Ohio Vegetable & Small Fruit Research & Development Program

Final Report

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Project Title: Efficacy of Fungicides Against Powdery Mildew in Pumpkins

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Why was this project funded? Powdery mildew is one of the most important diseases of cucurbit crops, especially squash and pumpkins. Although some varieties are available with intermediate resistance to powdery mildew, the disease is mainly managed using fungicides. However, the powdery mildew pathogen, *Podosphaera xanthii*, develops resistance to fungicides relatively quickly. We have conducted bioassays for fungicide sensitivity to pumpkin powdery mildew in the recent past in one or more locations, often with slightly different results depending on location. In 2020 the fungicides Torino, Rally, Aprovia Top, Bravo Weather Stik, Fontelis, Merivon Xemium and Pristine failed to control the disease and Quintec provided only moderate control. Normally the bioassays are conducted late in the season. In this project, we propose to conduct powdery mildew bioassays in two locations, one with high fungicide use and the other with lower use, two times during the season (early and late) at these locations. We will also conduct a full season replicated field trial to test the same fungicides at the high use location. In addition to the fungicides noted above, we will test fungicides that were effective in the 2020 bioassay: Inspire Super, Procure, Vivando and Gatten.

Project outline: We established a field trial on OSU NCARS with pumpkin variety 'Solid Gold F1' susceptible to powdery mildew. Treatments were arranged in a randomized complete block design with four replications. Water-treated plots served as a non-treated control. Foliage was evaluated weekly after symptoms appeared for disease severity, and pumpkin fruits were assessed for disease and yield at harvest. Bioassays were conducted by exposing fungicide-treated and control pumpkin seedlings to powdery mildew inoculum in Wooster (low fungicide use) and NCARS (high fungicide use) on 20 Aug (early season) or 27 Sep (late

season), followed by incubation in a greenhouse and rating for powdery mildew severity.

Take-home messages:

- In the field trial the fungicides Cevya, Inspire Super, Gatten, Prolivo, Procure or Vivando were highly effective against powdery mildew on the upper leaf surface (<10% severity) and Velum Prime, Fontelis, Aprovia Top, Rally and Quintec also provided good control (severity 12 to 13.8%).
- Velum Prime, Cevya, ProLiva and Gatten were less effective in controlling powdery mildew on the undersides of leaves than the fungicides mentioned above.
- Bioassays at both locations showed similar results to those of the field trial and can be a good, inexpensive predictor of fungicide efficacy against powdery mildew.
- Merivon Xemium, Inspire Super and Gatten are promising for management of Plectosporium blight.

Impacts: Use of partially resistant pumpkin varieties and fungicides applied judiciously beginning at the first appearance of the disease should effectively manage powdery mildew. Fungicides with different modes of action should be alternated.

What was discovered? Powdery mildew pressure was high in the field 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 (Area Under the Disease Progress Curve; AUDPC) on the top of the leaves compared to the non-treated control (Table 1). 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 (Table 2). Plectosporium blight emerged naturaly in this trial, and its incidence on handles was high (44.2%) in the non-treated control (Table 2); 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.

Powdery mildew severity on bioassay plants exposed to early season inoculum was low (<10%) in both locations (Table 3). 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).

Table 1. Foliar powdery mildew severity, field trial, Fremont, OH 2021

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.

Table 2. Powdery mildew and Plectosporium blight on pumpkin handles and marketable and cull yield.

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.

Table 3. Efficacy of fungicides against pumpkin powdery mildew – bioassay 2021.

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	b	99.7	1.5	c	97.7
Fontelis, 16 fl oz/A	0.2	bcd	97.4	9.8	b	75.2	0.1	b	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	b	99.7	0.1	c	99.8
Merivon Xemium, 5.5 fl	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	b	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	0.0	b	99.3	0.0	c	100.0
Prolivo 300SC, 5 fl oz/A	0.0	d	99.5	0.0	c	99.9	0.0	b	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	b	95.5	13.5	b	78.9
P-value	<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.