

Evaluation of biofungicides used with compost tea for managing powdery mildew of pumpkin, 2004.

A field experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead, NY, on Haven loam soil to evaluate foliar treatments for managing powdery mildew in organically-produced pumpkin. Products tested included the biofungicides Sonata (*Bacillus pumilus*) and Serenade (*Bacillus subtilis*), copper hydroxide formulated as Champion, and mineral oil formulated as JMS Stylet-oil. All are registered for use in the US. All but Sonata have been approved by OMRI for organic production. A conventional fungicide program was included for comparison. All treatments were evaluated on pumpkin variety Appalachian. Compost tea was also tested on powdery mildew resistant (PMR) Hobbit. Pumpkins were grown in black plastic mulch with a clover living mulch between the rows of plastic. Fertilizer (N-P-K 10-10-10) at 1000 lb/A was broadcast and incorporated on 7 May. Black plastic mulch and drip irrigation were laid on 12 May. Dutch white clover (11 lb/A) was drilled at 7-in. row spacing in the driveways between plots on 12 May and seed was hand-spun on 14 May over the approximately 32-inch-wide bare soil strips between the plastic strips after smoothing the soil with a rototiller. Weeds were managed by applying the herbicides Sandea (0.5 oz/A) on 4 Jun and Round-up Ultra (1.5 qt/A) on 24 Jun, mowing before transplanting, and hand-removal. Seeding was done in the greenhouse on 27 May. Seedlings were transplanted with starter fertilizer (20-20-20) at 24-in. plant spacing and 68-in. row spacing on 25 Jun. A randomized complete block design with four replications was used. Plots were 3 rows of 4 plants each. There was 10 ft between plots. To manage *Phytophthora* fruit and crown rot (*Phytophthora capsici*), the low end of the field with poor drainage was not planted. Ridomil Gold EC (1 pt/A) was broadcast over the entire field then incorporated on 7 May, and Phostrol (5 pt/A) was applied on 12 Aug, 25 Aug, 4 Sep, and 17 Sep. Downy mildew was managed by applying Ridomil Gold (1/4 pt/A) with Phostrol on 12 and 25 Aug, Curzate (3.2 oz/A) on 14 Aug, 4 Sep, and 12 Sep, and Acrobat 50 WP (6.4 oz/A) on 20 Aug, 7 Sep and 14 Sep. These fungicides were selected because they were not expected to affect powdery mildew. Applications of Ridomil and Acrobat also may have been beneficial for managing *P. capsici*. The field was irrigated when irrometer readings indicated soil was dry due to inadequate rainfall. Average monthly high and low temperatures (F) were 72/51 in May, 77/59 in Jun, 82/65 in Jul, 82/66 in Aug, 78/60 in Sep, and 64/49 in Oct. Rainfall (in.) was 2.96, 0.88, 3.33, 3.94, 6.97, and 2.04 for these months, respectively. Compost tea was applied separately from the other treatments beginning 16 Jul, before powdery mildew was observed. Fungal-based compost (4 lb dairy manure-based vermicompost and 4 lb leaf-based compost) was brewed with 12 oz Fertrell Liquid Kelp, 4 oz fish hydrolysate (Organic Gem Liquid Fish 3-3-3 or Neptune's Harvest Benefits of Fish 2-4-1), and 16 oz humic acid (Fertrell Bio-Hume) for about 24 hour in a 60-gal Sotillo brewer. Compost tea was filtered, Nu-Film-P (6 oz/A) and fish hydrolysate (1 oz/30 gal) were added, then it was applied undiluted to foliage on 16, 23, and 29 Jul; 4, 11, 17, and 25 Aug; and 1 and 8 Sep. To minimize potential damage to microbes in the compost tea, it was applied at low pressure (40 psi) using a nozzle with a large orifice that causes little resistance (FloodJet). Most applications were made before 10 am. Samples of the leaf-based compost, tea, and leaves were submitted to the Soil Foodweb Laboratory in Port Jefferson, NY, for analysis of the organism biomass content. Compost samples were submitted on 28 Apr and 8 Sep. Samples of the tea were collected on 8 Sep from the brewer and from the spray nozzle attached to the boom of a CO₂ backpack sprayer. The two samples were collected to determine if the spray nozzle had a detrimental impact on the microbes. Leaves were collected before and after tea was applied on 8 Sep to assess the delivery and deposition of microbes. Fungicide treatments were started after the IPM threshold of one leaf with powdery mildew symptoms of 50 old leaves examined was reached in most plots (27 Jul). Treatments were applied weekly with a tractor-mounted boom sprayer equipped with D5-25 hollow cone nozzles spaced 17 in. apart that delivered 85 gal/A at 100 psi. Upper and lower surfaces of 5 to 50 leaves in each plot were examined weekly for powdery mildew beginning when fruit were starting to enlarge. Initially, 50 older leaves were examined in each plot. The examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed, mid-aged and young leaves were also examined and the number of leaves examined was adjusted based on the incidence of affected leaves in a plot. 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. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Canopy condition was assessed on 1 and 9 Sep. Number of plants that appeared dead and quality of fruit handles were assessed on 15, 22, and 30 Sep and 6 Oct. Yield was determined on 1 Oct by measuring length and width of all mature fruit. Weight was estimated for these fruit using a regression equation developed by measuring and weighing at least 17 representative fruit of each cultivar.

Powdery mildew was first observed on 26 Jul in 19 of 36 plots of susceptible Appalachian on only 71 of the 1800 older leaves examined. Symptoms also were found at that time in 1 of 8 plots (4 of 400 leaves) of PMR Hobbit. Powdery mildew became moderately severe. Neither Sonata nor compost tea suppressed powdery mildew when used alone. Compost tea also did not significantly improve control achieved with the PMR variety. Based on the analysis of tea prepared on 9 Sep, fungal activity was low (0.91 and 0.45 ppm for tea from brewer and nozzle, respectively) while active bacterial biomass was in a good range (16 and 54.4 ppm, respectively), thus the tea is considered bacterial with good fungal biomass. The leaf-based compost had very high fungal activity before the experiment was started (99.8 ppm on 28 Apr); it was only 36.8 ppm on 8 Sep. Active bacterial biomass increased from 47.8 ppm in Apr to 69.4 ppm in Sep. The leaf organism assay revealed that leaf coverage with bacteria and fungi was inadequate on leaves collected immediately before tea application. Leaves collected about 1 hour after tea was applied were 61% covered by bacteria and 5% covered by fungi, which is considered adequate. A tea with more fungal activity may be needed to suppress powdery mildew. Effective control with compost tea may necessitate modifying application timing, such as applying late in the day and/or starting earlier in crop development, perhaps including a seed treatment. Compared to nontreated pumpkins, powdery mildew was significantly less severe on pumpkins treated with both compost tea and either Sonata, Serenade, or JMS Stylet-oil. Based on AUDPC values, level of control was 50-71% on upper leaf surfaces and 47-57% on lower leaf surfaces. Champion was as effective as the standard program of Quintec + sulfur (Microthiol Dispers) alternated with Procure + Bravo. Control was 84% and 88%, respectively, on upper leaf surfaces based on AUDPC values and 65% and 80% on lower leaf surfaces. Sonata applied with Champion did not improve control over that obtained with Champion alone. The four treatments providing the best control of powdery mildew (both treatments with the PMR cultivar, standard program, and Champion) had less defoliation, fewer dead plants, and more fruit with solid handles on all assessment dates (select data shown). On 6 Oct, there were 1-2.25 dead plants for these treatments and 2.5-5.5 for the other treatments. There were no significant differences in average fruit weight among treatments for each cultivar (data not shown), which were 4.7 lb for nontreated Hobbit, 7.3 lb for compost tea-treated Hobbit, and ranged for Appalachian from 12.1 lb for nontreated to 14.2 lb for Sonata + Champion treated plants. Among treatments tested on Appalachian,

average weight of fruit exceeded 15 lb/plant (data not shown) for the 3 with the lowest AUDPC values: standard program, Champion, and Sonata + Champion. No phytotoxicity was observed.

Cultivar, treatments, rate/A (application time) ^y	Powdery mildew severity (% leaf coverage) ^z						Defolia- tion (%)	% Solid handles
	Upper leaf surface			Lower leaf surface				
	9 Aug	23 Aug	AUDPC	9 Aug	23 Aug	AUDPC		
Hobbit								
Nontreated control	0.48 cde ^x	4.0 cd	37 de	0.68 bc	7.2 def	48 ef	26 de	90 a
Compost tea ^w	0.51 cde	1.8 d	28 de	0.63 bc	3.1 f	32 f	24 de	87 a
Appalachian								
Nontreated control	6.10 a	14.4 a	206 a	7.13 a	26.9 a	340 a	55 a	34 f
Microthiol Disperss 80W 4 lb (1,3,5,7), Quintec 4 fl oz (3,5), Procure 50WS 6 oz + Bravo Ultrex 82.5WG (2,4,6).....	0.21 cde	0.8 d	26 e	0.33 c	4.0 ef	67 def	4 f	82 ab
Champion WP 2 lb (1-7)	0.05 de	1.9 d	32 de	1.04 bc	13.8 cde	117 cde	11 ef	74 abc
Sonata AS 2 qt (1-7)	3.50 ab	11.2 ab	185 ab	6.94 a	23.2 abc	338 a	45 abc	48 def
Sonata AS 2 qt + Champion WP 2 lb (1-7)	0.04 e	2.5 d	32 de	0.98 bc	14.7 bcd	99 cdef	13 ef	77 abc
Compost tea ^w	5.05 a	10.2 abc	183 ab	7.36 a	26.0 a	295 ab	48 ab	45 ef
Compost tea ^w + Serenade AS 4 qt (1-7)	1.42 bcd	11.9 a	104 bc	2.18 abc	25.0 ab	180 bc	33 bcd	59 cde
Compost tea ^w + Sonata AS 2 qt (1-7)	1.57 bc	4.4 bcd	80 cd	3.85 ab	15.4 bcd	148 cd	29 cde	67 bcd
Compost tea ^w + JMS Stylet-oil 1.5% (1-7)	0.42 cde	2.5 d	59 cde	0.67 bc	18.7 abc	169 bc	40 abcd	54 de
P value	0.0001	0.0002	0.0001	0.0033	0.0001	0.0001	0.0001	0.0001

^z Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf = 1%. Area under the disease progress curve (AUDPC) was calculated for severity from 26 Jul through 23 Aug.

^y Rate of formulated product/A. Application times were: 1=27 Jul, 2=4 Aug, 3=11 Aug, 4=18 Aug, 5=24 Aug, 6=30 Aug, and 7=6 Sep.

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

^w Compost tea was applied undiluted with Nu-Film-P (6 oz/A) at 85 gal/A 9 times from 16 Jul to 8 Sep.