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

M. T. McGrath and Z. F. Sexton
Plant Pathology & Plant-Microbe Biology Section
SIPS, Cornell University, LIHREC
3059 Sound Avenue, Riverhead, NY 11901

Efficacy of fungicides for managing powdery mildew in pumpkin, 2016.

The primary objective of this study was to evaluate the efficacy of several fungicides with mobility that enables them to move to the lower surface of leaves where powdery mildew develops best. They have single-site mode of action, which puts them at risk for resistance development. Both new (Prolivo) 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, 11, and 13 fungicides and moderate resistance to FRAC code 3 fungicides. 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 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 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 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 2 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. A randomized complete block design with four replications was used. Treatments were applied five times on a 7-day IPM schedule (starting after disease detection) beginning on 9 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. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces on 9, 16, 22, and 29 Aug; and 9 and 16 Sep. The primary source of initial inoculum in this area is considered to be long-distance wind-dispersed spores from affected plants. 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 22 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 6, 13, and 24 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 Aug 9 in 18 of the 32 plots on less than 2% of the leaves examined. Treatments were started right after this assessment. All of the fungicides controlled powdery mildew compared to the non-treated control based on at least AUDPC values. Five treatments consisted of individual products evaluated alone. This is neither a labeled nor recommended use pattern for growers. Such evaluations, however, identify appropriate rates for new products and monitor efficacy of registered fungicides at risk for resistance development in order to develop management recommendations for growers. Pristine (FRAC Code 7 and 11) applied at its highest label rate was least effective, providing only 77% and 43% control on upper and lower leaf surfaces, respectively, based on AUDPC values. It was ineffective at the last assessment for managing powdery mildew on lower leaf surfaces. This fungicide has exhibited variable efficacy in previous experiments at this location where resistance was first documented in 2008. Procure (FRAC 3) and Quintec (FRAC 13) provided stellar control across all measurements and were as effective as the grower recommended rotation in 2016 of Vivando (FRAC U8), Quintec, and Torino (FRAC U6), with all providing 100% control on upper leaf surfaces and 91% to 98% control on lower surfaces based on AUDPC values. The rotation of Fontelis (FRAC 7) and Vivando was also highly effective at all assessments although poor control was obtained with Pristine, another FRAC 7 fungicide. Prolivo (FRAC U8) was similarly effective at the two application rates tested. Both treatments were as effective as the grower recommended rotation for controlling powdery mildew on upper leaf surfaces but less effective on lower leaf surfaces, providing 66% and 73% control versus 97% based on AUDPC values. Interestingly, the higher rate of Prolivo had numerically higher AUDPC values than the lower rate and was ineffective for reducing defoliation. Controlling powdery mildew resulted in longer leaf retention and improved fruit quality, measured in terms of handle quality, through mid-Oct, which is especially important for Pick-Your-Own Halloween pumpkins. Death of leaves and vines leads to handles shriveling and rotting. The least effective treatment, Pristine, failed to perform significantly better than the non-treated control in both % defoliation and fruit quality. No phytotoxicity was observed.

Treatment and rate/A (application dates) [x]	Powdery mildew severity (%) [y,z]				Defoliation (%) [z]	Fruit quality (% good handles) [z]	
	Upper leaf surface		Lower leaf surface				
	16 Sep	AUDPC	16 Sep	AUDPC	28 Sep	13 Oct	24 Oct
Non-treated Control	38.2 a	693.3 a	46.3 a	747.7 a	72.5 a	42.5 b	22.1 d
Pristine 38WG 18.5 oz (1-5)	18.0 b	160.2 b	46.3 a	428.8 b	60.0 abc	60.6 b	23.3 cd
Procure 480SC 8 oz (1-5)	0.3 c	3.3 c	4.9 c	64.8 de	41.3 cd	97.9 a	72.3 ab
Quintec 2.08SC 6 oz (1-5)	1.7 c	3.5 c	2.4 c	18.2 e	36.3 d	95.3 a	81.3 a
Prolivo 480SC 4 oz (1-5)[w]	1.2 c	8.4 c	24.4 b	201.6 cd	47.5 bcd	86.8 a	49.4 bc
Prolivo 480SC 5 oz (1-5)[w]	1.4 c	37.6 c	29.7 b	250.7 c	63.8 ab	95.3 a	66.8 ab
Fontelis 20SC 16 oz (1,3,5) Vivando 2.5SC 15.4 oz (2,4)	0.2 c	2.9 c	5.2 c	88.0 de	41.3 cd	94.9 a	70.8 ab
Vivando 2.5SC 15.4 oz (1,4) Quintec 2.08SC 4 oz (2,5) Torino 0.85SC 3.4 oz (3)	1.7 c	2.8 c	4.9 c	24.1 e	31.3 d	90.9 a	81.8 a
P-value (treatment)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[z] Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).
[y] When needed, values were square root transformed before analysis. Table contains de-transformed values.
[x] Rate of formulated product/A. Application dates were 1=9 Aug, 2=16 Aug, 3= 23 Aug, 4=30 Aug, and 5=9 Sep.
[w] Prolivo was applied with Quark 0.125% v/v (non-ionic surfactant).