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

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Efficacy of biopesticides 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 main objective was to evaluate recently developed biopesticides suitable for organic production. 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 symptoms of powdery mildew 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, 25, and 30 Aug, and 8 Sep. Powdery mildew colonies were counted; 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 the disease progress curve (AUDPC) values were calculated from 26 Jul through 8 Sep using the formula: $\sum_{i=1}^{n}[(R_{i+1} + R_i)/2] [t_{i+1} - t_i]$, 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 8, 13, 21 and 27 Sep; and 4 Oct. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 21 Sep, 27 Sep and 4 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%). Biopesticide treatment applications started one day later. The IPM action threshold recommended to growers for initiating fungicide applications is 1 out of 50 old leaves with symptoms (2%). Therefore, the first application in this experiment is considered a preventive application because it is before symptoms would be found through routine scouting. On 2 Aug symptoms were found in 27 of the 36 plots on 50 of 540 leaves examined (9%). The fifth application scheduled for 24 Aug was delayed by two days because of extensive rainfall (2.6 in.) with Hurricane Henri on 22 and 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 and last application, severity in the untreated control plots averaged 0.3% on upper leaf surfaces and 33% on lower surfaces (data not shown). Severity increased substantially over the next week. All treatments suppressed powdery mildew on upper leaf surfaces. Kocide 3000-O, the organic copper treatment included for comparison with the biopesticides, was the most effective treatment, providing 77% control based on 8 Sep severity and AUDPC values. It was only significantly better than Aviv + Timorex Act which provided 38% control. The other biopesticides provided 51 to 60% control. No treatment controlled powdery mildew on lower leaf surfaces, documenting these products have contact activity and are not able to move to the underside of leaves. Consequently, no treatment significantly reduced defoliation due to powdery mildew or improved fruit quality compared to the untreated control. No phytotoxicity was observed.

Treatment and rate (application dates) [y]	Severity of powdery mildew (%) [z]					Defoliation (%) [z]	Fruit quality (% good handles) [z]	
	Upper leaf surface		Lower leaf surface					
	8 Sep	AUDPC	25 Aug	8 Sep	AUDPC	27 Sep	21 Sep	4 Oct
Untreated control	58 a	267 a	10.5	73	639	88 ab	91	25 ab
Howler 5 lb/A (1-6) [x]	28 bc	131 bc	5.8	62	548	92 ab	83	20 ab
Theia 3 lb/A (1-6) [x]	23 bc	109 bc	10.3	71	637	85 ab	98	32 ab
Howler 5 lb/A (1, 3, 5) Theia 3 lb/A (2, 4, 6) [x]	23 bc	110 bc	8.2	63	577	80 b	96	29 ab
MBI-121 2 qt/A (1-6)	29 bc	130 bc	6.9	67	544	91 ab	94	13 b
Tril-21 1% (1-6)	24 bc	111 bc	5.4	67	535	91 ab	92	20 ab
Aviv 30 fl oz/100 gal + Timorex ACT 35 fl oz/A (1-6) [x]	36 b	164 b	8.3	69	595	95 a	94	36 a
Aviv 30 fl oz/100 gal (1-6) [x]	20 bc	91 bc	9.6	60	603	86 ab	94	24 ab
Kocide 3000-O 1.25 lb/A (1-6)	13 c	60 c	10.9	61	650	89 ab	92	18 ab
P-value (treatment)	<0.0001	<0.0001	0.1397	0.2217	0.7796	0.0322	0.1279	0.0346

[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). No transformations were needed before analysis.

[y] Application dates were 1=27 Jul, 2=2 Aug, 3=10 Aug, 4=17 Aug, 5=26 Aug, and 6=31 Aug.

[x] Treatment applied with the nonionic surfactant Dyne-Amic at 0.38% v/v.