

**Evaluation of integrated management programs with biopesticides and a resistant cultivar for managing powdery mildew in butternut squash, 2007.**

The objective of this experiment was to evaluate on butternut squash two biopesticides, Organocide (5% sesame oil) and Milstop (85% potassium bicarbonate) that effectively controlled powdery mildew in experiments conducted previously with pumpkin. This experiment was part of a study with two parallel, adjacent field experiments conducted with pumpkin and muskmelon. Biopesticides were evaluated alone and in integrated programs with powdery mildew resistant cultivars and/or conventional, mobile fungicides (Quintec, Pristine, and Procure). The integrated programs evaluated consisted of biopesticides plus conventional fungicides applied on a 7-day spray interval to a susceptible cultivar and on a 14-day spray interval to a cultivar with resistance to powdery mildew. The experiment was conducted in a field with Haven loam soil. Fertilizer (400 lb/A of 10-10-10) was applied on 16 May. Black plastic mulch and drip tape were laid on 22 May. Additional fertilizer (N-P-K 46-0-0) at 30 lb/A was injected through the drip irrigation system on 9 and 30 Jul. Water was provided as needed through drip irrigation. Weeds were controlled between plastic mulch strips by applying Strategy (2 pt/A) on 31 May and RoundUp WeatherMax (1% solution) on 12 and 27 Jun between the rows of black plastic mulch with a shielded sprayer, and hand-weeding. Seeds were hand-planted on 7 Jun into holes cut into the plastic. Plots consisted of 3 rows of 5 plants each. Plants were at 24-in. spacing and rows were at 68-in. spacing. Plots were separated by 18 ft in the row. Cucumber beetles were managed with Admire 2F applied after transplanting as a soil drench around transplants (0.0007 fl oz/plant) on 22 Jun and with Asana XL (9.6 oz/A) applied to foliage on 16 Jul. The following fungicides were applied preventively for downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): Forum 4.16SC (6 oz/A) on 16 Jul, Curzate 60 DF (3.2 oz/A) on 22 Jul, Ranman 400 SC (2.75 fl oz/A) on 12 Aug, Acrobat 50 WP (6.4 oz/A) on 19 Aug, and Previcur Flex 6 F (1.2 pt/A) on 30 Aug. All treatments were started after the IPM threshold of 1 affected leaf out of 50 older leaves (Plant Dis. 80:910-916) was reached in most plots scouted. Applications were made with a tractor-mounted boom sprayer operated at 100 psi and 96 gpa (D5-25 hollow cone nozzles spaced 17 in. apart). Upper and lower surfaces of 5 to 50 leaves in each plot were examined weekly for powdery mildew beginning on 17 Jul, which was the start of fruit production. 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, and mid-aged and young leaves also were examined. 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. Area under Disease Progress Curve (AUDPC) was calculated for severity from 18 Jul through 16 Aug for squash. Canopy condition including defoliation was assessed on 23 Aug and 5 Sep. Mature fruit were harvested and weighed on 10, 17 and 25 Sep. Average monthly high and low temperatures (°F) were 79/61 in Jun, 82/66 in Jul, 82/65 in Aug, and 77/60 in Sep. Rainfall (in.) was 3.37, 3.63, 2.60, and 1.51 for these months, respectively.

Powdery mildew was first seen on 17 Jul. Symptoms were found in almost all plots on 17 Jul. Fungicide treatments were started on 20 Jul. Powdery mildew was suppressed well on upper leaf surfaces by Organocide applied alone to the susceptible cultivar (Butternut Supreme) as well as to the resistant cultivar (Butternut 401). The degree of control on upper leaf surfaces was not significantly different from that achieved by also applying conventional fungicides with Organocide in integrated fungicide programs on either cultivar. Surprisingly, one of the two integrated fungicide programs tested on the susceptible cultivar (Program #2) and the integrated fungicide program tested on the resistant cultivar did not improve control significantly on lower leaf surfaces over Organocide applied alone. However, there was less defoliation on 5 Sep in plots treated with an integrated fungicide program than those treated with Organocide. Milstop suppressed powdery mildew only on upper leaf surfaces of the susceptible cultivar. None of the treatments affected yield (data not shown). The resistant cultivar produced a greater number of fruit (6.5 fruit/plant versus 5.5/plant) of a slightly smaller size than the susceptible cultivar (2 lb versus 2.9 lb).

Cultivar; Fungicide treatment (application date) <sup>x</sup>	Powdery mildew severity (%) <sup>z,y</sup>					
	Upper leaf surface		Lower leaf surface		Defoliation (%)	
	16 Aug	AUDPC	16 Aug	AUDPC	23 Aug	5 Sep
Butternut Supreme (susceptible cultivar)						
Fungicide Program #1 (1, 2, 3, 4, 5) <sup>v</sup> .....	2.4 bc <sup>w</sup>	11.7 cd	6.7 d	33.2 e	22 b	60 b
Fungicide Program #2 (1, 2, 3, 4, 5) <sup>v</sup> .....	1.5 bc	7.1 d	11.0 cd	50.6 de	15 b	67 b
Organocide 2 oz/gal (1, 2, 3, 4, 5) <sup>v</sup> .....	1.5 c	8.8 d	18.0 bc	85.7 bcd	50 a	95 a
Milstop 3 lb/A (1, 2, 3, 4, 5) <sup>v</sup> .....	3.8 bc	31.6 c	26.3 a	127.7 a	40 a	96 a
Nontreated .....	12.0 a	80.7 a	22.4 ab	111.4 ab	49 a	96 a
Betternut 401 (mildew resistant cultivar)						
Fungicide Program #3 (1, 3, 5) <sup>v</sup> .....	4.6 bc	21.2 cd	5.5 d	25.4 e	11 b	33 c
Organocide 2 oz/gal (1, 3, 5) <sup>v</sup> .....	6.5 b	33.3 c	13.2 cd	62.0 cde	16 b	73 b
Milstop 3 lb/A (1, 3, 5) <sup>v</sup> .....	12.8 a	70.7 ab	20.5 abc	95.9 abc	19 b	89 a
Nontreated .....	11.3 a	55.8 b	12.8 cd	59.6 cde	24 b	90 a
<i>P</i> -value	< .0001	0.0001	0.0004	0.003	0.0001	0.0001

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

<sup>y</sup> Data were transformed from percentages by a square root transformation when needed to obtain normality of variance, analysis of variance was performed and means were detransformed back to the percentages presented in table.

<sup>x</sup> All treatments were on an IPM schedule with threshold of 1 affected leaf out of 50 older leaves. Application dates were 1=20 Jul, 2=27 Jul, 3=4 Aug, 4=12 Aug, and 5=17 Aug.

<sup>w</sup> Means followed by the same letter are not statistically different from each other (Fisher's Protected LSD, P=0.05).

<sup>v</sup> Fungicide Program #1: Organocide 2 oz/gal + Kocide 3000 0.5 lb/A (1, 2, 3, 4, 5), Quintec 2.08SC 4 fl oz/A (1, 4), Procure 480SC 8 fl oz/A (2, 5), Pristine 38WG 18.5 oz/A (3).

Fungicide Program #2: Organocide 2 oz/gal (1, 2, 3, 4, 5), Kocide 3000 0.5 lb/A (1, 2, 3), Quintec 2.08SC 4 fl oz/A (1, 3), Pristine 38WG 18.5 oz/A (2).

Fungicide Program #3: Organocide 2 oz/gal + Kocide 3000 0.5 lb/A (1, 3, 5), Quintec 2.08SC 4 fl oz/A (1), Pristine 38WG 18.5 oz/A (3), Procure 480SC 8 fl oz/A (5).