SQUASH, WINTER (*Cucurbita moschata*)
Powdery mildew; *Podosphaera xanthii*

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Powdery mildew-resistant butternut-type winter squash cultivar evaluation, 2008.

The goal of this study was to determine whether hybrids with homozygous resistance, e.g. two copies of the powdery mildew resistance gene (PMRR), provide better suppression of powdery mildew than cultivars with heterozygous resistance (PMR). In order to have good comparisons, PMR and PMRR experimental hybrids were obtained from 2 plant breeders. A susceptible hybrid was also obtained from one of these breeders. Three additional PMRR hybrids were obtained from another source. A field experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead on Haven loam soil. Fertilizer (N-P-K 10-10-10) at 500 lb/A was broadcast and incorporated on 5 May. Black plastic mulch and drip tape were laid on 6 May. Most seeds were sown on 28 May in the greenhouse. The NH experimental hybrids were seeded on 5 Jun. Prior to transplanting, pre and post-emergent weed control between the plastic mulch was achieved by roto-tilling on 29 May and then applying Strategy (3 pt/A) on 30 May followed by overhead irrigation (about 0.5 in.) on 31 May to activate the herbicide. Seedlings were transplanted into the plastic-covered beds on 12 Jun. Water was provided as needed through drip irrigation lines located beneath the mulch. Additional fertilizer (N-P-K 46-0-0) at 30 lb/A was injected through the drip irrigation system on 2 and 17 Jul. Weeds were controlled during the season by hand weeding and by applying Roundup WeatherMax (3%) + Scythe (1%) + Succeed (1%) on 27 Jun with a hand-held shielded sprayer to soil between plastic and Select 2E (8 oz/A) with 1% COC on 8 Aug. Cucumber beetles were managed with Admire 2F applied after transplanting as a soil drench around transplants (0.0007 fl oz/plant) on 24 Jun and with Asana XL (9.6 oz/A) applied to foliage on 13 Jun, 30 Jul, and 14 Aug. No fungicides were applied specifically for powdery mildew. The following fungicides were applied preventively for downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): Curzate 60 DF (3.2 oz/A) on 30 Jul and Ranman 400 SC (2.75 fl oz/A) on 19 Jul and 14, 23, and 30 Aug. Plots were three adjacent rows each with three plants spaced 24-in. apart. Rows were spaced 68 in. apart. A single plant of Multipik summer squash, a susceptible variety, was planted between each plot in each row to separate plots and provide a source of inoculum. A randomized complete block design with four replications was used. Upper and lower leaf surfaces were assessed for powdery mildew on 15 Jul, 25 Jul, 29 Jul, 8 Aug, and 15 Aug. Initially 50 old leaves were selected in each plot based on leaf appearance and position in the canopy. Beginning on 29 Jul the quantity examined in each plot was adjusted based on the incidence of symptomatic leaves. Mid-aged and young leaves were also assessed on 15 Aug. Powdery mildew colonies (spots) were counted; severity was estimated when colonies had coalesced or were too numerous to count. Colony counts were converted to severity values using the conversion factor of 30 colonies/leaf = 1%. Average severity for the entire canopy was calculated from the individual leaf assessments. These canopy severity values were used to calculate area under disease progress curves (AUDPC) to obtain a measure of severity from 29 Jul through 15 Aug. Powdery mildew control was calculated for upper and lower leaf surfaces using AUDPC values relative to the average AUDPC value for the susceptible hybrid. Squash fruit were harvested, weighed, and measured on 9 and 16 Sep. Two representative fruit per plot were selected for measuring fruit width, fruit length, and cavity width and for assessing sugar content, which was done with a hand-held refractometer using fruit samples that were frozen and then thawed. Fruit characteristics were also evaluated and overall appearance was rated on a scale of 1 to 5 with 1= poor and 5 = best. Average monthly high and low temperatures (^{o}F) were 80/63 in Jun, 84/67 in Jul, 79/63 in Aug, and 75/61 in Sep. Rainfall (in.) was 3.88, 3.67, 3.76, and 8.34 for these months, respectively.

Powdery mildew symptoms were first seen on 25 Jul, 43 days after transplanting. At the last assessment on 15 Aug, powdery mildew was at a low severity on the susceptible hybrid (average of 4% and 9% of upper and lower leaf surfaces covered with symptoms). Powdery mildew was significantly more severe on the susceptible hybrid compared to the resistant hybrids at most assessments. There were no significant differences in powdery mildew severity among the PMR and PMRR hybrids in the two sets of experimental hybrids. Among the three WSXP hybrids, the one with the greatest severity values, WSXP1036, had significantly more powdery mildew on lower leaf surfaces based on AUDPC values than 3 of the 4 other PMRR hybrids and also 1 of the 2 PMR hybrids. Based on these results, butternut hybrids with one gene for resistance provide adequate suppression, equivalent to that obtained by hybrids with two genes, and PMRR hybrids can vary in the degree of suppression possibly reflecting modifier genes. The hybrids provided 38% to 78% suppression of powdery mildew on upper leaf surfaces and 46% to 92% suppression on lower leaf surfaces. Greater suppression of powdery mildew on lower leaf surfaces is highly desirable because this disease develops best on this surface where control with fungicides can be compromised by resistance to mobile products. JWS 61079 produced significantly more fruit by weight than the others, but it was the only entry with fruit characteristic ratings below 4.

Experimental hybrid (resistance)	Powdery mildew severity (%) [z]								Marketable fruit					
	Upper leaf surface				Lower leaf surface									
	8-Aug		AUDPC		8-Aug		AUDPC		Number/ plant		Weight/ plant (lb)		Weight/ fruit (lb)	
WSXP1035 (PMRR)	0.49	bc [y]	8.1	b	0.43	c	11.9	cd	2.78	bc	6.06	bc	2.21	cd
WSXP1037 (PMRR)	0.58	bc	11.6	b	1.59	bc	34.5	bc	3.39	b	7.17	b	2.16	d
WSXP1036 (PMRR)	1.18	b	16.4	ab	4.28	b	39.4	b	2.81	bc	6.53	bc	2.34	cd
JWS 61079 (PMRR)	0.55	bc	6.5	b	0.21	c	9.7	cd	3.67	b	11.88	a	3.24	a
JWS 61019 (PMRR)	0.72	bc	14.5	ab	0.50	c	15.3	bcd	2.81	bc	7.48	b	2.68	bc
JWS 6823 (PMR)	0.27	c	10.8	b	0.47	c	23.5	bcd	4.97	a	7.62	b	1.53	e
NH1517 F1 (PMRR)	0.20	c	6.7	b	0.23	c	7.6	d	1.56	d	4.16	cd	2.90	ab
NH1503 F1 (PMR)	0.22	c	5.7	b	0.15	c	6.2	d	2.65	bcd	7.84	b	2.93	ab
JWS 6238c (susceptible)	3.84	a	26.5	a	11.69	a	73.5	a	1.81	cd	3.08	d	1.63	e
P-value	< .0001		0.0487		< .0001		0.0012		0.0002		< .0001		< .0001	

[z] Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1%. Data were transformed from percentages by a square root transformation when needed to obtain normality of variance before analysis of variance was performed. The table has de-transformed means. Only older leaves were assessed on 8 Aug. AUDPC values were calculated for canopy severity, which included assessments of young and mid-aged leaves examined on 15 Aug.

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