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

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Efficacy of biopesticides applied with conventional fungicides for managing powdery mildew in pumpkin, 2021.

An experiment with field-grown pumpkins was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, in a field with Haven loam soil. The objectives were to evaluate programs with biopesticides applied in place of conventional fungicides for some applications and to evaluate Cevya, a new FRAC 3 fungicide. The field was moldboard plowed and urea fertilizer (46-0-0) was applied at 80 lb/A N on 8 Apr. For management of Phytophthora blight, caused by *Phytophthora capsici*, a mustard biofumigant cover crop (cv. Rojo Caliente) was seeded at 10 lb/A by drilling on 9 Apr. On 7 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface; the field could not be irrigated to initiate biofumigation as usually done, but the soil was moist. Pumpkins were planted with a vacuum seeder at approximately 24-in. plant spacing on 21 Jun after disking. Controlled-release fertilizer (N-P-K, 19-10-9) was used at 525 lb/A (101 lb/A N) and applied with the seeder in two bands about 2 in. to the side of the seed. Strategy 3 pt/A, Sandea 0.5 oz/A, and Curbit EC 1 pt/A were applied prior to seedling emergence for weed control on 21 Jun using a tractor-mounted sprayer. During the season, weeds were managed by cultivating and hand weeding as needed. Drip tape was laid along each row of pumpkin seedlings on 25 Jun. The following fungicides were applied throughout the season to manage Phytophthora blight: Omega 24 fl oz/A on 12 Jul, 23 Jul and 6 Aug, Presidio 4 fl oz/A on 16 Jul, Orondis Ultra 7 fl oz/A on 30 Jul, 20 Aug and 3 Sep, Revus 8 fl oz/A on 14 Aug, and Ranman 2.75 fl oz/A on 27 Aug. No foliar or fruit symptoms of *P. capsici* were seen. Plots were three 15-ft rows spaced 68 in. apart with a 15-ft in-row untreated area between plots. The 15-ft area between plots was also planted to pumpkin. A randomized complete block design with four replications was used. The primary source of initial inoculum for powdery mildew in this area is considered to be long-distance wind-dispersed spores from affected plants. Treatments were applied six times on a preventive schedule using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 72 gal/A at 50 psi and 2.3 mph. Plants were inspected for powdery mildew symptoms on upper and lower leaf surfaces. Initially only old leaves were examined: 20 in each plot on 26 Jul and 15 on 2 Aug. Old, mid-aged and young leaves (usually five of each selected based on leaf physiological appearance and position in the canopy) were examined in each plot on 10, 16 and 30 Aug, and 7, 13 and 20 Sep. Colonies of powdery mildew were counted and severity was assessed by visual estimation of percent leaf area affected when colonies could not be counted accurately because they had coalesced and/or were too numerous to count. Colony counts were converted to severity values using the conversion factor of 30 colonies/leaf = 1% severity. Average severity for the entire canopy was calculated from the individual leaf assessments. Area under disease progress curve (AUDPC) values were calculated from 26 Jul through 13 Sep using the formula: $\sum n\ i=1[(Ri+1 + Ri)/2]\ [ti\ +1 – ti]$, where R = disease severity rating (% of leaf surface affected) at the *i*th observation, ti = time (days) since the previous rating at the *i*th observation, and n = total number of observations. Defoliation, which was mainly due to powdery mildew, was assessed on 7, 13, 20 and 27 Sep; and 4 and 12 Oct. Quality of each fruit was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 21 and 27 Sep; and 4 and 12 Oct. Handles were considered good if they were green, solid, and not rotting. Data were analyzed with one-way ANOVA and Tukey's HSD to separate means using JMP statistical software. Average monthly high and low temperatures (^{o}F) were 82 and 67.4 in Jul, 83.4 and 68.4 in Aug, 77.1 and 62.5 in Sep, and 69.1 and 54.7 in Oct. Rainfall (in.) was 6.2, 9.0, 4.9 and 6.4 for these months, respectively.

Powdery mildew was first observed in this experiment on 26 Jul in one of the 36 plots on only one of the 720 leaves examined (0.14%). A biopesticide was applied one day later for the four treatments with biopesticides. This application was considered to be preventive because it was before symptoms would be found through routine scouting. The IPM action threshold recommended to growers for initiating fungicide applications is 1 out of 50 old leaves with symptoms (2%). On 2 Aug symptoms were found in 31 of the 36 plots on 76 of 540 leaves examined (14%). The fifth application scheduled for 24 Aug was delayed by two days because of extensive rainfall (2.6 in.) with Hurricane Henri on 22-23 Aug. The last application was applied early due to rain forecast with remnants of Hurricane Ida starting late on 1 Sep (3.3 in. total). It is possible efficacy of treatments was affected by the impact of these storms on application timing, product residues, and/or disease development. Severity was low throughout August especially on upper leaf surfaces, which may be partly due to some contact activity for powdery mildew of the pesticides applied for *P. capsici* and insect pests. On 30 Aug, one day before the sixth application, severity in the untreated control plots averaged 3% on upper leaf surfaces and 52% on lower surfaces (data not shown). Severity increased substantially over the next week reaching 51 and 66%, respectively, on 7 Sep. All four programs with biopesticides and conventional fungicides effectively suppressed powdery mildew on upper and lower leaf surfaces providing 98 to 100% and 84 to 90% control, respectively, based on AUDPC values. However, these treatments were not significantly better than the two parallel treatments with just the three applications of the conventional fungicides made on the same dates, documenting the excellent efficacy of Proline and Vivando. The grower standard conventional program with these fungicides applied weekly provided slightly but significantly better control than all other treatments based on AUDPC values for severity on lower leaf surfaces (99%). On 20 Sep, 2 wk after the last application, the grower standard was the only treatment still providing control on upper leaf surfaces (92%) and one of two providing control on lower surfaces (80%), documenting residual activity of Vivando (data not shown). Cevya was the least effective treatment for powdery mildew on lower leaf surfaces (67% control). All treatments had less defoliation than the control through 20 Sep; only the grower standard had significantly less through 12 Oct, five wks after the last application (not all data shown). All treatments had significantly better fruit quality on 27 Sep than the control; only the grower standard did on 12 Oct. No phytotoxicity was observed.

Treatment and amount/A (application dates) [y]	Severity of powdery mildew (%) [z]					Defoliation (%) [z]	Fruit quality (% good handles) [z]	
	Upper leaf surface		Lower leaf surface					
	13 Sep [x]	AUDPC [x]	7 Sep [x]	13 Sep	AUDPC [x]	20 Sep	27 Sep	12 Oct
Untreated Control	61.6 a	575.6 a	65.5 a	73 a	1255.8 a	93 a	64 b	40 b
Sil-Matrix (1,3,5,7) Proline 5.7 fl oz (2,6) Vivando 15.4 fl oz (4)	0.7 cd	2.4 c	3.0 c	13 cd	121.0 c	18 bc	96 a	74 ab
Howler 5 lb (1,3,5,7) Proline 5.7 fl oz (2,6) Vivando 15.4 fl oz (4)	2.4 cd	7.4 c	3.8 c	19 cd	120.8 c	26 bc	97 a	67 ab
Theia 3 lb (1,3,5,7) Proline 5.7 fl oz (2,6) Vivando 15.4 fl oz (4)	2.6 cd	8.5 c	6.7 bc	20 cd	200.1 bc	28 bc	97 a	68 ab
Theia 3 lb (1,4,6,7) Proline 5.7 fl oz (2,5) Vivando 15.4 fl oz (3)	2.8 cd	10.5 bc	2.6 c	35 bc	172.6 c	33 bc	97 a	66 ab
Proline 5.7 fl oz (2,6) Vivando 15.4 fl oz (4)	3.8 bcd	12.0 bc	5.2 bc	14 cd	160.6 c	33 bc	97 a	69 ab
Proline 5.7 fl oz (2,5) Vivando 15.4 fl oz (3)	15.3 b	48.8 b	2.8 c	31 bc	136.6 c	38 bc	99 a	71 ab
Proline 5.7 fl oz (2,4,6) Vivando 15.4 fl oz (3,5,7)	0.0 d	0.2 c	0.7 c	1 d	14.1 d	10 c	100 a	92 a
Cevya 5 fl oz (2-7)	4.7 bc	17.1 bc	16.6 b	48 b	411.0 b	49 b	85 a	60 ab
P-value (treatment)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0146

[z] Numbers in each column with a letter in common or no letters are not significantly different from each other (Tukey's HSD, P=0.05).
[y] Rate of formulated product/A. Application dates were 1=27 Jul, 2=3 Aug, 3=10 Aug, 4=17 Aug, 5=26 Aug, 6=31 Aug, and 7=7 Sep. All applied with Dyne-Amic at 0.38% v/v.
[x] Values were square root transformed before analysis because raw data were not distributed normally. Table contains de-transformed values.