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

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Efficacy of genetic control, used alone and combined with fungicides, for managing powdery mildew in acorn-type winter squash, 2002.

The objectives of this study were to evaluate powdery mildew resistant (PMR) cultivars of acorn squash and to determine if there is a benefit to integrating chemical control with host-plant resistance by applying fungicides to these resistant cultivars. The resistant cultivars were evaluated by comparing them to nontreated and fungicide-treated susceptible cultivars. Taybelle PM is heterozygous for the incompletely dominant resistance gene and is horticulturally similar to Taybelle. Autumn Delight is homozygous for resistance to PM and compares to Table Ace. Seed of these four cultivars were obtained from Seminis Vegetable Seeds, Inc. The other 2 PMR cultivars evaluated were obtained from the Cornell Plant Breeding program. The fungicide program (Quadris applied in alternation with Nova + Bravo) was applied on a 7-day schedule to susceptible cultivars and on a 14-day schedule to resistant cultivars. Harlequin is a multicolored acorn; the others evaluated are dark green acorns. A field experiment was conducted to address these objectives 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, and 76/61 in Sep. Rainfall (in.) was 4.73, 1.2, 3.09, and 5.92, for these months, respectively. The field was overhead irrigated (approx. 1.0 in.) on 27 Jun, 30 Jul, and 12 Sep 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 24-25 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.

Symptoms of powdery mildew were first observed on the susceptible cultivars on 12 Aug and on the resistant cultivars on 20 Aug. Fungicide applications were started 1-2 days later. Host plant resistance provided good control of powdery mildew without the addition of fungicide treatment. Taybelle PM provided control of powdery mildew on lower leaf surfaces equivalent to that achieved with fungicides applied weekly to the susceptible cultivar Taybelle; however, chemical control was more effective for control on upper surfaces. Compared to fungicide-treated Table Ace, Autumn Delight provided better control on lower leaf surfaces and equivalent control on upper surfaces. Chemical control, however, may have been compromised by resistance to Quadris, which was documented in a near-by pumpkin experiment and reported in Fungicide & Nematicide Tests. Autumn Delight, which has homozygous resistance, was less severely infected than Taybelle PM, which has heterozygous resistance, at all assessments (this difference was significant on 6 Sep, data not presented). Powdery mildew severity on Cornell PMR Acorn and Harlequin did not differ significantly from the other two PMR cultivars until 12 Sep when Autumn Delight was less severely infected on upper leaf surfaces. Control of powdery mildew provided by genetic resistance was not improved by applying fungicides twice based on powdery mildew severity; however, defoliation was significantly less in fungicide-treated plots. Additionally, a reduced fungicide program could function to delay selection of a new pathogenic race able to overcome this resistance. Fungicide treatment delayed senescence in addition to suppressing powdery mildew in Taybelle and Table Ace. Powdery mildew was the only foliar disease observed. Cornell PMR Acorn and Harlequin had the least defoliation. Sucrose content was highest for Harlequin and lowest for Autumn Delight. Applying fungicides to Taybelle improved sucrose content; values were higher, but not significantly, for Taybelle PM and Autumn Delight treated with fungicides. Fungicide treatment did not affect fruit size for any cultivar. Fruit of Table Ace, Cornell PMR, and Harlequin were smaller than others.

	Powdery mildew severity (%coverage) [z]				Defolia-	Mature fruit		
	Upper leaf surface		Lower leaf surface		tion (%)	Sucrose	Quantity	Weight
Cultivar, Treatment [y]	26 Aug	12 Sep	26 Aug	12 Sep	12 Sep	(% Brix)	(No./plant)	(lb/fruit)
Taybelle, No Fungicide	27.6 ab [x]	40.3 a	37.0 a	76.3 a	63 ab	8.5 cd	4.6	2.0 a
Taybelle, Fungicide	6.4 bc	3.1 d	15.3 bc	24.8 c	36 cde	10.2 b	5.0	2.0 a
Taybelle PM, No Fungicide	15.4abc	29.2 ab	7.2 c	9.7 d	49 bc	8.0 cde	4.9	1.9 a
Taybelle PM, Fungicide	8.0 bc	17.9 bc	5.0 c	8.9 d	25 de	9.6 bc	5.5	2.1 a
Table Ace, No Fungicide	29.3 a	30.3 ab	38.3 a	79.3 a	79 a	8.3 cde	4.9	1.5 bc
Table Ace, Fungicide	17.2 abc	1.1 d	24.6 ab	38.1 b	46 bcd	8.0 cde	5.7	1.6 b
Autumn Delight, No Fungicide	2.9 bc	5.7 cd	1.0 c	0.5 d	35 cde	6.7 e	4.6	2.0 a
Autumn Delight, Fungicide	1.8 c	4.3 cd	0.6 c	0.1 d	23 e	7.6 de	5.1	2.1 a
Cornell PMR Acorn, No Fungicide	2.2 bc	22.3 b	1.2 c	7.8 d	15 e	9.0 bcd	4.9	1.3 c
Harlequin, No Fungicide	13.5 abc	21.4 b	1.3 c	4.1 d	15 e	13.2 a	6.6	1.4 bc
P-value	0.0171	0.0001	0.0001	0.0001	0.0001	0.0001	0.0802	0.0001

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

[y] PMR=powdery mildew resistant. 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 dates were: 1=15 Aug, 2=21 Aug, 3=27 Aug, 4=6 Sep, and 5=13 Sep. Taybelle and Table Ace were treated with Quadris at dates 1, 3,and 5 and Bravo + Nova at dates 2 and 4. Taybelle PM and Autumn Delight were treated with Quadris at date 2 and Bravo + Nova at date 4.

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