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

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Fungicide sensitivity of cucurbit powdery mildew pathogen populations on Long Island, 2018.

Fungicide resistance can be a major constraint to effectively managing powdery mildew in cucurbit crops. Fungicides that are most effective for managing powdery mildew (because they are mobile and thus can redistribute from the deposition site on upper leaf surfaces to the lower surfaces where powdery mildew develops best) are also more prone to the pathogen developing resistance (because they typically have a single-site mode of action). In this study a seedling bioassay was used to obtain site-specific information about resistance in cucurbit powdery mildew pathogen populations. Bioassays were conducted in commercial and research plantings during the growing season. Pumpkin seeds were sown in 48-cell trays. Seedlings at about the cotyledon stage were transferred individually to 4-in. pots. At approximately the 3-leaf stage, the growing tip with unexpanded leaves was removed, and then plants were sprayed to coverage with a fungicide dose. Applications were made with a backpack sprayer using a Twin-jet nozzle delivering 50 gal/A operated at 55 psi. The following morning the seedlings were organized into replications each with one plant of each treatment plus two untreated control plants. They were placed next to field-grown plants naturally infected by *Podosphaera xanthii*, with up to four replications in a location. Seedlings remained there for the rest of the day (5-8 hours) to be exposed to spores dispersed by wind, then the seedlings were returned to the greenhouse until symptoms developed. Seedlings regularly received water with 20-20-20 fertilizer applied to the top of the pot so leaves stayed dry and any new growth was removed. There was no supplemental lighting. Severity of powdery mildew was assessed as percent coverage with symptoms on the upper surface of each leaf. The first four bioassays were conducted during Jul and Aug in commercial summer squash plantings not treated with targeted fungicides for powdery mildew and in non-treated and treated cucurbit experiments at LIHREC. These bioassays provided interesting information, but data was not suitable for statistical analysis because severity was low in some replications reflecting 1 day being too short field exposure where inoculum level was low or greenhouse temperature being too high where some replications were kept. The last two bioassays were conducted in cucurbit experiments at LIHREC. In bioassay 5, treated on 12 Sep, the six replications of plants were split into two groups, four replications were placed in an experiment that was only sprayed with organic fungicides (Location A, acorn squash) and the remaining two replications were placed in an experiment that had been sprayed with a rotation of Vivando, Procure, and Quintec (Location B, winter squashes). In bioassay 6, which was conducted with seedlings at the cotyledon stage treated on 25 Sep, the five replications were similarly split, the first three replications were placed in plots of a pumpkin experiment (PDMR 13:V119) that had not been treated with any fungicides (Location C) and the remaining two replications were placed in plots in the same experiment that had been treated with a rotation of Vivando, Procure, and Quintec (Location D). Data were analyzed with one-way analysis of variance (ANOVA) and Tukey's honest significance test (HSD) to separate means using JMP statistical software.

Control seedlings became severely affected in bioassays 5 and 6. Resistance was common to Topsin M (FRAC 1), Flint (FRAC 11), and Torino (FRAC U6) in both locations for both bioassays; treated seedlings were not significantly less severely affected by powdery mildew than the controls. Endura (FRAC 7) was effective at label rate in both bioassays but not at half rate in Location A, suggesting intermediate resistance present in the pathogen population. This chemistry (FRAC 7) had not been used in fungicide-treated Locations B and D, but Miravis Prime and Luna Sensation were applied to select plots near those for Location D. Rally was effective at the high label rate in both bioassays but not at the low label rate when tested at Location A, again suggesting intermediate resistance present. Quintec was only effective consistently at high label rate; intermediate resistance to low rates (1.5 and 3 fl oz/A) was detected at Location A. Luna Privilege (FRAC 7 chemistry not permitted for use on Long Island) and Vivando (FRAC U8) were very effective at label, half, and quarter rates in both bioassays. Bravo Ultrex (FRAC M5) at full label rate was also effective across both bioassays. This protectant fungicide served as a positive control. Bioassay 2, with seedlings treated on 18 Jul and placed in two commercial summer squash plantings not treated with powdery mildew fungicides, revealed that resistance to Topsin M was very common and there was some resistance to Flint and Endura early in powdery mildew development in the area. Resistance to Torino and Quintec were not detected. Detecting fungicide-resistant pathogen isolates in plantings where targeted fungicides were not applied (bioassay 2, bioassay 5 location A, and bioassay 6 location C) suggests they may be common and able to compete with sensitive isolates.

	Severity of powdery mildew on upper leaf surface (%) [x,z]															
	Bioassay 5								Bioassay 6							
	Location A [w]				Location B [v]				Location C [w]				Location D [v]			
Treatment and Rate/A [y]	21 Sep		25 Sep		21 Sep		25 Sep		5 Oct		9 Oct		5 Oct		9 Oct	
Control 1	28.8	ab	63.1	ab	25.1	a	34.9	a	12.6	a	32.1	a	15.0	a	43.7	a
Control 2	35.0	ab	60.0	ab	26.1	a	29.7	a	8.4	ab	27.0	ab	10.0	ab	43.7	a
Bravo Ultrex 2 lb/A	6.1	cd	3.4	c	0.2	b	1.3	bcd	0.5	cde	1.5	c	0.5	de	0.7	d
Topsin 8 oz/A	43.8	a	78.8	a	19.9	ab	24.9	a	3.0	bcd	11.1	abc	3.5	bcd	28.0	abc
Flint 2 oz/A	31.3	ab	63.1	ab	9.2	ab	19.9	ab	3.2	bcd	10.0	abc	5.2	bc	29.9	ab
Endura 3.25 oz/A	17.5	bcd	38.2	abc					2.2	bcde	3.5	bc	1.0	cde	5.0	bcd
Endura 6.5 oz/A	0.8	cd	5.1	c	0.1	b	0.8	cd	4.7	abc	8.1	abc	1.5	cde	3.9	bcd
Rally 2.5 oz/A	18.1	bcd	42.8	abc					0.5	cde	0.8	c	0.1	e	0.7	d
Rally 5 oz/A	3.3	cd	3.9	c	1.1	ab	1.6	bcd	0.2	de	0.5	c	0.1	e	0.5	d
Torino 0.85 fl oz/A	19.4	bcd	41.2	abc					2.4	bcde	12.8	abc	1.9	cde	9.3	abcd
Torino 1.7 fl oz/A	15.9	bcd	35.0	bc					2.0	bcde	7.7	abc	0.7	cde	2.0	cd
Torino 3.4 fl oz/A	17.3	bcd	41.3	abc	7.7	ab	13.0	abc	2.3	bcde	13.7	abc	0.7	cde	3.3	bcd
Quintec 1.5 fl oz/A	20.0	bcd	50.0	ab					0.5	cde	1.1	c	0.5	de	0.7	d
Quintec 3 fl oz/A	21.9	bc	43.1	abc					0.2	de	0.8	c	0.5	de	1.0	d
Quintec 6 fl oz/A	5.0	cd	6.4	c	0.9	ab	2.0	bcd	0.5	cde	0.8	c	0.1	e	0.5	d
Luna Privilege [u] 1.7 fl oz/A	0.1	d	0.3	c					0.5	cde	0.5	c	0.0	e	0.5	d
Luna Privilege 3.4 fl oz/A	0.0	d	0.2	c					0.0	e	0.5	c	0.1	e	0.1	d
Luna Privilege 6.8 fl oz/A	0.5	cd	0.3	c	0.0	b	0.1	cd	0.1	de	0.2	c	0.0	e	0.1	d
Vivando 3.85 fl oz/A	0.0	d	0.0	c					0.5	cde	0.5	c	0.1	e	0.5	d
Vivando 15.4 fl oz/A	0.1	d	0.1	c	0.0	b	0.0	d	0.2	de	0.5	c	0.5	de	0.5	d
Vivando 7.7 fl oz/A	0.1	d	0.0	c					0.1	de	0.2	c	0.1	e	0.5	d
P-value (treatment)	<0.0001		<0.0001		0.0031		0.0001		<0.0001		<0.0001		<0.0001		<0.0001	

[z] Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).

[y] Rate of formulated product/A. Applied at 50 gal/A on 12 Sep for bioassay 1 and 25 Sep for bioassay 2, which were one day prior to exposure to field inoculum.

[x] When needed, values were square root transformed before analysis. Table contains de-transformed values.

[w] Field inoculum location was field grown cucurbits with no conventional fungicides applied for powdery mildew.

[v] Field inoculum location was field grown cucurbits with conventional fungicide rotation including Vivando, Procure, and Quintec.

[u] Luna Privilege was used rather than Luna Experience or Luna Sensation, which are labeled for cucurbit powdery mildew, because they contain a second active ingredient (FRAC code 3 or 11, respectively) which would confound results.