2022 Cucumber Research Funding			
	Project	Researcher	$ Amount Funded
1	Cucumber downy mildew monitoring program, 2022	Tomecek Agronomy	$4,237.50 incl. HST
2	Processing Cucumber Variety Evaluation	J. O'Sullivan	$25,000
3	Efficacy of Fungicides for Downy Mildew Control in Processing Cucumbers	J. O'Sullivan	$7,500
4	Weed Control Evaluations in Processing Cucumbers	D. Robinson	$4,000
5	Integrating fungicide programs and host resistance for cucurbit downy mildew management	C. Trueman	$5,000

November 28, 2022

To: Ontario Cucumber Research Committee (OCRC),

Re: Cucumber Downy Mildew Monitoring Program 2022 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 13th – 19th. 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 18th – 24th. 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.

The presence of Downy Mildew was detected in three of the five fields by our scout in the last week of the project. 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 19th, upon which the grower, Ontario Cucumber Research Committee, OPVG and OMAFRA Extension were all notified immediately.

Thank you for allowing us to be part of this project. We would certainly be interested in participating again next year, and have submitted a proposal for your consideration for the 2023 growing season.

Kind regards,

Joe Tomecek, CCA, 4RNMS

Tomecek Agronomy Services Inc.

RESEARCH REPORT 2022

Processing Cucumber Variety Evaluation

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

Research Team: Rachel Riddle, John O'Sullivan, Rene Van Acker
Ontario Crops Research Centre – Simcoe
University of Guelph

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 2022: (1) Parthenocarpic (seedless) Multipick (hand harvest), (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 multipick variety trial included 11 commercial varieties for evaluation. The trial was seeded on June 2 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 a total of 10 harvests from July 15 to August 16.

Machine Harvest Trials
The conventional machine harvest trial included 5 commercial varieties for evaluation and the parthenocarpic machine harvest trial included 9 commercial varieties. Trials were seeded on June 8 and June 22 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 July 29 (51 DTH) and August 3 (56 DTH). For the parth machine trial, the harvest days were Aug 5 (44 DTH). Aug 8 (47 DTH) and Aug 10 (49 DTH).

For all trials, the crop was grown according to accepted commercial practices used in Ontario. Data was taken on fruit length to diameter ratios (LD) on a weekly basis for hand harvest and once for machine harvest. Yields were measured at harvest as fruit weights (ton/acre), graded out by size and dollar value per acre. 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 in September.

Brine and fresh evaluations, LD and bitterness data will be provided in a complete report to the industry and will not be included in this summary.

Results:
Yields shown are for each graded size and a total yield which includes grades #1 to #4 (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.

Multipick Parthenocarpic (hand harvest): Speed, Lennon, Rubinstein and Aristan were the highest yielding varieties with approximately US $13,300, $12,600,$12,300 and 11,900 per acre and 24, 24, 21 and 22 tons/acre, respectively. Most varieties were in the US $11,000 to $9,000 and 21 to 19 tons per acre range (Table 1).

Conventional Machine Harvest: Expedition and Chaperon were the highest yielding varieties with approximately the same yield of US $3,200 and 16 tons/acre (Table 2).

Parthenocarpic Machine Harvest: V 5025, Henley and V 5016 were the highest yielding varieties with approximately US $5,300, $4,700 and $4,100 per acre and 22, 19, and 18 tons/acre, respectively. Most varieties were in the US $4,000 to $2,000 per acre and 14 to 11 tons per acre range (Table 3).

Table 1: Yield of cucumbers harvested from the parthenocarpic multipick (hand harvest) variety trial, Simcoe, ON, 2022.

Cultivar	Source	Total Yield 1-4, NC T/ac	$/ac	Fruit/ Plant	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
Speed	Nunhems	23.6 a	13,330 a	35	4	35	32	20	6	2	0	0
Lennon	Rijk Zwaan	24.4 a	12,630 ab	33	5	31	26	22	9	6	1	0
Rubinstein	Rijk Zwaan	21.2 a	12,292 abc	33	7	39	31	14	6	4	1	0
Aristan	Bejo	21.5 a	11,971 abc	32	6	35	30	17	7	4	1	1
Liszt	Rijk Zwaan	22.1 a	11,817 abc	32	3	31	33	20	8	4	1	0
Amarok	Bejo	20.7 a	11,615 a-d	32	4	35	31	19	8	2	1	0
Platina	Nunhems	22.4 a	11,364 a-d	30	3	27	31	21	9	6	1	1
Merengue	Seminis	19.4 a	10,972 a-d	32	6	37	27	17	9	2	1	0
Absolut	Bejo	19.1 a	9,861 bcd	27	5	29	33	20	9	4	1	0
Gerswhin	Rijk Zwaan	21.3 a	9,498 cd	30	15	24	25	19	10	5	1	0
Puccini	Rijk Zwaan	19.1 a	8,900 d	27	12	25	29	19	10	5	0	0

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 7.3; 1.5		: 70 lbs/ac of P
Planting Date	: June 2		: 100 lbs/ac of K
Row Spacing	: 5ft.	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 6"	Harvest Dates	: July 15 - August 16 (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, 2022.

Cultivar	Source	Total Yield 1-4, NC T/ac	Total Yield 1-4, NC $/ac	Fruit/ Plant	Days to Harvest	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
Expedition	Seminis	15.9 a	3,222 a	2.7	51	8	4	4	13	23	28	13	8
Chaperon	Seminis	15.8 a	3,221 a	3.3	51	7	4	9	22	19	22	8	8
Peacemaker	Seminis	16.0 a	2,653 a	2.2	56	10	1	1	8	9	31	23	16
Journey	Seminis	13.5 a	2,625 a	1.9	56	6	2	3	8	17	37	18	8
Vlaspik	Seminis	13.3 a	2,593 a	2.3	51	9	3	4	14	24	26	16	4

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.6; 1.2		: 70 lbs/ac of P
Planting Date	: June 8		: 100 lbs/ac of K
Row Spacing	: 30"	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 4"	Harvest Date	: July 29 (51 DTH); August 3 (56 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 4: Yield of cucumbers harvested from the parthenocarpic machine harvest (simulated once-over harvest) variety trial, Simcoe, ON, 2022.

Cultivar	Source	Total Yield 1-4, NC T/ac	Total Yield 1-4, NC $/ac	Fruit/ Plant	Days to Harvest	Percent Breakout by weight N/C	1AB	2A	2B	3A	3B	4	O/S
V 5025	Nunhems	22.0 a	5,365 a	5.0	49	1	1	0	4	32	57	4	2
Henley	Rijk Zwaan	18.9 ab	4,694 ab	5.4	44	5	1	4	16	40	32	2	0
V 5016	Nunhems	17.7 ab	4,087 ab	3.4	47	3	1	1	5	21	58	8	3
V 5031	Nunhems	14.8 ab	3,948 ab	4.5	47	1	0	1	20	58	20	0	0
Rubinstein	Rijk Zwaan	13.2 ab	3,278 ab	3.5	49	5	0	1	11	35	39	0	9
Liszt	Rijk Zwaan	13.7 ab	2,846 b	2.9	47	3	0	0	3	17	49	19	10
Bowie	Rijk Zwaan	10.1 b	2,519 b	3.2	49	6	1	2	17	49	24	0	0
Gershwin	Rijk Zwaan	10.3 b	2,507 b	5.4	47	9	3	6	19	49	14	0	0
Lennon	Rijk Zwaan	10.6 b	2,414 b	2.9	47	4	1	1	7	24	51	10	2

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.8; 1.4		: 70 lbs/ac of P
Planting Date	: June 22		: 100 lbs/ac of K
Row Spacing	: 30"	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 8"	Harvest Dates	: Aug 5 (44 DTH), Aug 8 (47 DTH), Aug 10 (49 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 2022

Efficacy of Fungicides for Downy Mildew Control in Processing Cucumbers

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

Research Team: Rachel Riddle, John O'Sullivan and Rene Van Acker
Ontario Crops Research Centre – Simcoe
University of Guelph

Objective: Downy mildew, an aggressive plant pathogen, 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 was low in Ontario from 2016 to 2019, detected late in the season and having minimal effect on cucumber crops. In 2022, the disease was first detected in Ontario in Norfolk County on July 13, which was later than detection in 2021. It was first observed in cucumber trials at the research centre in Simcoe on August 3.

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, there are currently three downy mildew tolerant cucumber varieties that are commercially available. These varieties are Peacemaker, Citadel and Chaperon and are marketed as DM-Defense varieties by Seminis Vegetable Seeds (Bayer Crop Science). This intermediate form of resistance can be used, along with the application of effective fungicides to help ensure acceptable levels of control of downy mildew.

Methodology: A fungicide efficacy trial was conducted at Ontario Crops Research Center – Simcoe, in 2022. Two cucumber varieties, 'Vlaspik' and 'Chaperon (DM-Defense variety)', were seeded using a precision seeder on July 4 in rows 30 inches apart with in-row plant spacing of 4" to give a plant population of 55,000 plants/per acre. The crops were grown according to accepted commercial practices used in Ontario. The trial was setup as a randomized complete block design with a split-plot arrangement and four 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 (AI TeeJet 110015-VS) nozzles at a pressure of 40 psi and water volume of 450 L/ha. Ten treatments were evaluated, including an untreated control. Treatments were applied to plots on July 26, August 3 and 10.

Downy mildew visual ratings were made at weekly intervals starting on July 26. Mature fruit were harvested by hand on August 17, 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. Oversize fruit (>2 1/8 " in diameter) were not included in the yield data.

Results: In 2022, downy mildew infection was similar to 2021. The disease was detected in significant amounts (>5%) in untreated trial plots on August 3, just prior to flowering. By the time the crop was ready for harvest on August 17, infection in untreated plants was 48% and 76% for the cucumber varieties Chaperon and Vlaspik, respectively. The Orondis Ultra alternated with Bravo treatment provided the best control of the disease with 3% and 20% leaf infection for Chaperon and Vlaspik, respectively. Intermediate disease control was observed from plants treated with Torrent, Zampro, Tattoo C and Allegro. The highest levels of disease infection was observed in the Cueva and Cueva + Phostrol treatments. Torrent alternated with Diplomat and Phostrol had 22% more disease infection when compared to the Torrent only treatment for Vlaspik and had comparable low amounts of disease infection on Chaperon (Tables 1 & 2).

Final harvest yields were significantly reduced for several treatments with high downy mildew infection when compared to the best treatment of Orondis Ultra alternated with Bravo on the variety Vlaspik (Table 1). 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. Torrent, Zampro and Allegro provide intermediate control suggesting that if used in a program with Orondis, these products remain the best downy mildew control option. There were no significant differences between fungicide treatments on the yield (T/acre) of Chaperon (Table 2).

When comparing the level of disease between the two varieties, 'Vlaspik' and 'Chaperon' (DM-tolerant), it was observed that Chaperon had less disease infection in all treatments. This difference in disease infection was in a range of 9 to 28% less disease with Chaperon when compared to Vlaspik. Chaperon yielded better than Vlaspik in all treatments, 33% and 53% higher yields for the Orondis (alt. Bravo) and untreated treatments, respectively (Tables 1 & 2). Differences in final yield between treatments was overall less for Chaperon than Vlaspik, thus some products such as Torrent alternated with Diplomat + Phostrol and Cueva + Phostrol could have a role in a spray program if used on Chaperon.

Table 1: Incidence of cucumber leaves with downy mildew symptoms and yield of cucumbers, variety 'Vlaspik', harvested from plots sprayed with different fungicides, Simcoe, ON, 2022.

Product**	Rate per Acre	% Downy Mildew Infection* Aug 3	Aug 9	Aug 16	Yield T/acre	$/acre
Bravo ZN	1.9 L	0	21	40	5.8 abc	1,356 a-d
Torrent + Sylgard	81 mL 0.1 % v/v	0	11	28	7.4 ab	1,891 a
Zampro + Sylgard	400 mL 0.1 % v/v	0	16	30	7.3 ab	1,680 abc
Orondis Ultra alt. Bravo ZN	243 mL 1.9 L	0	6	20	7.9 a	1,763 ab
Tattoo C	1.1 L	0	13	28	5.1 abc	1,165 a-d
Allegro	708 mL	0	25	33	8.5 a	1,905 a
Torrent, alt Diplomat + Phostrol	81 mL 0.4; 1.2 L	0	21	50	5.3 abc	1,108 bcd
Cueva	1.8 % v/v	4	38	50	2.8 c	536 d
Cueva + Phostrol	1.8%; 1.2 L	2	38	48	4.4 bc	943 cd
Untreated Control		10	58	76	4.1 c	872 d

Planting Date : July 4
Plant Population : 55,000 plants/Ac
Date of First Application : July 26
Harvest Date : August 17

* 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 'Chaperon', harvested from plots sprayed with different fungicides, Simcoe, ON, 2022.

	Rate	% Downy Mildew Infection*			Yield	
Product**	**per Acre**	**Aug 3**	**Aug 9**	**Aug 16**	**T/acre**	**$/acre**
Bravo ZN	1.9 L	0	13	26	8.9 a	1,928 ab
Torrent + Sylgard	81 mL 0.1 % v/v	0	6	19	13.1 a	2,975 a
Zampro + Sylgard	400 mL 0.1 % v/v	0	9	18	12.2 a	2,799 ab
Orondis Ultra alt. Bravo ZN	243 mL 1.9 L	0	1	3	11.8 a	2,610 ab
Tattoo C	1.1 L	0	3	13	12.1 a	2,778 ab
Allegro	708 mL	0	15	23	10.5 a	2,386 ab
Torrent, alt Diplomat + Phostrol	81 mL 0.4; 1.2 L	0	5	15	11.9 a	2,805 ab
Cueva	1.8 % v/v	3	14	33	12.1 a	2,593 ab
Cueva + Phostrol	1.8%; 1.2 L	1	15	34	9.6 a	2,072 ab
Untreated Control		7	28	48	8.7 a	1,853 b

Planting Date : July 4
Plant Population : 55,000 plants/Ac
Date of First Application : July 26
Harvest Date : August 17

* 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)

Project Title: Weed Control Evaluations in Processing Cucumbers – 2022

Research Agency: Ridgetown Campus, University of Guelph

Lead Investigator: Darren Robinson

Executive Summary:

In addition to completing the proposed objective, which was to determine tolerance of cucumber to a number of unregistered herbicides for the purpose of supporting potential minor use submissions, we completed additional trial work on the tolerance of cucumber to tank mixes of Command and Sandea.

Prowl H20 caused less than 10% injury at twice the proposed label rate; stand and marketable yield were not reduced. Cucumber is tolerance to PRE applications of ShieldEx, but without an appropriate tank mix partner does not control a wide spectrum of weeds in cucumber. Both Zidua and pethoxamid caused significant injury and loss of yield in cucumber.

Objective:

1. Determine the tolerance of cucumber to preemergence applications of pethoxamid, Zidua, Prowl H2O and Shieldex.

TRIAL 1. TOLERANCE OF CUCUMBER TO PREEMERGENCE HERBICIDES

Materials and Methodology:

Crop: Cucumber

Variety: Vlasstar	Planting date: May 29/22
Planting rate: 113750 seeds/ha	Depth: 2 cm
Row spacing: 75cm	

Design: Randomized Complete Block Design

Plot width: 2m	Plot length: 10m
Reps: 4	

Field Preparation: Trial fertilized with 19-19-19 at 580 kg/ha on May 28/22.

Soil Description:

Sand: 56%	OM: 3.9%	Texture: sandy clay loam
Silt: 20%	pH: 7.6	Soil: Watford/Brady Series
Clay: 24%	CEC 14	

Application Information:

	A
APPLICATION DATE	MAY 28/22
TIME OF DAY	7:00 AM
TIMING	PRE
AIR TEMP (c)	16
RH (%)	80
WIND SPEED (KPH)	6
SOIL TEMP (c)	20
CLOUD COVER (%)	0
CROP STAGE	PRE

Results:

Both pethoxamid and Zidua caused considerable injury (mostly leaf puckering and stunting), and though the number of harvestable cucumber plants per plot was not affected, yields were decreased (Table 1.1). Injury ranged from 15 to 24% in the pethoxamid treatments, and from 13 to 17% in the Zidua treatments. Injury ratings in the Prowl H2O and Shieldex treatments was less than 5%. There was a significant decrease in yield in the pethoxamid treatments (from 30 T/ac to 11 T/ac) and the Zidua treatments (from 30 T/ac to 20 T/ac). There were no yield reductions in the Prowl H2O or Shieldex treatments.

Table 1.1. Effect of herbicide treatment on cucumber visual injury 7, 14 and 28 days after application, cucumber plant number per plot and yield.

HERBICIDE	RATE	VISUAL INJURY 7D	14D	28D	#/PLOT	YIELD T/AC
1. Check (WEEDFREE)		0B	0C	0C	14A	30A
2. pethoxamid	1200 G/HA	7A	7B	15B	10B	22B
3. pethoxamid	2400 G/HA	9A	12A	24A	8B	11C
4. ZIDUA	47 G/AC	7A	14A	13C	11B	18B
5. ZIDUA	94 G/AC	9A	15A	17B	9B	10C
6. PROWL H20	0.96 L/AC	3B	1C	0C	13A	31A
7. PROWL H20	1.92 L/AC	2B	2C	1C	13A	30A
8. SHIELDEX	16.3 G/AC	0B	0C	0C	13A	31A
9. SHIELDEX	32.6 G/AC	0B	0C	0C	12A	29A
LSD (P <0.05)		3	4	5	2	5

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

Conclusions:

The tolerance of cucumber to the treatments in this trial has been variable depending upon the year. In 2022, pethoxamid and Zidua significantly reduced cucumber stand and yield. Injury included leaf distortion, stem twisting, and stunting – the injury remained until harvest. In previous years, injury was less noticeable. This year, we had a heavy rainfall event (>2") that fell as the crop was emerging, which is the likely reason for the injury observed. In 2021, both pethoxamid and Zidua caused considerable injury (mostly leaf puckering and stunting), and though the number of harvestable cucumber plants per plot was not affected, yields were decreased. This was the same observation made in 2020, but differed from results in 2018 and 2019. In 2019 and 2018, though pethoxamid injured cucumber, it did not cause any reductions in yield in 2018. The difference in results is hypothesized to be due to cool, wet conditions at time of emergence in 2021 (and 2020). Zidua and Prowl H20 caused less than 10% injury at twice the proposed label rate; stand and marketable yield were not reduced.

Moving forward, I'm going to suggest we consider some herbicides that are being developed for corn and soybean in Canada, including acetochlor (similar to Dual II Magnum [s-metolachlor], but with greater control of broadleaf weeds than Dual).

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

2022 Research Report

Integrating fungicide programs and host resistance for cucurbit downy mildew management

Prepared for the Ontario Cucumber Research Committee (OCRC)
September 22, 2022

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 was to evaluate low and high input fungicide programs using cucurbit downy mildew (CDM) susceptible and resistant hybrids for effects on CDM intensity and yield. The low input programs included the broad-spectrum fungicide, Bravo, applied either at the beginning or end of the fungicide program while the high input program included Orondis Ultra, Torrent, and Zampro, with Orondis Ultra being applied either once or twice during the season. This was a replication of a trial completed in 2019 (no results due to lack of downy mildew), 2020, and 2021.
- In 2020, disease pressure was moderate. All fungicide programs reduced yield loss to similar levels, suggesting that the low input programs beginning or ending with two applications of Bravo as just as effective as the high input programs for both 'Vlaspik' (susceptible) and 'Peacemaker' (resistant). However, the fungicide program that reduced disease the most varied by cultivar. The only program to reduce whole plot severity below 10% for 'Vlaspik' was the high input-2x Orondis program, while for 'Peacemaker' all programs resulted in less than 10% of the whole plot leaf area affected. Thus, it might be possible to use less expensive fungicide programs for 'Peacemaker' while limiting the inoculum load in a region.
- In 2021, most fungicide programs reduced downy mildew incidence and severity, however, not always to the same level. Like in 2020, program response sometimes differed by cultivar (host resistance). However, in general the low input-begin with Bravo program was most consistent in reducing symptoms. This was unexpected and differed from results in 2020 as well as previous trials completed with 'Vlaspik' (2016-2018). A possible explanation for this poor performance of high-input fungicides is the evolution of fungicide resistance. In collaboration with Katie Goldenhar (OMAFRA), downy mildew samples were submitted to M. Hausbeck's lab at Michigan State University for oxathiapiprolin resistance testing. Results are pending.
- In 2022, disease pressure was low and we did not observe any differences in disease incidence or severity among fungicide programs. Downy mildew levels were greater in the 'Vlaspik' nontreated control compared to 'Peacemaker', which was expected.

Funding: Ontario Cucumber Research Committee and the Ontario Agri-Food Innovation Alliance. We also thank Seminis for providing cucumber seed.

Cheryl Trueman – RCUG
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TITLE: Integrating fungicide programs and host resistance for cucurbit downy mildew management

OBJECTIVE: Evaluate low and high input fungicide programs using CDM susceptible and resistant hybrids for effects on CDM intensity and yield.

PEST(S): Cucumber downy mildew (*Pseudoperonospora cubensis*)

MATERIALS: Bravo ZN (chlorothalonil 500 g L^{-1}), Orondis Ultra (oxathiapiprolin 30 g L^{-1} + mandipropamid 250 g L^{-1}), Torrent (cyazofamid 34.5%), Zampro (ametoctradin 27% + dimethomorph 20.3%).

METHODS: The trial was conducted at Ridgetown Campus, University of Guelph. Two cucumber cultivars, 'Vlaspik' and 'Peacemaker', were used to identify potential differences to fungicide program when host resistance varies. Previous research at Ridgetown and elsewhere showed that 'Vlaspik' was susceptible to CDM, while 'Peacemaker' was more resistant. The trial was seeded with a cone seeder on July 4 at a rate of 10 seeds per meter. The planting date was late to increase probability of high disease pressure conditions. Rows were spaced 0.75 m apart. Each treatment plot was 7 m long and consisted of 3 rows. The left most row was planted to the pollinator, while the second and third rows were planted with the treatment cultivar. The trial was designed as a 2 x 5 factorial with four replications. Factor A was host resistance to CDM and Factor B was fungicide treatment. Treatments were applied using a hand-held CO_2 boom sprayer with Hypro ULD 120-02 nozzles at a pressure of 40 psi and water volume of 200 L ha^{-1}. A 2.0 m boom width was used for all applications. Each treatment received five fungicide applications (application codes ABCDE) which were applied approximately seven to eight days apart on July 18, 25, Aug 1, 9 and 15. The trial was irrigated as needed using drip irrigation.

Downy mildew was reported in Chatham-Kent in mid July. To help ensure development of disease in the trial, leaves from a commercial field were obtained and used to inoculate the exterior guard rows of the trial by placing sporulating leaves within the canopy on July 20.

The trial was assessed for downy mildew on Aug 11 and 16. The number of leaves in a 1 m section of one plot per rep was counted and used to estimate the number of leaves in the whole plot on each assessment date. The number of infected leaves was counted for the whole plot, and then the percentage of infected leaves was calculated. The percentage of affected leaf area was assessed by estimating the area affected by downy mildew in whole plots. It was not possible to calculate the area under the disease progress curve (AUDPC) because disease symptoms appeared just prior to harvest, and a minimum of three assessment dates are required to calculate this variable.

Fruit was harvested on August 19 from a 7 m section of the center row of each plot. Harvested fruit was graded based on width and the number and weight of each grade documented. Grades used were: Grade 1 $<$ 2.75 cm, Grade 2 $>$ 2.75 cm, but $<$ 3.5 cm, Grade 3 $>$ 3.5 cm, but $<$ 4.0 cm, Grade 4 $>$ 4.0 cm, but $<$ 5.75 cm, Oversize $>$ 5.75 cm, and Nubs. Crop value for each treatment was also calculated based on the graded yields for each treatment multiplied by price per ton for each grade in US dollars (USD). The calculated prices per ton for each grade were then summed to determine the crop value for each treatment.

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Prices used were based on Hartung Brothers 2022 grower agreement for machine harvested cucumbers (Grade 1 = $0 USD per ton, Grade 2 = $310 USD per ton, Grade 3 = $256 USD per ton, Grade 4 = $66 USD per ton, and nubs $30 USD per ton).

Statistical analysis was conducted using Proc Glimmix in SAS v9.4 (SAS Institute Inc., Cary, NC). Means comparisons were performed when $P \leq 0.05$ using Tukey's HSD. In some cases, there was a significant interaction between the two factors, host resistance and fungicide treatment, meaning that differences between treatments were a results of fungicide program and cultivar effects combined. In these cases, the mean for the interaction is presented.

RESULTS & DISCUSSION: Disease pressure in the trial was low. The inoculation in July was unsuccessful, possibly because the leaves collected for inoculation were from a commercial field that was sprayed with fungicide prior to collection.

For the incidence and severity of leaves with downy mildew, nontreated 'Vlaspik' had higher levels of downy mildew than other treatments on Aug 11 and 16 (Table 1). On August 16, downy mildew severity on infected leaves in nontreated 'Peacemaker' was higher than all fungicide treatments, but lower than the nontreated 'Vlaspik'. There were no differences among fungicide programs for downy mildew incidence or severity. This was different than prior years when disease intensity in the trial was higher.

The number of cucumbers harvested was higher for 'Vlaspik' than 'Peacemaker' and this was not affected by fungicide program. Within cultivars, none of the fungicide programs resulted in greater harvestable weight or crop value than the nontreated control, except for 'High input-2x Orondis' in cultivar 'Peacemaker' (Table 2). The reason for this difference is unknown, but is not likely related to downy mildew, since disease pressure in the trial was low.

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Table 1. Incidence of leaves with symptoms (%) and their severity (% leaf area affected) with cucurbit downy mildew symptoms in susceptible 'Vlaspik' and resistant 'Peacemaker' treated with different fungicides programs, Ridgetown, ON, 2022.

Host CDM Resistance x Fungicide Program		Incidence (% leaves w/ symptoms)		Severity (% leaf on symptomatic leaves)	
		Aug 11	Aug 16	Aug 11	Aug 16
Vlaspik	Nontreated control	1 a	7 a	3 a	**15 a**
Vlaspik	'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	0 b	0 b	0 b	**0 c**
Vlaspik	'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	0 b	0 b	0 b	**0 c**
Vlaspik	'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	0 b	0 b	0 b	**0 c**
Vlaspik	'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	0 b	0 b	0 b	**0 c**
Peacemaker	Nontreated control	0 b	1 b	0 b	**5 b**
Peacemaker	'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	0 b	0 b	0 b	**0 c**
Peacemaker	'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	0 b	0 b	0 b	**0 c**
Peacemaker	'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	0 b	0 b	0 b	**0 c**
Peacemaker	'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	0 b	0 b	0 b	**0 c**
Significance					
Cultivar		*	*	*	*
Fungicide program		*	*	*	*
Cultivar x Fungicide program		*	*	*	*

[a] Significance at $P < 0.05$ denoted by an '*' and a non-significant difference by 'NS' for each main effect factor and their interaction. [b] Fungicides applied on: A=July 18, B= July 25, C=Aug 1, D=Aug 9, E=Aug 15. [c] Fungicide rates applied were Bravo (4.8 L ha^{-1}), Orondis Ultra (500 ml ha^{-1}), Torrent + Sylgard 309 (200 ml ha^{-1} + 150 ml ha^{-1}), Zampro + Sylgard 309 (1 L ha^{-1} + 150 ml ha^{-1}). [d] Means followed by the same letter within a column are not significantly different at $P \leq 0.05$, Tukey's adjustment. Means for main effects were separated because there was a significant interaction involving the main effects. [e] Aug 16 was the final date of disease assessment prior to harvest on Aug 19. Abbreviations: AUDPC = area under the disease progress curve.

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Table 2. Yield and value of cucurbit downy mildew susceptible 'Vlaspik' and resistant 'Peacemaker' treated with different fungicides programs, Ridgetown, ON, 2022.

Main Effects [a]	Yield (per 7 m of row)			Value ($/acre)	
	Number	Weight (kg)			
Host CDM Resistance		Vlaspik	Peacemaker	Vlaspik	Peacemaker
Vlaspik	141 a	.	.	.	.
Peacemaker	108 b	.	.	.	.
Fungicide Program[b,c]					
Nontreated control	116	12.17 abc	8.26 d	2168 ab	1421 c
'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	116	11.83 abc	9.32 cd	1967 abc	1615 bc
'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	132	14.07 a	10.31 bcd	2495 a	1835 bc
'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	134	14.18 a	10.43 bcd	2492 a	1749 bc
'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	122	12.55 ab	12.79 ab	1942 abc	2036 abc
Significance					
Cultivar	*	*		*	
Fungicide program	NS	*		*	
Cultivar x Fungicide program	NS	*		*	

[a] Significance at $P < 0.05$ denoted by an '*' and a non-significant difference by 'NS' for each main effect factor and their interaction. [b] Fungicides applied on: A=July 18, B= July 25, C=Aug 1, D=Aug 9, E=Aug 15. [c] Fungicide rates applied were Bravo (4.8 L ha^{-1}), Orondis Ultra (500 ml ha^{-1}), Torrent + Sylgard 309 (200 ml ha^{-1} + 150 ml ha^{-1}), Zampro + Sylgard 309 (1 L ha^{-1} + 150 ml ha^{-1}). [d] Means followed by the same letter within a column are not significantly different at $P \leq 0.05$, Tukey's adjustment. Means for a main effect were separated only if there was no significant interaction involving that main effect. [e] Aug 16 was the final date of disease assessment prior to harvest on Aug 19. Abbreviations: AUDPC = area under the disease progress curve.