throughout the season (Table 1). Once the respective high-risk trigger was initiated treatments were sprayed with the required 'high-risk' fungicides in addition to the low-risk program (Table 2). Fungicide treatments, application date, and their 'risk' level are listed in Table 1. Applications were made using a hand-held CO_2 sprayer with nozzles ULD 120-03, and a water volume of 300 L Ha^{-1}.

Despite the absence of late blight symptoms, trials were assessed for disease intensity on foliage by estimating the percent of leaf canopy affected. Defoliation ratings were taken approximately every seven days starting on July 26 and continuing until September 13. These values were used to calculate the area under the disease progress stairs (AUDPC) using the following equation: AUDPC = $[(Y_1 + Y_n)/2 \times (D/n-1)]$, where Y_1 is the disease level at first assessment, Y_n is the disease level at last assessment, D is the difference in the number of days from the last assessment to the first assessment, n is the number of assessments.

Since there was no late blight in the trial, yield was not measured.

RESULTS: No late blight symptoms were observed in the trial despite a growing season conducive to the development of late blight, a BliteCast DSV accumulation of 18 reached by June 21 at Cedar Springs and June 30 at Ridgetown (Appendix A) and the first positive Spornado result being recorded on July 12 and Rotorod on July 22 (see previous report 'Comparison of spore trap technology for *Phytophthora infestans* surveillance'. The accumulated DSV value and positive Spornado result triggered the initiation of the high-risk sprays beginning on July 14 for treatment 8 and July 26 for treatment 9 (Table 3), respectively. The detection of late blight symptoms on August 10 in Ontario triggered the initiation of the high-risk sprays in treatment 3. While *P. infestans* sporangia were also detected by the Rotorod trap, no sample sporangia count reached the required threshold, 10 per m^3, to trigger the application of high-risk fungicides.

Defoliation rating values were primarily a result of bacterial disease, not late blight, and so are not presented here.

CONCLUSIONS: Late blight did not occur during the experiment, so we were unable to identify if any of the high-risk spray triggers decreased late blight damage. However, treatment initiation triggers of a Rotorod sporangia count of 10 per m^3 most closely aligned with the lack of late blight observed in the trial. This was similar to 2019, when treatment initiation triggers of a Rotorod sporangia count of 10 per m^3 or the identification of late blight symptoms in potato or tomato elsewhere in ON, MI, or OH most closely aligned with lack of late blight in the trial. The BliteCast disease severity values threshold to determine initiation of higher-risk, late blight fungicides was reached on June 21 and 30 in Cedar Springs and Ridgetown, respectively, while the Spornado and Rotorod traps tested positive and initiated high-risk fungicide use on July 14 and July 26 respectively, using the positive/negative thresholds. As several of the high-risk *P. infestans* fungicides are more costly than the low-risk, producers would have begun a more costly management program earlier than required this year using Blitecast, positive detections in the Spornado or Rotorod systems compared to the Rotorod with a 10 sporangia m^3 threshold or the current practice of waiting for reports of symptoms from the Great Lakes Region, which is a similar result as in 2019. However, this is the second year of research and further data is required to best identify appropriate application triggers of high-risk late blight fungicides.

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

Table 1. Low-Risk Fungicide Application Schedule. This program was applied to all treatments except the no fungicide control.

Ridgetown			Cedar Springs		
Product	**Rate / Ha**	**Date**	**Product**	**Rate / Ha**	**Date**
Bravo ZN	2.4 L	Jul 9	Bravo ZN	2.4 L	Jul 15
Quadris	400 mL	Jul 20	Quadris	400 mL	Jul 27
Bravo Zn	2.4 L	Jul 30	Bravo Zn	2.4 L	Aug 6
Aprovia Top	805 mL	Aug 10	Aprovia Top	805 mL	Aug 20
Bravo Zn	2.4 L	Aug 20	Bravo Zn	2.4 L	Sep 1
Bravo Zn	2.4 L	Sep 1			

Table 2. High-Risk Fungicide Application Schedule.

Application Order	Product	Rate / Ha
1st	Orondis Ultra	600 mL
2nd	Torrent + Sylgard 309	150 mL + 4:3 ratio
3rd	Tanos	560 g
4th	Revus + Sylgard 309	500 mL + 0.25%
5th	Torrent + Sylgard 309	150 mL + 4:3 ratio
6th	Tanos	560 g
7th	Orondis Ultra	600 mL
8th	Torrent + Sylgard 309	150 mL + 4:3 ratio
9th	Tanos	560 g

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

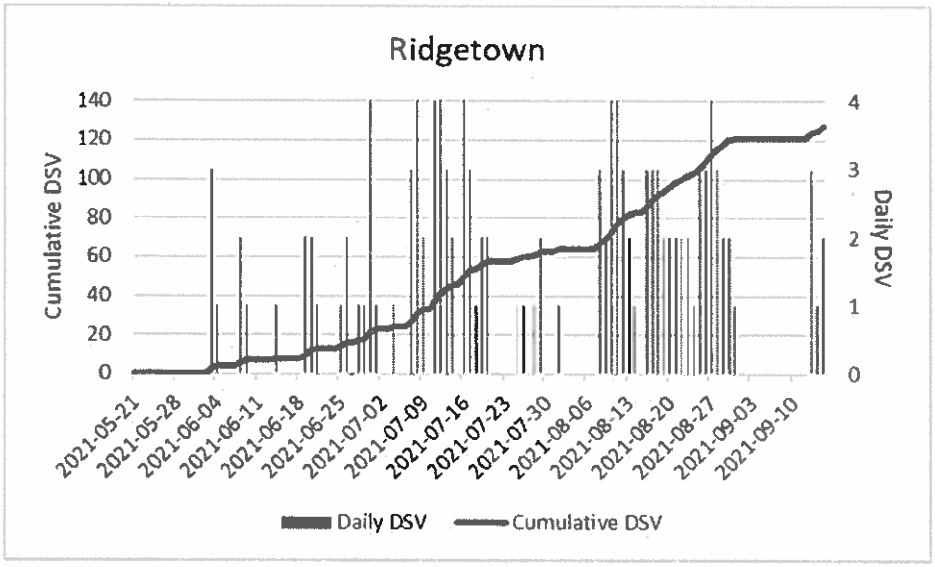
Table 3. Fungicides applied to processing tomato to validate fungicide programs based on *P. infestans* surveillance methods, 2021.

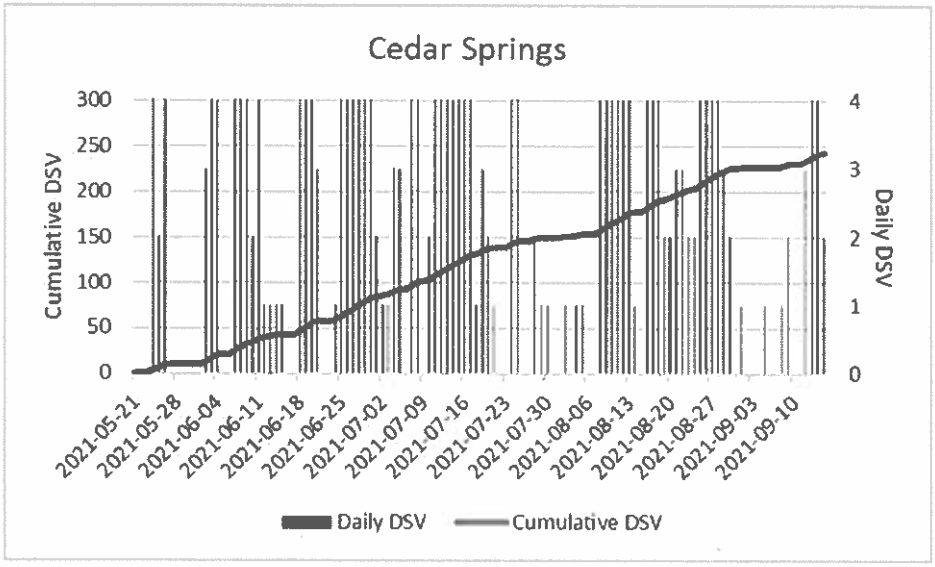
Trt[a]	Trigger	High-Risk Fungicide Application[b]					
		Ridgetown			Cedar Springs		
		Product[c]	Date	# Applications	Product[c]	Date	# Applications
1	Non-treated Control	-	-	0	-	-	0
2	Control	-	-	0	-	-	0
3	Symptoms on potato or tomato in ON, MI, OH	Orondis Ultra Torrent + Sylgard 309 Tanos	Aug 13 Aug 23 Aug 31	3	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309	Aug 13 Aug 23 Aug 31 Sep 10	4
4	Spornado Detection	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra	Jul 15 Jul 26 Aug 3 Aug 11 Aug 19 Aug 27 Sep 3	7	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra	Jul 15 Jul 27 Aug 4 Aug 13 Aug 20 Aug 27 Sep 3	7
5	Rotorod Detection	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 -	Jul 27 Aug 6 Aug 14 Aug 23 Aug 31 -	5	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos	Jul 27 Aug 6 Aug 16 Aug 23 Sep 1 Sep 10	6
6	Rotorod Detection (≥10 sporangia/m^3)	-	-	0	-	-	0
7	BliteCast (18 DSV)	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra Torrent + Sylgard 309 -	Jul 1 Jul 12 Jul 21 Jul 29 Aug 6 Aug 14 Aug 23 Sep 2 -	8	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra Torrent + Sylgard 309 Tanos	Jun 22 Jul 5 Jul 13 Jul 21 Jul 30 Aug 6 Aug 16 Aug 27 Sep 3	9
8	BliteCast (18 DSV) + Spornado Detection	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra	Jul 15 Jul 26 Aug 3 Aug 11 Aug 19 Aug 27 Sep 3	7	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos Orondis Ultra	Jul 15 Jul 27 Aug 4 Aug 13 Aug 20 Aug 27 Sep 3	7
9	BliteCast (18 DSV) + Rotorod Detection	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 -	Jul 27 Aug 6 Aug 14 Aug 23 Aug 31 -	5	Orondis Ultra Torrent + Sylgard 309 Tanos Revus + Sylgard 309 Torrent + Sylgard 309 Tanos	Jul 27 Aug 6 Aug 16 Aug 23 Sep 1 Sep 10	6
10	BliteCast (18 DSV) + Rotorod Detection (≥10 sporangia/m^3)	-	-	0	-	-	0

[a] The trigger, initiating the start of high risk fungicide applications, for treatments 6 and 10 was not reached during trial evaluation dates. [b] All treatments except the nontreated control received the low-risk fungicide spray program (see Table 1). [c] See Table 2 for product rates.

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

APPENDIX A: BliteCast DSV accumulation at Ridgetown Campus and Cedar Spring Research Farm in 2021. A threshold of DSV 18 was used to initiate a high-risk program for late blight.





2021 Research Report

Fungicides for management of early blight, Septoria leaf spot, and anthracnose in processing tomatoes

Prepared for the Ontario Tomato Research Committee (OTRI)
November 1, 2021

Research Agency/Location: University of Guelph, Ridgetown Campus

Lead & Key Investigators:
- Cheryl Trueman, Ph.D., Assistant Prof, Dept of Plant Ag, Ridgetown Campus – Univ. of Guelph
- Kevin Dufton, Research Technician

Executive Summary:
- The objective of this research was to evaluate the efficacy of new and recently registered fungicides for management of early blight, Septoria leaf spot, and anthracnose.
- Both early blight and Septoria leaf spot were present; disease established well. Total disease over the season (AUDPC) was lower in all fungicide treated plots than the nontreated control except Cueva and Phostrol. The lowest AUDPC was achieved using Aprovia Top, but this was equivalent to both rates of Bravo ZN, Maestro, Quadris, Sercadis, Miravis Duo, Luna Privilege, Phostrol + Bravo ZN, and Cevya.
- Anthracnose incidence was moderate but variable, and few treatment differences were observed. Anthracnose severity calculated using the number of lesions on each fruit, was lower in Quadris than the nontreated control. There was also high variability in yield measurements, resulting in no significant increases in yield in fungicide-treated plots compared to the nontreated control.
- Both the low and the high rate of Bravo ZN limited defoliation to a similar extent. This is an important observation since the high rate represents the middle rate under the previous label for chlorothalonil, while the low rate is the rate approved for seven applications under the new chlorothalonil label in Canada. This is the second year we have observed this effect (2019 & 2021).
- Results are used to update fungicide efficacy tables which are then posted to ONvegetables.com in late winter each year. We now have three or more years of data under moderate to high disease pressure for early blight and anthracnose on the following fungicides: Bravo (high rate), Cueva, Quadris, Tanos, Sercadis, Fontelis, Aprovia Top, Phostrol, Phostrol + Bravo ZN. Some of these can be removed from future efficacy trials to make space for different products and/or reduce trial size, while some should stay as current or previous standards (ie. Quadris, Bravo (high rate)).

Funding:
- Ontario Tomato Research Institute, Ontario Agri-Food Innovation Alliance, Belchim Crop Protection Canada. We thank Heinz Seed for seed donation and crop protection companies for in-kind product donations.

TITLE: Fungicides for management of early blight, Septoria leaf spot, and anthracnose in processing tomatoes

OBJECTIVE:

PEST(S): early blight (*Alternaria solani*), anthracnose (*Colletotrichum coccodes*), Septoria leaf spot (*Septoria lycopersici*)

MATERIALS: Bravo ZN (chlorothalonil 500g L^{-1}), Quadris Flowable (azoxystrobin 250 g L^{-1}), Fontelis (penthiopyrad 200 g L^{-1}), Aprovia TOP (benzovindiflupyr ('Solatenol') 100 g L^{-1}, difenoconazole 117 g L^{-1}), Sercadis (fluxapyroxad ('Xemium'), 26.55%), Miravis Duo (pydiflumetofen ('Adepidyn') 75 g L^{-1}, difenoconazole 125 g L^{-1}), Cueva (copper octanoate 1.8%), Tanos (famoxadone 25%, cymoxanil 25%), Phostrol (mono- and di-potassium salts of phosphorous acid 53.6%), Luna Privilege (fluopyram 500 g L^{-1}), and Cevya (mefentrifluconazole 98.5%), Maestro (captan 80%), Sercadis (fluxapyroxad 300 g L^{-1}), Diplomat (polyoxin D zinc salt 5%)

METHODS: The trial was completed at Ridgetown Campus, University of Guelph. Tomato transplants cv. H9706 were transplanted into twin rows on May 25 using a mechanical transplanter at a rate of 3 plants per metre. Each twin row was spaced 2 m apart. Each treatment plot was 7m long and consisted of one twin row. The trial was setup as a randomized complete block design, with 4 replications per treatment. Applications were made using a hand-held CO_2 sprayer with nozzles ULD 120-03, and a water volume of 300 L Ha^{-1}.

The trial was inoculated with plants exhibiting symptoms of early blight and Septoria leaf spot after the first fungicide application on June 28. This was done by removing and replacing one healthy seedling at the front and back of each plot with a tomato seedling previously inoculated with *A. solani* or *S. lycopersici*, respectively. The seedlings were inoculated 2-3 weeks before transplanting. Overhead irrigation was applied every night for approximately 15 minutes, on days when no natural precipitation occurred. This continued until Jul 22, when disease symptoms consistent with early blight and Septoria leaf spot were observed in control plots.

Whole plot defoliation was estimated Jul 30, Aug 19, 26, and Sept 2 using an incremental 5% scale (i.e. 0, 5, 10, etc.). These values were used to calculate the area under the disease progress stairs (AUDPS) using the following equation: AUDPC + $[(Y_1 + Y_n)/2 \times (D/n-1)]$, where Y_1 is the disease level at first assessment, Y_n is the disease level at last assessment, D is the difference in the number of days from the last assessment to the first assessment, n is the number of assessments, and AUDPC = $\sum [((Y_i + Y_{i-1}) (X_i - X_{i-1}))/2]$. For AUDPC, Y_i is number of infected leaves at day X_i and Y_{i-1} is number of infected leaves at day X_{i-1}.

Tomatoes were harvested from a 1 m section of each plot on Sept 10; red fruit, green fruit, and rots were separated and weighed. Fifty randomly selected red fruit were assessed for anthracnose after three days in storage by sorting into the following classes: 0 = no lesions, 1 = one lesion, 2 = two to three lesions, 3 = four or more lesions. A disease severity index (DSI) was calculated using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of fruit in each class})]}{(\text{total no. fruit per sample})(\text{no. classes} - 1)} \times 100$$

Statistical analysis was conducted using ARM 2019 (Gylling Data Management, Brookings, SD). Data were tested for normality using Levene's test. Analysis of variance was conducted using Tukey's HSD and mean comparisons were performed when $P \leq 0.05$.

RESULTS & CONCLUSIONS: Foliar disease pressure from early blight and Septoria leaf blight was high, with obvious visual differences between plots appearing by mid-August and 80% defoliation in control plots by early September. On the final assessment date on Sep 2, defoliation was lower in all fungicide treated plots except Cueva, Phostrol, and Phostrol + Cueva + Diplomat than the nontreated control (Table 1). The lowest level of defoliation on Sept 2 was observed with both rates of Bravo ZN, Quadris, Sercadis, Aprovia Top, Miravis Duo, Phostrol + Bravo ZN, and Cevya; these treatments had less defoliation than Cueva, Tanos, Phostrol, Phostrol + Cueva, and Phostrol + Cueva + Diplomat, but were equivalent to Maestro, Fontelis, and Luna Privilege. Total disease over the season (AUDPC) was lower in all fungicide treated plots than the nontreated control except Cueva and Phostrol. The lowest AUDPC was achieved using Aprovia Top, but this was equivalent to both rates of Bravo ZN, Maestro, Quadris, Sercadis, Miravis Duo, Luna Privilege, Phostrol + Bravo ZN, and Cevya.

Anthracnose incidence in the nontreated control was moderate (17%) but variable (Table 2). None of the fungicide treatments had significantly lower incidence of anthracnose than the nontreated control, although some treatments had, on average, ≤6% infection, including both rates of Bravo ZN, Quadris, Sercadis, Phostrol + Bravo ZN, and Cevya. Anthracnose severity in tomatoes treated with Quadris was the only treatment to have lower severity than the nontreated control.

Tomato yield was high, but variable, and none of the treatments had higher yield than the nontreated control.

Table 1. Percent defoliation and area under the disease progress curve (AUDPC) in tomatoes inoculated with *A. solani* (early blight) and *S. lycopersici* (Septoria leaf spot) and treated with different fungicides, Ridgetown, ON, 2021.

Treatment (per Ha) [a]	Defoliation (%) [b]				
	Jul 30	Aug 19	Aug 26	Sept 2	AUDPC
Nontreated control	9 a	31 a	73 a	80 a	1297 a
Bravo ZN @ 3.2 L	3 bc	2 d	6 fg	3 e	112 fg
Bravo ZN @ 2.4 L	3 bc	2 d	8 fg	3 e	120 fg
Maestro @ 4.25 kg	5 abc	6 cd	28 cdef	21 de	401 defg
Cueva @ 1% v/v	8 ab	20 b	59 ab	66 abc	988 ab
Quadris @ 400 mL	1 c	2 d	5 fg	2 e	79 fg
Tanos @ 560 g	5 abc	13 bc	33 cde	43 cd	595 cde
Sercadis @ 250 mL	1 c	2 d	9 fg	5 e	116 fg
Fontelis @ 1.5 L	4 abc	11 bcd	23 defg	21 de	426 def
Aprovia TOP @ 805 mL	2 c	1 d	2 g	3 e	58 g
Miravis Duo @ 1 L	2 c	2 d	8 fg	7 e	122 fg
Luna Privilege @ 225 mL	2 c	4 cd	19 efg	24 de	288 efg
Phostrol @ 5.6 L	8 ab	20 b	63 ab	73 ab	1036 ab
Phostrol @ 5.6 L + Bravo ZN @ 2.4 L	2 c	1 d	8 fg	3 e	97 fg
Cevya @ 190 mL	1 c	1 d	5 fg	4 e	74 fg
Phostrol @ 5.6 L + Cueva @ 1% v/v	5 abc	14 bc	43 bcd	48 bcd	699 bcd
Phostrol @ 5.6 L + Cueva @ 1% v/v + Diplomat @ 500 mL	5 abc	18 b	48 bc	61 abc	833 bc

[a] Treatments were applied on A = Jun 24, B = Jul 5, C = Jul 15, D = Jul 26, E = Aug 5, F = Aug 17, G = Aug 27.

[b] Numbers in a column followed by the same letter are not significantly different at $P \leq 0.05$. Tukey's HSD.

Table 2. Anthracnose incidence and severity on tomatoes inoculated with *A. solani* (early blight) and *S. lycopersici* (Septoria leaf spot) and treated with different fungicides, Ridgetown, ON, 2021.

Treatment (per Ha) [a]	Anthracnose	
	Severity (DSI)	Incidence (%)
Nontreated control	10 ab	17 abc
Bravo ZN @ 3.2 L	2 bc	5 bc
Bravo ZN @ 2.4 L	2 bc	6 bc
Maestro @ 4.25 kg	5 bc	10 abc
Cueva @ 1% v/v	14 a	23 a
Quadris @ 400 mL	1 c	3 c
Tanos @ 560 g	4 bc	8 bc
Sercadis @ 250 mL	3 bc	6 bc
Fontelis @ 1.5 L	5 bc	13 abc
Aprovia TOP @ 805 mL	4 bc	8 bc
Miravis Duo @ 1 L	7 abc	14 abc
Luna Privilege @ 225 mL	6 bc	10 abc
Phostrol @ 5.6 L	10 abc	18 ab
Phostrol @ 5.6 L + Bravo ZN @ 2.4 L	3 bc	6 bc
Cevya @ 190 mL	2 bc	5 bc
Phostrol @ 5.6 L + Cueva @ 1% v/v	5 bc	10 abc
Phostrol @ 5.6 L + Cueva @ 1% v/v + Diplomat @ 500 mL	6 abc	23 abc

[a] Treatments were applied on A = Jun 24, B = Jul 5, C = Jul 15, D = Jul 26, E = Aug 5, F = Aug 17, G = Aug 27.

[b] Numbers in a column followed by the same letter are not significantly different at $P \leq 0.05$. Tukey's HSD.

Table 3. Yield of tomatoes inoculated with *A. solani* (early blight) and *S. lycopersici* (Septoria leaf spot) and treated with different fungicides, Ridgetown, ON, 2021.

Treatment (per Ha) [a]	Yield (tons/acre)			
	Reds	Greens [c]	Rots [c]	Total
Nontreated control	44.0	2.2 ab	2.2	48.3
Bravo ZN @ 3.2 L	50.0	6.6 a	2.2	58.7
Bravo ZN @ 2.4 L	51.7	6.0 ab	1.6	59.2
Maestro @ 4.25 kg	49.9	3.9 ab	1.6	55.5
Cueva @ 1% v/v	41.7	1.6 b	1.6	44.8
Quadris @ 400 mL	52.7	5.8 ab	0.6	59.2
Tanos @ 560 g	47.0	3.2 ab	1.5	51.7
Sercadis @ 250 mL	50.2	3.4 ab	1.4	55.0
Fontelis @ 1.5 L	40.0	2.7 ab	0.9	43.6
Aprovia TOP @ 805 mL	49.7	5.1 ab	0.9	55.7
Miravis Duo @ 1 L	45.2	4.0 ab	1.5	50.7
Luna Privilege @ 225 mL	50.0	3.8 ab	1.1	54.9
Phostrol @ 5.6 L	46.9	1.4 b	2.0	50.2
Phostrol @ 5.6 L + Bravo ZN @ 2.4 L	41.4	4.4 ab	1.7	47.5
Cevya @ 190 mL	47.5	4.1 ab	0.8	52.3
Phostrol @ 5.6 L + Cueva @ 1% v/v	45.9	2.2 ab	1.6	49.6
Phostrol @ 5.6 L + Cueva @ 1% v/v + Diplomat @ 500 mL	42.6	2.4 ab	1.1	46.1

[a] Treatments were applied on A = Jun 24, B = Jul 5, C = Jul 15, D = Jul 26, E = Aug 5, F = Aug 17, G = Aug 27.

[b] Numbers in a column followed by the same letter are not significantly different at $P \leq 0.05$, Tukey's HSD.