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

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Efficacy of fungicides for managing cucurbit powdery mildew and pathogen sensitivity to fungicides, 2011.

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 2 May and tilled on 30 May. Seeds were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on 21 Jun. The seeder applied fertilizer in two bands about 2 in. away from the seed. Controlled release fertilizer (N-P-K, 19-10-9) was used at 625 lb/A. 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 0.52 inches of rain and 2.38 inches on 23 Jun. During the season, weeds were controlled by cultivating and hand weeding as needed. Cucumber beetles were managed by applying the insecticide Admire Pro (7.5 fl oz/treated A) in a narrow band over the planted rows immediately after the herbicide application on 22 Jun. To manage damping-off, Ridomil Gold EC (1 pt/A) was broadcast over the field and incorporated mechanically on 16 Jun. A soil penetrant to increase water penetration, SprayHandler (0.5 pt/A), was applied with Ridomil. The following fungicides were applied to preventively control downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): Presidio (3.5 oz/A) on 28 Jul and 14 Sep; ProPhyt (3 qt/A) on 6 Aug; Curzate (3.2 oz/A) on 26 Aug and 14 Sep; and Ranman 400 SC (2.75 fl oz/A) on 20 Aug and 1 Sep. Plots were three 15-ft rows spaced 68 in apart. The plots were 18 ft apart in the row 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. Treatments were applied five times on a 7- or 14-day schedule beginning on 3 Aug using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 54 gal/A at 100 psi. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces weekly beginning on 1 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, 17, 26 and 30 Aug. Mid-aged and young leaves were also assessed beginning on 17 Aug. Eight 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. Canopy condition including defoliation was assessed on 2 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 13 and 19 Sep. Handles were considered good if they were green, solid, and not rotting. Average monthly high and low temperatures ($^{\circ}$F) were 79/61 in Jun, 87/68 in Jul, 82/66 in Aug, and 76/63 in Sep. Rainfall (inches) was 6.1, 2.35, 10.61, and 6.88 for these months, respectively. There was a hurricane (28 Aug) and several atypical intensive rain events during the 2011 growing season on Long Island. 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_2-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 26 Jul in nearby experiments. The assay was conducted on 13 and 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 used. 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 quinoxyfen (a.i. in Quintec) (FRAC code 13) was also determined.

Powdery mildew started to develop earlier than expected compared to similar previous experiments with this cultivar based on both plant growth stage and calendar date. On 1 Aug, two days before treatments were started, powdery mildew was observed on 1 to all 8 older leaves examined in all but 2 of the 64 plots; overall incidence of affected leaves was 75%. Fruit had just started to develop and plant canopy had not closed between rows. Thus when treatments were started on 3 Aug powdery mildew in all plots greatly exceeded the IPM threshold of one affected leaf out of 50 old leaves (Plant Dis. 80:910-916). In contrast, only 5% of leaves were affected on 2 Aug 2010 in a similar experiment with the same cultivar planted on the same day. Efficacy of treatments in 2011 may have been impacted by applications starting after the IPM threshold. Based on AUDPC values for upper leaf surfaces, the most effective fungicides were four new products: Luna Experience, Torino SC, Mervion (higher rate), and Fontelis SC. Treatments with these products had the lowest AUDPC values for lower leaf surfaces. These fungicides were not more effective than currently registered mobile fungicides with single site mode of action, Pristine, Quintec, and Procure. Overall degree of control on lower leaf surfaces was below expectation, and concluded to be a documentation of the importance of starting applications early in powdery mildew development. Pathogen sensitivity to fungicides may have affected efficacy of some products. Based on the results of the 26 Jul bioassay conducted in a nearby cucurbit cultivar evaluation, 100% of the *Podosphaera xanthii* population was resistant to QoI fungicides (FRAC code 11) and 30% was resistant to boscalid (FRAC code 7), the active ingredients in Pristine. Additionally, the population tolerated FRAC code 3 fungicides at 40 ppm (difenconazole, myclobutanil, tebuconazole, and triflumizole, the active ingredient in Procure). The population exhibited good sensitivity to FRAC code 13 fungicides, being able to tolerate 1 ppm quinoxyfen, the active ingredient in Quintec, but not 10 ppm quinoxyfen.

	Powdery mildew severity (%)[z]					
	Upper leaf surface			Lower leaf surface		
Treatment and rate/A; (application time)[y]	9 Aug[x]	26 Aug	AUDPC	9 Aug	26 Aug	AUDPC
Non-treated Control……..	0.4 a	21.7 a	302.1 a	2.7 ab	32.0 ab	586.2 ab
YT669 12 fl oz (1-5)[w]…….	0.0 b	5.9 ab	172.1 ab	1.9 b	43.8 a	555.9 ab
Torino SC 3.4 fl oz (1, 3, 5)……	0.1 ab	13.4 ab	146.4 bc	1.0 b	33.7 ab	512.9 ab
YT669 6 fl oz (1-5)…….	0.0 b	5.8 ab	141.7 bc	3.2 ab	39.5 ab	661.1 ab
Rally 5 fl oz (1, 3, 5); Quintec 2.08SC 4 fl oz (2, 4)…..……...	0.1 b	2.5 b	135.6 bc	6.8 ab	33.0 ab	691.0 b
YT669 12 fl oz (1-5)……...	0.0 b	21.6 a	87.4 bc	2.0 b	27.4 ab	511.3 ab
Fontelis SC 1 pt (1, 3, 5); Quintec 2.08SC 4 fl oz (2, 4)……..	0.0 b	5.8 ab	80.3 bc	2.3 ab	24.4 ab	499.0 ab
Pristine 38 WG 18.5 oz) (1-5)[w]……..	0.0 b	3.3 b	71.1 bc	1.2 b	23.2 ab	421.4 ab
Mervion 4 fl oz (1-5)[w]…….	0.0 b	0.0 b	50.1 bc	0.8 b	9.5 ab	266.4 ab
Fontelis SC 1 pt (1-5)……...	0.0 b	1.5 b	41.5 bc	2.4 ab	3.0 b	235.3 ab
Quintec 2.08SC 6 fl oz (1-5)……	0.0 b	2.8 b	32.8 bc	1.8 b	25.7 ab	346.3 ab
Procure 480SC 8 fl oz (1-5)[w]……...	0.1 ab	2.9 b	32.5 bc	2.0 ab	24.2 ab	459.2 ab
Fontelis SC 1 pt (1-5)[w]……..	0.0 b	1.8 b	30.8 c	1.6 b	17.9 ab	337.1 ab
Mervion 5.5 fl oz (1-5)[w]……..……..	0.0 b	2.1 b	24.2 c	1.6 b	5.6 b	231.2 a
Torino SC 3.4 fl oz (1-5)……...	0.0 b	1.2 b	23.4 c	1.4 b	5.1 b	224.5 ab
Luna Experience 6.85 fl oz (1-5)[w]……	0.0 b	0.3 b	19.0 c	1.7 b	8.7 ab	264.9 ab
P-value (treatment)	0.0089	<.0001	<.0001	0.0218	0.0025	0.0022

[z] Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1% severity. AUDPC was calculated from 1 Aug to 30 Aug.

[y] 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 1=3 Aug, 2=11 Aug, 3=18 Aug, 4=25 Aug, 5=1 Sep.

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

[w] Applied with 1% Latron B-1956 adjuvant.