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

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Evaluation of management programs without chlorothalonil for powdery mildew in pumpkin, 2016.

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 purpose of this experiment was to examine means to reduce use of chlorothalonil-based fungicides because of concern about their potential impact on bees. Two alternative multi-site mode of action fungicides, Tritek and Microthiol Disperss, were evaluated on a cultivar resistant to powdery mildew, Bayhorse Gold, as well as a susceptible cultivar, Gold Challenger. They were compared to Bravo Ultrex used alone and as part of a fungicide program for powdery mildew. Both alternatives are approved for organic production. The field was plowed on 13 Apr. Ammonium nitrate fertilizer (34-0-0) was applied on 14 Apr at 235 lb/A (80 lb/A N). Mustard biofumigant cover crop ('Caliente 199') was seeded at 10 lb/A by drilling on 19 Apr. On 15 Jun the mustard was flail chopped, immediately incorporated by disking, followed by a cultipacker to seal the soil surface. Pumpkins were planted with a vacuum seeder at approximately 24-in. plant spacing on 23 Jun. The seeder applied fertilizer in two bands about 2 in. away from the seed. Controlled release fertilizer (N-P-K, 15-5-15) was used at 675 lb/A (101 lb/A N). Strategy 3 pt/A, Sandea 0.5 oz/A and Roundup PowerMax 22 oz/A were applied prior to seedling emergence for weed control on 25 Jun using a tractor-mounted sprayer. Select Max 16 oz/A was also applied on 20 Jul to control grasses. During the season, weeds were controlled by cultivating and hand weeding as needed. Initial moisture for seed was provided using overhead irrigation. Drip tape was laid along each row of pumpkin seedlings on 30 Jun. The following fungicides were applied throughout the season to control Phytophthora blight (caused by *Phytophthora capsici*): K-Phite 1 qt/A on 16 Jun, Forum 6 oz/A and K-Phite 1 qt/A on 24 Jun, Presidio 4 oz/A and K-Phite 1 qt/A on 30 Jun, Presidio 4 oz/A on 12 Aug, Ranman 2.75 oz/A on 20 Aug, Revus 8 oz/A on 29 Aug, Ranman 2.75 oz/A on 2 Sep, Forum 6 oz/A on 12 Sep, and Presidio 4 oz/A on 21 Sep. Plots were three 15-ft rows spaced 68 in. apart. The 20-ft area between plots was also planted to pumpkin that was partly treated in the process of applying treatments to adjacent plots. A completely randomized split plot design with four replications was used with cultivar as the whole plot factor and treatment as the split plot factor. Treatments were applied five times on a 7-day IPM schedule (starting after disease detection) beginning on 8 Aug using a tractor-drawn boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 72 gal/A at 50 psi and 2.3 mph. The primary source of initial inoculum in this area is considered to be long-distance wind-dispersed spores from affected plants. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces on 7, 15, and 22 Aug, and 2, 9, and 16 Sep. At each assessment, nine young, nine mid-aged, and nine old leaves (selected based on leaf physiological appearance and position in the canopy) were rated in each plot, except at the last assessment when five leaves were rated. 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. 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 7 Aug through 16 Sep. Defoliation was assessed on 23 and 28 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 5, 10, and 19 Oct. Handles were considered good if they were green, solid, and not rotting. Average monthly high and low temperatures (^{o}F) were 86/70 in Jul, 86/71 in Aug, and 77/61 in Sep. Rainfall (in.) was 2.93, 2.19, and 3.23 for these months, respectively.

Powdery mildew was first observed in this experiment on 7 Aug in 33 of the 48 plots on 2% of the leaves examined. The resistant cultivar, Bayhorse Gold, was less severely affected by powdery mildew than the susceptible cultivar, Gold Challenger, across all measurements of severity, which resulted in less defoliation. Interestingly, cultivar had no effect on fruit quality, which was only significantly affected by fungicide treatments. A significant cultivar by treatment interaction was present in many of the measurements of powdery mildew severity, and most significant for severity on the lower leaf surface. The sulfur-based fungicide, Microthiol Disperss, was as effective as the chlorothalonil-based fungicide, Bravo Ultrex, across all measurements of severity for both cultivars. The mineral oil-based fungicide, Tritek, effectively managed powdery mildew, but not as well as Microthiol Disperss. Relative to the non-treated susceptible cultivar, control of powdery mildew on upper leaf surfaces based on AUDPC values was 89%, 93%, and 59% for Bravo Ultrex, Microthiol Disperss, and Tritek, respectively for the susceptible cultivar and 97%, 96%, and 76%, respectively for the resistant cultivar. Effectively managing powdery mildew on lower leaf surfaces necessitated using targeted fungicides able to move through leaves. No significant differences were detected between the fungicide programs with a rotation of Luna Experience, Vivando, and Torino that had Bravo Ultrex as the multi-site fungicide or had Microthiol Disperss and Tritek. Relative to the non-treated susceptible cultivar, control of powdery mildew on lower leaf surfaces based on AUDPC values achieved with these two fungicide programs was 87% with Bravo and 97% with the Bravo alternatives for the susceptible cultivar, and 94% and 96%, respectively, for the resistant cultivar.

Treatment and rate/A (application dates) [x]	Powdery mildew severity (%) [y,z]								Defoliation (%) [y]		Fruit quality (% good handles) [y]			
	Upper leaf surface				Lower leaf surface									
	16 Sep		AUDPC		16 Sep		AUDPC		28 Sep		10 Oct		19 Oct	
Bayhorse Gold (Resistant cultivar) [w]	10.42		56.08		31.18		322.20		50.42		83.58		63.31	
Non-treated control	39.9	ab	375.6	b	61.8	a	530.4	bc	73.8	abc	59.5	c	53.9	bcd
Tritek 2 gal/100 gal (1-5)	13.0	cd	157.5	cd	31.8	cd	352.7	cde	67.5	abc	73.7	abc	38.4	d
Microthiol Disperss 5 lb (1-5)	3.7	d	23.4	ef	48.3	abc	479.4	bcd	48.8	cd	85.0	abc	57.6	abcd
Bravo Ultrex 82.5DG 1.8 lb (1-5)	3.9	d	19.9	ef	37.9	bc	467.4	bcd	57.5	bc	84.5	abc	68.7	abcd
Luna Experience 400SC 6 oz (1,4) Vivando 2.5SC 15.4 oz (2,5) Torino 0.85SC 3.4 oz (3) Microthiol Disperss 5 lb (1,2,3) Tritek 2 gal/100 gal (4,5)	0.1	d	1.7	f	0.7	e	44.8	e	30.0	d	100.0	a	76.7	abc
Luna Experience 400SC 6 oz (1,4) Vivando 2.5SC 15.4 oz (2,5) Torino 0.85SC 3.4 oz (3) Bravo Ultrex 82.5DG 1.8 lb/A (1-5)	1.9	d	5.7	f	6.6	e	58.5	e	25.0	d	98.9	a	84.6	ab
Gold Challenger (Susceptible cultivar) [w]	16.47		99.68		44.14		582.23		61.46		81.50		65.54	
Non-treated control	48.1	a	661.9	a	63.2	a	993.6	a	85.0	a	60.9	bc	49.5	bcd
Tritek 2 gal/100 gal (1-5)	26.7	bc	268.9	bc	56.5	ab	546.3	bc	81.3	ab	59.8	c	41.1	cd
Microthiol Disperss 5 lb (1-5)	8.0	d	44.5	def	63.4	a	788.5	ab	70.0	abc	84.9	abc	57.8	abcd
Bravo Ultrex 82.5DG 1.8 lb (1-5)	15.8	cd	75.0	de	67.5	a	1005.5	a	75.0	ab	87.1	ab	59.4	abcd
Luna Experience 400SC 6 oz (1,4) Vivando 2.5SC 15.4 oz (2,5) Torino 0.85SC 3.4 oz (3) Microthiol Disperss 5 lb (1,2,3) Tritek 2 gal/100 gal (4,5)	0.1	d	1.2	f	2.2	e	31.6	e	27.5	d	97.6	a	92.6	a
Luna Experience 400SC 6 oz (1,4) Vivando 2.5SC 15.4 oz (2,5) Torino 0.85SC 3.4 oz (3) Bravo Ultrex 82.5DG 1.8 lb/A (1-5)	0.1	d	1.8	f	12.2	de	127.9	de	30.0	d	98.7	a	92.9	a
P-value (cultivar)	0.0025		0.0013		<0.0001		<0.0001		0.0006		0.5087		0.609	
P-value (treatment)	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
*P-value (cultivar*treatment)*	0.1159		0.041		0.0096		0.0032		0.2255		0.6818		0.6105	

[z] When needed, values were square root transformed before analysis. Table contains de-transformed values.
[y] Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).
[x] Rate of formulated product/A. Application dates were 1=8 Aug, 2=15 Aug, 3=24 Aug, 4=29 Aug, and 5=8 Sep.
[w] Numbers in this row are statistical means for all fungicide treatments applied to the cultivar.