SQUASH, WINTER (*Cucurbita moschata*)
Powdery mildew; *Podosphaera xanthii* (formerly named *Sphaerotheca fuliginea*)

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Efficacy of genetic control and chemical control for managing powdery mildew in butternut-type winter squash, 2002.

The objectives of this study were to compare a new cultivar of butternut squash that has homozygous resistance for powdery mildew (Bugle) to a susceptible standard cultivar (Waltham) and to determine if there is a benefit to augmenting powdery mildew control by applying fungicides to the resistant cultivar. Bugle seed was obtained from the Cornell Plant Breeding program and Waltham from Hollar Seeds. In addition to a nontreated control, each cultivar received a grower standard fungicide program (Quadris applied in alternation with Nova + Bravo on a 7-day schedule) and a reduced fungicide program (standard program applied on a 14-day schedule). The field experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead, NY, on Haven loam soil. Fertilizer (666 lb/A of 15-15-15) was broadcast and incorporated on 4 Jun. Transplants were seeded in the greenhouse on 28 May and planted into bare ground on 19 Jun with starter fertilizer (15-30-15) at 24-in. plant spacing and 68-in. row spacing. Plots contained a total of 9 plants in three rows of 3 plants each. There was 10 ft between plots. Weeds were managed by applying the herbicide Curbit EC (2 pt/treated A) between the planted rows on 19 Jun, followed by irrigation to incorporate, and by mechanical cultivation and hand weeding. Cucumber beetles were managed with a soil drench of Admire 2F (0.02 ml/plant) on 17 Jun and foliar applications of Asana XL (9.6 oz/A) on 11 Jul and 3 Sep and Sevin XLR (1 qt/A) on 1 Aug. To manage Phytophthora fruit and crown rot, Ridomil Gold EC (1 pt/A) was broadcast over the entire field then incorporated on 10 Jun and Acrobat (6.4 oz/A) was applied on 11 Jul, 1 Aug, 17 Aug, 3 Sep, and 20 Sep. Additionally, soil drainage was improved by subsoiling on 18 Jul between rows before vines grew over. Average monthly high and low temperatures (F) were 78/60 in Jun, 85/67 in Jul, 84/67 in Aug, 76/61 in Sep, and 63/50 in Oct. Rainfall (in.) was 4.73, 1.2, 3.09, 5.92, and 4.92 for these months, respectively. The field was overhead irrigated (approx. 1.0 in.) on 27 Jun, 15 and 30 Jul, and 12 Aug due to inadequate rainfall. Fungicide applications for each treatment were initiated after the IPM threshold of one leaf with symptoms of 50 old leaves examined was reached in all plots. This threshold was shown previously to be as effective as using a preventive schedule (Plant Dis. 80:910-916). Fungicides were applied weekly with a tractor-mounted boom sprayer equipped with D5-45 hollow cone nozzles spaced 17 in. apart that delivered 100 gal/A at 150 psi. A randomized complete block design with four replications was used. Upper and lower (under) surfaces of 5 to 50 leaves in each plot were examined approximately weekly for powdery mildew from 31 Jul through 17 Sep. Initially, 50 older leaves were examined in each plot. As disease progressed, the number of leaves examined was adjusted based on the incidence of affected leaves in a plot. Beginning on 4 Sep, mid-aged and young leaves were also 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. Defoliation was assessed on 5, 12 and 19 Sep. Ripe fruit were counted and a representative sample of about one-third of the fruit from each plot was weighed on 30 Sep. Percentage of sucrose was determined using a hand refractometer for two fruit per plot. To facilitate getting juice from the fruit for this measurement, a center section from each fruit was frozen and thawed. Data were analyzed using a planned comparison (non-fungicide-treated Bugle versus Waltham treated with the standard fungicide program) as well as a standard 2-factor ANOVA and multiple comparison test.

Symptoms of powdery mildew were first observed on the susceptible cultivar Waltham on 13 Aug and on the resistant cultivar Bugle on 20 Aug. Fungicide applications were started 1-2 days later. Compared to non-fungicide-treated Waltham, the resistant cultivar provided control of powdery mildew on upper leaf surfaces that was equivalent to that achieved with fungicides applied weekly to the susceptible cultivar (86% and 92% control, respectively, based on AUDPC values). Genetic control (non-treated Bugle) was superior to chemical control (fungicide-treated Waltham) for powdery mildew on lower leaf surfaces, providing 98% control versus 69% based on AUDPC values. Chemical control, however, may have been compromised by resistance to Quadris, which was documented in a near-by pumpkin experiment reported in Fungicide & Nematicide Tests (see McGrath, 2003). Control of powdery mildew provided by genetic resistance with Bugle was not improved by applying fungicides. However, a reduced fungicide program could function to delay selection of a new pathogenic race able to overcome this resistance. Powdery mildew in the susceptible cultivar was not controlled on upper leaf surfaces with fungicides applied on a 14-day schedule (reduced fungicide program) as effectively as with a 7-day schedule (standard fungicide program). Powdery mildew causes leaves to senesce prematurely; thus, as a consequence of better suppression with genetic than chemical control, Bugle not treated with fungicides had significantly less defoliation on all 3 assessment dates in Sep than Waltham receiving the standard fungicide program. Fungicide treatment did not affect size, quantity, or sucrose content of fruit produced for either cultivar. Non-fungicide-treated Bugle produced smaller fruit than fungicide-treated Waltham (P=0.0001 for this planned comparison) but more fruit (P=0.0011); however, this was not quite enough to compensate for the smaller fruit size (15 versus 18 lb mature fruit/plant; P=0.0407). Sucrose content, a measure of fruit quality, was slightly higher for Bugle than Waltham, but this difference was not significant (P=0.36). There were no significant differences among treatments in the quantity of immature fruit present at harvest. A few fruit had long splits that extended into the flesh. There was a trend toward fewer fruit with splits as fungicide input increased.

	Powdery mildew severity (%coverage) [z]				Defolia-	Mature fruit			
	Upper leaf surface		Lower leaf surface		tion (%)	Weight	Quantity	Sucrose	Split
Cultivar, Treatment [y]	12 Sep	AUDPC	12 Sep	AUDPC	5 Sep	(lb/fruit)	(No./plant)	(% Brix)	(%)
Bugle, standard fungicide program	0.1 c [x]	0.6 c	0.2 c	3.3 c	1.5 b	2.7 b	5.9 a	9.0	2.2
Bugle, reduced fungicide program	0.3 c	7.8 c	1.0 c	5.1 c	1.0 b	2.6 b	5.8 a	9.6	2.8
Bugle, no fungicide	0.8 bc	19.8 c	0.8 c	7.1 c	1.3 b	2.5 b	5.9 a	8.9	3.3
Waltham, standard fungicide program	0.4 c	9.8 c	14.1 b	95.5 b	21.7 a	4.0 a	4.6 b	8.2	0.5
Waltham, reduced fungicide program	2.8 ab	75.1 b	16.0 b	135.8 b	28.8 a	3.9 a	4.4 b	8.4	1.8
Waltham, no fungicide	4.7 a	137.6 a	44.0 a	306.0 a	32.5 a	4.0 a	4.2 b	8.8	3.8
P-value	0.0051	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.4589	0.1127
Source of Variation for 2-factor ANOVA									
Cultivar	0.0036	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.1025	0.2199
Treatment	0.0214	0.0001	0.0001	0.0001	0.4788	0.7100	0.8222	0.7115	0.0258
Cultivar X Treatment interaction	0.1232	0.0001	0.0001	0.0001	0.4414	0.7551	0.6807	0.5604	0.3415

[z] Exact colony counts were made when possible and severity was estimated using the conversion factor of 10 colonies/leaf = 1%.

[y] Fungicide treatment was Quadris F (15.4 oz/A) applied in alternation with Nova 40W (5 oz/A) plus Bravo Ultrex 82.5WG (2.7 lb/A). Application times were: 1=15 Aug, 2=21 Aug, 3=27 Aug, 4=6 Sep, and 5=13 Sep. Standard program for Waltham was Quadris (week 1,3,5) and Bravo + Nova (2,4) and for Bugle it was Quadris (week 2,4) and Bravo + Nova (3,5). Reduced program was Quadris (week 2) and Bravo + Nova (4) for both Waltham and Bugle.

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