

### Evaluation of fungicides for management of powdery mildew on pumpkin, 2006.

The primary objective of this study was to evaluate the efficacy of several fungicides and fungicide programs for the control of cucurbit powdery mildew in an area where in previous years strains of the pathogen with QoI resistance and moderate DMI resistance were detected before fungicide use. Various conventional fungicides representing several classes of chemicals were evaluated. An experimental chemical LEM 12 20 SC (E.I. du Pont de Nemours and Company, Wilmington, DE) was evaluated at three rates applied alone and in combination with another experimental (KQ926 1.7 fl oz/A). A second formulation of this product (LEM 17 50 WDG) was also evaluated. A field experiment was conducted at LIHREC on Haven loam soil. The field was plowed on 19 Apr and tilled on 1 May. Fertilizer (N-P-K 10-10-10) at 500 lb/A was broadcast on 8 May. Red clover at 10 lb/A was planted with a grain drill to establish driveways on 25 May. On 19 Jun the field was disked. Seeds were planted at approximately 24-in. plant spacing within rows with a Monosem vacuum seeder on 20 Jun. Cucumber beetles were managed by applying the insecticide Admire 2 F (20 fl oz/A) in the furrow at planting and Asana XL (9.6 fl oz/A) as a foliar treatment on 15 Jul. Additional fertilizer (N-P-K 34-0-0) at 88 lb/A was side-dressed on 2 Aug. During the season weeds were controlled by cultivation, roto-tilling between plots, and hand weeding along with a single application of Strategy (3 pt/A) over seed beds at planting. To manage *Phytophthora* fruit and crown rot (*Phytophthora capsici*), Ridomil Gold EC (1 pt/A) was broadcast over seed beds on 20 Jun, Acrobat 50 WP (6.4 oz/A) was applied to foliage on 12 Jul, and Tanos 50 DF (8 oz/A) was applied on 24 Aug and 22 Sep. Downy mildew (*Pseudoperonospora cubensis*) was managed with these two Tanos 50 DF applications along with one application of Previcur Flex 6 F (1.2 pt/A) on 29 Jul. These fungicides were selected because they were not expected to affect powdery mildew development. Plots were three 15-ft rows spaced 68 in apart. There was 10 ft between plots. A randomized complete block design with four replications was used. Average monthly high and low temperatures (°F) were 77/62 in Jun, 84/69 in Jul, 82/67 in Aug, 73/58 in Sep, and 64/48 in Oct. Rainfall (in.) was 5.83, 3.79, 5.48, 3.66, and 5.53 for these months, respectively. On 31 Jul, at least 15 old leaves per plot in one replication were inspected for powdery mildew symptoms, which revealed that the IPM threshold of one affected leaf out of 50 old leaves (Plant Dis. 80:910-916) had been reached in all plots scouted. Treatments were started on 4 Aug with subsequent applications made weekly on 11 Aug, 18 Aug, 25 Aug, 1 Sep, and 8 Sep 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 10 leaves per plot were examined to assess powdery mildew severity beginning on 10 Aug when fruit were starting to enlarge. The examined leaves were selected then from the oldest third of the foliage based on leaf physiological appearance and position in the canopy. Ten old leaves were again evaluated on 16 Aug, mid-aged leaves only were examined on 23 Aug and young leaves were also examined beginning on 31 Aug and weekly thereafter on 8 Sep, 13 Sep, and 26 Sep. Powdery mildew colonies were counted; severity was assessed by visual estimation of percent leaf area infected 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. Canopy condition including defoliation was assessed on 14 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 18 Sep. Handles were considered good if they were green, solid, and not rotting. Occurrence of fungicide resistant strains was examined by conducting a seedling bioassay and testing isolates. The seedling bioassay was conducted on 26 Jul in a nearby experiment where powdery mildew had already started to develop to determine resistance frequency at LIHREC before fungicide treatments were started. Fungicides in three chemical classes (the QoI Flint, the DMI Nova, and the MBC Topsin M) were applied with a backpack CO<sub>2</sub> pressurized sprayer to squash seedlings in the greenhouse. The next day these plus nontreated seedlings were put in four sites in the field for 4 hours. Afterwards they were maintained in a greenhouse for one week and then powdery mildew severity was assessed. Isolates were collected for fungicide sensitivity testing on 18 Sep from nontreated plots and plots treated with Pristine, Nova, Quintec, Endura and/or Cabrio. 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 leaf tissue treated with Flint 50 WDG at 50 ppm a.i. were considered resistant to QoIs, those tolerating Topsin M at 50 ppm a.i. were considered resistant to MBCs, and those tolerating Nova 40 WP at 40 ppm a.i. were considered moderately resistant to DMIs.

Powdery mildew was first seen on 31 Jul on 12% of leaves examined (average of 2.3 colonies per leaf). Early in the season, on 16 Aug, disease severity was low on both upper and lower leaf surfaces. At this time, on the upper leaf surface, both Cabrio and the high rate of Nova (5 oz/A) were not controlling powdery mildew. The only treatment with significant control on the lower leaf surface was the dry formulation of the experimental chemical LEM 17 (50 WP). As the season progressed, differences in control among treatments became more distinguished and on 13 Sep, the best treatment on both the upper and lower leaf surfaces was the experimental chemical LEM 17 20 SC combined with another experimental KQ926. Endura and Quintec provided statistically equivalent control on both leaf surfaces. LEM 17 20 SC was also evaluated alone at three rates (9.59, 16.78, and 23.96 fl oz) and each provided good control of powdery mildew with the lowest rate being significantly less effective than the two higher rates on the lower leaf surface based on AUDPC. The QoI fungicide Cabrio and the DMI fungicides Procure and Nova (at both rates tested) did not control powdery mildew based on severity on 31 Aug, 9 Sep, 13 Sep and AUDPC values, perhaps due to fungicide resistance. Procure was effective in a near-by experiment with butternut squash. Similar results occurred with these crop species in GA (see reports in this volume by D. Langston). Pristine, which has the same active ingredients as Cabrio (pyraclostrobin) and Endura (boscalid), provided control that was similar to Endura, thus there was no indication of synergistic activity. When Procure was applied in alternation with either Quintec or Pristine starting with Procure, powdery mildew was not controlled as effectively as the alternation product used alone based on AUDPC for the lower leaf surface. The alternation treatment that started with Quintec was as effective as Quintec alone. The seedling bioassay performed on 26 Jul before fungicides were applied indicated that 2 of the 4 sites tested had a 100% frequency of DMI resistance with the other 2 sites having an 89% and 14% frequency of resistance to DMI's. Only 1 of the 4 sites had a 100% frequency of resistance to QoI fungicides and the other sites had a 53%, 23%, and 16% frequency of resistance to QoI's. Of the 17 *Podosphaera xanthii* isolates collected on 18 Sep, all were resistant to QoI fungicides and 65% were moderately resistant to DMI fungicides. The QoI-resistant isolates were completely insensitive to the test concentration, exhibiting no reduction in growth on treated leaf disks compared to nontreated disks, whereas the moderately DMI-resistant isolates exhibited a reduction in growth on treated leaf disks compared to nontreated disks. All moderately DMI-resistant isolates also were

resistant to QoIs. Thus resistance to these two fungicide groups continues to be an issue in NY. The high frequency of QoI and DMI resistance could account for results with Cabrio, Nova, and Procure treatments. Canopy condition and fruit quality generally corresponded to level of powdery mildew control with the notable exception of the Nova high rate treatment, which resulted in significantly less defoliation than the nontreated control and also significantly more fruit with solid handles, although AUDPC values did not differ significantly from the control. No phytotoxicity was observed.

Treatment and rate/A <sup>y</sup>	Powdery mildew severity (%) <sup>z</sup>									Defoliation	Good handles
	Upper leaf surface			Lower leaf surface							
	16-Aug	13-Sep	AUDPC		16-Aug	13-Sep	AUDPC		14-Sep	18-Sep	
LEM 17 20SC 9.59 fl oz +											
KQ926 1.7 fl oz.....	1.7 c <sup>x</sup>	3.8 e	35 j		5.4 ab	9.5 g	63 g		21 f	94 a	
LEM 17 20SC 23.96 fl oz.....	1.7 c	20.3 bcd	204 fgh		8.2 a	32.6 def	336 de		24 ef	94 a	
LEM 17 20SC 16.78 fl oz.....	2.2 c	21.2 bcd	173 fghi		6.0 ab	38.2 bcde	430 d		26 ef	78 bc	
LEM 17 20SC 9.59 fl oz.....	1.5 c	32.9 abc	445 cde		6.9 ab	50.3 abc	792 bc		59 cd	88 ab	
LEM 17 50 WDG 3.92 oz.....	1.3 c	23.9 abcd	279 def		3.2 b	34.6 cdef	550 cd		15 f	95 a	
Quintec 2.08 SC 4 fl oz alt. Procure											
480 SC 6 fl oz + Silwet 2 fl oz.....	2.0 c	20.6 bcd	111 abcd		5.4 ab	35.5 cdef	323 def		25 ef	94 a	
Procure 480 SC 6 fl oz + Silwet 2											
fl oz alt. Quintec 2.08 SC 4 fl oz...	3.1 bc	23.5 abcd	246 efg		7.9 a	41.3 abcd	513 cd		21 f	86 ab	
Procure 480 SC 6 fl oz + Silwet 2 fl											
oz alt. Pristine 38 WDG 18.5 oz...	2.5 c	17.7 cd	193 fgh		6.3 ab	38.4 bcde	439 d		23 f	89 ab	
Quintec 2.08 SC 4 fl oz.....	1.6 c	11.7 de	57 ij		4.8 ab	22.7 efg	160 efg		26 ef	93 a	
Endura 70W 6.66 oz.....	2.9 bc	4.0 e	61 ij		7.8 a	21.0 ef	140 fg		21 f	93 a	
Pristine 38 WG 18.5 oz.....	2.0 c	10.5 de	86 hij		5.7 ab	30.4 def	163 efg		24 ef	83 ab	
Procure 480 SC 6 fl oz +											
Silwet 2 fl oz.....	2.9 bc	29.4 abc	484 bcd		6.3 ab	43.7 abcd	918 b		53 cd	90 ab	
Nova 40W 2.5 oz.....	1.8 c	36.9 ab	653 abc		6.3 ab	51.3 abc	972 b		65 bc	92 ab	
Nova 40W 5 oz.....	5.5 ab	36.8 ab	762 ab		7.6 a	44.6 abcd	1056 ab		44 de	92 a	
Cabrio EG 11.84 oz.....	5.4 ab	34.8 abc	663 abc		7.2 ab	53.8 ab	1131 ab		84 ab	87 ab	
Nontreated (control) .....	7.3 a	41.2 a	946 a		8.6 a	55.5 a	1421 a		96 a	68 c	
P-value	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001		0.0001	0.0293	

<sup>z</sup> Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1%.

Severity data is for old leaves on 16 Aug and mid-aged plus young leaves on 13 Sep. AUDPC was calculated for 10 Aug to 13 Sep.

<sup>y</sup> Rate of formulated product/A. All treatments were on an IPM schedule with threshold of 1 affected leaf out of 50 older leaves.

Application dates were 4 Aug, 11 Aug, 18 Aug, 25 Aug, 1 Sep, and 8 Sep.

<sup>x</sup> Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD ( $P = 0.05$ ).