

Bioassay for sensitivity of *Podosphaera xanthii* to fungicides in OH, 2017.

The experiment was conducted in a greenhouse located at The Ohio State University - Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH. Pumpkin 'Solid Gold F1' FarMore-treated seeds were sown on 2, 18 and 31 Aug and 12 and 20 Sep into 4 in. pots filled with Baccto Professional Grower Potting Mix. The experiment was set up in a randomized complete block design with four replications. Each replication consisted of three individual potted plants. 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 second true leaf was fully expanded, treatments were applied to the top surface of both the first and second true leaves by using a hand held sprayer at a rate of 54 gal/A. Non-treated control plants were sprayed with water. Each leaf received approximately 0.08 fl oz. of spray. Pumpkin leaves containing >80% powdery mildew severity were used for inoculation. Eight leaves were shaken on top of the seedlings per replication; leaves remained in the room for approximately 8 hours. Leaves with inoculum were collected from three cucurbit fields: OARDC North Central Agricultural Research Station in Fremont, OH, OARDC Western Agricultural Research Station in South Charleston, OH, and the OSU South Centers in Piketon, OH. Inoculum from each location was used in separate greenhouse rooms. Treatments were sprayed one day after inoculation. Any new growth after the third true leaf was removed. Phytotoxicity and the severity of powdery mildew were evaluated on the upper surface of the first two true leaves at 3, 7, 10, and 14 days post inoculation (DPI). Disease severity per leaf was assessed using a rating scale illustrating powdery mildew at 0.5, 1, 2, 4, 8, 16, 32, 64, and 80 percent foliage affected. Experiments were performed twice for each location. Analysis of variance was performed on the angular transformed ($\arcsin[\sqrt{(\text{severity}/100)}]$) powdery mildew percent severity data using the GLIMMIX procedure, and transformed means were separated by Fisher's least significant difference test with SAS software. Powdery mildew severity data were analyzed independently for each location and for each experiment. Transformed means were back-transformed by squaring the sine of the means. Average maximum and minimum temperature for each experiment before inoculation was: Fremont early season inoculation: 93.7 F and 76.4 F, Fremont late season inoculation: 86.4 F and 72.3 F, South Charleston early season inoculation: 87.7 F and 76.7 F, South Charleston late season inoculation: 92.1 F and 71.8 F, Piketon early season inoculation: 85.4 F and 72.6 F, and Piketon late season inoculation: 86.9 F and 72.9 F. Average maximum and minimum temperature for each experiment after inoculation was: Fremont early season inoculation: 88.8 F and 70.7 F, Fremont late season inoculation: 84.1 F and 66.0 F, South Charleston early season inoculation: 86.3 F and 76.8 F, South Charleston late season inoculation: 84.9 F and 68.8 F, Piketon early season inoculation: 85.0 F and 72.7 F, and Piketon late season inoculation: 82.4 F and 73.7 F.

Powdery mildew severity was medium to high ($\geq 60\%$ severity) on all experiments at 14 days post inoculation (Tables 1 and 2), except the experiment using late season inoculum from Piketon (untreated control: 32.2% powdery mildew severity). No phytotoxicity was observed with any of the treatments, except Quintec 2.08SC on the experiments using late season inoculum.

Powdery mildew severity was high in the non-treated controls of the early season inoculation. Based on disease severity 14 days after inoculation, all fungicide treatments except Bravo Weather Stik with inoculum from all locations, MBI_10612 at a rate of 24 fl oz/A with inoculum from Fremont or South Charleston, and Pristine WG with inoculum from Fremont or Piketon performed significantly better than the non-treated control. Plants treated with Procure 480SC, Quintec 2.08SC or Rally 40WSP showed <11% powdery mildew severity with inoculum from all locations. Plants treated with Aprovia Top EC or Inspire Super EW showed <10% powdery mildew severity with inoculum from Piketon and South Charleston, while those treated with Fontelis 1.67SC, Merivon Xemium 2.09SC, or Torino 0.85SC showed <10% powdery mildew severity only with inoculum from South Charleston. Based on the season-long severity (AUDPC) all the treatments performed better than the non-treated control when inoculum from South Charleston was used. When inoculum from the other two locations was used, all treatments performed better than the non-treated control based on AUDPC, except Bravo Weather Stik and MBI_10612 at a rate of 24 fl oz/A with inoculum from Fremont, and Bravo Weather Stik and Pristine WG with inoculum from Piketon (Table 1).

Powdery mildew severity was high on the non-treated controls in the experiments using late season inoculum 10 days post inoculation, except for Piketon (untreated control: 13.6% powdery mildew severity). Plants treated with Procure 480SC, Quintec 2.08SC, Rally 40WSP, Aprovia Top EC or Inspire Super EW showed <14% disease severity with inoculum from Fremont and South Charleston (Figure 1). Those treated with Fontelis 1.67SC, Merivon Xemium 2.09SC, and Torino 0.85SC showed <10% powdery mildew severity only with inoculum from South Charleston (Figure 1), as observed in the early season inoculum experiments. Severity at 14 days post inoculation was <15% on plants treated with Procure 480SC, Quintec 2.08SC, Rally 40WSP, Aprovia Top EC or Inspire Super EW and inoculated with inoculum from all locations, except Quintec 2.08SC with Fremont inoculum. Quintec 2.08SC showed some level of phytotoxicity. Plants treated with Fontelis 1.67SC, Merivon Xemium 2.09SC, and Torino 0.85SC showed <15% powdery mildew severity with inoculum from South Charleston. For inoculum from Piketon at 14 days post inoculation, Inspire Super EW, and Torino 0.85SC also showed <15% powdery mildew severity. For season-long severity (AUDPC), all treatments performed better than the non-treated control, except Bravo Weather Stick at all locations, and Fontelis 1.67SC, Merivon Xemium 2.09SC, and Pristine WG with inoculum from Piketon (Table 2).

Table 1. Powdery mildew (PM) severity (percent) on pumpkin ‘Solid Gold F1’ leaves 7, 10, and 14 days post inoculation (DPI) of treatments, percentage control, and Area Under the Disease Progress Curve (AUDPC). Results experiments using early season inoculum.

Location	Treatment and rate/A	% PM ^{z,y,x}		% PM ^{z,y,x} (% control ^s)		% PM ^{z,y,x} (% control ^s)		AUDPC ^r			
		7 DPI	10 DPI	14 DPI	14 DPI	14 DPI					
Fremont ^w	Aprovia Top EC 13.5 fl oz	4.7	fgh	n.e. ^t	15.1	ef	(83.5)	81.6	ef		
	Bravo Weather Stik 6SC 48 fl oz	78.6	a	n.e.	97.7	a	(0.0)	771.4	a		
	Fontelis 1.67SC 16.0 fl oz	10.1	ef	n.e.	36.6	d	(60.0)	185.9	de		
	Inspire Super EW 20.0 fl oz	19.1	de	n.e.	38.7	d	(57.7)	242.8	d		
	Merivon Xemium 2.09SC 5.5 fl oz	12.8	ef	n.e.	40.7	d	(55.5)	216.5	d		
	Pristine WG 18.5 oz	37.2	c	n.e.	81.3	bc	(11.3)	475.1	c		
	Procure 480SC 8.0 fl oz	1.3	gh	n.e.	5.7	f	(93.8)	30.2	f		
	Quintec 2.08SC 6.0 fl oz	0.8	h	n.e.	7.1	f	(92.2)	32.4	f		
	Rally 40WSP 5.0 oz	7.1	fg	n.e.	10.6	ef	(88.4)	79.2	ef		
	Torino 0.85SC 3.4 fl oz	6.8	fg	n.e.	23.0	de	(74.9)	120.2	def		
	MBI-10612 24 fl oz	38.9	c	n.e.	90.6	abc	(1.1)	530.0	bc		
	MBI-10612 32 fl oz	27.1	cd	n.e.	75.5	c	(17.6)	414.9	c		
	Non-treated control	56.1	b	n.e.	91.6	ab		620.5	b		
	P-value	<0.0001		<0.0001		<0.0001		<0.0001			
South	Aprovia Top EC 13.5 fl oz	0.1	e	n.e.	1.7	fg	(97.2)	8.7	e		
Charleston ^v	Bravo Weather Stik 6SC 48 fl oz	7.6	ab	n.e.	44.6	ab	(25.6)	201.2	b		
	Fontelis 1.67SC 16.0 fl oz	0.3	de	n.e.	7.5	defg	(87.6)	45.0	de		
	Inspire Super EW 20.0 fl oz	0.2	e	n.e.	8.7	def	(85.5)	37.3	de		
	Merivon Xemium 2.09SC 5.5 fl oz	0.0	e	n.e.	2.3	fg	(96.2)	11.1	e		
	Pristine WG 18.5 oz	0.4	de	n.e.	14.5	cde	(75.8)	56.5	de		
	Procure 480SC 8.0 fl oz	0.0	e	n.e.	0.8	g	(98.7)	4.2	e		
	Quintec 2.08SC 6.0 fl oz	0.0	e	n.e.	1.6	fg	(97.3)	6.0	e		
	Rally 40WSP 5.0 oz	0.2	e	n.e.	6.1	efg	(89.8)	25.5	e		
	Torino 0.85SC 3.4 fl oz	0.1	e	n.e.	1.4	fg	(97.6)	8.4	e		
	MBI-10612 24 fl oz	4.3	bc	n.e.	30.2	bc	(49.6)	134.5	c		
	MBI-10612 32 fl oz	2.2	cd	n.e.	18.8	cd	(68.7)	89.7	cd		
	Non-treated control	10.7	ab	n.e.	60.0	ab		267.3	a		
		P-value	<0.0001		<0.0001		<0.0001		<0.0001		
Piketon ^u	Aprovia Top EC 13.5 fl oz	0.2	ef	1.5	de	(96.0)	5.3	de	(92.3)	20.4	de
	Bravo Weather Stik 6SC 48 fl oz	23.9	a	42.5	a	(0.0)	63.8	a	(6.6)	362.0	a
	Fontelis 1.67SC 16.0 fl oz	2.5	cde	7.9	cd	(79.7)	17.3	cd	(74.6)	73.9	cde
	Inspire Super EW 20.0 fl oz	1.1	def	2.5	de	(93.6)	7.2	de	(89.5)	35.6	de
	Merivon Xemium 2.09SC 5.5 fl oz	8.0	bc	19.0	bc	(51.0)	36.7	bc	(46.3)	179.2	bc
	Pristine WG 18.5 oz	16.2	ab	27.2	ab	(30.1)	49.1	ab	(28.1)	260.5	ab
	Procure 480SC 8.0 fl oz	0.0	f	0.1	e	(99.9)	0.3	e	(99.6)	1.6	e
	Quintec 2.08SC 6.0 fl oz	0.2	ef	0.7	e	(98.1)	3.2	e	(95.2)	16.2	de
	Rally 40WSP 5.0 oz	0.2	ef	0.7	e	(98.1)	2.3	e	(96.6)	8.6	de
	Torino 0.85SC 3.4 fl oz	7.3	c	18.5	bc	(52.5)	37.2	bc	(45.5)	168.2	bc
	MBI-10612 24 fl oz	7.0	c	18.0	bc	(53.6)	38.4	b	(43.7)	169.4	bc
	MBI-10612 32 fl oz	4.5	cd	12.1	c	(68.9)	27.2	bc	(60.1)	116.3	cd
	Non-treated control	18.9	a	38.9	a		68.2	a		341.0	a
	P-value	<0.0001		<0.0001		<0.0001		<0.0001			

^zDisease 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.

^yValues are the back-transformed means of leaf 1 and 2, upper surface only.

^xMeans followed by the same lower case letter within a column are not significantly different at P<0.05. Means were separated using Fisher’s least significant difference test on angular transformed data.

^wOhio North Central Agricultural Research and Development Center Snyder Farm, Fremont, OH.

^vOhio Agricultural Research and Development Center Western Agricultural Research Station, South Charleston, OH.

^uOSU South Centers, Piketon, OH.

^tn.e. = not evaluated.

^sPercentage control values were calculated for each plot according to the formula: [(SC – ST)/SC]*100 where SC is the average severity on the non-treated control and ST is the average severity on the treatment.

^fArea under the disease progress curve values were 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 number of days between evaluations.

Table 2. Powdery mildew (PM) severity (percent) on pumpkin ‘Solid Gold F1’ leaves 7, 10, and 14 days post inoculation (DPI) of treatments, percentage control, and Area Under the Disease Progress Curve (AUDPC). Results experiments using late season inoculum.

Location	Treatment and rate/A	% PM ^{z,y,x}		% PM ^{z,y,x} (% control ^l)		% PM ^{z,y,x} (% control ^l)		AUDPC ^s
		7 DPI	10 DPI	14 DPI	14 DPI	14 DPI		
Fremont ^w	Aprovia Top EC 13.5 fl oz	4.5 ef	9.9 e (84.6)	13.6 g (83.2)	77.8 ef			
	Bravo Weather Stik 6SC 48 fl oz	47.3 a	63.4 a (1.6)	83.5 a (0.0)	552.2 a			
	Fontelis 1.67SC 16.0 fl oz	17.1 cd	36.0 cd (44.0)	51.8 de (36.0)	292.1 cd			
	Inspire Super EW 20.0 fl oz	2.9 ef	8.7 ef (86.5)	14.4 g (82.3)	70.4 ef			
	Merivon Xemium 2.09SC 5.5 fl oz	24.9 bc	44.2 bc (31.3)	63.5 cd (21.6)	369.5 bc			
	Pristine WG 18.5 oz	25.1 bc	46.0 bc (28.6)	66.1 cd (18.3)	381.2 bc			
	Procure 480SC 8.0 fl oz	0.0 g	0.3 g (99.6)	1.0 h (98.8)	4.3 f			
	Quintec 2.08SC 6.0 fl oz	6.5 e	13.1 e (79.6)	33.8 f (58.3)	138.3 e			
	Rally 40WSP 5.0 oz	1.7 f	3.5 f (94.6)	4.3 h (94.7)	27.4 f			
	Torino 0.85SC 3.4 fl oz	28.2 bc	53.1 ab (17.4)	70.7 bc (12.6)	426.5 b			
	MBI-10612 24 fl oz	25.5 b	44.8 bc (30.3)	60.1 cd (25.8)	366.5 bc			
	MBI-10612 32 fl oz	15.7 d	31.1 d (51.6)	44.5 ef (45.1)	260.2 d			
	Non-treated control	44.7 a	64.4 a	81.0 ab	542.5 a			
	P-value	<0.0001	<0.0001	<0.0001	<0.0001			
South Charleston ^y	Aprovia Top EC 13.5 fl oz	0.0 f	0.4 gh (99.4)	0.6 f (99.3)	3.9 e			
	Bravo Weather Stik 6SC 48 fl oz	50.4 a	77.6 a (0.0)	89.9 a (0.0)	627.0 a			
	Fontelis 1.67SC 16.0 fl oz	2.6 de	7.1 e (89.3)	11.9 d (86.1)	59.4 e			
	Inspire Super EW 20.0 fl oz	0.1 f	1.1 fgh (98.4)	1.7 ef (98.1)	11.3 e			
	Merivon Xemium 2.09SC 5.5 fl oz	3.0 de	7.4 e (88.9)	12.1 d (85.8)	66.7 e			
	Pristine WG 18.5 oz	6.6 cd	21.4 d (67.9)	33.5 c (60.8)	169.9 d			
	Procure 480SC 8.0 fl oz	0.0 f	0.0 h (100.0)	0.0 f (100.0)	0.0 e			
	Quintec 2.08SC 6.0 fl oz	0.0 f	1.8 fg (97.2)	1.4 f (98.4)	10.1 e			
	Rally 40WSP 5.0 oz	0.0 f	0.0 h (100.0)	0.4 f (99.5)	1.0 e			
	Torino 0.85SC 3.4 fl oz	1.1 ef	4.6 ef (93.2)	7.3 de (91.4)	37.2 e			
	MBI-10612 24 fl oz	11.7 c	34.7 c (47.9)	57.5 b (32.8)	277.3 c			
	MBI-10612 32 fl oz	11.3 c	29.2 cd (56.1)	44.4 bc (48.1)	234.0 cd			
	Non-treated control	30.8 b	66.6 b	85.5 a	511.1 b			
	P-value	<0.0001	<0.0001	<0.0001	<0.0001			
Piketon ^u	Aprovia Top EC 13.5 fl oz	0.0 e	0.3 fg (97.7)	0.4 g (98.7)	2.3 f			
	Bravo Weather Stik 6SC 48 fl oz	18.9 a	34.9 a (0.0)	60.3 a (0.0)	311.5 a			
	Fontelis 1.67SC 16.0 fl oz	5.1 bc	9.9 bc (26.6)	21.6 bcd (33.1)	99.3 bcd			
	Inspire Super EW 20.0 fl oz	0.0 e	0.1 fg (99.1)	1.1 g (96.7)	5.6 ef			
	Merivon Xemium 2.09SC 5.5 fl oz	4.8 bc	11.1 bc (17.8)	18.1 bcde (43.9)	102.8 bcd			
	Pristine WG 18.5 oz	5.1 bc	11.8 bc (12.9)	28.5 bc (11.7)	130.1 bc			
	Procure 480SC 8.0 fl oz	0.0 e	0.0 g (99.9)	0.0 g (100.0)	0.2 f			
	Quintec 2.08SC 6.0 fl oz	0.1 e	1.9 ef (86.0)	2.2 fg (93.2)	11.8 ef			
	Rally 40WSP 5.0 oz	0.0 e	0.0 g (100.0)	0.0 g (100.0)	0.0 f			
	Torino 0.85SC 3.4 fl oz	1.5 d	3.5 de (74.4)	8.5 ef (73.6)	35.6 ef			
	MBI-10612 24 fl oz	3.3 cd	6.5 cd (51.9)	15.6 cde (51.4)	68.1 cde			
	MBI-10612 32 fl oz	1.4 d	4.1 de (70.1)	11.0 de (65.8)	42.2 def			
	Non-treated control	7.2 b	13.6 b	32.2 b	143.7 b			
	P-value	<0.0001	<0.0001	<0.0001	<0.0001			

^fDisease 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.

^yValues are the back-transformed means of leaf 1 and 2, upper surface only.

^xMeans followed by the same lower case letter within a column are not significantly different at P<0.05. Means were separated using Fisher’s least significant difference test on angular transformed data.

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^lPercentage control values were calculated for each plot according to the formula: $[(SC - ST)/SC]*100$ where SC is the average severity on the non-treated control and ST is the average severity on the treatment.

^sArea under the disease progress curve values were 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 number of days between evaluations.

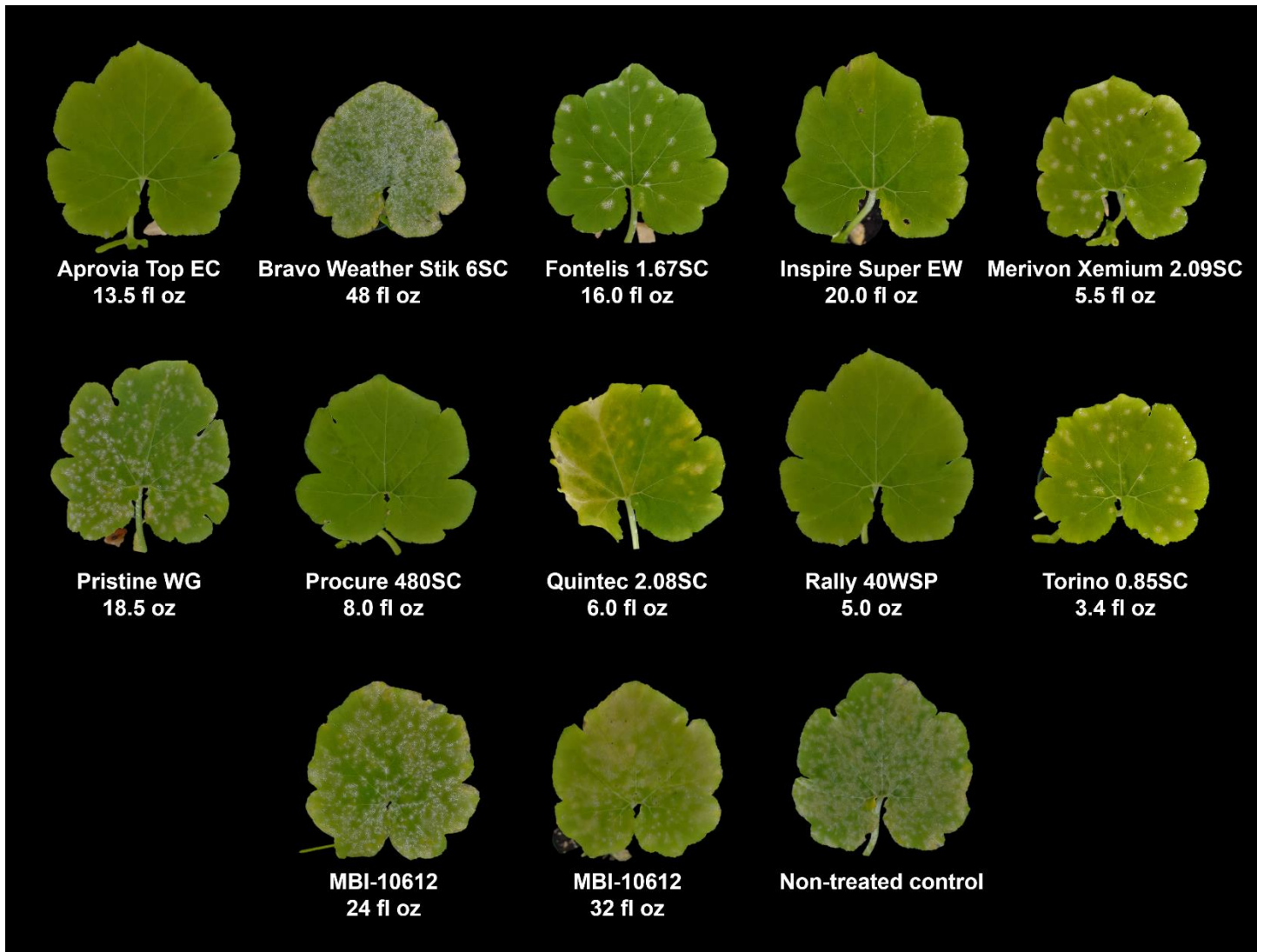


Figure 1. Powdery mildew on second true leaves of pumpkin ‘Solid Gold F1’ 10 days post inoculation (DPI). Results of second experiment with inoculum from South Charleston, OH.