SQUASH, ZUCCHINI (*Cucurbita pepo* 'Payroll' and 'Spineless Beauty')
Powdery mildew; *Podosphaera xanthii*

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Evaluation of an integrated management program with fungicides and a resistant cultivar for managing powdery mildew in zucchini squash, 2007.

The goal of this study was to determine if powdery mildew could be effectively managed in zucchini using a resistant cultivar treated with fungicides as needed based on disease occurrence. The threshold for this IPM program was one affected leaf out of 50. This program was compared to another fungicide program using a reduced fungicide program (14-day spray interval) on a resistant cultivar (Payroll), which was effective in previous experiments. An integrated management program with fungicides applied to a resistant cultivar is recommended for managing powdery mildew in cucurbit crops in order to ensure effective control and to manage pathogen evolution to overcome either management tool. A field experiment was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, on Haven loam soil. Fertilizer (N-P-K 10-10-10) at 1000 lb/A was broadcast and incorporated on 11 May. Plants were established by hand-seeding on 19 Jun into black plastic mulch with drip tape. Two seeds were placed per hole, and thinned to 1 plant on 27 Jun. Water was provided as needed through drip irrigation lines placed beneath the mulch. During the season weeds were controlled with a clover living mulch broadcast seeded between plastic mulch on 25 May, hand weeding, and mowing. Cucumber beetles were managed with Admire 2F applied after seedlings were established as a soil drench around seedlings (0.02 ml/plant) on 30 Jun and with Asana XL 9.6 oz/A applied to foliage on 16 Jul. No fungicides were applied specifically for powdery mildew. 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, 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 29 Aug. Both diseases were effectively controlled. Plots were three adjacent rows each with five plants spaced 24 in apart. Rows were spaced 68 in apart. There was a 13-ft unplanted buffer between plots. A randomized complete block design with four replications was used. Powdery mildew develops every year in the experiment location, therefore inoculation was not needed. Several other near-by experiments on powdery mildew ensured there was ample inoculum. The fungicide program was Pristine (18.5 oz/A) plus Microthiol Disperss (4 lb/A) alternated with Procure 480SC (8 fl oz/A) plus Silwet (2 fl oz/A) plus Microthiol Disperss (4 lb/A). Pristine and Procure are the currently recommended mobile fungicides for cucurbit powdery mildew. Fungicides were applied with a tractor-mounted boom sprayer from 27 Jul through 14 Sep, for a total of 8 applications for the weekly spray programs. Sprayer was equipped with D5-25 hollow cone nozzles spaced 17 inches apart that delivered 86 gal/A at 100 psi. Symptoms were observed every week, thus for the second program fungicides were applied every 7 days. Upper and lower surfaces of leaves were assessed for powdery mildew beginning on 26 Jul. Depending on incidence of affected leaves, 15 to 50 old leaves were selected on 26 Jul, 3 Aug, and 8 Aug in each plot. On 14 Aug old and mid-aged leaves were assessed. Leaves for each age category were selected based on leaf appearance and position in the canopy. Young leaves were also assessed on 24 Aug. Powdery mildew colonies (spots) were counted; severity was assessed when colonies could not be counted accurately because they had coalesced and/or were too numerous. 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 (AUDPC) to obtain a measure of severity over the entire assessment period. Powdery mildew control was calculated using AUDPC values relative to the nontreated susceptible cultivar. Powdery mildew severity was assessed on petioles and on the main plant stem on 15 Aug and 14 Sep. Fruit were harvested as they reached marketable size 14 times from 1 Aug through 18 Sep. Marketable and unmarketable (mostly over-sized) fruit were removed, counted and weighed. Average monthly high and low temperatures (^{o}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.

The resistant cultivar in this experiment did not provide the level of control that was observed in 2006 in a cultivar evaluation experiment, suggesting that the pathogen has already evolved to overcome genetic resistance. Powdery mildew severity exceeded threshold each week, thus fungicides were applied every 7 days for the IPM fungicide schedule. Nontreated Payroll was significantly less severely affected by powdery mildew than nontreated Spineless Beauty on 8 and 14 Aug, but these two treatments did not differ significantly on 24 and 30 Aug (only 14 Aug data included in table). Powdery mildew had become quite severe by 30 Aug when average severity on both leaf surfaces exceeded 50% for plants of both varieties that were not treated with fungicides. Based on AUDPC values, Payroll provided some suppression of mildew on lower leaf surfaces (18% control). Consequently, the integrated program with fungicides applied every 7 days to Payroll was more effective than applying fungicides every 7 days to the susceptible cultivar (68% versus 31% control), and resulted in 3.3 more marketable fruit/plant. Applying fungicides every 14 days to Payroll resulted in control on lower leaf surfaces equivalent to that achieved with fungicides applied every 7 days to Spineless Beauty (37%). Control on upper leaf surfaces was not as effective with the 14-day spray program. The resistant cultivar and the fungicide programs were providing excellent control of powdery mildew on leaf petioles and on the main stem of the plant early in disease development based on the 15 Aug assessment, when severity was 45% and 26%, respectively, on nontreated Spineless Beauty and less than 6% and 1% for the other treatments (data not presented). One month later (14 Sep) the resistant cultivar was providing limited suppression while the 7-day fungicide program was still performing well. Total number of fruit produced per plant was greater for Payroll than Spineless Beauty. For both cultivars, plants treated with fungicides produced significantly more fruit based on total weight than non-treated plants, and nontreated Spineless Beauty produced the lowest number of fruit, documenting the benefit of controlling powdery mildew.

Cultivar	Fungicide application interval [y]	Powdery mildew severity (%) [z]					Yield/plant	
		Upper leaf surface		Lower leaf surface		Leaf petiole	Total	Total
		14-Aug	AUDPC	14-Aug	AUDPC	14-Sep	number	weight (lb)
Payroll	7-day ……	0.2 c [x]	34 c	2.2 c	124 d	5.9 b	24.0 a	24.0 a
Payroll	14-day ……..	0.1 c	358 b	1.0 c	468 c	17.8 b	20.1 b	20.5 b
Payroll	Nontreated …..	22.4 b	685 a	24.1 b	800 bc	48.3 a	20.5 ab	20.1 b
Spineless Beauty	7-day ……	0.5 c	69 c	17.5 b	563 bc	6.7 b	19.5 bc	24.3 a
Spineless Beauty	Nontreated …..	32.0 a	919 a	53.9 a	1194 a	61.6 a	16.4 c	18.3 b
P-value		< .0001	<.0001	< .0001	<.0001	< .0001	0.0087	0.0054

[z] Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1%. AUDPC was calculated for 26 Jul to 30 Aug.

[y] The fungicide program was Pristine (18.5 oz/A) plus Microthiol Disperss (4 lb/A) alternated with Procure (8 fl oz/A) plus Microthiol Disperss (4 lb/A).

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