

### Efficacy of fungicides for managing cucurbit powdery mildew and pathogen sensitivity to fungicides, 2010.

The primary objective of this study was to evaluate the efficacy of several fungicides with single site mode of action for the control of cucurbit powdery mildew. Both new and currently registered products were tested in an area where in previous years strains of the pathogen were detected with resistance to FRAC code 1, 7, and 11 fungicides and moderate resistance to FRAC code 3 fungicides. The field experiment was conducted at the Long Island Horticultural Research and Extension Center on Haven loam soil. The field was plowed on 10 May and tilled on 14 Jun. Seeds were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on 21 Jun. The planter applied fertilizer in a band about 2 in. away from the seed. A blend of controlled release fertilizers, consisting of 300 lb/A 15-18-12 and 100 lb/A ESN, was used. The herbicides Strategy (3 pt/A) and Sandea (0.5 oz/A) were applied over the entire plot area on 22 Jun, which was followed by 0.4 inches of rain overnight. During the season, weeds were controlled by cultivating, roto-tilling between plots, and hand weeding as needed. Cucumber beetles were managed by applying the insecticide Admire 2F (20 fl oz/A) in a narrow band over the planted rows immediately after the herbicide application on 22 Jun and applying Asana XL (9.6 fl oz/A) to foliage on 23 Jul. To manage damping-off, Ridomil Gold EC (1 pt/A) was broadcast over the field and incorporated mechanically on 15 Jun. A soil penetrant to increase water penetration, SprayHandler (0.5 pt/A), was applied with Ridomil. The following fungicides were applied to foliage to preventively control downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): ProPhyt (3 qt/A) on 23 and 30 Jul; Curzate (3.2 oz/A) on 23 Jul; Ranman 400 SC (2.75 fl oz/A) on 7 Aug, 2 Sep, and 18 Sep; Forum (6 fl oz/A) on 30 Jul and 21 Aug; and Revus (8 fl oz/A) on 28 Aug and 11 Sep. Plots were three 15-ft rows spaced 68 in apart. The plots were 18 ft apart initially until plants began to vine. Vines were moved as needed to maintain plot separation. A randomized complete block design with four replications was used. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces weekly beginning on 2 Aug. Initially the examined leaves were selected from the oldest third of the foliage based on leaf physiological appearance and position in the canopy. Additional powdery mildew assessments were made on 9, 16 and 26 Aug; and 1 and 8 Sep. Mid-aged and young leaves were also assessed beginning on 26 Aug. Thirty leaves per age group were examined in each plot initially; fewer leaves were examined as symptoms became more common. Powdery mildew colonies were counted; severity was assessed by visual estimation of percent leaf area infected when colonies could not be counted accurately because they had coalesced and/or were too numerous. Average severity for the entire canopy was calculated from the individual leaf assessments. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Canopy condition including defoliation was assessed on 21 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 22 and 29 Sep; and 7, 14, and 20 Oct. Handles were considered good if they were green, solid, and not rotting. Treatments were started on 4 Aug when the IPM threshold of one affected leaf out of 50 old leaves (Plant Dis. 80:910-916) was suspected to have been reached in most plots. Subsequent applications were made weekly using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 53.5 gal/A at 100 psi. Average monthly high and low temperatures (°F) were 81/64 in Jun, 87/70 in Jul, 83/67 in Aug, 77/62 in Sep, and 66/50 in Oct. Rainfall (in.) was 1.63, 3.46, 2.02, 2.87, and 3.32 for these months, respectively. Fungicide sensitivity of pathogen strains in the experiment was examined by conducting an in-field seedling bioassay and by testing isolates in the laboratory on treated leaf disks. For the bioassay, pumpkin seedlings were produced in a growth chamber and then greenhouse, treated with various doses of different fungicides applied with a CO<sub>2</sub>-pressurized backpack sprayer, then next day put in the field for at least 4 hours, then kept in a greenhouse for about 10 days until mildew developed. Severity of powdery mildew on leaves of treated seedlings was compared to non-treated ones to estimate the proportion of the pathogen population able to tolerate each fungicide dose tested. The bioassay was conducted on 31 Aug in a nearby experiment where fungicides targeting powdery mildew were not applied. The assay was conducted on 21 Sep in plots that had been treated weekly with Pristine, Procure or Quintec and in a nearby experiment where a fungicide program with these fungicides was applied to the same pumpkin cultivar. Isolates were collected on 13 and 20 Sep from several plots. Their sensitivity to fungicides was assessed using a leaf disk bioassay (Plant Dis. 80:633-639). Isolates were considered resistant to boscalid (FRAC code 7) if they were able to grow and sporulate on leaf tissue treated with 500 ppm boscalid (a.i. in Endura 70 WDG, used for the assay, and Pristine 38 WG), resistant to QoIs (FRAC code 11) if they tolerated 50 ppm trifloxystrobin (a.i. in Flint 50 WDG), resistant to MBCs (FRAC code 1) if they tolerated 50 ppm thiophanate-methyl (a.i. in Topsin M), and those tolerating 40 ppm myclobutanil (a.i. in Nova 40 WP) were considered moderately resistant to DMIs (FRAC code 3). Strains tolerating 40 ppm myclobutanil are resistant to the previously registered DMI Bayleton. Fungicide sensitivity to quinoxifen (a.i. in Quintec) (FRAC code 13) was also determined.

On 2 Aug, two days before treatments were started, powdery mildew was observed at a very low severity being on only 5% of the old leaves examined, which were in 78% of the plots examined. All treatments were suppressing powdery mildew on upper leaf surfaces early in disease development based on the assessment on 16 Aug when severity for non-treated leaves was 4% (data not shown). Pristine at both the low and high label rates was ineffective for powdery mildew on upper leaf surfaces at the 26 Aug assessment (data not shown). The low rate was also ineffective at that time for powdery mildew on lower leaf surfaces, as were several treatments with BAS experimentals. Several other treatments were no longer effective by the assessment on 1 Sep, including Fontelis (previously known as LEM17) and Procure at the intermediate label rate (6 fl oz/A). Both Pristine and Procure effectively controlled powdery mildew in a similar fungicide evaluation conducted at this location in 2009 (PDMR 4:147). Quintec was the most effective treatment providing 95% control of powdery mildew on lower leaf surfaces based on AUDPC. Degree of control of powdery mildew was related to defoliation and fruit quality expressed as handle condition. Based on the results of the 31 Aug bioassay conducted in a nearby cucurbit cultivar evaluation where fungicides targeting powdery mildew were not applied, 73% of the *Podosphaera xanthii* population was QoI resistant and 37% was resistant to boscalid, which could account for why Pristine was ineffective. Additionally, 14% of the population tolerated 40 ppm triflumizole (a.i. in Procure). Based on the results of the 21 Sep bioassay, proportion of the pathogen population resistant to boscalid was estimated to be 70% in a plot treated with Pristine at the lowest label rate, 29% in a plot treated with Pristine at the highest label rate, and 13-14% in plots treated with Procure or Quintec. Additionally, proportion of the pathogen population able to tolerate 10 ppm quinoxifen was 20% in the Quintec plot compared to only 1-3% in the other plots. Boscalid resistance was detected in 47% of the isolates tested with the leaf disk bioassay. Boscalid resistance was at a lower level in 2009.

Treatment and rate/A <sup>y</sup>	Powdery mildew severity (%) <sup>z</sup>													
	Upper leaf surface		Lower leaf surface		Defoliation (%)	Good handles (%)								
	1-Sep	AUDPC	1-Sep	AUDPC	21-Sep	7-Oct	20-Oct							
Nontreated control.....	20.10	a <sup>x</sup>	517.2	a	56.04	a	975.3	a	100.0	a	16.08	c	7.80	e
Pristine 38 WG 12.5 oz <sup>w</sup> .....	4.67	ab	131.1	b	46.97	ab	673.2	ab	92.5	ab	33.21	bc	13.56	de
BAS 9150 F 4.39 fl oz <sup>w</sup> .....	2.69	ab	130.1	b	36.78	abc	560.4	abc	91.3	ab	41.63	abc	22.65	cde
Pristine 38 WG 18.5 oz <sup>w</sup> .....	4.91	ab	166.4	b	37.48	abc	490.7	abc	88.8	ab	48.08	abc	36.75	abcde
BAS 9150 F 7.0 fl oz <sup>w</sup> .....	7.71	ab	81.6	b	50.76	ab	562.1	abc	97.5	a	43.53	abc	25.43	bcde
Fontelis SC 16 fl oz.....	5.45	ab	83.4	b	41.21	abc	484.6	abc	93.8	a	44.51	abc	19.19	cde
Procure 480SC 6 fl oz <sup>w</sup> .....	5.50	ab	80.5	b	37.27	abc	483.5	abc	91.3	ab	50.48	abc	29.10	abcde
BAS 639 F 6.85 fl oz <sup>w</sup> .....	0.79	b	51.3	b	28.60	abc	414.4	abc	66.3	abc	62.05	ab	49.56	abcd
BAS 639 F 6.85 fl oz .....	0.77	b	35.8	b	28.08	abc	402.5	abc	73.8	abc	62.64	ab	50.78	abcd
BAS 560 F 9.14 fl oz <sup>w</sup> .....	0.56	b	32.1	b	21.93	abc	344.1	bc	58.5	abc	80.43	a	63.83	ab
Procure 480SC 8 fl oz <sup>w</sup> .....	1.80	b	30.7	b	13.85	abc	304.8	bcd	83.8	abc	66.21	ab	38.53	abcde
Torino SC 5.9 fl oz (14-day) ..	4.39	ab	55.3	b	10.74	bc	224.2	bcd	75.0	abc	59.31	abc	34.75	abcde
BAS 639 F 9.14 fl oz <sup>w</sup> .....	0.13	b	11.9	b	17.46	abc	240.0	bcd	51.3	bc	71.85	ab	57.07	abc
BAS 560 F 15.36 fl oz <sup>w</sup> .....	1.42	b	32.4	b	13.48	bc	177.4	cd	46.3	c	75.53	ab	66.51	a
Torino SC 5.9 fl oz .....	0.36	b	18.7	b	4.40	c	171.5	cd	83.8	abc	54.30	abc	38.18	abcde
Quintec 6 fl oz .....	0.38	b	31.7	b	3.40	c	51.1	d	58.8	abc	68.04	ab	51.72	abcd
<i>P</i> -value (treatment)	0.0011		<0.0001		0.0001		<0.0001		<0.0001		0.0002		<0.0001	

<sup>z</sup> Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1% severity. AUDPC was calculated for 2 Aug to 8 Sep. Data for sample dates and lower leaf AUDPC were transformed from percentages by a square root transformation when needed to obtain normality of variance before analysis of variance was performed. Those values have de-transformed means.

<sup>y</sup> Rate of formulated product/A. Treatments listed based on the sum of AUDPC values for both leaf surfaces. All treatments were started after disease detection and made on a 7-day schedule except where noted otherwise. Applications were made on 4, 12, 19, and 26 Aug; 2, 9, and 16 Sep. Torino was applied above the intended rate of 3.4 oz due to a calculation error.

<sup>x</sup> Numbers in each column with a letter in common are not significantly different according to Tukey's HSD ( $P = 0.05$ ).

<sup>w</sup> Applied with 1% Latron B-1956 adjuvant.