SQUASH, WINTER (*Cucurbita pepo* subsp. *pepo*)
Powdery mildew; *Podosphaera xanthii* (formerly *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, 2003.

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 an incompletely dominant PM resistance gene and is horticulturally similar to Taybelle. Autumn Delight is homozygous for resistance to PM and horticulturally similar to Table Ace. Seed of these four cultivars were obtained from Seminis Vegetable Seeds, Inc. A homozygous resistant experimental line from Seminis, 10605, was also evaluated. A 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 27 May and planted into bare ground on 27 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 controlled by cultivation and hand weeding. Asana XL (9.6 oz/A) was applied on 11 Jul and Sevin XLR (2 pt/A) on 1 Aug to control cucumber beetles. To manage Phytophthora fruit and crown rot (*Phytophthora capsici*), Phostrol (2.5-5 pt/A) was applied on 26 Jul; 6, 13, 20, and 28 Aug; and 7 Sep. Additionally, soil drainage was improved by subsoiling on 25 Jul between rows before vines grew over. Average monthly high and low temperatures (F) were 76/59 in Jun, 82/66 in Jul, 83/69 in Aug, 75/61 in Sep, and 63/47 in Oct. Rainfall (in.) was 8.3, 2.8, 2.8, 5.9, and 5.1 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. Upper and lower (under) surfaces of 5 to 50 leaves in each plot were examined approximately weekly for powdery mildew. Symptoms were first observed on the susceptible cultivars on 31 Jul and on the resistant cultivars on 14 Aug. Fungicide applications were started 0-2 days after detection. Applications were made weekly with a tractor-mounted boom sprayer equipped with D5-25 hollow cone nozzles spaced 17 in. apart that delivered 110 gpa at 100 psi. The last two applications were delayed by rainy weather. The fungicide program was Flint (2 oz/A) plus Bravo (2.7 lb/A) applied in alternation with Procure (6 oz/A) plus Microthiol Disperss (sulfur)(4 lb/A) then Microthiol Disperss applied alone the last week. Defoliation was assessed during September. Representative samples of 10 ripe fruit were harvested from each plot and weighed on 1 and 14 Oct, and the remaining fruit were counted. Percentage of sucrose was determined using a hand-held refractometer for two fruit per plot.

Fungicides suppressed powdery mildew through 26 Aug, then control declined, especially on the lower surface of the susceptible cultivars, possibly due to the development of fungicide resistance. On 9 Sep, the level of control obtained with weekly applications was 92% and 97% on the upper leaf surface for Taybelle and Table Ace, respectively, but only 43% and 48% on the lower surface of these leaves. This was a decline from control on the lower leaf surface of 87% and 79% on 26 Aug. Systemic fungicides provide most of the control on lower surfaces because protectant fungicides function where the spray is deposited, which is mostly upper surfaces. Good control on upper leaf surfaces indicates application timing was good. Resistance to the two types of systemic fungicides used for powdery mildew control was common on Long Island by the end of August. In an adjacent experiment, 100% of the isolates were resistant to QoI fungicides, such as Flint, and 56% were moderately insensitive to DMI fungicides, such as Procure, based on a seedling bioassay conducted on 31 Aug. Powdery mildew was managed better with chemical control (fungicide-treated Taybelle) than with heterozygous-based genetic control (non-treated Taybelle PM) on upper surfaces of leaves (94% and 51% control based on AUDPC values), while similar control was obtained on lower leaf surfaces (67% and 66% control). Numerically there was less defoliation with chemical control, but differences were not statistically significant. Powdery mildew was managed better with homozygous-based genetic control (non-treated Autumn Delight) than with chemical control (fungicide-treated Table Ace) based on severity on lower leaf surfaces (93% and 58% control); chemical control was better based on defoliation. Based on severity on 9 Sep, control of powdery mildew on upper leaf surfaces of PMR cultivars was improved significantly by applying fungicides. Reduced fungicide program (14-day spray interval) was as effective as a standard program (7-day interval) when applied to resistant Taybelle PM. Reduced fungicide program applied to susceptible Table Ace was not as effective as a standard program based on severity on lower leaf surfaces on 9 Sep. Controlling powdery mildew with resistant cultivars and/or fungicides did not affect yield as much as in a parallel experiment conducted in 2002. Non-treated plants tended to produce fewer fruit and smaller fruit than fungicide-treated plants, but these differences were not significant. Fruit of 10605, Table Ace, and Autumn Delight tended to be smaller than Taybelle (1.5 lb/fruit versus 1.7 lb/fruit). Sucrose content of fruit, a measure of fruit quality, did not vary significantly among treatments or cultivars. In conclusion, growing varieties with resistance to powdery mildew is an effective and economic means to manage powdery mildew. Although neither control of powdery mildew nor yield were improved significantly by applying fungicides to Taybelle PM, Autumn Delight, or 10605, there was a trend toward improvement. An integrated program with two applications on a 14-day schedule would reduce selection pressure for new races of the pathogen able to overcome host resistance or become less sensitive to fungicides. Although seed of Taybelle PM and Autumn Delight is priced slightly higher than seed of Taybelle and Table Ace, overall production costs are lower because of the cost difference between a 7- and 14-day fungicide program. It will cost about $109 less to grow an acre of Autumn Delight sprayed thrice compared to Table Ace sprayed seven times and $131 less for Taybelle PM compared to Taybelle.

Cultivar, Treatment [y]	Powdery mildew severity (%coverage) [z] Upper leaf surface 26 Aug	Upper leaf surface AUDPC	Lower leaf surface 26 Aug	Lower leaf surface AUDPC	Defoliation (%) 15 Sep	Mature fruit Weight (lb/fruit)	Mature fruit Quantity (No./plant)	Mature fruit Sucrose (% Brix)
Taybelle PM (PMR), fungicide (7-day)….	0.2d [x]	2.7c	1.5de	27.6efg	18e	1.7a	4.6bcd	9.5
Taybelle PM (PMR), fungicide (14-day)…	0.3cd	3.6c	1.9de	34.0def	25bcde	1.7ab	4.6bcd	9.3
Taybelle PM (PMR), no fungicide ……	2.2bc	17.2b	8.3c	44.3de	46ab	1.6bcd	4.3cde	10.0
Taybelle, fungicide (7-day)……	0.7bcd	2.9c	6.5cde	48.1cd	24bcde	1.7a	4.1cde	9.8
Taybelle, no fungicide……	11.1a	38.0a	51.3a	84.6ab	43abcd	1.7abc	3.3e	9.5
Autumn Delight (PMR), fungicide (14-day)……	0.6bcd	2.5c	0.7e	9.6g	31abcde	1.5d	4.6bcd	7.6
Autumn Delight (PMR), no fungicide……	0.5cd	14.3b	0.6e	12.3g	50a	1.5de	3.7de	8.5
Table Ace, fungicide (7-day)……	0.4cd	1.5c	9.6bc	46.1de	21de	1.4ef	4.5bcd	9.6
Table Ace, fungicide (14-day)……	0.4cd	5.6c	19.5b	66.6bc	45abc	1.4f	4.8bc	8.5
Table Ace, no fungicide……	3.1b	42.3a	44.9a	89.1a	28abcde	1.4f	3.9cde	9.1
10605 (PMR), fungicide (14-day)…….	0.9bcd	4.1c	1.9de	11.6g	19e	1.5def	6.3a	9.6
10605 (PMR), no fungicide……	1.1bcd	18.8b	0.5e	23.6fg	23cde	1.5cd	5.4ab	8.6
P-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.4156

[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. Taybelle PM is horticulturally similar to Taybelle. Autumn Delight is similar to Table Ace. Fungicide treatment was Flint (2 oz/A) plus Bravo Ultrex (2.7 lb/A) applied in alternation with Procure (6 oz/A) plus Microthiol Disperss (sulfur)(4 lb/A) then Microthiol Disperss applied alone on the last date. Application dates were: 1=31 Jul, 2=7 Aug, 3=14 Aug, 4=20 Aug, 5=26 Aug, 6=6 Sep, and 7=17 Sep. The last two applications were delayed by rainy weather. The first application was on date 1 for Taybelle and Table Ace and date 3 for the resistant cultivars.

[x] Numbers in each column with a letter in common or no letters are not significantly different according to Fisher's Protected LSD (*P* = 0.05).