

Evaluation of fungicide programs for managing pathogen resistance and powdery mildew of pumpkin, 2004.

A field experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead, NY, on Haven loam soil. Fertilizer (N-P-K 10-10-10) at 1000 lb/A was broadcast and incorporated on 10 May. A spring pea and triticale mix cover crop was seeded (100 lb/A) on 11 May, then mowed and disked under on 21 Jun. On 1 Jul, pumpkin seeds were planted at approximately 24-in. plant spacing within rows and 68-in. row spacing, next the herbicide Strategy 2EC (3 pt/treated A) and the insecticide Admire 2F (16 fl oz/ treated A) for cucumber beetles were applied in a 10-inch band over the row, then the field was irrigated. During the season, weeds were controlled by cultivation and hand weeding. To manage *Phytophthora* fruit and crown rot (*Phytophthora capsici*), Ridomil Gold EC (1 pt/A) was broadcast over the entire field then incorporated on 30 Jun and Phostrol (4-5 pt/A) was applied on 2 Aug, 12 Aug, 25 Aug, 4 Sep, and 17 Sep. Additionally, soil drainage was improved by subsoiling on 3 Aug between rows before vines grew over. Downy mildew was managed by applying Ridomil Gold EC (0.25 pt/A) with Phostrol on 12 and 25 Aug, Curzate (3.2 oz/A) on 14 Aug, 4 Sep, and 12 Sep, and Acrobat 50WP (6.4 oz/A) on 20 Aug, 7 Sep and 14 Sep. These fungicides were selected because they were not expected to affect powdery mildew. Applications of Ridomil and Acrobat also may have been beneficial for managing *P. capsici*. Plots averaged 18 plants in three 15-ft rows. There was 10 ft between plots. A randomized complete block design with four replications was used. Average monthly high and low temperatures (°F) were 77/59 in Jun, 82/65 in Jul, 82/66 in Aug, 78/60 in Sep, and 64/49 in Oct. Rainfall (in.) was 2.96, 0.88, 3.33, 3.94, 6.97, and 2.04 for these months, respectively. All treatments were initiated on 11 Aug when powdery mildew was near the IPM threshold of one leaf of 50 old leaves examined with symptoms (Plant Dis. 80:910-916). Fungicides were applied weekly with a tractor-mounted boom sprayer equipped with D5-25 hollow cone nozzles spaced 17 in. apart that delivered 85 gal/A at 100 psi. Upper and lower surfaces of 5 to 25 leaves in each plot were examined weekly for powdery mildew beginning on 9 Aug when fruit were starting to enlarge. Initially, 25 older leaves were examined in each plot. The examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed, the number of leaves examined was adjusted based on the incidence of affected leaves in a plot. Mid-aged and young leaves were also examined beginning on 24 Aug and 7 Sep, respectively. Powdery mildew colonies were counted; severity was assessed when colonies could not be counted accurately because they had coalesced and/or were too numerous. Average severity for the entire canopy was calculated from the individual leaf assessments. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Sixteen isolates were collected for fungicide sensitivity testing on 9 Aug from non-treated plots, and on 23 Aug and 23 Sep from non-treated plots and plots treated with Procure 50WS and Quintec 2.08SC or Flint 50WDG. Their sensitivity to QoI and DMI fungicides was assessed using a leaf disk bioassay (Plant Dis. 80:633-639). Isolates able to grow and sporulate on disks treated with Flint 50WDG at 50 ppm ai were considered resistant to QoIs and those tolerating Nova 40WP at 20 ppm ai were considered moderately resistant to DMIs. Canopy condition including defoliation was assessed on 16 Sep and 1 Oct. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 18 Oct. Handles were considered good if they were green, solid, and not rotting.

Powdery mildew was first seen earlier than expected based on crop phenology. On 9 Aug fruit had not started to set and the canopy had not closed between rows. First flowers were open. Symptoms were observed in 31 of 32 plots on a total of 78 of the 800 older leaves examined. Procure 50WS tank-mixed with sulfur (Microthiol Disperss) and applied in alternation with Flint 50WDG plus sulfur on a weekly schedule effectively controlled powdery mildew on pumpkin through the end of Aug. By the 13 Sep assessment, control on the underside of leaves had dropped to 69% compared to 93% where a similar program was used with Quintec 2.08SC substituted for Flint 50WDG and 98% where Quintec 2.08SC was applied alone on the same dates. Resistance to QoI fungicides was shown to be common on Long Island at the start of powdery mildew development through another project. Control on 13 Sep was 87% with Pristine 38WG plus sulfur applied in alternation with Nova 40WP plus sulfur. This degree of control was not significantly different from that obtained with Procure 50WS and Quintec 2.08SC. Based on AUDPC values, control on the underside of leaves was significantly more effective when block applications of Procure and Quintec were used than when a strict alternation was used (88% versus 98%). Of the 14 isolates tested from nontreated pumpkins on 9 Aug before treatments were started, 14% were resistant to QoI fungicides and 79% were moderately resistant to DMIs. On 23 Aug, frequency of QoI-resistant strains was 20% in plots receiving the block alternation schedule of Procure 50WS and Quintec 2.08SC while it was 44% in non-treated plots, 45% where Procure 50WS and Quintec 2.08SC were alternated weekly, and 71% where Procure 50WS was alternated with Flint 50WDG. Frequency of isolates moderately resistant to DMIs for these treatments was 80%, 69%, 73%, and 94%, respectively. On 23 Sep, frequency of QoI-resistant strains was 43%, 44%, 60%, and 80%, respectively, and frequency of moderately DMI-resistant strains was 93%, 94%, 90%, and 100%. Most QoI-resistant strains (92%) were also moderately resistant to DMIs. Four of the 123 isolates tested tolerated Nova 40WP at 50 ppm ai. Presence of resistant strains likely affected efficacy of QoI and DMI fungicides. While not as effective as the treatments with conventional fungicides based on AUDPC values, Vigor-K did suppress powdery mildew well on both upper and lower leaf surfaces (71 and 65% control, respectively). Defoliation was high where Quintec 2.08SC was used alone, despite good control of powdery mildew, likely because the other treatments contributed to downy mildew control. No significant differences were detected among treatments in fruit quality.

	Powdery mildew severity (% leaf coverage) ^z						Defolia- tion (%)	% Solid handles
	Upper leaf surface			Lower leaf surface				
Treatments and rate/A (application time) ^y	23 Aug	13 Sep	AUDPC	23 Aug	13 Sep	AUDPC	1 Oct	18 Oct
Nontreated control.....	2.73 a ^x	24.5 a	115.9 a	11.34 a	41.8 a	528.7 a	60.0 ab	95
Vigor-K (II) 2 qt/A + SprayTech oil 0.5% (1-6)	0.17 b	7.9 b	33.3 b	3.58 b	29.2 b	181.2 b	71.3 a	91
Pristine 38WG 14.5 oz + Microthiol Disperss ^w (1,3,5), Nova 40WP 5 oz + Microthiol Disperss (2,4), Microthiol Disperss 80W (6)	0.01 bc	1.4 cd	5.9 cd	1.95 bc	5.2 d	71.2 cd	17.5 d	100
Pristine 38WG 14.5 oz + Microthiol Disperss (1,5), Quintec 4 fl oz + Microthiol Disperss (2,4), Nova 40WP 5 oz + Microthiol Disperss (3), Microthiol Disperss 80W (6) ^w	0.00 c	0.8 cd	3.4 cd	0.17 d	5.3 d	43.8 d	32.5 cd	97
Procure 50WS 8 oz + Microthiol Disperss (1,3,5), Flint 50WDG 2 oz + Microthiol Disperss (2,4), Microthiol Disperss (6) ^w	0.00 c	2.8 c	9.6 c	1.07 bcd	12.7 c	88.5 c	40.0 bcd	100
Procure 50WS 8 oz + Microthiol Disperss (1,3,5), Quintec 4 fl oz + Microthiol Disperss (2,4); Microthiol Disperss 80W (6)	0.00 c	0.7 cd	3.1 cd	0.81 cd	2.7 de	62.6 cd	27.5 d	98
Procure 50WS 8 oz + Microthiol Disperss (1,4,5), Quintec 4 fl oz + Microthiol Disperss (2,3); Microthiol Disperss 80W (6)	0.04 bc	1.6 cd	6.1 cd	0.77 cd	1.1 e	12.6 e	27.5 d	96
Quintec 2.08SC 4 fl oz (1-6)	0.01 c	0.3 d	1.6 d	0.25 cd	0.6 e	8.7 e	51.3 abc	87
<i>P</i> value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.1598

^z Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1%. Area under the disease progress curve (AUDPC) was calculated for severity from 9 Aug through 13 Sep.

^y Rate of formulated product/A. Application times were: 1=11 Aug, 2=18 Aug, 3=24 Aug, 4=1 Sep, 5=7 Sep, and 6=14 Sep. Applications 3 and 5 were applied early due to forecasts for rain

^x Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD (*P* = 0.05).

^w Microthiol Disperss 80W was always applied at 4 lb/A.