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Tomato, Pepper, Cucumber, Pumpkin, Cabbage, and Collards
Vegetable Disease Diagnostics

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Table of Contents

Acknowledgments 2

Tomato

Evaluation of fungicides for the control of anthracnose in processing tomatoes, 2021 3

Evaluation of fungicides for the control of anthracnose, black mold and Septoria leaf spot in processing tomatoes, 2021 .. 5

Pepper

Evaluation of resistance of pepper cultivars to bacterial canker, 2021 7

Evaluation of resistance of pepper cultivars to Pseudomonas leaf spot, 2021. 10

Evaluation of fungicides for the control of anthracnose in peppers, 2021 13

Cucumber

Evaluation of resistance of cucumber varieties to downy mildew, 2021 15

Bioassay for sensitivity of *Pseudoperonospora cubensis* to fungicides in OH, 2021 18

Pumpkin

Evaluation of fungicides for the control of powdery mildew and Plectosporium blight of pumpkin, 2021 20

Bioassay for sensitivity of *Podosphaera xanthii* to fungicides in OH, 2021 22

Bioassay for sensitivity of *Podosphaera xanthii* to OMRI-listed products in OH, 2021 24

Cabbage

Evaluation of fungicides and biologicals for the control of Alternaria leaf spot and soft rot of cabbage, 2021 26

Evaluation of biologicals and fungicides for the control of white mold of cabbage, 2021 28

Collards

Evaluation of biologicals and copper for the managment of black rot and peppery leaf spot of collards, 2021 29

Vegetable Disease Diagnostics, 2021 31

Contacts 36

Acknowledgments

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TOMATO (*Solanum lycopersicum* 'GEM 611')
Anthracnose; *Colletotrichum coccodes*

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Evaluation of fungicides for the control of anthracnose in processing tomatoes, 2021.

The experiment was conducted at The Ohio State University's North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sand. On 23 Mar, the herbicide Roundup PowerMAX (32 fl oz/A) was applied to the field to control winter weeds. The test field was disk chiseled on 6 Apr and worked with a mulch finisher on 7 Apr. Tomato 'GEM 611' seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) on 7 Apr and sown on 19 Apr into 288-cell plug trays containing Baccto Professional Growers Mix. On 26 Apr, the fertilizers 46-0-0 (N-P-K, 250 lb/A), 10-52-0 (100 lb/A) and 0-0-60 (450 lb/A) and 10% granular boron (10 lb/A) were broadcast and incorporated into the field. Raised beds were prepared on 5 ft centers on 27 Apr. The herbicides Dual Magnum (20 fl oz/A), Metribuzin (0.33 lb/A), and Roundup PowerMAX (22 fl oz/A) were applied to the field on 13 May. Tomato seedlings were transplanted on 17 May using a row transplanter. Starter fertilizer (0.7 qt/50 gal; 10-34-0) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. Insecticides were applied as needed: Warrior II with Zeon Technology (1.92 fl oz/A; 24 Jun and 4 Aug), Carbaryl 4L (32 fl oz/A; 24 Jun), Mustang Maxx (4 oz/A; 6 Jul and 20 Aug), Beleaf 50 SG(2 fl oz/A; 13 Aug), Assail 30 SG (4 oz/A; 29 Jun and 28 Jul), Actara (5.5 oz/A; 21 Jul), and Baythroid XL (3 fl oz/A; 13 Aug). Fungicides were applied as needed: Orondis Ultra (8 fl oz/A; 24 Jun, 28 Jul and 20 Aug), Ranman (2.75 fl oz/A; 6 Jul and 4 Aug), and Presidio (4 fl oz/A; 21 Jul and 23 Aug). The field was cultivated on 14 Jun and 7 and 21 Jul and hand weeded and hoed on 14, 23 and 29 Jun and 7 and 23 Jul. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 41.3 gal/A, 3 mph) beginning on 23 Jun and ending on 26 Aug for a total of nine applications. On 31 Aug, five tomato plants were harvested from the center of each treatment or non-treated control row. Weights of marketable tomatoes, green tomatoes, tomatoes showing anthracnose symptoms and culls were measured. Average maximum temperatures for May, Jun, Jul, 1-24 Aug were 70.9, 82.8, 83.5 and 85.1°F; average minimum temperatures were 48.3, 64.4, 64.6 and 63.2°F; and rainfall amounts were 4.5, 5.5, 6.1 and 1.4 in., respectively. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher's least significant difference test with SAS software.

Anthracnose fruit rot pressure was high, with fruit rot incidence reaching 39.1% in the non-treated control. Yields of tomato fruits with anthracnose ranged from 6.4 to 14.5 t/A and were significantly lower in plots treated with Bravo Weather Stik (6.4 t/A), Quadris Flowable (7.3 t/A), Quadris Top (8.4 t/A), or Aprovia Top (10.0 t/A) than in non-treated control plots. The incidence of anthracnose fruit rot ranged from 13.5 to 38.9% in treated plots and was significantly lower for plots treated with these fungicides, as well as with Miravis Prime, Fontelis or Cevya, compared to non-treated control plots. The lowest anthracnose incidence occurred in plots treated with Bravo Weather Stick (13.5%), Quadris Flowable (16.3%), or Quadris Top (18.8%). Marketable yields ranged from 17.0 to 36.0 t/A; percentages of marketable fruit ranged from 50.4 to 77.0%. All treatments except Inspire Super and Rhyme significantly increased marketable yield and percentage marketable fruit compared to the non-treated control. The highest marketable yield percentages were from plots treated with Quadris Flowable (77.0%), Bravo Weather Stik (76.3%), or Quadris Top (74.7%). There were no significant differences in yield of green fruit and total yield among treated and non-treated plots. This trial was supported by funds provided by the Ohio Produce Growers and Marketers' Ohio Vegetable and Small Fruit Research and Development Program (OPGMA OVSFRDP).

Treatment, rate (application timing)[z]	Fruit w/ anthracnose (t/A)	Fruit w/ anthracnose (%)	Green fruit (t/A)	Green fruit (%)	Total yield (t/A)	Marketable yield (t/A)[y]	Marketable yield (%)[x]
Non-treated	13.7 a	39.1 a	2.8	7.9	34.4	17.0 f	50.4 e
Miravis Prime, 11.4 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	12.9 ab	30.1 bc	2.5	5.7	42.9	26.5 cde	62.0 d
Inspire Super, 20 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	14.0 a	36.3 ab	3.3	7.8	40.0	21.4 def	52.3 e
Aprovia Top, 13.5 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	10.0 bc	25.4 cd	2.6	6.2	40.7	27.9 bcd	67.9 bcd
Quadris Flowable, 6.2 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	7.3 cd	16.3 e	2.5	5.4	45.3	34.9 ab	77.0 a
Quadris Top, 8 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	8.4 cd	18.8 de	2.6	5.7	45.4	34.0 abc	74.7 abc
Fontelis, 24 fl oz/A Activator 90, 0.125 % v/v (1-9)	12.7 ab	29.8 bc	2.8	6.2	43.4	27.2 b-e	62.4 d
Bravo Weather Stik, 2.75 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	6.4 d	13.5 e	4.3	9.0	47.3	36.0 a	76.3 ab
Cevya, 5 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	12.1 ab	26.1 cd	3.4	7.3	46.8	30.9 abc	65.8 cd
Rhyme, 7 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	14.5 a	38.9 a	2.5	6.7	37.8	19.9 ef	52.7 e
P-value	<0.0001	<0.0001	0.5777	0.3703	0.1411	0.0001	<0.0001

[z]Application dates: 1= 23 Jun; 2= 6 Jul; 3= 15 Jul; 4= 21 Jul; 5= 27 Jul; 6= 4 Aug; 7= 12 Aug; 8= 19 Aug; 9= 26 Aug.
[y]Means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.
[x]Percentages based on t/A values.

TOMATO (*Solanum lycopersicum* 'GEM 611')
Anthracnose; *Colletotrichum coccodes*
Black mold; *Alternaria alternata*
Septoria leaf spot; *Septoria lycopersici*

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Evaluation of fungicides for the control of anthracnose, black mold and Septoria leaf spot in processing tomatoes, 2021.

The experiment was conducted at The Ohio State University CFAES Wooster Campus Snyder Farm in Wooster, OH on Canfield silt loam. Tomato 'GEM 611' seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) on 7 Apr and sown on 19 Apr into 288-cell plug trays containing Baccto Professional planting mix. The field was plowed on 18 May, and on 23 May, the fertilizer 10-20-20 (N-P-K, 400 lbs/A) was broadcast and incorporated into the field. The herbicides Dual Magnum (1.33 pt/A), and Sencor (0.66 lb/A) were applied to the field on 4 Jun. Tomato seedlings were transplanted on 8 Jun using a row transplanter. Starter fertilizer (2 lb/50 gal; 12-48-8 N-P-K) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Treated and control rows were alternated with non-treated border rows. Insecticides were applied as needed: Mustang Maxx (3 fl oz/A; 24 Jun), PBO (3 fl oz/A; 24 Jun) and Warrior II (1.5 fl oz/A; 8 Jul). On 30 Jul, tomato plants were inoculated with approximately 10^6 spores/ml of *Alternaria alternata* isolate SM210-18 using a CO_2-pressurized backpack sprayer. Foliar fungicide treatments were applied using a tractor-mounted CO_2-pressurized sprayer (40 psi, 47.0 gal/A, 2.5 mph) beginning 23 Jun and ending 26 Aug for a total of nine applications. On 24 Sep, five tomato plants were harvested from the center of each treatment row. Weights of marketable tomatoes, green tomatoes, tomatoes with black mold, blossom end rot, and anthracnose were measured. Fifty asymptomatic tomatoes from each treatment row were randomly selected, half of which were stored in a cooler (40°F) and the other half at room temperature (70°F). After 7 days, black mold and anthracnose disease incidence was determined. Fruits with both fruit rots were counted in both categories. Average maximum temperatures for Jun, Jul, Aug, and 1-24 Sep were 81.9, 81.6, 84.9 and 78.4°F; average minimum temperatures were 61.2, 61.8, 63.2 and 56.5°F; and rainfall amounts were 2.1, 6.8, 2.9 and 2.4 in., respectively. Natural log transformation was performed on the AUDPC values. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher's least significant difference test with SAS software.

Septoria leaf spot disease pressure was very high in this trial, with disease severity reaching 98.8% in the non-treated control. Foliar application of any of the three rates of pyraziflumid tested, or Quadris Top alternated with Bravo Weather Stik significantly reduced final Septoria leaf spot severity and season-long disease progression (AUDPC) compared to the non-treated control. The incidence of black mold on fruit in the field was low (≤10.1%) and there were no significant differences among treated and non-treated control plots. Anthracnose fruit rot incidence was high in the field, reaching 38.3% in the non-treated control. All fungicide treatments significantly reduced anthracnose incidence. The percentage of fruits with anthracnose was significantly lower in plots treated with Quadris Top alternated with Bravo Weather Stik (2.4%) than in plots treated with pyraziflumid (16.7 to 23.9%). Marketable yield (t/A) and percentage marketable fruit were significantly higher for fungicide-treated than non-treated plots; plots treated with Quadris Top alternated with Bravo Weather Stik yielded significantly more marketable fruit than those treated with pyraziflumid. Seven days after harvest, among fruits held at 70°F, the incidence of black mold in fruits from fungicide-treated plots (0-7%) was significantly lower than in non-treated control fruits (25%), and there were no differences among the four fungicide treatments. Anthracnose incidence was high in fruits from non-treated control plots (76%), and only fruits from plots treated with Quadris Top alternated with Bravo Weather Stik showed significantly lower anthracnose incidence. Similarly, due to the high incidence of anthracnose in fruits from pyraziflumid-treated plots, the percentage marketable fruits was significantly higher from plots treated with Quadris Top alternated with Bravo Weather Stik than those treated with pyraziflumid or not treated. Among tomato fruits held for 7 days at 40°F, incidences of black mold (4%) and anthracnose (38%) in non-treated control fruits were lower than at 70°F and there were no significant differences in disease incidence or percent marketable fruit among fruits from fungicide- treated and non-treated control plots.

Treatment, rate (application timing)[z]	Septoria leaf spot severity		Yield of fruit with black mold		Yield of fruit with anthracnose		Marketable yield	
	20 Sep (%)[yx]	AUDPC[xwv]	(t/A)	(%)	(t/A)	(%)	(t/A)	(%)
Non-treated	98.8 a	1727.0 a	1.5	10.1	8.1 a	38.3 a	9.4 c	40.6 c
Pyraziflumid, 1.56 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	3.0 c	19.8 b	0.9	3.2	4.7 ab	16.7 b	18.6 b	66.1 b
Pyraziflumid, 2.34 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	3.0 c	24.6 b	1.7	5.3	7.7 a	23.9 b	17.2 b	54.7 b
Pyraziflumid, 3.11 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	6.3 b	56.8 b	1.2	3.8	6.8 a	22.6 b	17.6 b	60.8 b
Quadris Top, 8 fl oz/A (1,3,5,7,9) Bravo Weather Stik, 2.75 pt/A (2,4,6,8) Activator 90, 0.125 % v/v (1-9)	1.5 c	10.3 b	0.5	1.4	1.0 b	2.4 c	27.8 a	80.3 a
P-value	<0.0001	<0.0001	0.2735	0.3202	0.0128	<0.0001	0.0005	0.0006

[z]Application dates: 1= 23 Jul; 2= 30 Jul; 3= 6 Aug; 4= 13 Aug; 5= 20 Aug; 6= 27 Aug; 7= 4 Sep; 8= 10 Sep; 9= 17 Sep.
[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.
[x]Septoria leaf spot disease ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.
[w]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.
[v]Values are the back-transformed means.

Treatment, rate (application timing)[z]	Black mold and anthracnose fruit rot incidence 7 days after harvest					
	70°F			40°F		
	Marketable fruit (%)[y]	Fruit w/ black mold (%)	Fruit w/ anthracnose (%)	Marketable fruit (%)	Fruit w/ black mold (%)	Fruit w/ anthracnose (%)
Non-treated	24.0 b	25.0 a	76.0 a	62.0	4.0	38.0
Pyraziflumid, 1.56 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	25.0 b	4.0 b	75.0 a	73.0	6.0	27.0
Pyraziflumid, 2.34 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	11.0 b	7.0 b	89.0 a	74.0	5.0	26.0
Pyraziflumid, 3.11 fl oz/A (1-9) Activator 90, 0.125 % v/v (1-9)	23.0 b	0.0 b	77.0 a	73.0	4.0	27.0
Quadris Top, 8 fl oz/A (1,3,5,7,9) Bravo Weather Stik, 2.75 pt/A (2,4,6,8) Activator 90, 0.125 % v/v (1-9)	55.0 a	5.0 b	45.0 b	78.0	0.0	22.0
P-value	0.0016	0.0186	0.0016	0.2088	0.2114	0.2088

[z]Application Dates: 1= 23 Jul; 2= 30 Jul; 3= 6 Aug; 4= 13 Aug; 5= 20 Aug; 6= 27 Aug; 7= 4 Sep; 8= 10 Sep; 9= 17 Sep.
[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.

PEPPER (*Capsicum annuum*)
Bacterial canker; *Clavibacter michiganensis* subsp. *michiganensis*

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Evaluation of resistance of pepper cultivars to bacterial canker, 2021.

The experiment was conducted at The Ohio State University's Horticulture Research Unit 2 in Wooster, OH on Canfield silt loam. On 12 Apr, seeds of all varieties were treated by agitating them in a 20% Clorox (1.1% sodium hypochlorite) solution for 1 min, followed by a 5 min rinse in running tap water and then air-dried. Seeds were sown on 15 Apr into 200-cell plug trays containing Baccto Professional Growers Mix. On 21 May, pepper seedlings were inoculated in a greenhouse with approximately 10^8 CFU/ml *Clavibacter michiganensis* subsp. *michiganensis* strains C290 and A226 using a handheld sprayer. The test field was disked on 23 May and the fertilizer 10-20-20 (N-P-K) at 400 lb/A was broadcast and incorporated into the soil on 23 May. On 1 Jun, Command (20 fl oz/A) and Dual Magnum (1 pt/A) was applied and incorporated into the test field for weed control. The pepper seedlings were transplanted on 2 Jun; starter fertilizer solution (N-P-K 12-48-8; 2 lb/50-gal water) was applied at transplanting. Plots were arranged in a randomized complete block design with three replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Pepper plants were also inoculated in the field with approximately 10^8 CFU/ml *Clavibacter michiganensis* subsp. *michiganensis* strains C290 and A226 on 2 Jul using a CO_2-pressurized backpack sprayer. The field was cultivated on 28 Jun and hand weeded and hoed on 19 Jul. The insecticides Warrior II (3 fl oz/A; 11 Jun), PBO (4 fl oz/A; 11 and 24 Jun), Seven (2 qt/A; 15 Jun) and Mustang Maxx (3 fl oz/A; 24 Jun) were applied. Foliar bacterial canker severity was evaluated on 11, 18 and 25 Jun, 2, 12 and 26 Jul, 6, 16, 23 and 30 Aug and 7 Sep; severity was based on a scale of 0-100% foliage affected. Pepper fruits were harvested from 10 plants in the middle of each row on 12 Aug and 2 Oct. The number of healthy fruits, fruits with canker lesions, and minor fungal fruit rots or other diseases (culls) was recorded. Average maximum temperatures for Jun, Jul, Aug, Sep, and 1-2 Oct were 81.9, 81.6, 84.9, 77.6 and 77.3°F; average minimum temperatures were 61.2, 61.8, 63.2, 54.5 and 40.8 °F; and rainfall amounts were 2.1, 6.8, 2.9, 2.4 and 0.1 in., respectively. Arcsine transformation (arcsine $[\sqrt{(X/100)}]$) was performed on severity ratings, fruit with canker, marketable fruit, and culls. Natural log transformation was performed on AUDPC ratings. Regression analyses were preformed using the REG procedure; analysis of variance was performed using the GLIMMIX procedure, transformed means were separated by Fisher's least significant difference test with SAS software.

Environmental conditions were favorable for bacterial canker development early in the season, but became unfavorable later in the season, resulting in low final disease severity ratings (7 Sep). Therefore, season-long disease severity (AUDPC) reflects canker susceptibility better than end-of-season ratings. There were significant differences in AUDPC values among the varieties; the most susceptible varieties were Teniente (jalapeño), Mercer (bell), Pageant (sweet banana) and Dante (jalapeño), while the most resistant were Fury (hot banana), Playmaker (bell), Panuco (chili), 3108 (hot banana), Orizaba (jalapeño) and Everman (jalapeño). The percentage of fruits with bacterial canker symptoms differed significantly among varieties, ranging from 0.7 to 13.1% fruit infected. Similarly, varieties varied significantly in the percentage marketable fruits and cull fruit. Foliar symptom progression (AUDPC) and the percentage of fruits with canker symptoms ($R = 0.1296$; $P < 0.0001$) and marketable fruits ($R = 0.0505$; $P < 0.0194$) were positively and significantly correlated but R values were low. There was no significant correlation between AUDPC and the percentage of culled fruits ($R = 0.0049$; $P < 0.4710$). AUDPC values were marginally insignificant ($P = 0.0621$) when averaged among pepper types. However, the percentage of fruits with canker symptoms was highest for bell peppers (6.9%), intermediate for banana (2.6%) and jalapeño (4.1%), and lowest for chili (0.8%) varieties. Percentage marketable fruits was highest for jalapeño (88.1%) and chili (92.2%), intermediate for banana (82.3%) and lowest for bell (75.1%) pepper varieties. Percentage culls was significantly higher for bell (16.7%) and banana (14.4) varieties than for jalapeño (7.1%) and chili (6.6%) varieties.

Table 1. Average severity of foliar bacterial canker on 35 pepper varieties on 7 Sep, Area Under Disease Progress Curve (AUDPC), and harvest data.

Variety	Type	Foliar bacterial canker severity: 7 Sep (%)[zx]		Foliar bacterial canker severity: AUDPC[zyw]		Fruit with canker (%)[wv]		Marketable fruit (%)[v]		Culled fruit (%)[wv]	
Teniente	Jalapeño	8.3	ab	1053.9	a	10.6	abc	84.4	a-f	4.3	ij
Mercer	Bell	10.7	a	998.8	a	8.2	a-g	83.2	a-g	8.5	g-j
Pageant	Sweet banana	4.3	cd	890.9	a	3.6	f-k	81.3	b-h	15.1	c-i
Dante	Jalapeño	5.7	bc	797.7	ab	4.5	d-j	90	abc	5.4	ij
Paladin	Bell	3	cde	620.2	bc	6.2	b-i	82.5	a-g	10.7	f-j
2628/Shogun	Bell	3.7	cde	590.3	bcd	13.1	a	69.3	ij	17.6	c-h
2622/Nitro	Bell	3.7	cde	542	cde	8.8	a-f	73.6	f-j	17.4	c-h
Provider	Bell	3.7	cde	505.7	c-f	4.4	d-j	72.3	g-j	23.2	bc
Skyhawk	Bell	2.3	de	501.5	c-g	5.4	c-j	57.8	kl	35.9	a
Aristotle	Bell	2.3	de	477.2	c-h	4.8	c-j	83	a-g	12.1	c-j
Turnpike	Bell	3.7	cde	472.4	c-h	9.2	a-e	79.3	c-i	11	e-j
Tzotzil	Jalapeño	4.3	cd	441.6	d-i	3.6	f-k	81.8	b-g	14.6	c-i
PS11435807	Jalapeño	3.7	cde	418.6	e-j	3.8	e-k	89.8	abc	6.3	hij
Karisma	Bell	3	cde	405.9	e-j	8.5	a-f	85.9	a-e	5.3	ij
Currier	Bell	2.3	de	404.1	e-j	9.8	a-d	70	hij	18.6	b-g
Cuatrero	Jalapeño	3.7	cde	392.6	f-k	2.7	h-k	90.3	abc	6.6	hij
SV3782PP	Sweet banana	1	e	376.3	f-l	1.8	jk	75.5	e-j	22.2	b-e
Outsider	Bell	1	e	371.7	g-l	7.4	a-h	53.3	l	38.7	a
SVPP8114	Sweet banana	1	e	362.2	h-l	5.1	c-j	84.5	a-f	10.2	f-j
Samurai	Bell	3.7	cde	361.9	h-l	12.4	ab	73.1	f-j	14.2	c-j
SV3198HJ	Jalapeño	2.3	de	339.5	i-m	4.6	d-j	81.5	b-g	13.4	c-j
Regulator	Bell	2.3	de	336.8	i-m	4.5	d-j	82.4	a-g	13.1	c-j
Autry	Bell	2.3	de	324.1	j-n	8.7	a-f	68	ijk	23	bc
Ninja	Bell	3.7	cde	315.3	j-o	9.8	a-d	69.9	hij	20.3	b-f
Placepack	Bell	1.7	de	295.3	k-p	2.7	h-k	74.3	f-j	22.8	bcd
Standout	Bell	1.7	de	292.9	k-p	3.1	g-k	86.4	a-e	10	f-j
Lola	Sweet banana	1	e	289.7	k-p	1.9	jk	83.2	a-g	14.9	c-i
Wildcat	Chili	1.7	de	279.2	l-p	0.7	k	91.5	ab	7.4	g-j
Prodigy	Bell	3.7	cde	262.6	m-q	4.3	d-j	66.1	jk	29.4	ab
Fury	Hot banana	1	e	239.1	n-r	2.4	ijk	77.3	d-j	20.1	b-f
Playmaker	Bell	1	e	236.7	o-r	5.4	c-j	82.7	a-g	11.3	e-j
Panuco	Chili	1.7	de	230	pqr	0.9	k	92.6	ab	6.4	hij
3108	Hot banana	1	e	196.1	qr	1.5	jk	86.8	a-e	11.7	d-j
Orizaba	Jalapeño	1.7	de	193.5	r	3.2	g-k	93.5	a	3	j
Everman	Jalapeño	1.7	de	183	r	2	ijk	87.9	a-d	9.9	f-j
P-value		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	

[z] Foliar bacterial canker ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[y]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.

[x]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

[w]Values are the back-transformed means.

[v]Based on numbers of fruits.

Table 2. Average severity of foliar bacterial canker by pepper type on 7 Sep, Area Under Disease Progress Curve (AUDPC), and harvest data.

Type	Foliar bacterial canker severity								
	7 Sep (%)[zx]		AUDPC[zyw]	Fruit with canker (%)[wv]		Marketable fruit (%)[wv]		Culled fruit (%)[wv]	
Bell	3.1	ab	411.1	6.9	a	75.1	c	16.7	a
Banana	1.6	c	343.7	2.6	bc	82.3	b	14.4	a
Jalapeño	3.9	a	405.7	4.1	b	88.1	a	7.1	b
Chili	1.7	bc	253.4	0.8	c	92.2	a	6.6	b
P-value	0.0105		0.0621	<0.0001		<0.0001		<0.0001	

[z] Foliar bacterial canker ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[y] AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.

[x] Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

[w] Values are the back-transformed means.

[v] Based on numbers of fruit.

PEPPER (*Capsicum annuum*)
Pseudomonas leaf spot; *Pseudomonas syringae* pv. *syringae*

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Evaluation of resistance of pepper cultivars to Pseudomonas leaf spot, 2021.

The experiment was conducted at The Ohio State University's North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sand. On 12 Apr, seeds of all varieties were treated by agitating them in a 20% Clorox (1.1% sodium hypochlorite) solution for 1 min, followed by a 5 min rinse in running tap water and then air-dried. Seeds were sown on 15 Apr into 200-cell plug trays containing Baccto Professional Growers Mix. The fertilizers 46-0-0 (N-P-K) at 250 lb/A, 10-52-0 (N-P-K) at 100 lb/A, 0-0-60 (N-P-K) at 450 lb/A, and 10% granular boron at 10 lb/A were broadcast and the test field was disk chiseled, tilled, worked with a seedbed finisher, and disked again and 26 Apr. On 27 Apr, beds were prepared on 5 ft centers. Prior to transplanting, plants were inoculated with approximately 10^8 CFU/ml *Pseudomonas syringae* pv. *syringae* strains SM115-18 and SM156-18 on 20 May using a handheld spray bottle and kept in a high-humidity mist chamber until transplanting. Pepper seedlings were transplanted on 10 Jun. Starter fertilizer solution (N-P-K 10-34-0; 0.7 qt/50-gal water) was applied at transplanting. The experiment was laid out in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart. Insecticides were applied as needed and included Warrior II with Zeon Technology (1.92 fl oz/A; 4 Aug), Mustang Maxx (4 fl oz/A; 20 Aug and 17 Sep), Carbaryl 4L (32 fl oz/A; 24 Jun and 10 Sep at 16 fl oz/A), Radiant SC (6 fl oz/A; 10 Sep), Assail 30 SG (4 oz/A; 29 Jun and 28 Jul), LI700 NIS (11.3 fl oz/A; 29 Jun), Actara 25 WG (5.5 fl oz/A; 21 Jul and 27 Aug), Beleaf 50 SG (2 oz/A; 13 Aug), Preference NIS (11.3 fl oz/A; 21 and 28 Jul) and Baythroid XL (3 oz/A; 13 Aug and 3 Sep at 2.8 fl oz/A). Fungicides were also applied to manage anthracnose and phytophthora and included Orondis Ultra (8 fl oz/A; 24 Jun, 28 Jul, 20 Aug), Quadris Flowable (15 fl oz/A; 21 Jul, 4 and 20 Aug, 3 and 17 Sep), Presidio (4 fl oz/A; 21 Jul, 13 Aug, and 3 Sep), Ranman (2.75 fl oz/A; 4 and 27 Aug and 10 Sep) and Initiate 720 (1.5 pt/A; 28 Jul, 13 and 27 Aug, 10 Sep). The field was hoed and hand weeded on 20 Jul and cultivated on 6 and 21 Jul. Severity of Pseudomonas leaf spot on foliage was evaluated on 15, 22, and 29 Jun, 6, 15, 20, and 27 Jul, 3, 10, 17 and 25 Aug, 3, 9, and 16 Sep using a scale of 0-100% foliage affected. Average maximum temperatures for Jun, Jul, Aug, and 1-26 Sep were 82.8, 83.5, 85.8 and 79.4°F; average minimum temperatures were 64.4, 64.6, 64.4 and 56.7°F; and rainfall amounts were 5.5, 6.1, 3.0 and 3.3 in., respectively. Natural log transformation was performed on the AUDPC ratings. Analysis of variance was performed using the GLIMMIX procedure, and means were separated by Fisher's least significant difference test with SAS software.

Environmental conditions were favorable for Pseudomonas leaf spot development early in the season (see figure below), but became unfavorable later in the season, resulting in low final disease severity ratings (16 Sep). Therefore, season-long disease severity (Area Under the Disease Progress Curve; AUDPC) reflects Pseudomonas leaf spot susceptibility better than end-of-season ratings. There were significant differences in AUDPC values among the varieties (Table 1); the most susceptible varieties were PS11435807 (jalapeño) and Paladin (bell), followed by Regulator (Bell), Pageant (sweet banana), Mercer (bell), SV382PP (sweet banana), Provider (bell), Placepack (bell), Currier (bell), Karisma (bell), and Lola (sweet banana). AUDPC values were significantly lower for Everman (jalapeño), Orizaba (jalapeño), Autry (bell) and 3108 (hot banana) than all other varieties. AUDPC values were marginally insignificant (P = 0.1088) when averaged among pepper types (Table 2).

Table 1. Severity of Pseudomonas leaf spot on 35 pepper varieties on 16 Sep, and Area Under Disease Progress Curve (AUDPC).

Variety	Type	Pseudomonas leaf spot severity			
		16 Sep (%)[zyx]		AUDPC[zyw]	
Everman	Jalapeño	1.5	de	168.7	q
Orizaba	Jalapeño	1.0	e	188.3	pq
Autry	Bell	1.0	e	222.5	op
3108	Hot Banana	1.0	e	233.2	nop
Teniente	Jalapeño	1.0	e	242.9	mno
SVPP8114	Sweet Banana	1.0	e	243.6	l-o
Ninja	Bell	1.0	e	256.5	k-o
Prodigy	Bell	1.0	e	257.8	k-o
2628 / Shogun	Bell	1.0	e	261.7	j-o
Wildcat	Chili	1.0	e	265.6	j-o
Cuatrero	Jalapeño	1.0	e	267.1	j-o
Dante	Jalapeño	1.0	e	271.5	i-o
Samurai	Bell	1.0	e	281.3	h-n
Skyhawk	Bell	1.0	e	289.7	h-m
Fury	Hot Banana	1.5	de	292.2	h-m
Standout	Bell	1.0	e	298.1	g-m
Panuco	Chili	1.0	e	301.7	g-l
Playmaker	Bell	1.0	e	304.8	g-k
2622 / Nitro	Bell	1.0	e	316.1	f-k
Aristotle	Bell	1.0	e	320.6	e-j
SV3198HJ	Jalapeño	1.0	e	324.4	e-j
Turnpike	Bell	1.0	e	334.3	d-i
Outsider	Bell	1.0	e	339.7	d-h
Lola	Sweet Banana	1.0	e	363.6	c-g
Karisma	Bell	1.5	de	363.8	c-g
Currier	Bell	3.8	cd	388.2	c-f
Placepack	Bell	1.0	e	397.5	cde
Provider	Bell	1.0	e	402.9	cd
SV3782PP	Sweet Banana	1.0	e	406.3	cd
Mercer	Bell	4.8	bc	428.9	c
Pageant	Sweet Banana	1.0	e	434.4	c
Regulator	Bell	1.0	e	440.1	c
Tzotzil	Jalapeño	4.5	bc	958.3	b
Paladin	Bell	6.5	b	1025.3	ab
PS11435807	Jalapeño	11.3	a	1202.8	a
P-Value		<0.0001		<0.0001	

[z]Pseudomonas leaf spot ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[y]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.

[x]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

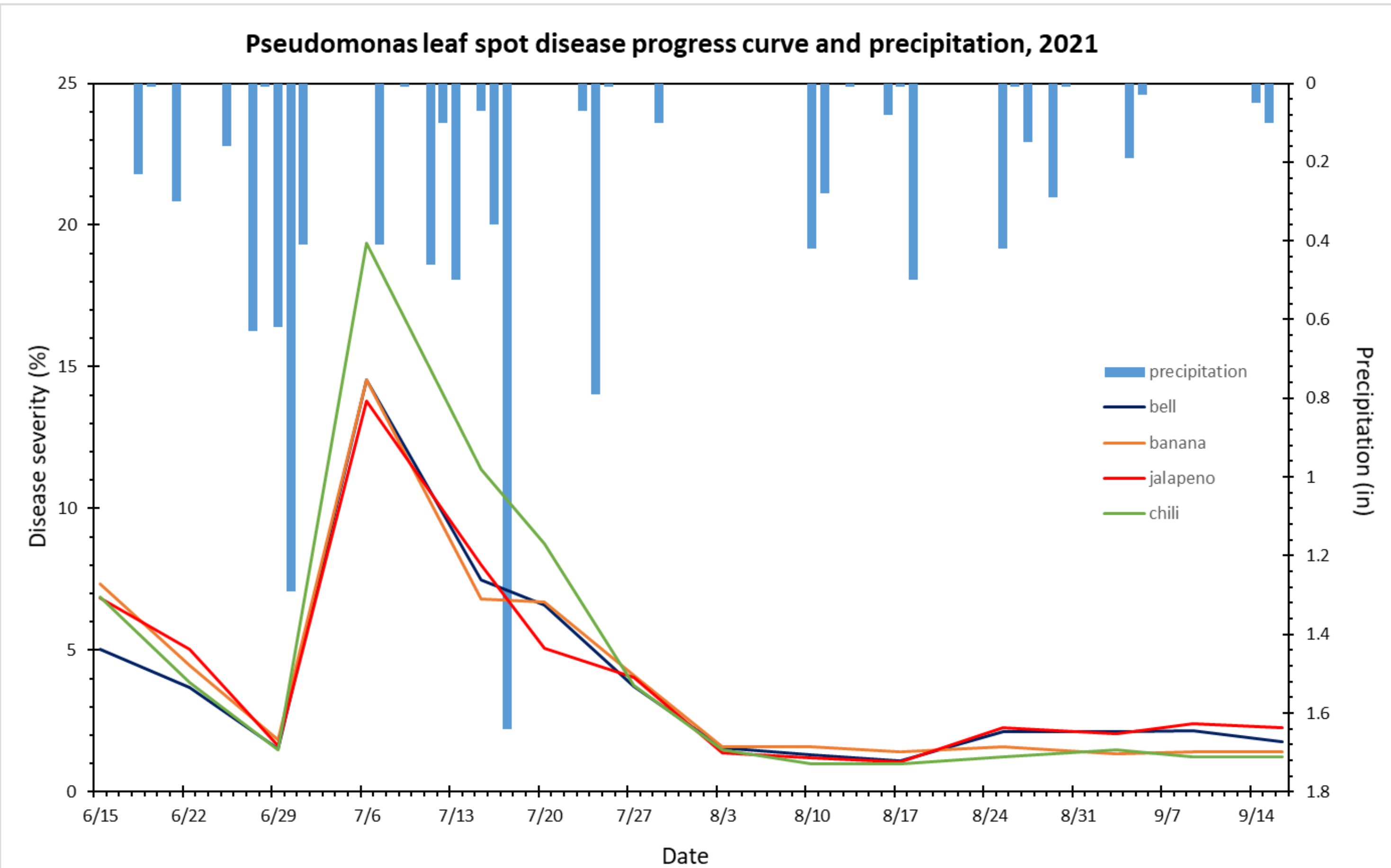
[w]Values are the back-transformed means.

Table 2. Average severity of Pseudomonas leaf spot by pepper type on 16 Sep, and Area Under Disease Progress Curve (AUDPC).

Type	Pseudomonas leaf spot severity	
	16 Sep (%)[z]	AUDPC[zy]
Bell	1.7	366.8
Banana	1.1	331.1
Jalapeño	2.8	456.7
Chili	1.0	285.8
P-Value	0.0592	0.1088

[z]Pseudomonas leaf spot ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[y]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.



PEPPER (*Capsicum annuum* ‘Paladin’)
Anthracnose; *Colletotrichum acutatum*

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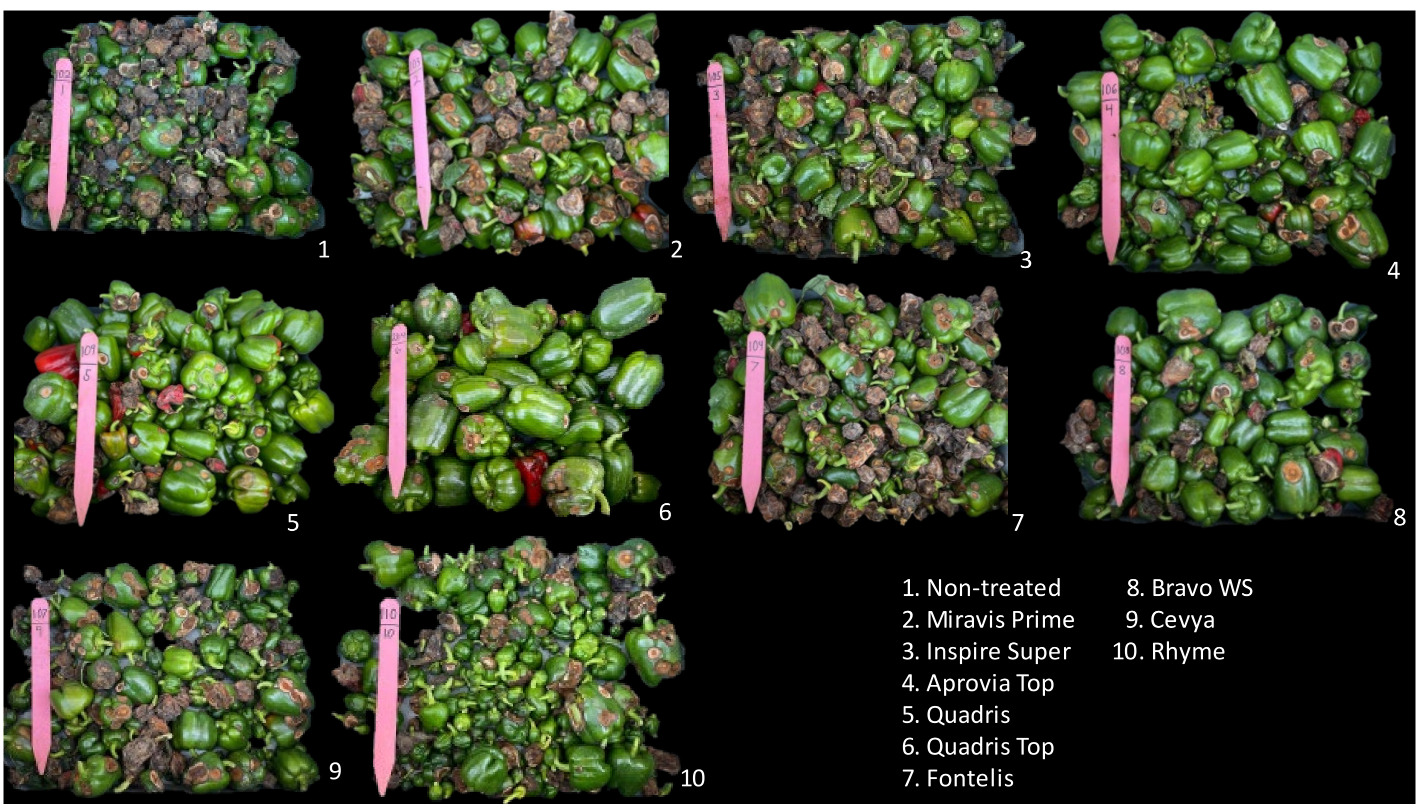
Evaluation of fungicides for the control of anthracnose of peppers, 2021.

The experiment was conducted at The Ohio State University’s North Central Agricultural Research Station in Fremont, OH on Hoytville Clay Loam. On 23 Mar, the herbicide Roundup PowerMAX was applied to the field. On 5 Apr, ‘Paladin’ pepper seeds were treated by agitating them in 20% Clorox (1.1% sodium hypochlorite) solution for 1 min, followed by a 5 min rinse in running tap water and air-drying. Seeds were sown on 5 Apr into 200-cell plug trays containing Baccto Professional Growers planting mix. On 26 Apr, the fertilizers 46-0-0 (N-P-K, 250 lb/A), 10-52-0 (100 lb/A), 0-0-60 (450 lb/A) and 10% granular boron (10 lb/A) were broadcast, and beds were formed. The herbicides Dual II Magnum (16 fl oz/A), Command 3ME (8 fl oz/A), and Roundup PowerMAX (22 fl oz/A) were applied to the field on 13 May. Pepper seedlings were transplanted on 17 May; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50 gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. Insecticides were applied as needed: Warrior II with Zeon Technology (1.92 fl oz/A; 24 Jun and 4 Aug), Carbaryl 4L (32 fl oz/A; 24 Jun), Mustang Maxx (4 oz/A; 6 Jul and 20 Aug), Beleaf 50 SG (2 fl oz/A; 13 Aug), Assail 30 SG (4 oz/A; 29 Jun and 28 Jul), Actara (5.5 oz/A; 21 Jul), and Baythroid XL (3 fl oz/A; 13 Aug). Fungicides were also applied to the field: Orondis Ultra (8 fl oz/A; 24 Jun, 28 Jul and 20 Aug), Ranman (2.75 fl oz/A; 6 Jul and 4 Aug), and Presidio (4 fl oz/A; 21 Jul and 23 Aug). The field was cultivated on 14 Jun, 7 and 21 Jul and hand weeded and hoed on 14, 23 and 29 Jun, 7 and 23 Jul. All plants in treated rows were inoculated with a suspension of 10^5 spores/ml of *Colletotrichum acutatum* SM214-2020 and SM215-2020 on 6 Jul using a CO_2-pressurized backpack sprayer. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 41.3 gal/A, 3 mph) beginning 23 Jun and ending 19 Aug for a total of eight applications. On 27 Jul, 15 pepper plants were harvested from the center of each treatment or non-treated control row. Only marketable sized peppers were harvested. Number and weights of marketable peppers, peppers with low (1-3), medium (4-9) and high (10-15) numbers of anthracnose lesions were determined. On 23 Aug, the same plants were harvested from the center of each treatment or control row. All peppers were harvested and sorted into the same categories as the first harvest except marketable and nonmarketable sized peppers were separated. Data from the two harvests were combined. Average maximum temperatures for May, Jun, Jul, 1-23 Aug were 70.9, 82.8, 83.5 and 85.1°F; average minimum temperatures were 48.3, 64.4, 64.6 and 63.2°F; and rainfall amounts were 4.5, 5.5, 6.1 and 1.4 in., respectively. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher’s least significant difference test with SAS software.

Anthracnose disease pressure was very high, with overall disease incidence on non-treated fruits reaching 92.1%. The incidence of anthracnose lesions on pepper fruits was significantly reduced compared to the non-treated control for plants treated with Miravis Prime (77.1%), Aprovia Top (76.1%), Quadris Flowable (73.3%), Quadris Top (64%), or Bravo Weather Stik (72%). Quadris Top was significantly more effective in suppressing anthracnose than all fungicide treatments except Quadris Flowable and Bravo Weather Stik. A similar trend was observed for disease intensity, with the exception of plants treated with Miravis Prime, for which fruit disease intensity did not differ significantly from that of the control. Both Quadris products significantly increased total yield, but only Quadris Top increased marketable yield compared to the non-treated control. This trial was supported by funds provided by the Ohio Produce Growers and Marketers’ Ohio Vegetable and Small Fruit Research and Development Program (OPGMA OVSFRDP).

Treatment, rate (Application timing)[z]	Fruits with anthracnose (%)[y,x]		Disease intensity[w]		Total yield (t/A)		Marketable yield (t/A)		Marketable yield (%)	
Non-treated	92.1	a	8.8	a	6.4	bcd	0.1	bc	2.1	bc
Miravis Prime, 11.4 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	77.1	bc	7.9	ab	5.0	bcd	0.01	c	0.2	c
Inspire Super, 20 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	83.6	ab	8.3	ab	6.8	bcd	0.6	bc	6.3	bc
Aprovia Top, 11 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	76.1	bc	6.7	bc	8.0	abc	0.2	bc	2.2	bc
Quadris Flowable, 15.5 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	73.3	bcd	5.1	cd	10.4	a	1.5	ab	12.8	ab
Quadris Top, 14 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	64.0	d	4.1	d	10.8	a	2.8	a	22.6	a
Fontelis, 24 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	88.3	a	9.2	a	4.2	d	0.0	c	0.0	c
Bravo Weather Stik, 1.5 pt/A (1-8) Activator 90, 0.125 % v/v (1-8)	72.0	cd	5.4	cd	7.5	a-d	0.9	bc	10.4	bc
Cevya, 5 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	82.8	ab	7.9	ab	8.2	ab	1.2	bc	13.2	ab
Rhyme, 7 fl oz/A (1-8) Activator 90, 0.125 % v/v (1-8)	88.2	a	9.0	a	4.8	cd	0.3	bc	5.1	bc
P-Value	0.0002		<0.0001		0.0026		0.0117		0.0087	

[z]Application dates: 1= 23 Jun; 2= 6 Jul; 3= 15 Jul; 4= 21 Jul; 5= 27 Jul; 6= 4 Aug; 7= 12 Aug; 8= 19 Aug.
[y]Means followed by the same lower-case letter within a column are not significantly different at the indicated P-value.
[x]Based on numbers of fruit.
[w]Disease intensity was calculated using the number of fruits in each of four categories and the midpoint value from four fruit categories: 0 lesions, 1-3 lesions, 4-9 lesions and 10-15 lesions. Intensity = (Σ(category midpoint*number of fruit in category))/n where n is the sum of fruits from each category.



CUCUMBER (*Cucumis sativus*)
Downy mildew; *Pseudoperonosora cubensis*

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Evaluation of resistance of cucumber varieties to downy mildew, 2021.

The experiment was conducted at two locations, The Ohio State University's Muck Crops Agricultural Research Station in Willard, OH (Huron County) on Linwood muck soil, and The Ohio State University CFAES Wooster Campus, Snyder Farm in Wooster, OH (Wayne County) on Wooster-Riddles silt loam. Cucumber seeds from fourteen different varieties were sown on 21 Jun for Huron and 22 Jul for Wayne into 72-cell plug trays containing Metro-Mix 360 growing medium. On 13 Jul (Huron), the herbicides Curbit EC (3 pt/A), Command 3ME (1 pt/A) and Compadre (5.9 mL/gal) were applied to the test field. On 14 Jul, the field was cultivated, disked, and leveled, and beds were prepared on 5-ft centers. Cucumber seedlings were transplanted on 15 Jul. On 11 Aug (Wayne), the field was cultivated, and the herbicide Dual Magnum (.75 fl oz/A) was applied as a pre-emergent on 12 Aug. Cucumber seedlings were transplanted on 13 Aug, with starter fertilizer (Miller SOL-U-GRO, 2.5 lb/50 gallons, N-P-K: 12-48-8) in the transplant water. Varieties for both locations were laid out in a randomized complete block design with four replications. Each plot consisted of a row of 12 plants spaced 2 ft apart. For Huron, the insecticides Assail 30SG (4 fl oz/A and 5 fl oz/A; 13 and 19 Aug respectively), Warrior II (1.92 fl oz/A; 31 Aug) and LI 700 (1.2 mL/gal; 13 and 19 Aug) were applied to all plots. The field was cultivated, hand weeded and hoed on 3 and 18 Aug and 14 Sep. To manage powdery mildew, the fungicides Gatten (8 fl oz/A) and Vivando (15.4 fl oz/A) were applied on 30 Jul and 6 Aug, respectively. Downy mildew was first observed in the test field on 10 Aug for Huron and rated on 10, 17, and 25 Aug, and 1, 8, 17, 21 and 29 Sep. For Wayne, downy mildew was first observed in the test field on 30 Aug and rated on 30 Aug, and 7, 14, and 20 Sep. All varieties were rated for downy mildew severity using a scale of 0-100% foliage affected. Cucumber fruits from all plants in Huron were harvested, counted, and weighed on 3 and 14 Sep. Average maximum temperatures in Huron for 14-31 Jul, Aug and 1-28 Sep were 82.0, 83.8, and 78.4°F; average minimum temperatures were 63.1, 63.7, and 55.4°F; and rainfall amounts were 6.8, 3.1, and 2.4 in., respectively. Average maximum temperatures in Wayne for 13-31 Aug and 1-27 Sep were 85.1 and 78.1°F; average minimum temperatures were 65.2 and 55.5°F; and rainfall amounts were 2.1 and 2.4 in., respectively. Regression analyses were performed using the REG procedure; analysis of variance was performed using the GLIMMIX procedure and means were separated using Fisher's least significant difference test with SAS software.

Downy mildew disease pressure was high in the Huron County trial, reaching an end-of-season (28 Sep) disease severity rating of 81.3% in the susceptible control variety 'Dasher II'. End-of-season disease severity was significantly lower for 'Southwind' (43.8%), '429x712' (41.3%), 'SVCN6404' (31.3%), 'Hawaii Increase' (30%), 'DMR 401' (12.8%) and 'DMR 264' (6.3%) than for 'Dasher II', with the two DMR varieties more resistant to downy mildew than all other varieties. Season-long disease progress (AUDPC) values were significantly lower for 12 varieties than for 'Dasher II' and 'SV4719CS', including 'CxG', 'Brickyard', 'Bristol', 'SV3462CS', 'Citadel', and 'Peacemaker' that exhibited high end-of-season downy mildew severity, indicating slower disease progression for these varieties than for the susceptible control. Total yields ranged from 1.2 to 7.6 t/A and were not correlated with AUDPC ($R = 0.0239$; $P < 0.2552$) or end-of-season severity ($R = 0.0236$; $P < 0.2579$) values. In the Wayne County trial downy mildew disease pressure was low, with end-of-season disease severity reaching only 21.3% in 'Dasher II'. With the exception of final disease severity in 'Citadel', final disease severity and AUDPC values were significantly lower for all varieties than for 'Dasher II'. This trial was conducted too late in the growing season to collect meaningful yield data.

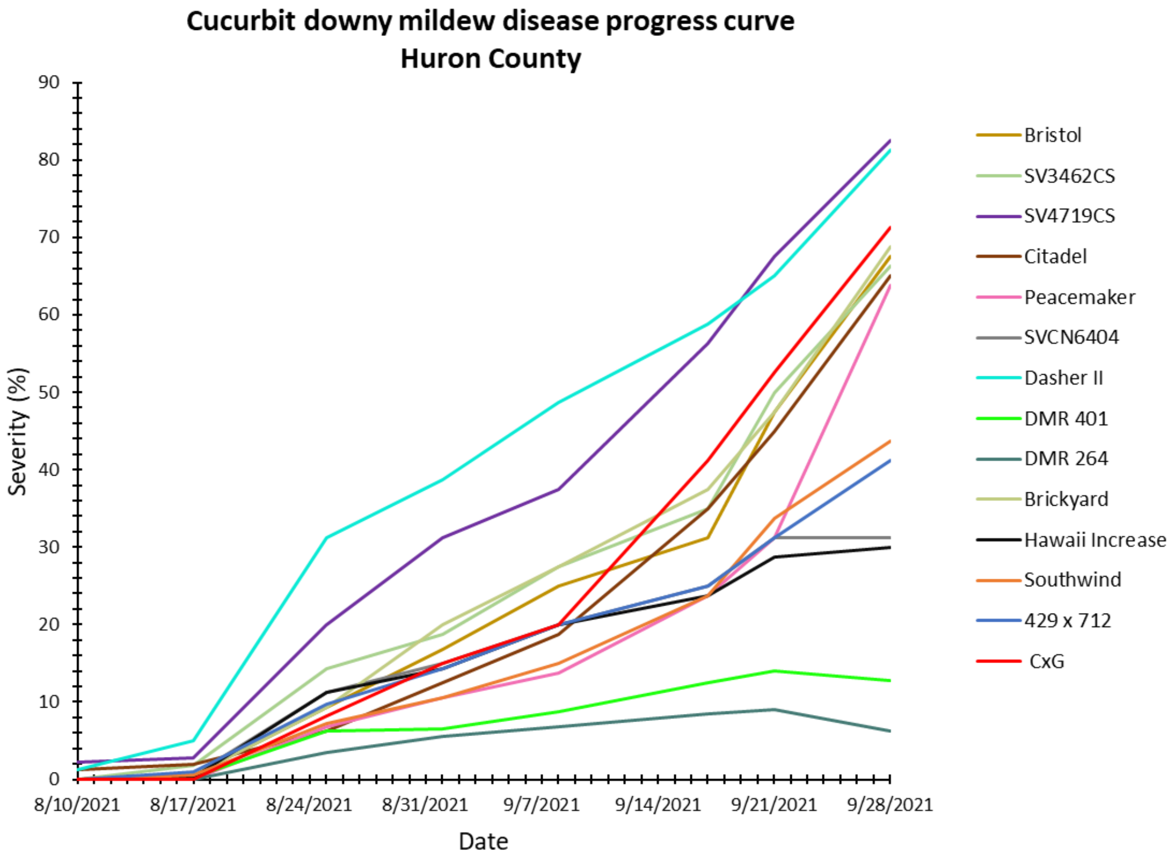
Variety	Cucumber type	Source[z]	Huron County trial: Downy mildew severity 28-Sep (%)	Huron County trial: Downy mildew severity AUDPC	Huron County trial: Total yield (t/A)	Wayne County trial: Downy mildew severity 20-Sep (%)[yx]	Wayne County trial: Downy mildew severity AUDPC[x]
SV4719CS	Slicing	Johnny's Seeds	82.5 a	1722.9 a	4.7 b	12.3 bcd	89.1 def
Dasher II	Slicing	SeedWise	81.3 ab	1961.3 a	4.4 b	21.3 a	231.3 a
CxG	Slicing	CWSG	71.3 ab	1133.1 bcd	1.9 cd	11.0 cde	127.6 bc
Brickyard	Slicing	Harris Seeds	68.8 ab	1178.8 bc	5.6 ab	14.8 bc	96.8 de
Bristol	Slicing	Johnny's Seeds	67.5 ab	1091.0 b-e	4.5 b	10.5 def	80.0 d-g
SV3462CS	Slicing	SeedWay	66.3 ab	1205.6 b	5.4 ab	9.3 def	71.8 efg
Citadel	Pickling	Johnny's Seeds	65.0 ab	1006.3 b-e	5.1 ab	22.5 a	106.3 cd
Peacemaker	Pickling	Seminis	63.8 b	783.5 de	4.8 ab	11.0 cde	62.9 fg
Southwind	Slicing	CWSG	43.8 c	744.8 e	4.2 b	10.5 def	146.8 b
429 x 712	Slicing	CWSG	41.3 c	819.1 cde	3.9 bc	9.3 def	77.3 d-g
SVCN6404	Pickling	Seminis	31.3 c	796.9 de	3.9 bc	15.5 b	76.8 d-g
Hawaii	Pickling	CWSG	30.0 cd	763.5 e	3.6 bc	12.3 bcd	106.6 cd
DMR 401	Slicing	CWSG	12.8 e	367.1 f	7.6 a	7.3 ef	53.0 g
DMR 264	Slicing	CWSG	6.3 e	245.4 f	1.2 d	7.0 f	61.6 fg
P-value			<0.0001	<0.0001	0.0009	<0.0001	<0.0001

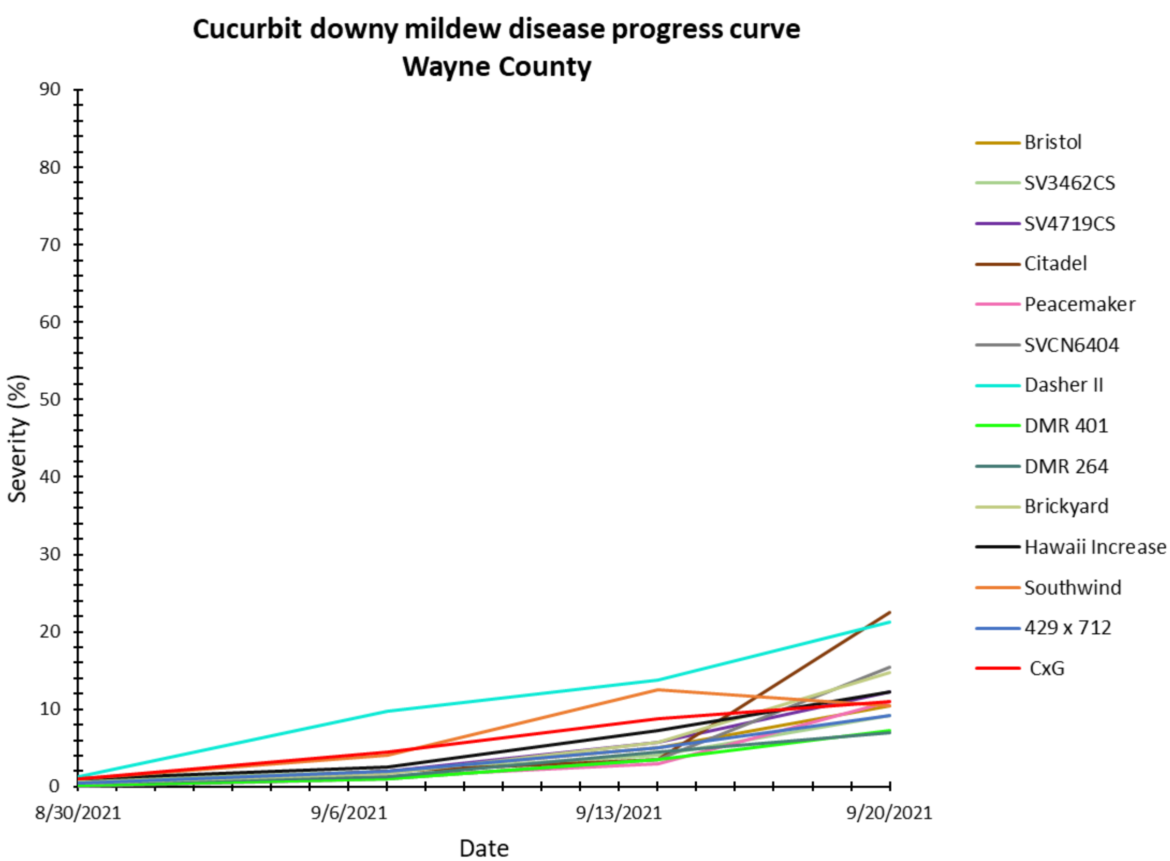
[z]CWSG = Common Wealth Seed Growers

[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.

Downy mildew disease ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[x]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.


Cucurbit downy mildew disease progress curve
Huron County
Severity (%)
Date
8/10/2021
8/17/2021
8/24/2021
8/31/2021
9/7/2021
9/14/2021
9/21/2021
9/28/2021
0
10
20
30
40
50
60
70
80
90
Bristol
SV3462CS
SV4719CS
Citadel
Peacemaker
SVCN6404
Dasher II
DMR 401
DMR 264
Brickyard
Hawaii Increase
Southwind
429 x 712
CxG


Cucurbit downy mildew disease progress curve
Wayne County
Severity (%)
Date
8/30/2021
9/6/2021
9/13/2021
9/20/2021
0
10
20
30
40
50
60
70
80
90
Bristol
SV3462CS
SV4719CS
Citadel
Peacemaker
SVCN6404
Dasher II
DMR 401
DMR 264
Brickyard
Hawaii Increase
Southwind
429 x 712
CxG

CUCUMBER (*Cucumis sativus* 'Straight Eight')
Downy mildew; *Pseudoperonospora cubensis*

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Wooster, OH 44691

Bioassay for sensitivity of *Pseudoperonospora cubensis* to fungicides in OH, 2021.

The experiment was conducted in a greenhouse located on The Ohio State University CFAES Wooster Campus in Wooster, OH. 'Straight Eight' cucumber seeds were sown on 19 Aug into 4 in. pots filled with Baccto Professional Growers planting mix. The experiment was set up in a randomized complete block design with four replications. Each replication consisted of one pot containing one plant. Plants were hand watered daily and fertilized (N-P-K 20-20-20; 0.53 oz/gal water) once per week from germination through the end of the experiment. Fungicides were applied when the second and third true leaves were fully expanded to the top surface of all leaves by using a handheld sprayer at a rate of 50 gal/A on 7 Sep. Non-treated control plants were sprayed with water. Each leaf received approximately 0.12 fl oz. of fungicide or water. On 8 Sep, the treated seedlings were transported in a covered truck to cucumber fields with sporulating downy mildew lesions (~60% severity) in Wooster, OH (Wayne County) and Willard, OH (Huron County). After 48 hours, seedlings were returned to the greenhouse to monitor downy mildew development and phytotoxicity on the leaves. Severity of downy mildew was evaluated on the treated and control leaves 7 and 10 days after plants were returned by using a scale of 0-100% leaf area affected. Seedlings exposed to downy mildew at the Wayne and Huron sites were maintained in separate greenhouse rooms with temperatures that varied from a low of 74°F to a high of 95°F (Wayne) and a low of 73°F and a high of 99°F (Huron). Arcsine transformation (arcsine [$\sqrt{(X/100)}$]) was performed on severity ratings. Analysis of variance was performed using the GLIMMIX procedure and transformed means were separated by Fisher's least significant difference test with SAS software. Back-transformed data are shown.

Cucumber plants exposed to downy mildew developed typical downy mildew symptoms within 7 days after exposure (DAE) in the field. For plants exposed to downy mildew in Wayne County, disease severity reached 57.6% in the non-treated control. There were no significant differences in disease severity among plants treated with Quadris, Revus or Presidio and non-treated control plants. The remaining treatments significantly reduced disease severity compared to the non-treated control. Treatment with Elumin, Omega, Previcur Flex, Curzate or Orondis Ultra A reduced disease severity to ≤ 5.3%, providing >90% control. There were no significant differences among these treatments in disease severity on bioassay plants. Disease severity on plants treated with Forum (17.6%; 69.5% control) or Ranman (7%; 87.9% control) was statistically similar to that on plants treated with Elumin (5.3%; 90.7% control). For cucumber plants exposed to downy mildew in Huron County, disease severity was very low, reaching only 7.2% in the non-treated control. However, trends in fungicide efficacy were similar in both locations, except that Presidio was marginally effective compared to the control and there were no significant differences in disease severity among plants treated with Presidio, Forum, Ranman, Elumin, Omega, Previcur Flex, Curzate, or Orondis Ultra A. This research was supported by a grant from the USDA Agricultural Marketing Service Regional Specialty Crop Block Grant Program # AMI170200XXXG007.

Treatment (rate/A)	Active Ingredient	Downy mildew severity and % control 7 days after exposure					
		Wayne County			Huron County		
		Severity (%)[zyx]		Control (%)[w]	Severity (%)[y]		Control (%)
Quadris 2.08F (15.5 fl oz)	Azoxystrobin 22.9%	69.0	a	-	10.4	a	-
Revus 2.08SC (8.0 fl oz)	Mandipropamid 23.3%	62.6	a	-	2.9	bc	-
Non-treated control		57.6	ab	-	7.2	ab	-
Presidio 4SC (4.0 fl oz)	Fluopicolide 39.5%	37.0	b	-	1.9	cd	73.6
Forum 4.16SC (6.0 fl oz)	Dimethomorph 43.5%	17.6	c	69.5	1.3	cd	81.9
Ranman 400SC (2.75 fl oz)	Cyazofamid 23.3%	7.0	cd	87.9	0.7	cd	90.3
Elumin 4SC (8.0 fl oz)	Ethaboxam 42.5%	5.3	cde	90.7	0.6	cd	91.7
Omega 500F (1.5 pt)	Fluazinam 40%	3.4	de	94.1	1.2	cd	83.3
Previcur Flex 6SL (1.2 pt)	Propamocarb 66.5%	2.1	de	96.4	0.3	cd	95.8
Curzate 60DF (5.0 oz)	Cymoxanil 60%	0.1	e	99.8	1.2	cd	83.3
Orondis Ultra A (2.4 fl oz)	Oxathiapiprolin 10.2%	0.1	e	99.8	0.2	d	97.2
P-value		<0.0001			<0.0001		

[z]Disease ratings after application based on scale of 0-100% foliage affected.
[y]Values are the back-transformed means.
[x]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.
[w]Percent control values were calculated according to the formula: [(SC-ST)/SC]×100 where SC is the average severity in the non-treated control and ST is the average severity in the treatment.

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PUMPKIN (*Cucurbita pepo* 'Solid Gold F1')
Powdery mildew; *Podosphaera xanthii*
Plectosporium blight; *Plectosporium tabacinum*

Evaluation of fungicides for the control of powdery mildew and Plectosporium blight of pumpkin, 2021.

The experiment was conducted at The Ohio State University's North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sand. Pumpkin 'Solid Gold F1' seeds were sown on 1 Apr into 72-cell plug trays containing Baccto Professional Growers planting mix. On 23 Mar, the herbicide Roundup PowerMAX (32 fl oz/A) was applied to the field. The fertilizers 46-0-0 (N-P-K, 250 lb/A), 10-52-0 (100 lb/A) and 0-0-60 (450 lb/A) and 10% granular boron (10 lb/A) were broadcast, and the field was disked on 26 Apr. Beds were also formed on 26 Apr. The herbicides Dual II Magnum (16 fl oz/A), Command 3ME (8 fl oz/A), and Roundup PowerMAX (32 fl oz/A) were applied to the field with a drift control agent (Compadre, 2.7 fl oz/A) on 13 May. Pumpkin seedlings were transplanted on 7 Jun; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50-gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 13 plants spaced 2 ft apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. Insecticides were applied as needed: Warrior II with Zeon Technology (1.92 fl oz/A; 12 and 17 Jun and 4 Aug), Carbaryl (32 fl oz/A; 24 Jun and 16 fl oz/A; 10 Sep), Assail 30SG (4 fl oz/A; 29 Jun and 28 Jul), Mustang Maxx (4 oz/A; 6 Jul and 20 Aug), Actara 25WG (5.5 oz/A; 21 Jul and 27 Aug), Baytroid XL (3 fl oz/A; 13 Aug and 2.8 fl oz/A; 2 Sep), Beleaf 50SG (2 fl oz/A; 13 Aug), and Radiant (6 fl oz/A; 10 Sep). Fungicides were also applied to the field: Orondis Ultra (8 fl oz/A; 24 Jun, 28 Jul, 20 Aug), Ranman (2.75 fl oz/A; 6 Jul, 4 and 27 Aug) and Presidio (4 fl oz/A; 21 Jul, 12 Aug, and 2 Sep). The field was hand weeded and hoed on 23 and 29 Aug. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 41.3 gal/A, 3 mph) beginning 22 Jul and ending 9 Sept for a total of eight applications. The severity of powdery mildew on the top surface of leaves of every plant and on the underside of ten randomly selected leaves in each treatment row was evaluated on 3, 10, 17 and 25 Aug, 3, 9, and 16 Sep using a scale of 0-100% foliage affected. Plectosporium blight appeared in the plots naturally. On 16 Sep, all pumpkins were harvested from each trial row. Number and weights of healthy pumpkins, and pumpkins handles with Plectosporium blight, powdery mildew and other diseases were determined. Average maximum temperatures for Jun, Jul, Aug, and 1-16 Sep were 82.8, 83.5, 85.8 and 81.5°F; average minimum temperatures were 64.4, 64.6, 64.4 and 57.5°F; and rainfall amounts were 5.5, 2.2, 3.0, and 0.4 in., respectively. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher's least significant difference test with SAS software.

Powdery mildew pressure was high in this trial, with disease severity in the non-treated control reaching 68.8% on the top surface of the leaves and 50.3% on the underside of the leaves by the end of the season (9 Sep). All the fungicides tested significantly reduced the final powdery mildew rating and season-long disease progress (AUDPC) on the top of the leaves compared to the non-treated control. Final disease severity ratings for plants treated with Cevya, Inspire Super, Gatten, Prolivo, Procure or Vivando were <10% (range 2.3 to 9.5%) and statistically similar. Velum Prime, Fontelis, Aprovia Top, Rally and Quintec also provided good control (severity 12 to 13.8%). Disease severity was statistically higher for plants treated with Merivon Xemium (30%) than for those treated with all other fungicides tested. However, season-long disease progress (AUDPC) for plants treated with Merivon Xemium was statistically similar to that of plants treated with any of the fungicides except Velum Prime (higher AUDPC) or Vivando (lower AUDPC). On the underside of leaves, end-of-season disease severity was not significantly different from the non-treated control on plants treated with Velum Prime, Cevya or Gatten, although season long disease progress on plants treated with these products was significantly less than for control plants. Final disease severity was low on the underside of leaves treated with Quintec (4.1%), Procure (6.8%), Vivando (11.1%), Rally (13.5%), Aprovia Top (13.9%), or Inspire Super (18%); there were no significant differences in disease severity among plants treated with these products. Season-long disease progress was significantly less than the non-treated control for plants treated with any of the fungicides tested. AUDPC values were lowest for plants treated with Procure, Quintec, Vivando, Aprovia Top, Merivon Xemium, or Rally. Cevya and Gatten treatments effectively suppressed powdery mildew end-of-season severity and disease progress on the upper sides of leaves but were less effective on the undersides of leaves. The incidence of powdery mildew on pumpkin handles was low, approximately 10% in the non-treated control, and none of the plots differed significantly in disease incidence from the control. The incidence of Plectosporium blight on handles was high (44.2%) in the non-treated control; disease incidence was significantly lower than the control in plants treated with Merivon Xemium (1.9%), Inspire Super (14.1%) or Gatten (23.6%). None of the treatments significantly increased the percentage of marketable fruit or reduced the percentage of cull fruit compared to the non-treated control. This research was supported by funds provided by the Ohio Produce Growers and Marketers' Ohio Vegetable and Small Fruit Research and Development Program (OPGMA OVSFRDP).

Treatment, rate (Application timing)[z]	Foliar powdery mildew severity							
	Upper leaf surface				Underside of leaves			
	9 Sep (%)[zy]		AUDPC[zyx]		9 Sep (%)[zy]		AUDPC[zyx]	
Non-treated	68.8	a	3471.3	a	50.3	a	2489.3	a
Merivon Xemium, 5.5 fl oz/A (1-8)	30.0	b	455.6	cd	23.5	cd	358.0	def
Velum Prime, 6.84 fl oz/A (1-8)	13.8	c	890.4	b	38.9	ab	1462.4	b
Fontelis, 16 fl oz/A (1-8)	13.8	c	433.0	cd	19.5	cde	758.1	cd
Aprovia Top, 13.5 fl oz/A (1-8)	13.8	c	264.8	cd	13.9	def	355.4	def
Rally 40WSP, 5 oz/A (1-8)	12.5	cd	588.4	bc	13.5	def	564.8	def
Quintec, 6 fl oz/A (1-8)	12.0	cd	247.1	cd	4.1	f	82.7	f
Cevya, 5 fl oz/A (1-8)	9.5	cde	509.0	bcd	41.8	ab	1157.3	bc
Inspire Super, 20 fl oz/A (1-8)	6.0	cde	484.9	cd	18.0	c-f	624.5	de
Gatten, 8 fl oz/A (1-8)	5.8	cde	581.5	bc	38.3	ab	1203.1	bc
Prolivo 300SC, 5 fl oz/A (1-8)	4.5	de	219.0	cd	30.4	bc	857.0	cd
Procure 480SC, 8 fl oz/A (1-8)	4.5	de	207.5	cd	6.8	ef	77.5	f
Vivando, 15.4 fl oz/A (1-8)	2.3	e	129.9	d	11.1	def	199.9	ef
P-Value	<0.0001		<0.0001		<0.0001		<0.0001	

[z]Application dates: 1= 22 Jul; 2= 28 Jul; 3= 15 Jul; 4= 12 Aug; 5= 19 Aug; 6= 26 Aug; 7= 2 Sep; 8= 9 Sep.
[y]Powdery mildew severity ratings and area under disease progress curve (AUDPC) for top ratings were based on the percent foliar disease. Bottom ratings and AUDPC were based on the average of 10 randomly selected leaves on a scale of 0-100% leaf area affected.
[x]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.
[w]Means followed by the same lower-case letter within a column are not significantly different at the indicated P-value.

Treatment, rate (Application timing)[z]	Fruit handles w/ powdery mildew (%)[y]		Fruit handles w/ Plectosporium blight (%)[x]		Marketable fruit (%)[x]		Culled fruit (%)[x]	
Non-treated	10.3	ab	44.2	abc	80.0	abc	20.1	bcd
Merivon Xemium, 5.5 fl oz/A (1-8)	15.5	a	1.9	f	75.7	a-d	24.3	a-d
Velum Prime, 6.84 fl oz/A (1-8)	0.0	b	31.7	b-e	60.1	d	39.9	a
Fontelis, 16 fl oz/A (1-8)	3.3	b	37.0	a-d	70.8	cd	29.2	ab
Aprovia Top, 13.5 fl oz/A (1-8)	0.0	b	26.8	cde	64.6	cd	35.4	ab
Rally 40WSP, 5 oz/A (1-8)	9.8	ab	31.4	b-e	89.4	ab	10.7	cd
Quintec, 6 fl oz/A (1-8)	6.1	ab	55.9	a	91.1	a	9.0	d
Cevya, 5 fl oz/A (1-8)	0.0	b	40.3	a-d	79.3	abc	20.7	bcd
Inspire Super, 20 fl oz/A (1-8)	3.6	b	14.1	ef	68.8	cd	31.2	ab
Gatten, 8 fl oz/A (1-8)	6.5	ab	23.6	de	71.6	bcd	28.4	abc
Prolivo 300SC, 5 fl oz/A (1-8)	0.0	b	34.7	bcd	91.3	a	8.7	d
Procure 480SC, 8 fl oz/A (1-8)	2.3	b	48.3	ab	81.4	abc	18.7	bcd
Vivando, 15.4 fl oz/A (1-8)	0.0	b	34.4	b-e	80.1	abc	19.9	bcd
P-Value	0.0702		0.0007		0.0223		0.0223	

[z]Application dates: 1= 22 Jul; 2= 28 Jul; 3= 15 Jul; 4= 12 Aug; 5= 19 Aug; 6= 26 Aug; 7= 2 Sep; 8= 9 Sep.
[y]Means followed by the same lower-case letter within a column are not significantly different at the indicated P-value.
[x]Based on t/A

PUMPKIN (*Cucurbita pepo* 'Solid Gold F1')
Powdery mildew; *Podosphaera xanthii*

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Bioassay for sensitivity of *Podosphaera xanthii* to fungicides in OH, 2021.

The experiment was conducted in a greenhouse located on The Ohio State University CFAES Wooster Campus. 'Solid Gold F1' pumpkin seeds were sown on 16 Jul and 1 Sep in 4 in. pots filled with Baccto Professional Grower's potting mix. The experiment was set up in a randomized complete block design with four replications. Each replication consisted of one pot containing one plant. Two locations were used to conduct this experiment. The North Central Agricultural Research Station (NCARS; Fremont, OH) was considered a "high-use fungicide" location and Snyder Farm (CFAES Campus, Wooster, OH) was considered a "low-use fungicide" location and both locations were utilized for both early-season and late-season inoculum. Plants were hand watered daily and fertilized (N-P-K 20-20-20; 0.53 oz/gal water) once per week from germination through the end of the experiment. When the third true leaf was fully expanded on 19 Aug and 27 Sep, fungicides were applied in a greenhouse to the top surface of all leaves using a handheld sprayer at a rate of 50 gal/A. Non-treated control plants were sprayed with water. Each leaf received approximately 0.12 fl oz. of suspension or water. On 20 Aug (early season inoculum) and 28 Sep (late season inoculum), pumpkins seedlings were transported in a covered truck to a planting of 'Solid Gold F1' pumpkins at Snyder Farm (CFAES Wooster Campus) and NCARS (Fremont, OH), both with active powdery mildew outbreaks (disease severity >75%). Seedlings were set in the field and returned to the greenhouse after approx. 24 hr of exposure. Powdery mildew development and symptoms of phytotoxicity were monitored and evaluated on the first three true leaves. Any leaves that emerged after the third true leaf were removed. Severity of powdery mildew was evaluated on the upper leaf surface using a rating scale illustrating powdery mildew at 0.5, 1, 2, 4, 8, 16, 32, 64, and 80 percent foliage affected. Arcsine transformation (arcsine $[\sqrt{(X/100)}]$) was performed on severity ratings. Analysis of variance was performed using the GLIMMIX procedure and transformed means were separated by Fisher's least significant difference test with SAS software. Back-transformed data are shown.

Powdery mildew severity on bioassay plants exposed to early season inoculum was low (<10%) in both locations. All fungicides tested significantly reduced disease severity compared to the non-treated control and there were no significant differences in disease severity among plants treated with any of the fungicides except Merivon Xemium in both locations. For pumpkin plants exposed to late season inoculum, disease severity on non-treated control plants 10 days after exposure was moderate (39.4%; Fremont) or high (64.2%; Wooster). All fungicides tested significantly reduced disease severity compared to the non-treated control at both locations. In plants exposed to powdery mildew in Fremont, Aprovia Top, Inspire Super, Procure, Rally, Cevya, Vivando, Gatten, Prolivo and Velum Prime provided >96% control. Disease severity was significantly higher on plants treated with Fontelis (9.8%; 75.2% control) or Merivon Xemium (16.3%; 58.5% control) compared to plants treated with the remaining fungicides (0.1-1.4%; 99.7-96.4% control). The same results were observed on plants exposed to late season inoculum in Wooster, except for plants treated with Velum Prime, for which disease severity (13.5%; 78.9% control) was statistically similar to that of plants treated with Fontelis (20.7%; 67.7% control) or Merivon Xemium (12.9%; 79.9% control). This research was supported by funds provided by the Ohio Produce Growers and Marketers' Ohio Vegetable and Small Fruit Research and Development Program (OPGMA OVSFRDP).

Treatment (rate/A)	Powdery mildew severity and % control 10 days after exposure to early and late season inoculum							
	Fremont, OH				Wooster, OH			
	Early		Late		Early		Late	
	Severity (%)	Control (%)	Severity (%)	Control (%)	Severity (%)	Control (%)	Severity (%)	Control (%)
Non-treated	9.3 a	-	39.4 a	-	6.2 a	-	64.2 a	-
Aprovia Top, 13.5 fl oz/A	0.2 cd	98.3	0.8 c	97.9	0.0 bc	99.7	1.5 c	97.7
Fontelis, 16 fl oz/A	0.2 bcd	97.4	9.8 b	75.2	0.1 bc	98.0	20.7 b	67.7
Inspire Super, 20 fl oz/A	0.0 d	100.0	0.1 c	99.7	0.0 bc	99.7	0.1 c	99.8
Merivon Xemium, 5.5 fl oz/A	1.5 b	83.9	16.3 b	58.5	0.4 b	94.2	12.9 b	79.9
Procure 480SC, 8 fl oz/A	0.0 d	100.0	0.1 c	99.8	0.1 bc	98.6	0.0 c	100.0
Rally 40WSP, 5 oz/A	0.0 d	99.8	0.7 c	98.3	0.0 c	100.0	0.1 c	99.9
Cevya, 5 fl oz/A	0.0 d	99.8	1.4 c	96.4	0.0 c	100.0	0.8 c	98.7
Vivando, 15.4 fl oz/A	0.0 d	99.8	0.0 c	99.9	0.0 c	100.0	0.3 c	99.5
Gatten, 8 fl oz/A	0.0 d	99.8	1.7 c	95.7	0.04 bc	99.3	0.0 c	100.0
Prolivo 300SC, 5 fl oz/A	0.0 d	99.5	0.0 c	99.9	0.03 bc	99.5	0.0 c	99.9
Velum Prime, 6.84 fl oz/A	1.3 d	85.9	0.3 c	99.2	0.3 bc	95.5	13.5 b	78.9
P-value	<0.0001		<0.0001		<0.0001		<0.0001	

[z]Disease ratings after application based on scale of 0-100% foliage affected using a rating scale that illustrates powdery at 0.5, 1, 2, 4, 8, 16, 32, 64, and 80 percent foliage affected.

[y]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.

[w]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

PUMPKIN (*Cucurbita pepo* 'Solid Gold F1')
Powdery mildew; *Podosphaera xanthii*

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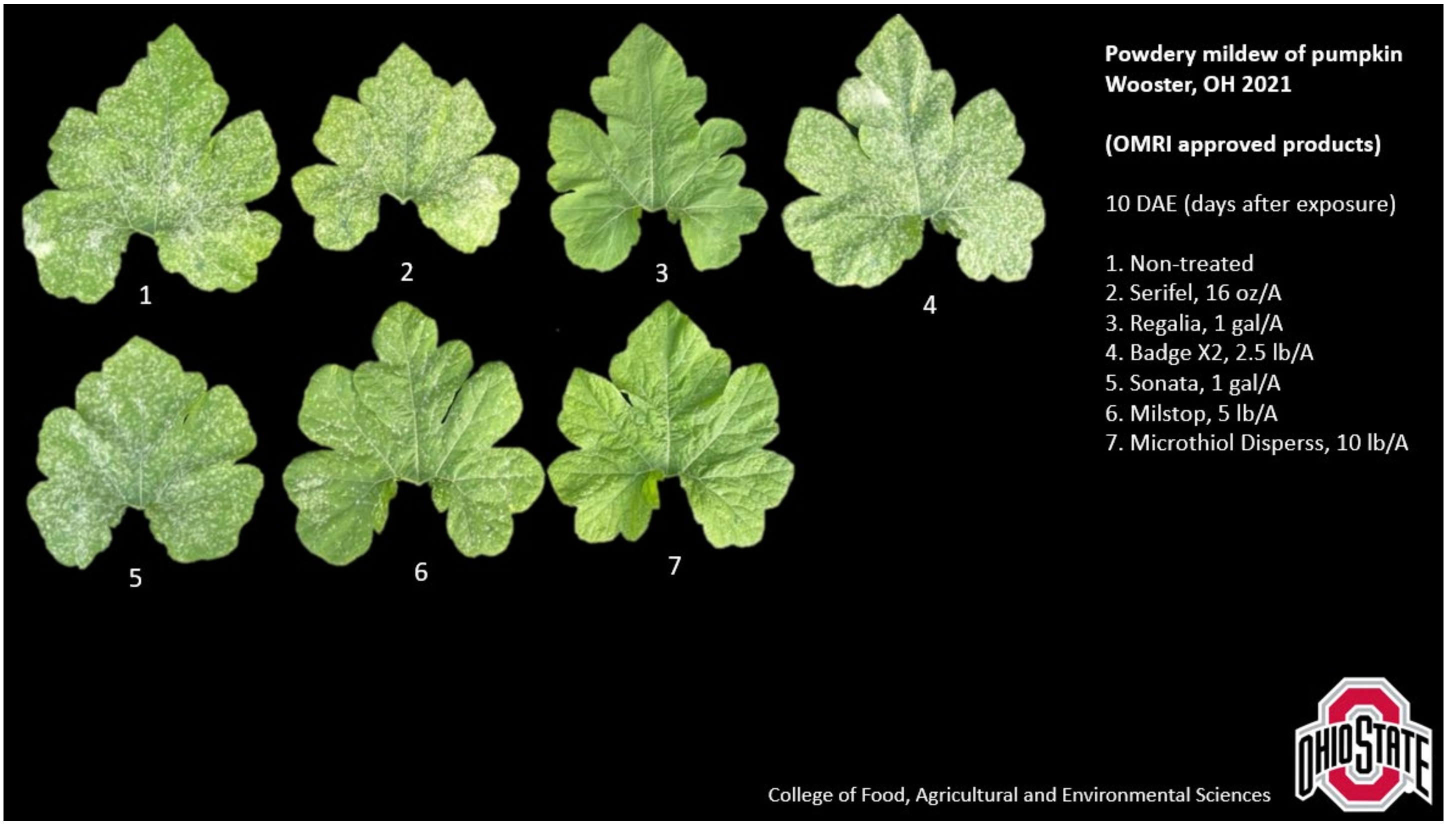
Bioassay for sensitivity of *Podosphaera xanthii* to OMRI-listed products in OH, 2021.

The experiment was conducted in a greenhouse located on The Ohio State University CFAES Wooster Campus. 'Solid Gold F1' pumpkin seeds were sown on 25 Aug in 4 in. pots filled with Baccto Professional Grower's potting mix. The experiment was set up in a randomized complete block design with three replications. Each replication consisted of one pot containing one plant. Plants were hand watered daily and fertilized (N-P-K 20-20-20; 0.53 oz/gal water) once per week from germination through the end of the experiment. When the third true leaf was fully expanded on 20 Sep, fungicides were applied to the top surface of all leaves using a handheld sprayer at a rate of 50 gal/A. Non-treated control plants were sprayed with water. Each leaf received approximately 0.12 fl oz. of suspension or water. On 20 Sep, 4 hrs after treatment, pumpkin seedlings were transported in a covered truck to a planting of 'Solid Gold F1' pumpkins at Snyder Farm (CFAES Wooster Campus) with active powdery mildew (disease severity >75%). Seedlings were set in the field and returned to the greenhouse after approx. 24 hr of exposure. Powdery mildew severity and symptoms of phytotoxicity were monitored and evaluated on the first three true leaves. Any leaves that emerged after the third true leaf were removed. Severity of powdery mildew was evaluated 7 and 10 days after exposure (DAE) on the upper leaf surface using a rating scale illustrating powdery mildew at 0.5, 1, 2, 4, 8, 16, 32, 64, and 80 percent foliage affected. Arcsine transformation (arcsine [$\sqrt{(X/100)}$]) was performed on severity ratings. Analysis of variance was performed using the GLIMMIX procedure and transformed means were separated by Fisher's least significant difference test with SAS software. Back-transformed means are shown.

Seven days after exposure (DAE) to powdery mildew in the field, disease severity was moderate (24.2%) on non-treated control bioassay plants. All of the OMRI-listed products significantly reduced powdery mildew severity compared to the non-treated control. Regalia, Milstop, and Microthiol Disperss reduced disease severity to ≤1%, providing 96-100% control, significantly lower than severity on plants treated with Badge X2 (7.8%; 68% control) or Serifel (9.5%; 61% control). Powdery mildew severity on pumpkin plants treated with Sonata (4.2%; 83% control) was statistically similar to that of plants treated with Milstop (1%; 96% control), Badge X2 and Serifel. Ten DAE to powdery mildew, disease severity on non-treated control plants increased to 42.1%. Powdery mildew severity was lowest on plants treated with Regalia (0.6%) and Microthiol Disperss (0%), followed by Milstop (9.8%), and Sonata (23%), corresponding to 99, 100, 77 and 45% control, respectively. Treatment with Serifel or Badge X2 did not significantly reduce powdery mildew on pumpkin plants 10 DAE compared to the non-treated control. This research was supported by funds provided by the Ohio Produce Growers and Marketers' Ohio Vegetable and Small Fruit Research and Development Program (OPGMA OVSFRDP).

Treatment, rate	Disease severity and % control 7 and 10 days after exposure (DAE) to powdery mildew			
	7 DAE		10 DAE	
	Severity (%)[zyx]	Control (%)[w]	Severity (%)[x]	Control (%)
Non-treated	24.2 a	-	42.1 a	-
Serifel, 16 oz/A	9.5 b	60.8	40.2 a	-
Regalia, 1 gal/A	0.0 d	100.0	0.6 d	98.5
Badge X2, 2.5 lb/A	7.8 b	67.7	46.6 a	-
Sonata, 1 gal/A	4.2 bc	82.7	23.0 b	45.4
Milstop, 5 lb/A	1.0 cd	95.9	9.8 c	76.7
Microthiol Disperss, 10 lb/A	0.0 d	100.0	0.0 d	100.0
P-value	<0.0001		<0.0001	

[z]Disease ratings after application based on a scale of 0-100% foliage affected using a rating scale that illustrates powdery mildew at 0.5, 1, 2, 4, 8, 16, 32, 64, and 80 percent foliage affected.
[y]Means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.
[x]Values are the back-transformed means.
[w]Percent control values were calculated according to the formula: [(SC-ST)/SC]×100 where SC is the average severity in the non-treated control and ST is the average severity in the treatment.


Powdery mildew of pumpkin
Wooster, OH 2021
(OMRI approved products)
10 DAE (days after exposure)
1. Non-treated
2. Serifel, 16 oz/A
3. Regalia, 1 gal/A
4. Badge X2, 2.5 lb/A
5. Sonata, 1 gal/A
6. Milstop, 5 lb/A
7. Microthiol Disperss, 10 lb/A
1
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College of Food, Agricultural and Environmental Sciences

CABBAGE (*Brassica oleracea* var. *capitata* ‘Cheers’)
Alternaria leaf spot; *Alternaria brassicicola*
Bacterial soft rot; *Pectobacterium carotovorum* subsp. *carotovorum*

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Evaluation of fungicides and biologicals for the control of Alternaria leaf spot and soft rot of cabbage, 2021.

The experiment was conducted at The Ohio State University’s North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sand and Colwood fine sandy loam. Cabbage ‘Cheers’ seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) and sown on 1 Apr into 200-cell plug trays containing Baccto Professional Growers Mix. On 23 Mar, the herbicide Roundup PowerMAX (32 fl oz/A) was applied to the field. On 26 Apr, the fertilizers 46-0-0 (N-P-K, 250 lb/A), 10-52-0 (100 lb/A) and 0-0-60 (450 lb/A) and 10% granular boron (10 lb/A) were broadcast, the field was disked, and beds were formed. The herbicides Dual II Magnum (16 fl oz/A), Command 3ME (8 fl oz/A), and Roundup PowerMAX (22 fl oz/A) were applied to the field with a drift control agent (Compadre, 2.7 fl oz/A) on 13 May. Cabbage seedlings were transplanted on 14 May and the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50-gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. Insecticides were applied as needed: Warrior II with Zeon Technology (1.92 fl oz/A; 7 Jun), Movento (5 fl oz/A; 7 and 15 Jun), Javelin WG (1 lb/A; 14 Jun), Radiant SC (8 fl oz/A; 22 Jun), Assail 30 SG (4 oz/A; 29 Jun and 28 Jul), and Actara (5.5 oz/A; 21 Jul). The field was cultivated on 14 Jun and hand weeded and hoed on 16, and 24 Jun and 23 Jul. All plants in treated and control rows were inoculated with a suspension of 10^6 spores/ml of *Alternaria brassicicola* SM1756-16 on 22 Jun using a CO_2-pressurized backpack sprayer. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 41.3 gal/A, 3 mph) beginning 14 Jun and ending 2 Aug for a total of eight applications. The severity of Alternaria leaf spot in each treatment row (all plants) was evaluated on 29 Jun, 6, 15, 20, and 27 Jul and 3 Aug using a scale of 0-100% foliage affected. On 9 Aug, 15 cabbage heads were harvested from the center of each treatment or control row. Two layers of leaves were removed from each cabbage head as a standard practice. Weights of marketable heads, heads with Alternaria leaf spot and heads with soft rot were measured. Heads with both diseases were counted/measured in both disease categories. Average maximum temperatures for May, Jun, Jul, and 1-9 Aug were 71.0, 82.8, 83.5 and 84.0°F; average minimum temperatures were 48.3, 64.4, 64.6 and 59.3°F; and rainfall amounts were 4.5, 5.5, 6.1, and 0.5 in., respectively. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher’s least significant difference test with SAS software.

Alternaria leaf spot disease pressure was very high in this trial, with disease severity reaching 73.8% in the non-treated control. All treatments significantly reduced Alternaria leaf spot severity at the end of the season to levels at or below 5%. Treatment with Howler, Theia and Endura resulted in negligible disease. Season-long disease severity (AUDPC) was significantly lower in all treated plots compared to the non-treated control but did not differ among treatments. The percentage and yield (t/A) of cabbage heads with Alternaria leaf spot symptoms were significantly lower in all treated plots than in the non-treated control, but there were no differences among treatments. Bacterial soft rot was severe in the non-treated control (75.2% of heads affected) and all treatments significantly reduced the percentage of heads with soft rot compared to the non-treated control. Treatment with Howler and Esendo significantly reduced soft rot percentage compared to treatment with Endura. The yield (t/A) of cabbage heads with bacterial soft rot was significantly lower in plots treated with Howler, Theia, and Esendo, but not Endura, than in non-treated control plots. Total and marketable yields (t/A) and percentage marketable heads were significantly higher for all treated plots compared to non-treated control plots. However, percentage marketable heads and marketable yield were significantly lower for plants treated with Endura than the other three products, likely due to higher bacterial soft rot in these plots.

Treatment, rate	Alternaria leaf spot severity		Heads with Alternaria		Heads with soft rot		Marketable yield		Total yield
	3 Aug (%)[yx]	AUDPC[yxw]	(%)[v]	(t/A)	(%)[v]	(t/A)	(%)[v]	(t/A)	(t/A)
Non-treated	73.8 a	1867.5 a	85.8 a	21.8 a	75.2 a	19.2 a	0.0 c	0.0 c	25.6 b
Howler, 5 lb/A (1-8) Dyne-Amic, 0.375% v/v (1-8)	0.0 c	14.4 b	42.2 b	14.1 b	22.8 d	7.8 c	44.9 a	14.9 a	33.4 a
Theia, 3 lb/A (1-8) Dyne-Amic, 0.375% v/v (1-8)	0.0 c	3.5 b	31.2 b	10.5 b	40.0 bc	13.6 b	40.4 a	13.5 a	33.7 a
Esendo, 2.8 lb/A (1-8) Dyne-Amic, 0.375% v/v (1-8)	5.0 b	64.5 b	42.2 b	13.8 b	25.4 cd	8.4 c	42.6 a	14.4 a	33.4 a
Endura, 8 oz/A (1-8) Dyne-Amic, 0.375% v/v (1-8)	0.8 c	9.8 b	40.2 b	12.6 b	46.2 b	14.5 ab	24.2 b	7.7 b	31.5 a
P-value	<0.0001	<0.0001	0.0007	0.0120	<0.0001	0.0014	0.0002	0.0002	0.0003

[z]Application dates: 1= 14 Jun; 2= 21 Jun; 3= 28 Jun; 4= 6 Jul; 5= 13 Jul; 6= 19 Jul; 7= 27 Jul; 8= 2 Aug.

[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.

[x]Alternaria leaf spot disease ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.

[w]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.

[v]Percentages based on t/A values.

CABBAGE (*Brassica oleracea* var. *capitata* 'Platinum Dynasty')
White mold; *Sclerotinia sclerotiorum*

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Evaluation of biologicals and fungicides for the control of white mold of cabbage, 2021.

The experiment was conducted at The Ohio State University's North Central Agricultural Research Station in Fremont, OH on Hoyteville clay loam. Cabbage 'Platinum Dynasty' seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) on 16 Mar and sown on 30 Apr into 200-cell plug trays containing Baccto Professional Growers Mix. On 23 Mar, the herbicide Roundup PowerMAX (32 fl oz/A) was applied to the field. On 26 Apr, the fertilizers 46-0-0 (N-P-K, 250 lb/A), 10-52-0 (100 lb/A) and 0-0-60 (450 lb/A) and 10% granular boron (10 lb/A) were broadcast, the field was disked, and beds were formed. The herbicides Dual II Magnum (16 fl oz/A), Command 3ME (8 fl oz/A), and Roundup PowerMAX (22 fl oz/A) were applied to the field with the drift control agents Compadre (2.7 fl oz/A) and Clasp (10.9 fl oz/A) on 21 May. Cabbage seedlings were transplanted on 14 Jun; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50-gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. Insecticides were applied as needed: Assail 30 SG (4 fl oz/A; 29 Jun and 28 Jul), Radiant (8 fl oz/A; 6 Jul and 6 Aug), Actara 25 WG (5.5 fl oz/A; 21 Jul), Baythroid XL (3 fl oz/A; 13 Aug and 1.6 fl oz/A; 20 Aug), Beleaf 50 SG (2 fl oz/A; 13 Aug), and Exirel (13.5 fl oz/A; 27 Aug). The field was cultivated on 6 and 21 Jul and 3 Aug and hand weeded and hoed on 14, 23 and 29 Jun and 9 Aug. All plants in treated rows were inoculated on 10 Aug by pouring 0.5 fl oz of a mycelial suspension of *Sclerotinia sclerotiorum* SAM 15-09 onto each plant. Inoculum was prepared by homogenizing mycelia from 4-day-old *S. sclerotiorum* cultures at a rate of 10 potato dextrose agar (PDA) plates (3.9 x 0.59 in.)/33.8 fl oz of deionized water. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 41.3 gal/A, 3 mph) beginning 2 Aug and ending 30 Aug for a total of five applications. On 3 Sep, 15 cabbage heads were harvested from the center of each treatment row. Two layers of leaves were removed from each cabbage head as a standard practice. Weights of marketable heads and heads with white mold were measured. Average maximum temperatures for Jun, Jul, Aug, and 1-3 Sep, were 82.8, 83.5, 85.8 and 77.6 °F; average minimum temperatures were 64.4, 64.6, 64.4 and 55.2°F; and rainfall amounts were 5.5, 5.2, 3.0 and 0.0 in., respectively. Analysis of variance was performed using the GLIMMIX procedure; means were separated by Fisher's least significant difference test with SAS software.

White mold disease pressure was high in this trial, with disease incidence reaching 87.1% in the non-treated control. The percentage of cabbage heads with white mold symptoms or signs was significantly lower in plots treated with Howler, Esendo or Endura (34-51% reduction) than in the non-treated control. Yield (t/A) of cabbage heads with white mold was significantly lower from plots treated with Howler or Esendo only. All treatments except Theia significantly increased the percentage and yield (t/A) of marketable cabbage heads, as well as total yield (t/A), but there were no significant differences among plots treated with Howler, Esendo or Endura.

Treatment, rate (application timing)[z]	Heads w/ white mold		Marketable heads		Total yield
	(%)[yx]	(t/A)	(%)[x]	(t/A)	(t/A)
Non-treated	87.1 a	19.1 a	13.0 c	3.1 c	22.2 b
Howler, 5 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	51.4 bc	13.2 b	48.6 ab	12.3 ab	25.5 a
Theia, 3 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	69.5 ab	15.7 ab	30.5 bc	6.9 bc	22.6 b
Esendo, 2.8 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	42.3 c	10.8 b	57.8 a	14.8 a	25.5 a
Endura, 8 oz/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	57.3 bc	15.3 ab	42.8 ab	11.5 ab	26.8 a
P-value	0.0073	0.0461	0.0073	0.0063	0.0047

[z]Application dates: 1= 2 Aug; 2= 9 Aug; 3= 16 Aug; 4= 23 Aug; 5= 26 Aug.
[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated p-value. Means were separated using Fisher's least significant difference test.
[x]Percentages based on t/A values.

COLLARDS (*Brassica oleracea* 'Vates')
Black rot; *Xanthomonas campestris* pv. *campestris*
Peppery leaf spot; *Pseudomonas syringae* pv. *maculicola*

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Evaluation of biologicals and copper for the management of black rot and peppery leaf spot of collards, 2021.

Two runs of the experiment were conducted at The Ohio State University's Muck Crops Agricultural Research Station in Willard, OH on Linwood muck soil, pH 5.8. Seeds for the first run were directly sown on 10 Jun into a field located on the south side of the station and for the second run, located at the north side of the station, seeds were sown into 72-cell plug trays containing Metro-Mix 360 growing medium on 22 Jul. On 8 Jun (South) and 13 Aug (North), the test fields were disk chiseled, tilled, worked with a seedbed finisher, and disked again. Beds were prepared on 5 ft centers. 26-day old collard seedlings were transplanted on 17 Aug (North). The experimental runs were laid out in a randomized complete block design with four replications. Plots consisted of three rows spaced 18 in. apart, with each row seeded at 4 in. spacing (South) or one row of 25 plants spaced 1 ft apart (North). Plants were inoculated with 10^8 CFU/ml *Xanthomonas campestris* pv. *campestris* strain SM070-21 on 10 Aug (South) and 9 Sep (North) using a CO_2-pressurized backpack sprayer. Peppery leaf spot developed naturally in the field for both runs. Insecticides were applied to the South field as needed and included Stinger (0.25 pt/A; 14 Jul), Mustang Maxx (3.5 fl oz/A; 4 Aug) and Widespread Max (1.8 mL/gal; 19 Aug). Fungicides were also applied and included Ranman (82.75 fl oz/A; 22 Jul and 19 Aug), Revus (8 fl oz/A; 28 Jul), Quadris (15.5 fl oz/A; 6 Aug) and Zampro (14 fl oz/A; 13 Aug). The Herbicides Dyne-Amic (14.2 mL/gal) and LI 700 (1.2 mL/gal) were applied on 28 Jul and 13 Aug, respectively. The fungicide Ranman (2.75 fl oz/A) was applied to the North field on 19 Aug. The field was hoed and hand weeded on 6 Jul (South) and 1, 8 and 29 Sep (North). Foliar treatments for both experiments were applied using a tractor-mounted CO_2-pressurized sprayer (50 psi, 44.3 gpa, 2.4 mph) beginning 2 Aug and ending 30 Aug for a total of five applications (South) and beginning on 2 Sep and ending on 12 Oct for a total of seven applications (North). Black rot did not develop in the South field but severity of peppery leaf spot on foliage was evaluated on 17, 24 and 31 Aug using a scale of 0-100% foliage affected. The severity of black rot and peppery leaf spot were both evaluated in the North field on 21 and 28 Sep and 5, 12 and 19 Oct using a scale of 0-100% foliage affected. Average maximum temperatures for 10-30 Jun, Jul, Aug, Sep and 1-19 Oct were 81.7, 81.6, 83.8, 78.1 and 75.4°F; average minimum temperatures were 63.1, 63.2, 63.7, 54.5 and 55.5°F; and rainfall amounts were 3.8, 8.7, 3.1, 2.4 and 1.0 in., respectively. Natural log transformation was performed on AUDPC ratings. Analysis of variance was performed using the GLIMMIX procedure, and means were separated by Fisher's least significant difference test with SAS software.

Naturally occurring peppery leaf spot disease pressure was high in the South trial (first run), with disease severity reaching nearly 60% in the non-treated control (Table 1). Treatment of collard plants with Howler, Theia or Kocide 3000-O significantly reduced (55-60%) peppery leaf spot severity compared to non-treated plants at the end of the season (31 Aug). Season-long disease progression (AUDPC) was also significantly lower in all treated plots than the non-treated control. There were no differences in peppery spot severity or AUDPC among plots treated with Howler, Theia or Kocide 3000-O. In the North trial (second run), peppery leaf spot disease pressure was low, with disease severity reaching approximately 15% in the non-treated control (Table 2). There were no significant differences between treated and control plots in end-of-season (19 Oct) disease severity or AUDPC compared to the non-treated control. Typical black rot V-shaped leaf lesions developed after inoculation of collards in the North trial, although disease pressure was relatively low with black rot severity in the non-treated control reaching 17.5%. Treatment of collard plots with Howler, Theia and Kocide 3000-O significantly reduced end of season black rot severity (51-77%) and AUDPC compared to non-treated control plants, but there were no differences in these values among treatments.

Table 1. Peppery leaf spot severity and AUDPC ratings for South field (first run).

Treatment, rate (application timing)[z]	Peppery leaf spot severity	
	31 Aug (%)[yw]	AUDPC[yx]
Non-treated	58.8 a	691.3 a
Howler, 5 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	26.3 b	328.1 b
Theia, 3 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	23.8 b	293.1 b
Kocide 3000-O, 0.75 lb/A (1-5) Dyne-Amic, 0.375% v/v (1-5)	23.8 b	297.5 b
P-value	<0.0001	<0.0001

[z]Application dates: 1= 2 Aug; 2= 9 Aug; 3= 16 Aug; 4= 23 Aug; 5= 30 Aug.
[y]Peppery leaf spot disease ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.
[x]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.
[w]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

Table 2. Black rot and peppery leaf spot severity and AUDPC ratings for North field (second run).

Treatment, rate (application timing)[z]	Black rot severity		Peppery leaf spot severity	
	19 Oct (%)[yw]	AUDPC[yxv]	19 Oct (%)[yw]	AUDPC[yxv]
Non-treated	17.5 a	284.4 a	14.8	272.3
Howler, 5 lb/A (1-7) Dyne-Amic, 0.375% v/v (1-7)	4.0 b	70.0 b	8.9	231.0
Theia, 3 lb/A (1-7) Dyne-Amic, 0.375% v/v (1-7)	8.5 b	124.3 b	7.5	193.2
Kocide 3000-O, 0.75 lb/A (1-7) Dyne-Amic, 0.375% v/v (1-7)	6.8 b	95.4 b	4.9	123.2
P-value	0.0009	0.0003	0.2007	0.1141

[z]Application dates: 1= 2 Sep; 2= 8 Sep; 3= 15 Sep; 4= 21 Sep; 5= 28 Sep; 6= 5 Oct; 7= 12 Oct.
[y]Black rot and peppery leaf spot disease ratings and area under disease progress curve (AUDPC) values were based on the percent foliar disease.
[x]AUDPC was calculated according to the formula: $\sum([(x_i+x_{i-1})/2](t_i-t_{i-1}))$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations.
[w]Means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.
[v]Values are the back-transformed means.

Vegetable Disease Diagnosis Report for 2021

Sally A. Miller, Francesca Rotondo

For the first part of 2021, we continued to use a digital first approach to diagnostics. We requested that clients send digital images first and if we were unable to diagnose the problem, we arranged for a contactless sample drop-off. For the second part of the year, starting from July 2021, we were able to allow in person sample drop-off. We then utilized a range of traditional and modern, state-of-the-art diagnostic methods. These include light microscopy to identify fungal and oomycete (Phytophthora, Pythium, downy mildew) pathogens based on morphology, culturing followed by microscopic or other identification, biochemical and plant tests for bacterial identification, serological assays, mainly for virus and bacterial identification, specific polymerase chain reaction (PCR and quantitative PCR) assays and genomic sequencing. When a sample was received digitally, by courier, US mail, or in person, it was immediately catalogued and given a unique number. After initial evaluation, the submitter was contacted within 24 hours by phone or email and provided with a preliminary diagnosis and management recommendations. In many cases this was also the final diagnosis. If culturing or other time-consuming tests were required, final results may not have been available for several days to one week.

This year the vegetable diagnostic program was still impacted by restrictions due to the Covid-19 pandemic. However, the second part of the year ran more smoothly and was similar to previous years in regard to number of samples. Commercial growers rely, and have relied, on this service for more than 15 years. Information from the lab was shared with the growers directly and through our blogs and Tweets: Ohio Veggie Disease News blog (u.osu.edu/miller.769), the VegNet Newsletter (vegnet.osu.edu), Twitter (@OhioVeggieDoc), and directly to county Extension educators. The sources (grower name, address) of the diagnostic samples are never revealed to the public. Grower communication in 2021 was predominantly through phone calls, video calls and by sharing pictures representative of the problem on social media platforms, websites and in newsletters. This year we were able to attend few crop walks and in-person field days. However, trainings were still carried out remotely (zoom meetings and webinars).

The estimated cost of providing the basic service to growers, considering labor and supplies, is $60 per physical sample. This does not include the cost of advanced diagnostics necessary in some cases or overhead costs. We estimate that the cost of diagnosing electronic samples is $20/sample. In 2021 we diagnosed 241 physical and 20 electronic vegetable samples. Therefore, the value of this service in 2021 to Ohio vegetable growers is at least $14,860.

Sample Type	**Vegetable Crops**	**Estimated Value ($)**
Physical	241	14,460
Electronic	20	400
Total		**14,860**

The 2021 growing season was characterized by heavy rains and high humidity. These conditions favored the spread of bacterial diseases on several crops (cole crops, peppers, and tomatoes). Average max temperature between the 1st of June and the 1st of July was 72°F, while the min average temperature was 62°F. These cool temperatures, together with the rain, favored the spread of Pseudomonas leaf spot on several crops (collards, kale, parsley and peppers) for a total of 10 samples diagnosed in month of June.

For both tomatoes and peppers the other most frequently diagnosed bacterial disease was bacterial spot (caused by *Xanthomonas* spp.). Bacterial canker was only diagnosed once in Coshocton County. Fusarium wilt continued to be a problem in both peppers (N=2) and tomatoes (N=10). Tomato spotted wilt virus (TSWV; Tospovirus) was diagnosed in tomato (four samples). As for the past seasons, we did not diagnose any cases of Tomato brown rugose fruit virus

(ToBRFV; Tobamovirus). This virus is mechanically transmitted and is causing severe damage to greenhouse tomato global production worldwide (Europe, Turkey, Jordan, Mexico and China), and the movement of tomato and pepper seeds, fruits and transplants is strictly regulated by APHIS in order to prevent the spread of this viral disease.

For vine crops, we pinpointed the first appearance of downy mildew in cucumbers, melons, pumpkins and squash in 12 counties in the state. All first reports were submitted to the multistate cucurbit downy mildew forecasting site (Cucurbit ipmPIPE; http://cdm.ipmpipe.org/). This year we were able to establish and monitor more sentinel plots than usual across multiple counties thanks to the Science Citizens project in collaboration with Master Gardner volunteers. Downy mildew was also reported on basil in Wayne County. This year downy mildew in cucurbits appeared in early July. Downy mildew (N=12), Phytophthora fruit rot (N=6) and Plectosporium blight (N=5) were the most frequently reported diseases among cucurbits.

Damage caused by herbicide drift were reported on tomatoes, peppers, cabbages, and broccoli. Cole crops were mainly affected by bacterial diseases caused by *Xanthomonas* (bacterial leaf spot) and *Pseudomonas* (peppery spot)
The major disease faced by leafy greens grown in hydroponic facilities was Pythium root rot (N= 22). The predominant species identified was *P. dissotocum*. Most of these facilities relies on organic management options, and a prompt diagnosis becomes a key-point to effectively control these pathogens.

A total of 241 samples (221 physical and 20 electronic) were diagnosed in 2021. The majority of the samples were submitted by or on behalf of commercial vegetable producers in Ohio (**Figure 1**).

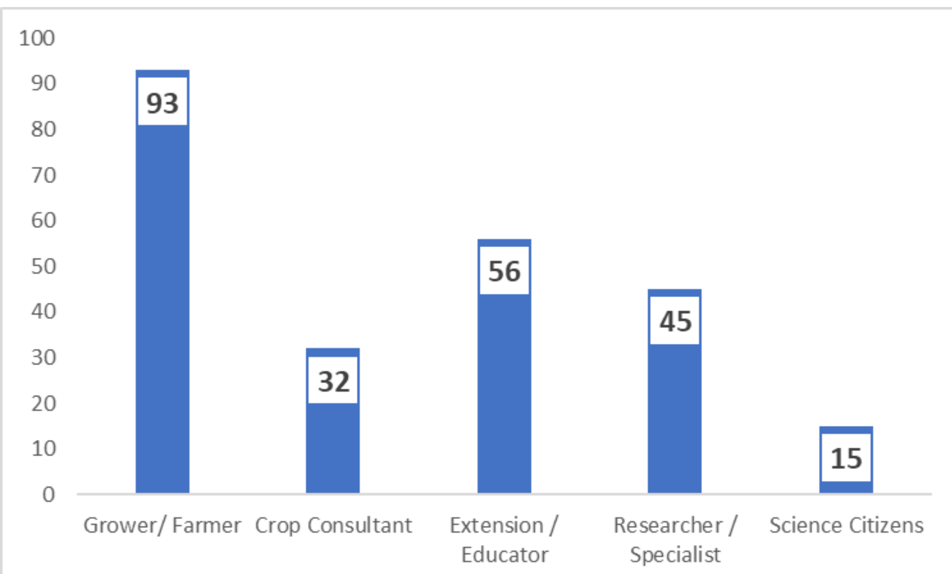

Figure 1. Sources of samples submitted to the OSU Vegetable Pathology Laboratory during 2021.

Vegetable samples were received from 41 Ohio counties and four samples came from outside the State of Ohio (Kentucky and Colorado) (**Figure 2**). The number of counties for this year was higher when compared to the number recorded in 2020 and 2019 (42 and 35 counties, respectively). A higher number of samples were submitted by hydroponic facilities, 22 vs 12 of the previous year. The Citizen Science project also contributed to the increment of the sample and the counties covered for the reporting of downy mildew. The highest number of samples were submitted from Huron County, Wayne County, Hamilton County, and Sandusky County (48, 31, 24, and 21, respectively), many in collaboration with the Muck Crops Agricultural Research Station in Willard, Wayne OSU Extension IPM Scouting program, and the North Central Agricultural Research Station in Fremont.

Figure 2. Number of vegetable samples received for diagnosis by the OSU Vegetable Pathology Laboratory, by Ohio county.

Most of the samples received were solanaceous crops (tomatoes, peppers, and eggplant) followed by cucurbits (cucumbers, melons, watermelon, zucchini, squash and pumpkins) (**Figure 3**). Among the solanaceous crops tomatoes were the most frequently received (**Table 1),** followed by peppers (**Table 2**), while among the cucurbitaceous crops, cucumbers were predominant (**Table 3**). The remaining samples included legumes and leafy greens, while the "other" category included beets, rhubarb, tomatillo, and weeds (honeysuckle weed, and pig weed). We also tested plugs and recirculation water for the presence of oomycete propagules.

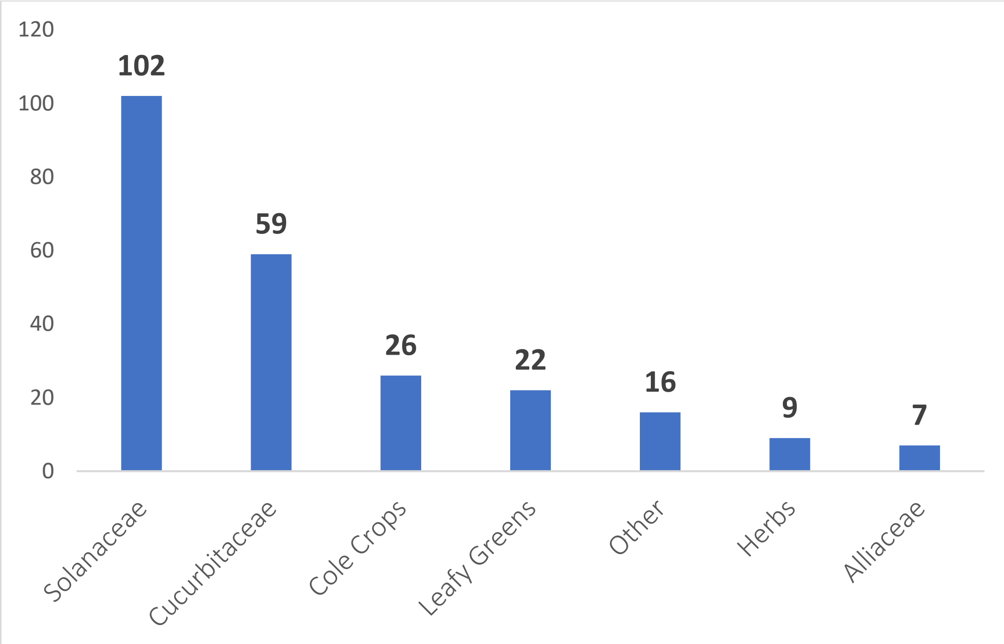

Figure 3. Number of samples received for diagnosis by the OSU Vegetable Pathology Laboratory in 2021.

Table 1. Major diseases and abiotic disorders diagnosed on tomato samples in 2021. We received a total of 56 tomato samples. These samples were from fields (N=45), greenhouses (N=3), and high tunnels (N=8). Some samples had more than one disease

Diagnosis	Number of Samples	Counties
Bacterial spot	12	Lake, Putnam, Sandusky, Seneca, Wayne
Bacterial speck	1	Hardin
Bacterial canker	1	Coshocton
Septoria leaf blight	1	Wayne
Leaf mold	1	Adams
Early blight	1	Lake
Anthracnose	1	Columbiana
Corky root rot	2	Adams, Jefferson
Pythium root rot	1	Franklin
Fusarium wilt	10	Adams, Columbiana, Hamilton, Holmes, Sandusky
RKN	2	Adams, Jefferson
Insect damage	2	Pickaway, Holmes
INSV	1	Wayne
TSWV	4	Erie
TMV	1	Hardin
Herbicide	4	Pickaway, Licking
Other abiotic stresses	10	Holmes, Hamilton, Holmes, Sandusky, Wayne

Table 2. Diseases and abiotic disorders diagnosed on pepper samples (N=37) in 2021. Some samples had more than one disease.

Diagnosis	Number of Samples	Counties
Pseudomonas leaf spot	3	Hardin, Wayne
Bacterial leaf spot	18	Hardin, Huron, Seneca, Wayne
Bacterial canker	1	Wayne
Anthracnose	3	Columbiana
Fusarium wilt	1	Columbiana
Broad mites	1	Butler
Herbicide	10	Huron
Other abiotic stresses	2	Huron, Sandusky

Table 3. Diseases and abiotic disorders diagnosed on cucurbit samples (N=56) in 2021.

Diagnosis	Number of Samples	Counties
Angular leaf spot	2	Huron, Wayne
Bacterial leaf spot	3	Franklin, Huron, Wayne
Alternaria leaf spot	3	Lake, Hardin, Wayne
Anthracnose	5	Columbiana, Hardin, Huron,
Gummy stem blight	1	Medina
Fusarium fruit rot	1	Franklin
Powdery mildew	3	Hardin, Sandusky, Wayne
Plectosporium blight	4	Hardin, Huron, Tuscarawas, Wayne
Downy mildew	12	Belmont, Champaign, Coshocton, Fulton, Geauga, Jefferson, Hardin, Huron, Muskingum, Sandusky, Seneca, Wayne
Phytophthora fruit rot	6	Geauga, Huron, Montgomery, Wayne
Squash mosaic virus	1	Jackson
Potyviruses	1	Huron, Wayne
Insect damage	5	Holmes, Wayne
Abiotic stresses	9	Adams, Franklin, Ross

For more information on these reports or to receive copies of this or similar publications, please contact:

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Report is available online: u.osu.edu/vegetablepathologylab/