2023 CUCUMBER RESEARCH			
	PROJECT	**RESEARCHER**	**$ AMOUNT FUNDED**
1	Cucumber downy mildew monitoring program, 2023	Tomecek Agronomy	$4,350.50 incl. HST
2	Processing Cucumber Variety Evaluation	R. Van Acker	$25,000
3	Efficacy of Fungicides for Downy Mildew Control in Processing Cucumbers	R. Van Acker	$7,500
4	Weed Control Evaluations in Processing Cucumbers	D. Robinson	$4,000
5	Evaluation of Downy Mildew (*Pseudoperonospora cubensis*) efficacy and crop tolerance of experimental fungicide rotations in Ontario produced pickling cucumbers	Sandy Knolls Research Inc.	$13,154.71
6	Cucumber Breeding	S. Loewen	$20,930
	Additional item:		
	Norfolk Scouting – Downy Mildew	Norfolk Fruit	$3,700 plus HST
	PPI Ag Research		$2,500

Tomecek Agronomy Services Inc.

November 15, 2023

To: Ontario Cucumber Research Committee (OCRC),

Re: Cucumber Downy Mildew Monitoring Program 2023 Final Report

Tomecek Agronomy monitored five hand-harvest cucumber fields within Chatham-Kent this season for the presence of Downy Mildew. Scouting began the week of June 12th – 18th. The five fields selected were located in Wallaceburg, Port Lambton, Dresden, Chatham, and Blenheim.

Scouting continued for a total of 6 weeks, ending the week of July 17th – 23rd. Fields were walked in a "W" pattern, with special attention being given to low-lying areas and field edges near windbreaks or woodlots that have longer leaf wetness periods, where Downy Mildew is likely to initially be found. The scout stopped at 20 locations per field at each visit and randomly inspected 10 leaves at each location. The scout was primarily looking for Downy Mildew symptoms but would also report any other in-field issues identified to the grower.

8613 Eberts Line, Chatham, ON N7M 5J2 | Joe: (519) 365-2006 | Ed: (519) 365-1896

The presence of Downy Mildew was detected in three of the five fields by our scout in the 4th week of the project (specifically between July 4th and July 7th). In all affected fields, DM was only spotted at 3 or fewer sites and the severity was low (less than 5% leaf area covered by lesions). It was confirmed by both Joe Tomecek and Elaine Roddy (OMAFRA) on July 4th, upon which the grower, Ontario Cucumber Research Committee, OPVG and OMAFRA Extension were all notified immediately. By the 5th week, we had found it in all 5 fields.

Thank you for allowing us to be part of this project. We would certainly be interested in participating again next year, and will submit a proposal for your consideration for the 2024 growing season.

Kind regards,

Joe Tomecek, CCA, 4RNMS

Tomecek Agronomy Services Inc.

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RESEARCH REPORT 2023

Project Title: Processing Cucumber Variety Evaluation

Prepared for: Ontario Processing Vegetable Growers,
Ontario Cucumber Research Committee

Research Location: Ontario Crops Research Centre - Simcoe
Department of Plant Agriculture, University of Guelph
1283 Blueline Rd, Simcoe, ON

Research Team: Principal Investigator: Rene Van Acker
Research Technician(s): Rachel Riddle and Lisa Weber

Objective: The objectives of these studies were to evaluate new cucumber varieties for yield performance, quality, adaptability and acceptability to North American processors for handpick and machine harvest applications. New superior yielding cucumber varieties are required to ensure that the industry can compete effectively. New varieties are being introduced by seed companies each year, therefore, variety evaluation is essential in order to recommend the best varieties to the industry. In particular, varieties that have local adaptability and market acceptance, together with higher yields, improved fresh quality, improved brining quality and better disease tolerance are needed.

Methodology: Three cucumber variety trials were conducted at the Ontario Crops Research Centre located in Simcoe, Ontario, in 2023: (1) Parthenocarpic Hand Harvest (multi-pick), (2) Conventional Machine Harvest (simulated once-over harvest) and (3) Parthenocarpic Machine Harvest (simulated once-over harvest).

Processing cucumber varieties were evaluated to compare how they perform under the same environmental conditions. Trials were set up as a randomized complete block design with three replications for the hand harvest trial and four replications for machine harvest trials. Commercial and experimental varieties were evaluated in all trials. Experimental varieties are not included in this report.

Hand Harvest Trials
The parthenocarpic multi-pick variety trial included 10 commercial varieties for evaluation. The trial was seeded on May 31 using a standard cone seeder mounted on a John Deere planter. The plot size of the trials was 1.5 m (5 ft.) x 6 m (20 ft.). Plants were thinned to 15 cm (6") in row, giving a target plant population of 18,000 plants/acre. Cucumber plots were harvested two times per week, for 10 harvests from July 17 to August 18.

Machine Harvest Trials
The conventional and parthenocarpic machine harvest trials both included 7 commercial varieties for evaluation. Trials were seeded on June 27 and June 13 for the conventional and parth machine harvest trials, respectively, using a standard cone seeder. The plot size for these trials were 0.75 m (2.5 ft.) x 6 m (20 ft.). Plants were thinned to 10 cm (4") and 20 cm (8") for the conventional and parth trials, respectively, giving a plant population of 55,000 and 28,000 plants/acre. Cucumber plots were harvested as a simulated once-over destructive pick, where plants were pulled by hand, and all cucumbers harvested into bushels down to a 1A/B size. Varieties were harvested to target correct maturity and thus harvest date is dependent on the variety. For the conventional machine trial, the harvest day for varieties in this report was August 10 (44 DTH). For the parth machine trial, the harvest days were July 31 (48 DTH) and August 2 (50 DTH).

For all trials, the crop was grown according to accepted commercial practices used in Ontario. Yields were measured at harvest as fruit weights (ton/acre), graded out by size and dollar value per acre (Tables 1-3). Data was taken on fruit length to diameter ratios (LD) on a weekly basis for hand harvest and once for machine harvest. Evaluations on fresh internal quality and bitterness were taken after grading. Selected varieties from all trials were brined at Simcoe for evaluation by the industry October 24. LD, fresh internal, bitterness and brine data is not shown in this report, however is available by request.

Results:

Yields shown are for each graded size and a total yield which includes grades #1 to #4 for hand harvest, and grades #1 to oversize (OS) for machine harvest, (including nubs and crooks) in ton/acre, US $/acre and a percent breakout by graded size. Please note that yields are for comparative purposes only. Small plots yields may not accurately reflect commercial yields.

Parthenocarpic Hand Harvest (multi-pick): Speed, Amarok, Liszt and Lennon were the highest yielding varieties with approximately US $14,600, $13,900 and $13,800 (Liszt, Lennon) and 23, 24, and 26 (Liszt, Lennon), respectively. Most varieties were in the US $12,000 to $11,000 and 23 tons per acre range (Table 1).

Conventional Machine Harvest: Chaperon and Expedition were the highest yielding varieties with approximately yield of US $2,700 and $2,400 and 12.5 and 10.9 tons/acre, respectively. Most varieties were in the US $2,300 to $1,800 and 10 to 11 tons per acre range (Table 2).

Parthenocarpic Machine Harvest: Henley, Springsteen and V 5025 were the highest yielding varieties with approximately US $6,000, $5,700 and $5,000 per acre and 24, 20, and 18 tons/acre, respectively. Most varieties were in the US $4,000 to $3,000 per acre range (Table 3).

Table 1: Yield of cucumbers harvested from the parthenocarpic hand harvest (multi-pick) variety trial, Simcoe, ON, 2023.

Variety	Source	Total Yield 1-4, NC T/ac	Total Yield 1-4, NC $/ac	Fruit/ Plant	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
Speed	Nunhems	23.1 a	14,555 a	40	4	39	34	16	6	2	0	0
Amarok	Bejo	23.9 a	13,879 a	33	3	31	35	19	7	4	1	0
Liszt	Rijk Zwaan	25.9 a	13,814 a	33	2	25	33	25	11	4	1	0
Lennon	Rijk Zwaan	25.6 a	13,803 a	44	4	27	30	25	10	2	1	0
Aristan	Bejo	19.9 a	12,778 a	33	3	40	33	18	4	2	0	0
Merengue	Seminis	23.5 a	12,478 a	32	6	26	32	24	8	4	0	0
Rubinstein	Rijk Zwaan	22.7 a	12,435 a	29	7	29	33	21	7	3	0	0
Absolut	Bejo	23.1 a	11,906 a	27	5	24	31	26	9	4	1	0
Puccini	Rijk Zwaan	19.8 a	11,178 a	35	5	31	31	23	7	3	1	1
Abbey	Bejo	18.8 a	9,484 a	39	6	23	32	22	10	5	1	0

Soil Type	: Very fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 7.2; 1.5		: 70 lbs/ac of P
Planting Date	: May 31		: 100 lbs/ac of K
Row Spacing	: 5ft.	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 6"	Harvest Dates	: July 17 - August 18 (10 total)

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

* Yields are for comparative purposes only. Small plot yields may not accurately reflect commercial yields.

Table 2: Yield of cucumbers harvested from the conventional machine harvest (simulated once-over harvest) variety trial, Simcoe, ON, 2023.

Variety	Source	Total Yield 1-OS, NC T/ac	Total Yield 1-OS, NC $/ac	Fruit/ Plant	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
Chaperon	Seminis	12.5 a	2,664 a	2.1	5	2	2	14	28	27	2	19
Expedition	Seminis	10.9 a	2,443 a	1.9	4	3	6	18	20	30	7	12
Stronghold	Seminis	9.3 a	2,333 a	1.9	4	4	5	23	29	24	10	0
Gatehouse	Seminis	10.8 a	2,043 a	1.8	4	1	6	15	16	24	6	28
Journey	Seminis	11.8 a	1,941 a	1.9	4	3	4	8	21	19	11	31
Peacemaker	Seminis	9.7 a	1,858 a	1.6	3	1	3	17	15	24	18	18
Vlaspik	Seminis	8.0 a	1,470 a	1.6	3	5	3	9	18	29	16	18

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.3; 1.1		: 70 lbs/ac of P
Planting Date	: June 27		: 100 lbs/ac of K
Row Spacing	: 30"	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 4"	Harvest Date	: August 10 (44 DTH)

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

* Yields are for comparative purposes only. Small plot yields may not accurately reflect commercial yields.

Table 3: Yield of cucumbers harvested from the parthenocarpic machine harvest (simulated once-over harvest) variety trial, Simcoe, ON, 2023.

Variety	Source	Total Yield 1-OS, NC T/ac	Total Yield 1-OS, NC $/ac	Fruit/ Plant	Days to Harvest	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
Henley	Rijk Zwaan	24.0 a	5,995 a	5.2	48	3	1	3	6	28	48	7	4
Springsteen	Rijk Zwaan	20.1 ab	5,700 a	5.1	50	1	1	6	13	38	40	1	0
V 5025	Nunhems	18.0 bc	4,988 ab	5.4	48	1	1	4	16	46	27	4	0
Lennon	Rijk Zwaan	16.5 bc	4,237 bc	3.6	48	1	1	3	7	23	54	9	2
Liszt	Rijk Zwaan	13.5 cd	3,203 cd	3.3	48	0	0	3	12	21	44	9	11
Bowie	Rijk Zwaan	10.6 d	3,051 cd	4.3	50	2	4	14	39	29	12	0	0
Gershwin	Rijk Zwaan	10.3 d	2,897 d	5.0	50	4	2	13	38	30	10	3	0

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.9; 1.7		: 70 lbs/ac of P
Planting Date	: June 13		: 100 lbs/ac of K
Row Spacing	: 30"	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 8"	Harvest Dates	: Jul 31 (48 DTH), Aug 2 (50 DTH)

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

* Yields are for comparative purposes only. Small plot yields may not accurately reflect commercial yields.

RESEARCH REPORT 2023

Project Title: Efficacy of Fungicides for Downy Mildew Control in Processing Cucumbers

Prepared for: Ontario Processing Vegetable Growers,
Ontario Cucumber Research Committee

Research Location: Ontario Crops Research Centre – Simcoe
Department of Plant Agriculture, University of Guelph
1283 Blueline Rd., Simcoe, ON

Research Team: Principal Investigator: Rene Van Acker
Research Technician(s): Rachel Riddle and Lisa Weber

Objective: Cucurbit downy mildew (CDM), an aggressive plant pathogen (*Pseudoperonospora cubensis)*, can develop at any time during the cucumber season and have devastating consequences for cucumber growers. It is a very destructive disease and progresses rapidly under favorable weather conditions. In 2006, downy mildew appeared early in Ontario causing extensive crop defoliation and yield losses. The severity of the disease resulted in some growers only meeting about 70% of the contracted tonnage. From 2007 to 2009, with the availability of more fungicides through emergency registrations, the severity of the disease was reduced, and crop yields were maintained. Disease pressure in Ontario varies from year to year, depending on when it first appears in the field. The last couple of years CDM has been detected mid-July. In 2023, the disease was first detected in Norfolk County on July 5, which is a week earlier than detection in 2022. It was first observed in cucumber trials at the research centre in Simcoe on July 31. A few days after first detection, the disease in the trial had increased significantly.

Over the past few years, we have seen disease resistance to some fungicides that were effective in the past in controlling downy mildew in cucumbers. Testing of current registered products is necessary for making informed recommendations on spray programs that will continue to be effective in controlling downy mildew. Evaluating new products is important for the registration of new effective fungicides to control downy mildew, which is a great benefit to the Ontario processing cucumber industry. In addition, the cucumber processing industry in North America is shifting to planting more parthenocarpic-type varieties. Current research on fungicide efficacy should be on the varieties being grown and processed, thus two parth varieties were used in the trial in 2023. These two varieties differ in their tolerance to CDM, with Bowie being more tolerant than Liszt.

Methodology: A fungicide efficacy trial was conducted at Ontario Crops Research Center – Simcoe, in 2023. Two cucumber varieties, 'Liszt' and 'Bowie', were seeded using a precision seeder on July 3 in rows 30 inches apart with in-row plant spacing of 4" to give a plant population of 55,000 plants/per acre. Please note that this was at a higher plant population that is typical of parth machine harvest cucumbers. The crops were grown according to accepted commercial practices used in Ontario. The trial was set up as a randomized complete block design with a split-plot arrangement and three replications with fungicide treatment as main plot and variety as subplot. Treatments were applied using a hand-held CO_2 backpack sprayer with air induction, low drift (Al TeeJet 110015-VS) nozzles at a pressure of 40 psi and water volume of 200 L/ha. Eleven treatments were evaluated, including an untreated control. Treatments were applied to plots on July 25, August 2 and 9.

Downy mildew visual ratings were made at weekly intervals starting on July 24. Mature fruit were harvested by hand on August 21, targeting a crop that was at approximately 10% grade 4 (2" in diameter). Yields were measured as graded fruit numbers and weights. Plot yields were converted to tons/acre and US $/acre for reporting purposes.

Results: In 2023, downy mildew infection was greater than 2022. The disease was detected in significant amounts (>5%) in untreated trial plots on July 31 which was prior to flowering. By August 9, significant amounts of disease was observed in all plots. A week later, disease had slowed down, due to less favourable weather conditions, allowing the cucumber plants to grow new healthy vines. The last disease assessments just prior to harvest showed slight improvements in disease control for this reason. Despite this, by the time the crop was ready for harvest on August 21, infection in untreated plants was 63% and 83% for the cucumber varieties Bowie and Liszt, respectively. Orondis Ultra and product A24367 (B) provided the best control of the disease with 27% and 28% leaf infection for Bowie and 50 and 47% leaf infection for Liszt, respectively. Intermediate disease control was observed from plants treated with Torrent and Zampro for Bowie. However, with Liszt, all other treatments had more than 63% leaf infection, up to 83% with the poorest treatment (Tables 1 & 2).

When comparing the level of disease between the two varieties, 'Bowie' and 'Liszt' it was observed that Bowie had less disease infection in all treatments. This difference in disease infection was in a range of 5 to 40% less disease with Bowie when compared to Liszt.

Final harvest yields were significantly reduced for most treatments with high downy mildew infection when compared to the best treatments of Orondis Ultra and A24367 (B) for both varieties of Liszt and Bowie (Tables 1 & 2). These results show that Orondis Ultra is still effective at controlling downy mildew to levels that do not have an economic impact on the final yield of cucumbers even under high disease pressure. Torrent and Zampro provided intermediate control suggesting that if used in a program with Orondis, these products remain the best downy mildew control option. Tattoo C also provided comparable control to Zampro.

Overall, Liszt had higher yields than Bowie when comparing all fungicide treatments, however Liszt is an earlier-maturing variety than Bowie. Thus if Bowie had been harvested several days later, allowing more time for the cucumbers to reach a more appropriate size, the yields would have been more comparable.

Table 1: Incidence of cucumber leaves with downy mildew symptoms and yield of cucumbers, variety 'Liszt', harvested from plots sprayed with different fungicides, Simcoe, ON, 2023.

Product**	Rate per Hectare	% Downy Mildew Infection* Aug 1	Aug 9	Aug 16	Yield T/acre	$/acre
Bravo ZN	4.8 L	35	73	77	1.8 e-i	425 efg
Torrent + Sylgard	200 mL 0.1 % v/v	12	63	63	8.4 bc	2,439 bc
Zampro + Sylgard	1 L 0.1 % v/v	40	65	63	4.8 c-f	1,327 c-f
Orondis Ultra	600 mL	2	67	47	18.6 a	5,387 a
A24367 (B)	1.31 L	1	43	50	20.0 a	5,926 a
Tattoo C	2.70 L	15	67	72	5.5 cde	1,527 b-e
Allegro	1.75 L	23	73	77	4.2 d-g	1,114 d-g
Torrent, alt Diplomat + Phostrol	200 mL 0.46; 2.9 L	8	78	83	4.2 d-h	957 d-g
Cueva	2.80 % v/v	23	80	80	0.6 ghi	88 g
Cueva + Phostrol	2.8%; 2.9 L	27	73	73	3.0 e-i	688 d-g
Untreated Control		32	767	83	1.7 e-i	356 fg

Planting Date : July 5 — Date of First Application : July 25
Plant Population : 55,000 plants/Ac — Harvest Date : August 21

* Based on % leaves infected

** First application was applied at the 3-4-leaf stage, subsequent applications were made on a 7-day spray interval, 3 applications total.

Means followed by the same letter do not signficantly differ (P=0.05, Tukey's HSD)

Table 2: Incidence of cucumber leaves with downy mildew symptoms and yield of cucumbers, variety 'Bowie', harvested from plots sprayed with different fungicides, Simcoe, ON, 2023.

Product**	Rate per Hectare	% Downy Mildew Infection* Aug 1	Aug 9	Aug 16	Yield T/acre	$/acre
Bravo ZN	4.8 L	8	60	60	0.9 efg	131 ef
Torrent + Sylgard	200 mL 0.1 % v/v	1	37	40	3.9 c-h	673 c-f
Zampro + Sylgard	1 L 0.1 % v/v	12	50	40	2.9 d-h	496 def
Orondis Ultra	600 mL	0	33	28	7.4 abc	1,796 abc
A24367 (B)	1.31 L	0	30	27	10.1 a	2,701 a
Tattoo C	2.70 L	5	53	50	3.5 c-h	791 c-f
Allegro	1.75 L	5	73	73	1.9 d-h	293 ef
Torrent, alt Diplomat + Phostrol	200 mL 0.46; 2.9 L	1	63	57	2.3 d-h	300 ef
Cueva	2.80 % v/v	7	67	67	0.1 h	1 f
Cueva + Phostrol	2.8%; 2.9 L	7	70	63	1.3 e-h	113 f
Untreated Control		13	67	63	0.6 ghi	69 f

Planting Date : July 5 — Date of First Application : July 25
Plant Population : 55,000 plants/Ac — Harvest Date : August 21

* Based on % leaves infected

** First application was applied at the 3-4-leaf stage, subsequent applications were made on a 7-day spray interval, 3 applications total.

Means followed by the same letter do not signficantly differ (P=0.05, Tukey's HSD)

Report Submission
for the
Ontario Processing Vegetable Growers (OPVG)
on behalf of
Sandy Knolls Research Inc.

Sponsor: Ontario Processing Vegetable Growers
Research Conduction: Sandy Knolls Research Inc. located in Vienna, Ontario
Lead Principal Investigator: Mike Vereecken, BSc., Research Specialist
Alternate Principal Investigator: Christine Dervaric, MSc., Research Technician

Submission Date:
Monday, November 13, 2023

Title:

Evaluation of Downy Mildew (*Pseudoperonospora cubensis*) efficacy and crop tolerance of experimental fungicide rotations in Ontario produced pickling cucumbers.

Objectives:

1. Verify suitable crop tolerance with a lack of phytotoxicity within fungicide rotation.
2. Determine level of Downy Mildew control by assessing pathogen incidence and severity.
3. Quantify efficacy by determining impacts on marketable yields.
4. Compare input costs relative to crop tolerance and efficacy of treatments.

Products:

Allegro (Fluazinam 500 g/L) SC
Orondis Ultra (Mandipropamid and Oxathiapiprolin 280 g/L) SC
Torrent (Cyazofamid 400 g/L) SC
Zampro (Ametoctradin and Dimethomorph 525 g/L) SC
Activate Plus (Alcohol Ethoxylate and Alkyl Phenol Ethoxyate 90%) NIS

Establishment:

The trial was conducted on site of Sandy Knolls Research located at 56992 Tunnel Line, Vienna, Ontario in a pocket of loamy sand that is conducive to the proper agronomic production of pickling cucumbers. The trial area was conventionally tilled by a series of disc and cultivation passes prior to planting in order to incorporate broadcasted nutrients as well as to prepare an adequate seed bed. The fertilizer program was selected in accordance with proper production of pickling cucumber crops based on the soil analysis that the trial was placed. The trial was maintained throughout the season to proper fertility, moisture, and pest standards while implementing a fungicide free spray program outside of trial treatments. The cucumber crop was planted approximately 0.75" (1.90 cm) deep on 40" (1.01 m) row spacing at a rate of 19,605 seeds/acre using Platina cultivar and a vacuum planter on June 23, 2023. The trial was staked with 5 treatment plots, 3.0m wide and 6.5m long replicated 4 times in a randomized complete block design, excluding the first replication as non-randomized. The crop emerged 5 days after planting with a uniform stand on June 28, 2023.

Application:

Foliar applications occurred throughout the growing season beginning 7 days after crop emergence on July 5, 2023 at the crop's first true leaf stage. The initial application was made pre-infection of the disease and subsequent applications made on 6–8-day re-treatment intervals based on suitable weather conditions. Treatment applications were made using a 1m hand held spray boom equipped with 2 Turbo TeeJet 11004 nozzles spaced 20" (50 cm) a part and held 20" (50 cm) above the crop canopy to facilitate uniform spray coverage. The spray boom was powered using compressed carbon dioxide gas regulated at 34 PSI in order to properly displace the spray solution at 400 L/ha. Prior to the first treatment's application a set of calibrations were performed with water to verify that each nozzle was discharging the same volume and to verify accurate ground speed. Experimental products were measured using a graduated syringe at the trial location and then added to a pre-measured volume of water carrier, agitated, and inserted into the spraying apparatus for immediate application. A water rinse was circulated through the spraying apparatus between treatments of new products or lower concentration of products. The rinse was rendered insignificant if subsequent treatments were identical tank mixes with the addition of a new product or with increasing tank mix concentrations. Treatments were applied to the centre row only (Row #2) in each of the 3 row plots, effectively providing treatment coverage to the middle row and not the exterior rows per plot (Row #1 and Row #3). By omitting coverage in each exterior row per plot, an unofficial untreated check was observed within each plot to determine whether treatments have control or whether the pathogen simply has not infected that plot yet as it spread across the trial.

Trial Treatments

DAP = Days After Planting DAE = Days After Emergence

Planting	Emergence	July 5, 2023	July 12, 2023	July 19, 2023	July 15, 2023	August 1, 2023
June 23	June 28, 2023	7 DAE	14 DAE	21 DAE	27 DAE	34 DAE
Treatment #	-	Application 1	Application 2	Application 3	Application 4	Application 5
1	Untreated Check	-	-	-	-	-
2	Lower Cost Rotation	Torrent + NIS	Zampro	Torrent + NIS	Zampro	Torrent + NIS
3	Moderate Cost Rotation	Torrent + NIS	Allegro	Orondis Ultra	Torrent + NIS	Zampro
4	Moderate Cost Rotation	Torrent + NIS	Allegro	Zampro	Torrent + NIS	Orondis Ultra
5	Higher Cost Rotation	Allegro	Allegro	Torrent + NIS	Orondis Ultra	Zampro

Planting	Emergence	August 9, 2023	August 16, 2023	August 22, 2023	August 30, 2023	September 6, 2023
June 23	June 28, 2023	Harvest Week 1	Harvest Week 2	Harvest Week 3	Harvest Week 4	Harvest Week 5
Treatment #	-	Application 6	Application 7	Application 8	Application 9	Application10
1	Untreated Check	-	-	-	-	-
2	Lower Cost Rotation	Orondis Ultra	Torrent + NIS	Orondis Ultra	Torrent + NIS	Zampro
3	Moderate Cost Rotation	Orondis Ultra	Torrent + NIS	Zampro	Zampro	Torrent + NIS
4	Moderate Cost Rotation	Torrent + NIS	Zampro	Torrent + NIS	Orondis Ultra	Torrent + NIS
5	Higher Cost Rotation	Torrent + NIS	Orondis Ultra	Zampro	Zampro	Torrent + NIS

Evaluation:

Assessments were taken throughout the growing season to document crop phytotoxicity, disease incidence, disease severity, and yield effects at crop maturity. Assessments were made before the first application, between each subsequent application, and after the last application. Each assessment was completed by starting at the first replication and working toward the fourth replication with each replication beginning at the untreated check plot. Each replication began at the untreated check for a reference point of crop health in order to evaluate each treatment's crop tolerance relative to the untreated check and as a reference point of disease pressure in order to evaluate each treatment's efficacy relative to the untreated check. Every plot was rated by observing the level of crop tolerance and control in the centre row compared to the centre row of the untreated check. 10 randomized plants along the centre row were assessed for the presence of Downy Mildew infections throughout the crop canopy. Two passes were completed by travelling down each side of the centre row from front to back and again back to front taking care in noting differences on the external and internal canopy. Infection severity was documented by recording the foliage's percent area infected per plant sampled and infection incidence was calculated by the percent of plants infected of the 10 plants sampled per plot. Harvest assessments were completed by hand harvesting each plot's centre row twice a week for 5 consecutive weeks. Yield data collected were fruit weights per grade with a grading scale of 1A/1B (up to 1-1/16" diameter), 2A (1-1/16" to 1-1/4" diameter), 2B (1-1/4" to 1-1/2" diameter), 3A (1-1/2" to 1-3/4" diameter), 3B (1-3/4" to 2" diameter), and 4 (>2" diameter). All assessment data was subjected to statistical models within an Analysis of Variance (ANOVA) using the Duncan's New MRT test at a confidence level of 95% and will be included in the trial report.

Results/Conclusions:

This trial demonstrated sufficient and statistically significant results of all 4 objectives providing a successful study. Each fungicide rotational treatment resulted in no observed crop phytotoxic symptoms throughout the duration of the study from initial application through crop maturity when compared to the untreated check (treatment 1). The lack of phytotoxic symptoms provides support that all fungicides used and in the specific rotational program had no negative impact on the crop. Natural infection of Downy mildew (*Pseudoperonospora cubensis*) infected the crop middle of July shortly after crop emergence and in combination of high moisture this season provided significant treatment differences in the control of the pathogen. All rotational treatments did not provide any level of incidence control compared to the untreated check as downy mildew was observed to have infected each plant sampled for lesions as the season progressed. Rotational treatments did however have statistical differences in the level of downy mildew severity compared to the untreated check which resulted in differences among treatments for season long marketable yields.

Rotational treatment 2 had statistically significant control compared to the untreated check late in the season with approximately 50% less infection severity, however there was no differences in severity control early or mid season when compared to the untreated check. Rotational treatment 3 had statistically significant control compared to the untreated check throughout the duration of the season with approximately 30% less infection severity. Rotational treatment 4 also had statistically significant

control compared to the untreated check throughout the duration of the season with approximately 40% less infection severity. Rotational treatment 5 similar to treatments 3 and 4 had statistically significant control compared to the untreated check throughout the duration of the season with approximately 35% less infection severity. All rotational treatments had significantly higher marketable yields compared to the untreated check indicating the necessary need for a fungicide program, however all rotational treatments were not comparable to one another. Rotational treatment 2 had approximately 20 metric tonnes/hectare yield increase over the untreated check whereas rotational treatments 3-5 had approximately 24 metric tonnes/hectare to 27 metric tonnes/hectare yield increases. Although, rotational treatment 3 yielded higher than rotational treatment 5 which yielded higher than rotational treatment 4, all 3 treatments were statistically insignificant to one another and statistically significant compared to rotational treatment 2.

The trial results demonstrated that rotational treatments 3-5 had no significant differences in efficacy of downy mildew and yields compared to one another but had significantly better efficacy and yields than rotational treatment 2 and the untreated check. Over the 10 in season applications treatment 1 (untreated check) had an expense of $0.00, treatment 2 (low cost) had an expense of $517.39/hectare, treatment 3 (moderate cost) had an expense of $574.74/hectare, treatment 4 (moderate cost) had an expense of $580.47/hectare, and treatment 5 (high cost) had an expense of $632.09/hectare. All rotational treatments 2-5 provided sufficient evidence to support the economical use in Ontario produced pickling cucumbers, however rotational treatment 3 or 4 of moderate costs provided the greatest return on investment when factoring in cost per hectare relative to the level of downy mildew control and inherent yield impacts.

	% Severity	% Severity	% Severity	% Severity	% Severity	% Severity	% Severity	% Severity	% Severity
	18-Jul-23	25-Jul-23	31-Jul-23	8-Aug-23	14-Aug-23	18-Aug-23	21-Aug-23	4-Sept-23	11-Sept-23
TRT 1	4.6	41.3	55.3	14.1	23.8	81.0	78.9	96.7	94.2
TRT 2	0.8	43.6	51.8	15.9	21.5	27.4	33.1	37.9	49.4
TRT 3	0.5	22.4	18.3	5.6	13.8	33.5	31.6	65.9	71.8
TRT 4	1.0	44.1	24.9	7.9	7.7	16.3	16.5	51.5	61.5
TRT 5	0.7	43.0	30.0	10.5	23.5	37.5	37.4	56.9	62.4

Rotational Treatment	Cost/Hectare (Canadian Dollars)	Yield (Metric Tonnes/Hectare)
TRT 1 (Untreated Check)	$0.00	6.5
TRT 2 (Low Cost)	$1,277.95	25.8
TRT 3 (Moderate Cost)	$1,419.60	34.2
TRT 4 (Moderate Cost)	$1,433.76	29.9
5 (High Cost)	$1,561.26	33.4

Project Title: Pickling cucumber breeding for Ontario: First steps

Research Agency and Location: University of Guelph Ridgetown Campus; 120 Main St. E., Ridgetown, ON N0P 2C0

Lead and Key Investigators: Steve Loewen

Objectives:

1. To engage in discussions with stakeholders in the Ontario pickling cucumber industry to (a) learn about the industry and (b) determine breeding objectives for a pickling cucumber breeding program.
2. To begin assembling cucumber germplasm as the basis for starting a breeding program.
3. To gain experience establishing and growing pickling cucumber field plots.
4. To gain experience growing field cucumbers in the greenhouse in preparation for controlled crosses.
5. To begin developing procedures for measuring fruit quality.

Materials and Methodology:

1. In June, July and August I arranged meetings by phone, Zoom, and in-person to speak with cucumber industry stakeholders to learn about the industry.

Stakeholder group	**Number of Individuals contacted**
Government (OMAFRA)	2
University Researchers	5
Grower representatives	3
Shippers and Packers	3
Seed Companies	3
Total	16
Meetings actually held	14

In addition, I also attended the Tacos at Twilight meeting July 11 and the Brinestock Evaluation meeting October 24.

Results and Conclusions:

1. Where possible, face-to-face meetings were arranged with many stakeholders. In other cases phone calls or Zoom meetings were held. There were 2 individuals where an initial response was received to my introductory email, but meeting arrangements did not work out.
   (a) Stakeholders were very helpful and open to responding to my questions as I tried to learn about the structure and workings of the pickling cucumber industry in Ontario. In a number of cases individuals were willing to share privileged or proprietary information to help me understand the industry at a deeper level. There are additional stakeholders that I would like to meet with in future years to continue my learning and to broaden my understanding.
   (b) Based on discussions to date for breeding objectives, I understand the Ontario pickling cucumber industry to need high yielding, parthenocarpic, gynoecious, hybrid cultivars for hand harvest, with resistance to downy mildew. Ontario production is distinguished by an

ability to reliably supply grade sizes 1 and 2, and the ability to harvest through August and into September. Any cultivars developed need to support these distinguishing features. The cucumbers of suitable cultivars need to have uniform green colour, tender skins and interiors that are firm and free of any hollowness after brining. Shape and size should be uniform with L:D ratio ranging from 2.8 to 3.2 and no taper. These breeding objectives will be refined over time.

2. Twenty different cultivars were already obtained at the start of the season. Plant Gene Resources of Canada holds a small collection of mostly old cucumber cultivars.
   (a) One of the most important findings this season was that Yiqun Weng (U. Wisconsin) does not have any germplasm to release. His work is focused on cucumber genetics but not on breeding. The lack of access to modern pickling cucumber germplasm will be one of the biggest limitations to advancing a breeding program at Ridgetown. There are still some options that need to be explored with seed companies and with researchers at MSU, NCSU and Cornell. In any case, future work at Ridgetown will need to focus on developing modern cucumber germplasm. While not preferred, it is possible that we may need to start with commercial hybrids not covered by plant breeders' rights, as a source of germplasm.
   (b) It was Y. Weng's opinion that *Cucumis hystrix* does not contain any useful genes for cultivated cucumber.
3. We were successful at establishing pickling cucumber field plots from transplants using the AMA Horticulture Ellepot trays. We gained experience controlling weeds and keeping the plot free of disease. We gained experience setting up a drip irrigation system.
   (a) A very valuable conversation was had with T. Wehner (recently retired cucumber breeder at NCSU) on pickling cucumber breeding field plots. Briefly, for breeding plots used to develop inbred lines, he recommended plots ranging from 4 to 5 feet long, in rows 5 feet apart, and separated by 4 to 5 foot alleys. At this plot size he recommended that sowing the row by hand was faster than sowing by machine, and that plants be thinned to a final number of 16 plants per plot. Several breeding strategies were discussed.
   (b) Another very important finding this season was that when managing both a processing tomato breeding program and a pickling cucumber breeding program at the same time there are not the synergies between the two programs that were expected. Operations such as spraying fungicides are frequent for both crops and the time required to accomplish this negatively affects weed control operations. In tomatoes, making controlled crosses by hand is not difficult but it is time consuming. In cucumbers, making controlled crosses is much more complicated because of the range of sex expression on plants and the need to manipulate that with ethylene and silver thiosulfate.
4. We were very successful in growing cucumber plants in the greenhouse. Growth was rapid and flowering was profuse.
   (a) We purchased reagents to make silver thiosulfate to manipulate sex expression in the flowers. As of this date of writing we do not yet have experience using it.
   (b) We should be able to achieve at least 3, and very likely 4 generations annually in the greenhouse. Because of the relative ease of making controlled crosses in the greenhouse, and the need identified for developing germplasm, the greenhouse component of this project will become very important.

(c) An important finding from this season is that we will need to set up the capability to propagate cucumbers vegetatively. Cuttings are not difficult to root but we may need to develop capacity for *in vitro* tissue culture. There are eight different variations of sex expression in cucumber plants (Haiyan, et al., 2023). Flower sex at 20 nodes must be observed to confirm sex expression in cucumber plants (Dhall, et al., 2022). During development of gynoecious and parthenocarpic cucumber inbred lines, plants at this stage of development are extremely difficult to induce production of male flowers as a pollen source for selfing. In addition to preventing the loss of individuals with desirable trait combinations by maintenance through tissue culture, regenerating plants from culture can result in young plants that are responsive to induction of male flowers as pollen sources for selfing.

5. The meeting with T. Wehner was helpful for starting to develop methods of measuring and assessing fruit quality parameters. Tasting a small piece of cotyledon can be used as an early-stage, rapid screening method to detect bitterness. A shear test has been used by some breeders as a quick way to test for firmness. Skin tenderness can be estimated rapidly using a thumbnail test and comparing to check varieties with known skin toughness. We will be developing further, rapid methods to screen breeding lines for important traits.