2021 Cucumber Research Funding			
	Project	Researcher	$ Amount Funded
1	Cucumber downy mildew monitoring program, 2021	Tomecek Agronomy	$3,500 +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

Norfolk Scouting ($2,700 + HST) for 6 weeks approx

Tomecek Agronomy Services Inc.

October 29, 2021

To: Ontario Cucumber Research Committee (OCRC),

Re: Cucumber Downy Mildew Monitoring Program 2021 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.

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

The presence of Downy Mildew was first detected in one of the five fields by our scout in the first week of the project. It was confirmed by both Joe Tomecek and Dr. Cheryl Trueman on July 17th, upon which the grower, Ontario Cucumber Research Committee, OPVG and OMAFRA Extension were all notified immediately. By the second week, it was found in 3 different locations within that particular field, with an average "% leaf area covered by lesions" of between >5 – 15%. It was not detected in any of the other project fields until July 6th (Week #4), when it was identified in 3 additional fields, bringing the total affected fields to 4 out of 5. The average "% leaf area covered by lesions" was between 1-5% for the new 3 fields, with a high of 20%. By July 13th (Week #5), Downy Mildew was detected in all 5 of the fields involved in the project, with the incidence and severity slightly up over the last week in all fields. By Week#6, incidence and severity of the Cucumber Downy Mildew had increased in 2 of the fields and remained stable in the other 3 fields.

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 2022 growing season.

Kind regards,

Joe Tomecek, CCA, 4RNMS

Tomecek Agronomy Services Inc.

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

RESEARCH REPORT 2021

Processing Cucumber Variety Evaluation

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

Research Team: John, O'Sullivan, Rachel Riddle and Peter White
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: Four cucumber variety trials were conducted at the Ontario Crops Research Centre located in Simcoe, Ontario, in 2021: (1) Conventional Multipick (hand harvest), (2) Parthenocarpic (seedless) Multipick (hand harvest), (3) Conventional Machine Harvest (simulated once-over harvest) and (4) 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 conventional multipack trial included 5 commercial varieties for evaluation and the parthenocarpic multipick variety trial included 11 commercial varieties. Both trials were 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 10 cm (4") and 15 cm (6") in row for the conventional and parth trials, respectively, giving a plant population of 27,000 and 18,000 plants/acre. Cucumber plots were harvested three times a week and two times per week for the conventional and parth trials respectively giving a total of 12 and 8 harvests from July 15 to August 17.

Machine Harvest Trials
The conventional machine harvest trial included 5 commercial varieties for evaluation and the parthenocarpic machine harvest trial included 7 commercial varieties. Trials were seeded on June 8 and June 23 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 26 (48 DTH). For the parth machine trial, the harvest days were Aug 9 (47 DTH), Aug 12 (50 DTH) and Aug 13 (51 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 October 2021.

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. Length to diameter data is also included. Please note that yields are for comparative purposes only. Small plots yields may not accurately reflect commercial yields.

Multipick Conventional (hand harvest): Vlasstar and Chaperon were the highest yielding varieties with approximately US $10,700 and $10,400 per acre and 31 and 33 tons/acre, respectively. The other varieties were in the US $8,000 and 24-25 tons/acre range (Table 1).

Multipick Parthenocarpic (hand harvest): Merengue, Speed, Liszt, and newly released variety Lennon were the highest yielding varieties with approximately US $8,200, $8,000,$7,800 and $7,800 per acre and 18, 18 and 19 and 20 tons/acre, respectively. Most varieties were in the US $7,000 to $6,000 and 17 to 14 tons per acre range (Table 2).

Conventional Machine Harvest: Chaperon and Expedition were the highest yielding varieties with approximately US $3,500 and $3,100 per acre and 18 and 15 tons/acre, respectively (Table 3).

Parthenocarpic Machine Harvest: V 5031, V 5025 and Lennon were the highest yielding varieties with approximately US $6,500, $5,900 and $5,000 per acre and 29, 27, and 23 tons/acre, respectively. Most varieties were in the US $5,000 to $4,000 per acre and 22 to 23 tons per acre range (Table 4).

Table 1: Yield of cucumbers harvested from the conventional multipick (hand harvest) variety trial, Simcoe, ON, 2021.

Cultivar	Source	Total Yield 1-4, NC T/ac	$/ac	Fruit/ Plant	Percent Breakout N/C	1AB	2A	2B	3A	3B	4	O/S
Vlasstar	Seminis	31.2 a	10,665 a	23	8	21	18	19	17	12	5	1
Chaperon	Seminis	32.9 a	10,358 a	21	9	17	17	20	18	15	4	0
Arabian	Seminis	25.0 a	8,871 a	20	12	23	19	21	14	7	4	0
Peacemaker	Seminis	24.5 a	8,751 a	20	9	23	19	20	15	12	3	0
Fanicpak	Seminis	24.6 a	8,693 a	18	6	21	21	23	14	12	3	0

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.8; 1.0		: 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	: 4"	Harvest Dates	: July 16 - August 17 (12 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 parthenocarpic multipick (hand harvest) variety trial, Simcoe, ON, 2021.

Cultivar	Source	Total Yield 1-4, NC T/ac	$/ac	Fruit/ Plant	Percent Breakout N/C	1AB	2A	2B	3A	3B	4	O/S
Merengue	Rijk Zwaan	18.5 a	8,213 a	23	3	33	26	27	9	3	0	0
Speed	Nunhems	17.6 a	7,966 a	23	3	34	32	24	6	1	0	0
Liszt	Rijk Zwaan	19.4 a	7,831 a	22	1	27	25	27	13	6	1	0
Lennon	Rijk Zwaan	20.2 a	7,821 a	22	2	25	25	24	17	6	2	0
Platina	Nunhems	17.7 a	7,131 a	22	2	26	26	27	14	5	0	0
Aristan	Bejo	13.3 a	6,280 a	19	3	40	34	16	7	1	0	0
Gershwin	Rijk Zwaan	18.1 a	6,224 a	20	8	19	24	25	17	6	1	0
Amarok	Bejo	14.3 a	6,221 a	18	2	32	28	23	11	3	0	0
Puccini	Rijk Zwaan	14.3 a	5,768 a	19	6	26	29	25	11	4	0	0
Absolut	Bejo	12.2 a	5,468 a	15	3	34	27	25	9	2	0	0
Bernstein	Rijk Zwaan	12.0 a	4,738 a	15	6	26	27	28	10	3	0	0

Soil Type	: Very fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.7; 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 10 (8 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 3: Yield of cucumbers harvested from the conventional machine harvest (simulated once-over harvest) variety trial, Simcoe, ON, 2021.

Cultivar	Source	Total Yield 1-4, NC T/ac	$/ac	Fruit/ Plant	Percent Breakout N/C	1AB	2A	2B	3A	3B	4	O/S
Chaperon	Seminis	18.4 a	3,516 a	2.2	3	2	2	7	19	39	18	10
Expedition	Seminis	14.8 a	3,131 a	2.4	4	3	5	10	20	51	5	3
Logan	Nunhems	14.5 a	3,069 a	2.7	3	4	8	15	13	47	8	1
Peacemaker	Seminis	13.4 a	2,581 a	2.1	5	4	2	8	21	33	11	16
Vlaspik	Seminis	12.4 a	2,372 a	2.3	3	3	6	6	12	32	12	27

Soil Type	: Fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.8; 1.0		: 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 26 (48 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, 2021.

Cultivar	Source	Total Yield 1-4, NC T/ac	$/ac	Fruit/ Plant	Days to Harvest	Percent Breakout N/C	1AB	2A	2B	3A	3B	4	O/S
V 5031	Nunhems	29.0 a	6,461 a	7	50	1	0	1	7	37	49	4	1
V 5025	Nunhems	26.6 ab	5,932 ab	8	50	3	1	2	19	34	39	2	0
Lennon	Rijk Zwaan	22.9 ab	5,033 ab	7	50	2	1	2	13	36	41	4	0
Bowie	Rijk Zwaan	22.1 ab	4,946 ab	7	51	3	2	3	20	44	25	2	0
Gershwin	Rijk Zwaan	22.2 ab	4,896 ab	8	51	5	2	10	11	39	30	1	1
Liszt	Rijk Zwaan	17.3 b	4,033 b	7	47	0	4	19	31	13	28	4	2
Rubinstein	Rijk Zwaan	18.8 ab	3,966 b	6	50	6	2	2	18	36	31	5	0

Soil Type	: Very fine sandy loam	Fertility	: 100 lbs/ac of N
Soil pH; % OM	: 6.8; 1.6		: 70 lbs/ac of P
Planting Date	: June 23		: 100 lbs/ac of K
Row Spacing	: 30"	Herbicides	: Command 0.4 L/acre PRE
Plant Spacing	: 8"	Harvest Dates	: Aug 9 (47 DTH), Aug 12 (50 DTH), Aug 13 (51 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 2021

Efficacy of Fungicides for Downy Mildew Control in Processing Cucumbers

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

Research Team: John, O'Sullivan, Rachel Riddle and Peter White
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 2021, the disease was first detected in Ontario in Kent County on June 17, which was earlier than detection in 2020. It was first observed and in cucumber trials at the research centre in Simcoe on July 23.

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: One trial was conducted at Ontario Crops Research Center – Simcoe, in 2021. Two cucumber varieties, 'Vlaspik' and 'Chaperon (DM-Defense variety)', were seeded using a precision seeder on June 28 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. A total of 11 treatments were evaluated, including an untreated control. Treatments were applied to plots on July 14, 21, 28 and August 4.

Downy mildew visual ratings were made at weekly intervals starting on July 21. Mature fruit were harvested by hand on August 11, 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 2021, downy mildew infection was slightly more severe than in 2020. The disease was detected in significant amounts (>5%) in trial plots on July 28, just as the crop was flowering. By the time the crop was ready for harvest on August 11, infection in untreated plants was 43% and 75% for the cucumber varieties Chaperon and Vlaspik, respectively. The Orondis Ultra alternated with Bravo treatment provided the best control of the disease with 8% and 18% leaf infection for Chaperon and Vlaspik, respectively. Intermediate disease control was observed from plants treated with Torrent, Zampro and Tattoo C. The highest levels of disease infection was observed in the Cueva and OxiDate treatments. Torrent alternated with Diplomat and Phostrol had 20% and 13% more disease infection when compared to the Torrent only treatment for Vlaspik and Chaperon, respectively (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 (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. Torrent and Zampro provide intermediate control suggesting that if used in a program with Orondis, these products remain the best downy mildew control option.

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 10 to 33% less disease with Chaperon when compared to Vlaspik. Chaperon yielded better than Vlaspik in all treatments, 26% and 59% 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 Allegro 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, 2021.

Product**	Rate per Acre	% Downy Mildew Infection* July 21	July 28	August 3	August 10	Yield T/acre	$/acre
Bravo ZN	1.9 L	0	12	29	43	4.1 b-e	681 cde
Torrent + Sylgard	81 mL 0.1 % v/v	0	1	16	23	6.5 ab	1,290 ab
Zampro + Sylgard	0.4 L 0.1 % v/v	0	3	20	33	6.5 ab	1,294 ab
Orondis Ultra alt. Bravo ZN	160 mL 1.9 L	0	4	15	18	8.1 a	1,704 a
Tattoo C	1.1 L	0	3	12	32	3.7 cde	736 b-e
Allegro	460 mL	0	10	27	42	5.0 bcd	1,002 bcd
Allegro	715 mL	0	10	33	43	5.5 bc	1,106 abc
OxiDate Sylgard	0.4 % v/v 0.1 % v/v	0	11	33	63	2.3 e	239 e
Torrent alt. Diplomat + Phostrol	81 mL 0.4; 1.2 L	0	3	37	43	5.6 abc	1,098 bc
Cueva	1 % v/v	0	13	48	68	2.8 de	402 de
Untreated Control		0	15	39	75	2.2 e	265 e

Planting Date : June 28
Plant Population : 55,000 plants/Ac
Date of First Application : July 14
Harvest Date : August 11

* Based on % leaves infected

** First application was applied at the 2-4-leaf stage, subsequent applications were made on a 7-day spray interval, 4 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, 2021.

Product**	Rate per Acre	% Downy Mildew Infection* July 21	July 28	August 3	August 10	Yield T/acre	Yield $/acre
Bravo ZN	1.9 L	0	5	12	27	8.5 a	1,770 a
Torrent + Sylgard	81 mL 0.1 % v/v	0	0	1	10	10.1 a	2,175 a
Zampro + Sylgard	0.4 L 0.1 % v/v	0	1	2	20	7.3 a	1,461 a
Orondis Ultra alt. Bravo ZN	160 mL 1.9 L	0	1	5	8	11.0 a	2,246 a
Tattoo C	1.1 L	0	1	6	17	8.1 a	1,586 a
Allegro	460 mL	0	4	13	28	8.4 a	1,778 a
Allegro	715 mL	0	4	10	25	8.7 a	1,797 a
OxiDate Sylgard	0.4 % v/v 0.1 % v/v	0	6	12	38	6.8 a	1,414 a
Torrent alt. Diplomat + Phostrol	81 mL 0.4; 1.2 L	0	0	6	23	9.3 a	1,939 a
Cueva	1 % v/v	0	7	22	35	8.0 a	1,679 a
Untreated Control		0	11	18	43	5.4 a	1,143 a

Planting Date : June 28
Plant Population : 55,000 plants/Ac
Date of First Application : July 14
Harvest Date : August 11

* Based on % leaves infected

** First application was applied at the 2-4-leaf stage, subsequent applications were made on a 7-day spray interval, 4 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

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.

Growers have observed that tank mixes of Command and Sandea can sometimes injure cucumber at high label rates, and there is concern about whether this will translate into yield loss. None of the treatments caused injury or yield loss in 2019, 2020 or 2021. In 2017, we observed a trend for greater injury as Sandea rate increased when tank mixed with Command, but we did not observe any reduction in yield. In 2017, we had excellent soil conditions at time of emergence. Soil temperatures were about 2C warmer than other years, and soil stayed moist from planting to emergence; however, a significant rain event (>3") occurred at the time of emergence, and may have been responsible for the injury we observed that year.

Objectives:

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

2. Determine the tolerance of cucumber to preemergence tank mixes of Sandea and Command at increasing rates of Sandea.

TRIAL 1. TOLERANCE OF CUCUMBER TO PREEMERGENCE HERBICIDES

Materials and Methodology:

Crop: Cucumber
Variety: Vlasstar
Planting rate: 113750 seeds/ha
Row spacing: 75cm
Planting date: May 24/21
Depth: 2 cm

Design: Randomized Complete Block Design
Plot width: 2m
Reps: 4
Plot length: 10m

Field Preparation: Trial fertilized with 19-19-19 at 580 kg/ha on May 23/21.

Soil Description:

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

Application Information:

	A
APPLICATION DATE	MAY 24/21
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)		0	0	0C	14	30A
2. pethoxamid	1200 G/HA	0	0	15B	13	22B
3. pethoxamid	2400 G/HA	0	0	24A	11	11C
4. ZIDUA	47 G/AC	0	0	13C	11	28AB
5. ZIDUA	94 G/AC	0	0	17B	9	20B
6. PROWL H20	0.96 L/AC	0	0	0C	13	31A
7. PROWL H20	1.92 L/AC	0	0	1C	13	30A
8. SHIELDEX	16.3 G/AC	0	0	0C	13	31A
9. SHIELDEX	32.6 G/AC	0	0	0C	12	29A
LSD (P <0.05)		0	0	5	NS	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 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.

TRIAL 2: EFFECT OF SANDEA RATE ON CUCUMBER TOLERANCE TO TANK MIXES OF SANDEA AND COMMAND

Materials & Methodology:

Crop: Cucumber
Variety: Vlasstar
Planting rate: 113750 seeds/ha
Row spacing: 75cm

Planting date: May 27/21
Depth: 2 cm

Design: Randomized Complete Block Design
Plot width: 2m
Reps: 4

Plot length: 10m

Field Preparation: Trial fertilized with 19-19-19 at 580 kg/ha on May 23/21.

Soil Description:
Sand: 56%
Silt: 20%
Clay: 24%

OM: 3.9%
pH: 7.6
CEC 14

Texture: sandy clay loam
Soil: Watford/Brady Series

Information:

	A
APPLICATION DATE	MAY 26
TIME OF DAY	8:00 AM
TIMING	PRE
AIR TEMP (c)	18
RH (%)	85
WIND SPEED (KPH)	8
SOIL TEMP (c)	21
CLOUD COVER (%)	50
CROP STAGE	PRE

Spray Equipment:

Application Method: CO_2 Backpack
Nozzle Type: Air Induction
Nozzle Spacing: 50 cm (20")
Spray Volume: 200 L/ha (20 GAL/AC)

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

Results:

The addition of Sandea at three different rates (25, 37.5 and 50 g/ac) to Command (0.45 L/ac) did not result in significant visual injury, and did not lead to a reduction in cucumber yield (Table 2.1). Injury ratings were 5% or less in all treatments, and yields of No.1, 2 and 3 ranged from 10.2 T/ac (untreated check) to 13.1 (Sandea + Command at 50 g/ac + 0.45 L/ac).

Weed control was influenced by Sandea rate (Table 2.1). Redroot pigweed, common lambsquarters and velvetleaf control were 69, 73, 81% in the Sandea + Command treatment with the lowest rate of Sandea (ie. 25 g/ac). Control of redroot pigweed, common lambsquarters, and velvetleaf, respectively, were 85, 78 and 87% in the Sandea + Command (50 g/ac + 0.45 L/ac) treatment.

Table 2.1. Effect of herbicide treatment on cucumber visual injury 7, 14 and 28 days after application and cucumber #1, #2, #3 yield.

HERBICIDE	RATE	VISUAL INJURY			YIELD (T/AC)		
		7D	14D	28D	#1	#2	#3
1. Check (WEEDFREE)		0	0	0	0.8A	0.5A	8.9A
2. Check (WEEDY)		0	0	0	0.2A	0.1A	4.2A
3. COMMAND	0.45 L/AC	0	0	0	0.7A	0.4A	9.1A
4. SANDEA	25 G/AC	0	0	0	0.8A	0.6A	9.4A
5. SANDEA	37.5 G/AC	0	0	0	0.9A	0.5A	9.1A
6. SANDEA	50 G/AC	0	0	0	0.7A	0.5A	9.4A
7. COMMAND +	0.45 L/AC	0	0	0	0.9A	0.6A	11.3A
SANDEA	25 G/AC						
8. COMMAND +	0.45 L/AC	2	1	0	0.8A	0.8A	11.5A
SANDEA	37.5 G/AC						
9. COMMAND +	0.45 L/AC	5	2	0	1.0A	0.6A	10.9A
SANDEA	50 G/AC						
LSD (P <0.05)		NS	NS	NS	0.4	0.4	2.3

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

Table 2.2. Effect of herbicide treatment on control of redroot pigweed (AMARE), lambsquarters (CHEAL), and velvetleaf (ABUTH) 56 days after application.

HERBICIDE	RATE	PERCENT CONTROL		
		AMARE	CHEAL	ABUTH
1. Check (WEEDFREE)				
2. Check (WEEDY)				
3. COMMAND	0.45 L/AC	60B	41C	74AB
4. SANDEA	25 G/AC	73AB	55C	53B
5. SANDEA	37.5 G/AC	76AB	64BC	56B
6. SANDEA	50 G/AC	76AB	69AB	58B
7. COMMAND + SANDEA	0.45 L/AC 25 G/AC	69AB	73AB	81A
8. COMMAND + SANDEA	0.45 L/AC 37.5 G/AC	73AB	75AB	84A
9. COMMAND + SANDEA	0.45 L/AC 50 G/AC	85A	78A	87A
LSD (P <0.05)		24	17	22

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

Conclusions:

This trial determined the effect of preemergence applications of tank mixes of Sandea plus Command at different rates of Sandea. Growers' observations have been that tank mixes that include Sandea can sometimes injure cucumber at high label rates, and there is concern about whether this will translate into yield loss. None of the treatments caused injury or yield loss in 2019, 2020 or 2021; however, the first year we ran this trial (ie. in 2017, we observed a trend for greater injury as Sandea rate increased when tank mixed with Command). Despite the injury, there was not a reduction in yield. There was a benefit in greater control of lambsquarters and velvetleaf as Sandea rate increased, though again – there was no beneficial impact on yield.

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2021 Research Report

Integrating fungicide programs and host resistance for cucurbit downy mildew management

Prepared for the Ontario Cucumber Research Committee (OCRC)
November 1, 2021

Research Agency/Location: University of Guelph, Ridgetown Campus

Lead & Key Investigators:

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- 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 first completed in 2019 (no results due to lack of downy mildew) and 2020.
- 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.
- This work should be repeated to assess cultivar and fungicide program response under a variety of environmental conditions since growing seasons with higher disease pressure might result in a different response. This is supported by the observation of differences in leaf symptom incidence and leaf area affected among fungicide programs and cultivars (ie. treatments differences we saw for disease this year might translate to yield differences in a year where disease severity is higher).

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

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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 6 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 four fungicide applications (application codes ABCD) which were applied approximately seven to eight days apart on July 19, 26, Aug 3 and 11. The trial was irrigated as needed using drip irrigation.

Downy mildew was reported in Chatham-Kent in early July. To 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 7.

The trial was assessed for downy mildew on July 28, Aug 6, 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. The values for percent infected leaves were used to calculate the area under the disease progress curve (AUDPC). The area under the disease progress curve for the percent infected leaves and leaf area affected in whole plots was calculated using the following equation: where Y_i is percent infected leaves at day X_i and Y_{i-1} is percent infected leaves at day X_{i-1}: AUDPC = $\sum [((Y_i + Y_{i-1}) (X_i - X_{i-1}))/2]$.

Fruit was harvested on August 16 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. Prices used were based on Hartung Brothers 2021 grower agreement for machine harvested cucumbers (Grade 1 = $0 USD per ton, Grade 2 = $275 USD per ton, Grade 3 = $230 USD per ton, Grade 4 = $70 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. AUDPC data in Table 1 did not fit a Gaussian distribution had a lognormal error distribution applied to the analysis. The back-transformed means are presented for ease of interpretation. For disease data in Table 1, 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. There was no interaction between the two factors for whole plot disease data in Table 2.

RESULTS:

Disease pressure in the trial was moderate. Symptoms were observed in all control plots on July 21.

For the incidence and severity of leaves with downy mildew, cucumber response to fungicide treatment differed depending on host resistance (Table 1). However, at harvest, the only treatment to have lower incidence of leaves with downy mildew than the nontreated control of the same cultivar was the 'low input-begin with Bravo' program. For total disease (AUDPC) calculated from leaf incidence data, all fungicide programs reduced downy mildew compared to the nontreated control within the same cultivar. For 'Vlaspik', this reduction was to the same level among fungicide programs. For 'Peacemaker', the 'low input-begin with Bravo' program had lower AUDPC for disease incidence than the 'high input-1x Orondis' program.

All fungicide programs applied to 'Vlaspik' treatments reduced the severity of symptoms on leaves with downy mildew at harvest compared to the nontreated control (Table 1). Severity in the 'low input-begin with Bravo' program was lower than the other three fungicide programs for 'Vlaspik' cucumbers, although total disease (AUDPC) did not differ among fungicide treatments. For programs applied to 'Peacemaker' cucumbers, only the 'low input-begin with Bravo' program had lower severity than 'Peacemaker' that received no fungicides. The total disease (AUDPC) for symptom severity in both low input programs was lower than the high input programs for 'Peacemaker'.

Whole plot severity in 'Vlaspik' was higher than 'Peacemaker' (Table 2), which was consistent with observations of incidence and severity of leaves with downy mildew symptoms (data not shown). For whole plot severity, both cultivars responded similarly to fungicide program at harvest and over the season (AUDPC). AUDPC and whole plot severity at harvest in the 'low input-begin with Bravo' program were lower than all other treatments. The 'low input-end with Bravo' and 'high input-2x Orondis' programs also had lower whole plot severity than the nontreated control at harvest and over the season (AUDPC). However, the 'high input-1x Orondis' program did not have lower severity than the nontreated control at harvest.

Yield data is not presented as cucumber development was overpredicted and harvest was completed too early (excess Grade 1s).

CONCLUSIONS: Most fungicide programs reduced downy mildew incidence and severity, however, not always to the same level. The 'low input-begin with Bravo' program was most consistent in reducing the incidence of leaves with downy mildew, the leaf area with symptoms on infected leaves, and the overall plot severity. This was unexpected and differed from results in 2020, when all fungicide programs were equally effective, and previous results on 'Vlaspik' at Ridgetown Campus, where programs with more Bravo applications tended to have more disease symptoms (2016-2018) and programs that began with Orondis Ultra had very few disease symptoms. 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, with results pending.

This research should be repeated to assess cultivar and fungicide program response under a variety of environmental conditions since growing seasons with higher disease pressure (ie. Near or complete burn down in nontreated susceptible control plots), might result in greater separation of treatments.

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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, 2021.

Host CDM Resistance x Fungicide Program		Incidence (% leaves w/ symptoms)		Severity (% leaf on symptomatic leaves)	
		Aug 16	AUDPC	Aug 16	AUDPC
Vlaspik	Nontreated control	16 ab	363 a	35 a	396 a
Vlaspik	'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	7 cd	159 c	9 ef	157 b
Vlaspik	'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	23 a	145 c	25 b	164 b
Vlaspik	'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	22 a	159 bc	23 bc	160 b
Vlaspik	'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	20 a	151 c	20 cbd	148 b
Peacemaker	Nontreated control	11 bc	256 ab	20 cbd	284 a
Peacemaker	'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	2 d	60 e	5 f	70 c
Peacemaker	'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	9 bcd	66 de	13 efd	101 c
Peacemaker	'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	12 bc	107 cd	16 cbde	141 b
Peacemaker	'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	10 bc	108 cde	15 cde	149 b
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 19, B= July 26, C=Aug 3, D=Aug 11. Application 'E' was not applied because the trial was ready for harvest. [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 16. Abbreviations: AUDPC = area under the disease progress curve.

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Table 2. Incidence of leaves with symptoms (%) of cucurbit downy mildew (whole plots) in susceptible 'Vlaspik' and resistant 'Peacemaker' treated with different fungicides programs, Ridgetown, ON, 2021.

Main Effects [a]	Severity (% leaf area affected, whole plots)	
	Aug 16	AUDPC
Host CDM Resistance		
Vlaspik	15 a	124 a
Peacemaker	9 b	81 b
Fungicide Program[b,c]		
Nontreated control	18 a	233 a
'Low input-begin with Bravo' Bravo ZN (AB) Orondis Ultra (C) Torrent + Sylgard 309 (D) ~~Zampro + Sylgard 309 (E)~~	2 c	44 c
'Low input-end with Bravo' Orondis Ultra (A) Torrent + Sylgard 309 (B) Zampro + Sylgard 309 (C) Bravo ZN (D~~E~~)	13 b	77 b
'High input-1x Orondis' Orondis Ultra (A) Torrent + Sylgard 309 (BD) Zampro + Sylgard 309 (C~~E~~)	14 ab	83 b
'High input-2x Orondis' Orondis Ultra (AD) Torrent + Sylgard 309 (B~~E~~) Zampro + Sylgard 309 (C)	12 b	75 b
Significance		
Cultivar	*	*
Fungicide program	*	*
Cultivar x Fungicide program	NS	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 19, B= July 26, C=Aug 3, D=Aug 11. Application 'E' was not applied because the trial was ready for harvest. [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 16. Abbreviations: AUDPC = area under the disease progress curve.