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

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Evaluation of fungicide programs for managing powdery mildew of pumpkin, 2005.

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 2004 strains of the pathogen with QoI resistance and moderate DMI resistance were detected before fungicide use. One treatment included two preventive applications of Microthiol Disperss 80 WP (4 lb/A) to determine if early control of the disease could be achieved with this product resulting in a delay in when the IPM threshold was reached and thus a delay in when to start applications of the more expensive mobile fungicides, which also are at risk for resistance development. The conventional formulation of triflumizole (Procure 50 WS) was compared to a new formulation (Procure 480 SC). A field experiment was conducted at the Long Island Horticultural Research and Extension Center on Haven loam soil. Fertilizer (N-P-K 16-8-8) at 400 lb/A was broadcast on 14 Apr. Fall seeded ryegrass was mowed down on 16 May. On 28 Jun, approximately 20-ft wide beds were made for the pumpkin plots using a rototiller and on 29 Jun, pumpkin rows were prepared with an Unverferth Zone Builder. Seeds were planted at approximately 24-in. plant spacing within rows and 68-in. row spacing. The insecticide Asana XL EC (16 fl oz/ treated A) was applied for cucumber beetles on 15 Jul. During the season weeds were controlled by cultivation and hand weeding along with a single application of Poast 1.5 E (3 pt/A) on 8 Aug. To manage Phytophthora fruit and crown rot (*Phytophthora capsici*), Ridomil Gold EC (1 pt/A) was broadcast over seed beds on 29 Jun, Phostrol 6.69 EC (5 pt/A) was applied on 5 Aug, and Acrobat 50 WP (6.4 oz/A) was applied on 23 Jul, 12 Aug, and 28 Aug. Downy mildew (*Pseudoperonospora cubensis*) was managed by applying Previcur Flex 66 F (1.2 pt/A) on 18 Aug and 10 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 were three 15-ft rows spaced 68-in apart. There were 10 ft between plots. A randomized complete block design with four replications was used. Average monthly high and low temperatures (^{o}F) were 81/61 in Jun, 84/67 in Jul, 85/69 in Aug, 79/62 in Sep, and 63/51 in Oct. Rainfall (in.) was 1.20, 1.36, 1.48, 3.46, and 20.32 for these months, respectively. The preventative applications of Microthiol Disperss 80 WP occurred on 5 Aug and 12 Aug. Most other treatments were started on 12 Aug after the IPM threshold of one leaf of 50 old leaves examined with powdery mildew symptoms (Plant Dis. 80:910-916) was reached in 5 of 48 plots scouted. Treatments were applied on 17 Aug, 24 Aug, 1 Sep, 8 Sep, and 14 Sep with a tractor-mounted boom sprayer equipped with D5-25 hollow cone nozzles spaced 17 in. apart that delivered 82 gal/A at 100 psi. Upper and lower surfaces of 5 to 50 leaves in each plot were examined weekly for powdery mildew beginning on 16 Aug when fruit were starting to enlarge. Initially, 50 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 also were examined beginning on 29 Aug and 19 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. The area under the disease progress curve (AUDPC) was calculated from severity values between 23 Aug and 9 Sep. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Isolates were collected for fungicide sensitivity testing on 20 Sep and 3 Oct from non-treated plots and plots treated with Pristine, Nova, Quintec, and/or Procure. 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 50 WDG at 50 ppm a.i. were considered resistant to QoIs and those tolerating Nova 40 WP at 50 ppm a.i. were considered moderately resistant to DMIs. Canopy condition including defoliation was assessed on 18 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 17 Oct. Handles were considered good if they were green or brown, solid, and not rotting.

Powdery mildew was detected in all plots on 16 Aug. The most effective fungicide applied on a 7-day interval was Procure 50 WS (6 oz/A), providing 98% and 93% control on upper and lower leaf surfaces, respectively, based on AUDPC values. Nova 40 W (5 oz/A) provided a similar level of control (91% and 82% control, respectively). Neither of these products should ever be used commercially as a stand-alone product because of high risk for control failure due to resistance development. They were tested alone to determine whether resistance to the DMI fungicides has developed to the point of affecting their efficacy. These results demonstrated that this has not occurred. Pristine (14.5 oz/A) was significantly less effective on lower leaf surfaces than Procure (46% control). Another treatment was Endura, a formulated product not registered for use on cucurbits with the active ingredient boscalid, which is one of the two active ingredients in Pristine. Endura provided a similar level of control as Pristine: 87% and 56%. This indicates that 1) the second active ingredient in Pristine, the QoI fungicide pyraclostrobin, is not contributing to control because of QoI resistance and that 2) there is not a synergistic relationship between pyraclostrobin and boscalid. The fungicide program tested was a three-way alternation among Pristine plus sulfur (Microthiol Disperss at 4 lb/A), Quintec plus sulfur and Nova plus sulfur for a total of 5 applications. Efficacy was not affected by whether the alternation started with Pristine or Quintec (96-96% and 71-74% control). The two preventive applications of sulfur did not delay when the IPM threshold was reached, which was one objective of including this treatment. Control achieved with this treatment was not significantly better than the other treatment with the same fungicide program except for the preventive sulfur applications: 98% and 87%. Of the 21 *Podosphaera xanthii* isolates tested, 67% were resistant to QoI fungicides and 33% 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 non-treated disks, whereas the moderately DMI-resistant isolates exhibited a reduction in growth on treated leaf disks compared to non-treated 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 resistance could account for results with Pristine and Endura. Excellent control achieved with the DMI fungicides Nova and Procure indicate that moderately DMI-resistant isolates are not able to tolerate the field rates used.

Treatments and rate/A (application time) [y]	Powdery mildew severity (% leaf coverage) [z]						Defoliation (%)	Good handles
	Upper leaf surface			Lower leaf surface				
	23-Aug	9-Sep	AUDPC	23-Aug	9-Sep	AUDPC	18-Sep	17-Oct
Nontreated…….	4.6 a[x]	1.5 a	166 a	8.5 a	7.9 a	348 a	46 a	32 e
Bravo Ultrex 82.5 WG 2.7 lb (1-5)…….	0.7 bc	0.2 bcd	15 bcde	5.5 ab	2.3 b	193 b	18 cd	45 cde
Pristine 38 WG 14.5 oz (1-5)……..	0.2 cde	0.1 cde	11 cde	3.0 bcd	1.7 bcd	188 b	7 d	68 ab
Endura 70 W 5.22 oz (1-5)……..	0.2 bcde	0.1 bcde	22 bcd	3.9 bc	2.1 bc	153 bc	6 d	73 a
Nova 40 W 5 oz (1-5)	0.7 bcd	0.4 bc	15 bcde	1.4 cdefg	0.8 cdef	62 ef	39 abc	50 bcde
Procure 50 WS 6 oz (1-5)…….	0.1 cde	0.1 cde	4 e	0.3 fg	0.2 f	24 f	11 d	61 abc
Procure 480 SC 6 fl oz (1-5)……..	0.1 cde	0.0 de	7 cde	0.4 fg	0.4 ef	82 def	29 abcd	61 abc
Procure 480 SC 6 fl oz (1,3,5) alt Quintec 4 fl oz (2,4).....	1.2 b	0.4 b	16 bcde	0.5 fg	0.4 ef	41 ef	41 ab	49 cde
Procure 480 SC 6 fl oz (1,3,5) alt Pristine 38 WG 14.5 oz (2,4)……..	0.0 de	0.1 cde	18 bcde	0.2 g	0.7 def	88 cdef	11 d	59 abcd
Nova 40 W 5 oz (1,4,5) alt Pristine 38 WG 14.5 oz (2,4)……..	0.2 cde	0.1 bcde	36 b	0.4 fg	1.4 bcde	138 bcd	45 ab	60 abcd
Pristine(1), Quintec(2), Nova(3), Pristine(4), Quintec(5)[w].....	0.1 cde	0.1 cde	5 de	1.3 defg	0.7 def	102 cde	25 abcd	57 abcd
Quintec(1), Pristine(2), Quintec(3), Nova(4), Pristine(5)[w].....	0.2 bcde	0.1 bcde	6 cde	0.8 efg	0.5 ef	92 cdef	45 ab	61 abcd
Microthiol Disperss 4 lb(1a,1b), Quintec(1), Pristine(2), Quintec(3), Nova(4), Quintec(5)[w].....	0.0 e	0.0 e	3 e	0.7 efg	0.5 ef	46 ef	10 d	53 bcde
P-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0006	0.0108

[z] 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 23 Aug. On 9 Sep, severity data is for old and mid-aged leaves combined.

[y] Rate of formulated product/A. All treatments except where Microthiol Disperss 80 WP (4 lb) was applied preventively were on an IPM schedule with threshold of 1 affected leaf out of 50 older leaves. Application dates were 1=17 Aug, 2=24 Aug, 3=1 Sep, 4=8 Sep, and 5=14 Sep. Preventative Microthiol Disperss 80 WP (4 lb) treatments were applied on 1a=5 Aug and 1b=12 Aug. Where rate is not specified product was applied at the same rate as listed for the previous treatment with this product.

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

[w] All treatments were tank-mixed with Microthiol Disperss 80 WP (4 lb).