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Efficacy of Fungicides for Managing Powdery Mildew in Pumpkin — 2014

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Powdery mildew is a very common disease that can reduce yield (fruit quantity and/or size) and market quality (flavor, color, storability, etc) in all cucurbit crop types. To effectively manage powdery mildew, fungicides are needed on the lower surface of leaves where the pathogen develops best. It is difficult to deliver a contact fungicide directly to this surface. Mobile fungicides able to move through leaves (via systemic or translaminar activity) or around them (vapor activity) are key to successful management of cucurbit powdery mildew. These fungicides tend to have single site mode of action and thus are at risk for resistance development.

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.

Materials and Methods

An experiment was conducted in a field with Haven loam soil at the Long Island Horticultural Research and Extension Center in Riverhead, NY. The field was plowed on April 11 and tilled on May 6. Seeds were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on June 23. 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).

The herbicides Strategy (3 pt/A), Curbit EC 1 pt/A, and Sandea (0.5 oz/A) were applied over the entire plot area on June 20, which was followed by irrigation to activate. During the season, weeds were controlled by cultivating and hand-weeding as needed. Cucumber beetles were managed by applying the insecticide Admire Pro (2.8 fl oz/1,000 ft) in a narrow band over the planted rows immediately after the herbicide application on June 25 and applying Assail (4 oz/A) to foliage on July 20 and 30. The following fungicides were applied for *Phytophthora* blight (*Phytophthora capsici*): Regalia (2 qt/A) on July 12, July 20, July 25, August 5, and August 11; K-Phite (1 qt/A) on July 12, July 20, August 11, August 18, August 25, September 3, and September 10; ProPhyt (2 pt/A) on August 5; Presidio (4 fl oz/A) on July 12; Ranman (2.75 fl oz/A) on July 20, August 5, August 18, and September 3; Revus (8 fl oz/A) on July 25 and August 25; and Forum (6 fl oz/A) on August 11 and September 10. A few young plants developed crown rot and were removed.

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 four or six times on a 7-day IPM schedule beginning on July 30 using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 68 gal/A at 65 psi and 2.3 mph.

Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces weekly beginning on July 23. 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 July 29; August 6, 12, 20, and 27; and September 4 and 19. Mid-aged and young leaves were also assessed beginning on August 6. At least nine leaves were examined in each plot on each assessment date. 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 August 20 through September 19. Defoliation was assessed on September 19 and October 9.

Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on September 26 and October 9. Handles were considered good if they were green, solid, and not rotting.

Average monthly high and low temperatures (°F) were 79/60 in June, 82/67 in July, 81/64 in Aug, 77/61 in September, and 66/53 in October. Rainfall (inches) was 2.47, 2.24, 2.42, 1.86, and 5.43 for these months, respectively.

Results and Discussion

Powdery mildew was first observed in this experiment on July 23 in 26 of the 52 plots; 8.8% of the older leaves examined had symptoms. Incidence had not increased by the next assessment date, which was one day before treatments were started. The action threshold for the IPM fungicide program is one out of 50 leaves with symptoms. Most treatments were 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.

Three fungicides registered for powdery mildew on pumpkin in 2014 were evaluated alone and in a combination program. Pristine (FRAC Code 7 and 11) applied at its highest label rate was moderately effective based on powdery mildew severity on lower leaf surfaces (54% control based on AUDPC values)(Table 1). In previous years at this location, pathogen isolates resistant to both components of this fungicide have been detected, and the fungicide has exhibited variable performance in previous evaluations. Pristine was ineffective at the last assessment date in 2014 based on powdery mildew severity on lower leaf surfaces, which suggests resistant strains were selected for during the experiment. It was the least effective treatment tested based on defoliation on September 19. Procure (FRAC 3) applied at its highest label rate was as effective as Quintec (FRAC 13) except for the last assessment on lower leaf surfaces. Procure has exhibited variable control in previous experiments. Quintec was highly effective (96% control based on AUDPC values for severity on lower leaf surfaces). Similar control (95%) was achieved by alternating among these three products with Quintec applied at its lowest labeled rate.

Vivando (FRAC U8), a new fungicide expected to be registered for this use before the 2015 season, was as effective as Quintec at both rates tested (95 and 98% control). Another FRAC U8 fungicide, IKF-309 (pyriofenone), was not as effective as Quintec based on severity on lower leaf surfaces (55 and 66% control). Effective control (92%) was obtained by applying these fungicides in alternation.

The other three treatments tested were applied four times. They were still exhibiting effective control on September 19, 25 days after the last application. Several treatments exhibited as much defoliation as the untreated control on October 9 (72–99%); treatments with less defoliation were the grower standard (46%), IKF-309 alternated with Quintec (48%), and Vivando (22% and 30%).

All treatments provided sufficient management of powdery mildew to avoid death of leaves and vines that leads to shriveled, rotting handles on pumpkin fruit. On September 26, 75% of good fruit had good handles for untreated plants versus 98-100% for fungicide-treated plants. Almost all fruit were good; few rotted. A high percentage of fruit still had good handles on October 9 for most treatments (92-99%). The percentage had dropped to 83% for plants treated with Pristine and 90% for those treated with Procure; however these treatments did not differ significantly from the others. There were no significant differences in fruit quality among any fungicide treatments on either assessment date; all had higher percentage of fruit with good handles than the control. No phytotoxicity was observed.

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Table 1. Impact of fungicide treatments on severity of powdery mildew and defoliation mostly due to this disease in pumpkin, Riverhead, New York, 2014.

Treatment and Rate/A (application dates) ^y	Powdery Mildew Severity (%) ^z						Defoliation (%)
	Upper Leaf Surface			Lower Leaf Surface			
	4 Sept	19 Sept	AUDPC ^x	4 Sept	19 Sept	AUDPC ^x	19 Sept
Untreated Control	64.3 a	63.0 a	1,374.6 a	74.3 a	72.6 a	1,724.3 a	89.8 a
Pristine 38 WG 18.5 fl oz (1-6)	2.5 b	25.4 b	225.0 b	19.8 b	71.3 a	799.5 b	61.3 b
Procure 8 fl oz (1-6)	2.1 b	5.4 cd	60.8 b	15.3 bc	43.2 b	509.6 b	36.3 bc
Quintec 6 fl oz (1-6)	0.0 b	2.3 cd	12.4 b	1.1 c	9.0 d	74.0 cd	13.8 c
Quintec 4 fl oz (1,3,5) Procure 8 fl oz (2,6) Pristine 18.5 oz (4) (Grower Std.)	0.0 b	0.2 d	1.3 b	4.0 c	7.9 d	88.4 cd	17.5 c
Luna Experience 6 fl oz (1,3) alt w/ Quintec 4 fl oz (2,4)	0.2 b	4.8 cd	38.8 b	1.1 c	19.2 cd	151.3 c	17.5 c
A19334 ^w 8.5 fl oz (1,3) alt w/ Quintec 4 fl oz (2,4)	0.6 b	14.4 bc	111.3 b	2.8 c	19.7 cd	169.7 c	15.0 c
A19334 ^w 10.5 fl oz (1,3) alt w/ Quintec 4 fl oz (2,4)	0.1 b	7.7 cd	50.4 b	0.9 c	11.9 d	94.6 cd	11.3 c
IKF-309 4 fl oz (1-6)	0.1 b	2.4 cd	21.6 b	21.6 b	38.8 bc	591.7 b	22.5 c
IKF-309 5 fl oz (1-6)	0.4 b	6.3 cd	52.6 b	29.0 b	51.2 ab	778.4 b	27.5 c
IKF-309 4 fl oz (1, 3, 5) alt w/ Quintec 0.38 pt (2, 4,6)	0.5 b	1.5 cd	13.0 b	3.4 c	13.6 d	136.9 cd	12.5 c
Vivando ^w 10 fl oz (1-6)	0.0 b	0.7 cd	7.7 b	1.5 c	7.9 d	81.0 cd	13.8 c
Vivando ^w 15 fl oz (1-6)	0.0 b	0.8 cd	4.0 b	1.2 c	3.4 d	36.0 d	8.8 c
<i>P-value (treatment)</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>

^zNumbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).

^yRate of formulated product/A. Application dates were 1=July 30, 2=August 7, 3=August 18, 4=August 25, 5=September 2, and 6=September 11.

^xAUDPC values were square root transformed before analysis. Table contains detransformed values.

^wA19334 was applied with Dyne-Amic 0.125 % v/v; Vivando was applied with Silwet L-77 0.125% v/v.