SQUASH, ACORN (*Cucurbita pepo* 'Royal Ace PM')
Phytophthora blight; *Phytophthora capsici*

M. T. McGrath and K. A. LaMarsh
Plant Pathology & Plant-Microbe Biology Section
SIPS, Cornell University, LIHREC
3059 Sound Avenue, Riverhead, NY 11901

Evaluation of biopesticides for managing Phytophthora blight in cucurbits, 2014.

The objective of this study was to evaluate the efficacy of EPA-classified biopesticides used in combination treatment schedules with applications to soil and foliage. Products tested are at the demonstration (labeled) level of development for Phytophthora blight in cucurbits. All are approved for organic production. Some treatments included foliar applications of a copper fungicide approved for organic production. One treatment included oomycete-targeted fungicides for conventional production. These treatments were compared to a non-treated control, a conventional 'standard' treatment with oomycete-targeted fungicides applied to foliage, and an organic 'standard' treatment with copper fungicide applied to foliage. The experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead, NY, in a field with Haven loam soil where Phytophthora blight has developed most years since 1994. Phytophthora blight was severe and occurred throughout the field in 2011 when conditions were very favorable for the pathogen. A parallel experiment was conducted on pepper adjacent to the experiment with squash. The same treatments were applied to pepper and squash in the two experiments at the same time with the exception that pepper received transplant treatments. Squash seeds were sown 4 Jun in the greenhouse. A few days before transplanting, herbicides Curbit EC (1 pt/A) and Sandea (0.5 oz/A) were applied to the experiment area. Controlled release fertilizer (N-P-K, 19-9-12 with 60% ESN slow release nitrogen) at 675 lb/A was spread over the rows to be planted. Seedlings were transplanted on 1 Jul by hand into holes opened in the bare-ground by a waterwheel transplanter that also placed in the holes a starter fertilizer, 20-20-20 Nutri-Leaf. Plants were irrigated using drip tape laid on the soil surface running down the length of the row next to the plant main stem. During the season, weeds in the plots were controlled by hand weeding while weeds between rows were mowed. Cucumber beetles were managed by applying the insecticide Admire Pro (2.8 fl oz/1000 ft) in a narrow band over the planted rows immediately after the herbicide application on 30 Jun. Powdery mildew was managed by selecting a resistant variety and routinely applying fungicides with targeted activity for this disease, alternating among Quintec, Torino and Procure. Insects were managed by applying Mustang Maxx (4 fl oz/A) on18 Jun and Assail 30SG (4 oz /A) on 30 Jul. A completely randomized block design with four replications was used. Plots consisted of 8 plants in a single row at 68-in row spacing. There was 4-ft spacing between plots in a row. Some biopesticides were applied to plants before and/or after transplanting following treatment protocol. Pre-transplant treatments were drenches to seedling trays done on 30 Jun. Additional soil applications were made along the rows directed at the base of the plants on 2, 10, 17, and 23 Jul. They were applied using a CO_2-pressurized backpack sprayer with a boom equipped with a single Twin-jet nozzle (TJ60-11003) delivering 57 gal/A at 54 psi. Drip irrigation was run after each soil application to incorporate. Foliar applications also were made with a backpack sprayer using Twin-jet nozzle(s) delivering 50 gal/A operated at 54 psi and 2.4 mph. A boom with a single TJ60-8006vs nozzle was used when squash plants were small. A boom with a nozzle delivering spray over the top of the plant plus two drop nozzles (all TJ60-8006vs) was used when squash plants were larger. Plants and their fruit were examined every one to two weeks for disease symptoms. Proportion of plant canopy affected by blight was estimated. Percent of fruit affected was estimated until the last assessment when all fruit were examined. Due to very limited disease development through early Aug, a piece of infected zucchini fruit was placed in the center of each plot before predicted rain on 11 and 19 Aug. Average monthly high and low temperatures (°F) were 79/60 in Jun, 82/67 in Jul, 81/64 in Aug, 77/61 in Sep, and 66/53 in Oct. Rainfall (inches) was 2.47, 2.24, 2.42, 1.86, and 5.43 for these months, respectively.

Conditions were not favorable for Phytophthora blight during most of the growing season due to limited rainfall, with less than 2.5 inches falling in Jul, Aug and Sep. Rainfall exceeded 1 inch on two days in Jul and Aug: 1 inch on 15 July and 1.8 inches on 13 Aug. Symptoms were first observed on 29 Jul. Disease development was slow initially. Symptoms were found in only four plots on 12 Aug. Many plants died due to blight following inoculation on 11 Aug and an intensive rainstorm on 13 Aug. None of the treatments were effective based on proportion of foliar tissue affected or percentage of fruit affected. Least amount of symptoms numerically were in plots treated with Serenade Soil post-transplant followed by weekly foliar applications of Revus alternated with Presidio. The next best treatment numerically was the same without Serenade Soil. The inoculation procedure combined with an intense rain event may have created disease pressure sufficiently high to overwhelm chemical control.

Treatment and Rate/A (application dates)[y]	Phytophthora blight canopy severity (%)[z]				Affected fruit (%)[z]	
	19 Aug	2 Sep	15 Sep	AUDPC[x]	9 Sep	15 Sep
Untreated control	2.5	38.1	88.1	1122.3 ab	14.7	20.7
Double Nickel 2 qt/100 gal (2,5) Cueva 2 qt (6-12)	4.9	30.5	73.6	826.6 ab	17.3	17.4
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Double Nickel 2 qt (6-12)	7.0	37.9	72.4	1024.0 ab	12.4	20.3
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Cueva 2 qt (6-12)	0.8	41.2	80.7	1024.0 ab	22.9	16.9
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Regalia 1 qt (6-12)	10.0	47.4	83.3	1207.6 ab	37.5	23.7
Regalia 2 qt/100 gal (1,4) Regalia 2 qt (6-12) + Cueva 2 qt (6-12)	9.4	51.4	90.3	1369.0 a	25.9	16.1
Regalia 2 qt/100 gal (1,4) Serenade Soil 6 qt (2) Regalia 2 qt (6-12) + Cueva, 2 qt (6-12)	13.8	51.3	86.6	1387.6 a	23.4	26.2
Regalia 2 qt/100 gal (1,4) Regalia 2 qt (6,8,10,12) + Revus[w] 8 fl oz (6,8,10,12) Alt w/ Actinovate 6 oz (7,9,11) + Presidio 4 fl oz (7,9,11)	5.0	19.1	70.3	826.6 ab	10.1	12.6
Serenade Soil 6 qt/100 gal (2) Cueva 2 qt (6-12)	5.5	36.4	89.1	1156.0 ab	15.9	18.3
Serenade Soil 6 qt/100 gal (2) Revus[w] 8 fl oz (6,8,10,12) Alt w/ Presidio 4 fl oz (7,9,11)	0.1	6.3	66.7	529.0 b	5.7	5.3
Cueva 2 qt (6-12)	3.8	33.1	76.4	961.0 ab	17.1	13.0
Revus[w] 8 fl oz (6,8,10,12) Alt w/ Presidio 4 fl oz (7,9,11)	0.1	24.3	64.4	756.3 ab	9.4	9.5
P-value	*0.5532*	*0.0606*	*0.0877*	*0.0230*	*0.2762*	*0.2864*

[z] Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, P=0.05).

[y] Rate of formulated product/A except where noted otherwise. Soil drench treatment was applied to transplants in trays on 1=30 Jun. Directed spray at base of plants was done on 2=7/3, 3=7/10, 4=7/17, and 5=7/23. Drip irrigation was run afterwards to mimic chemigation application through drip. Foliar application dates were 6=7/23, 7=7/29, 8=8/6, 9=8/14, 10=8/20, 11=8/27, and 12=9/4.

[x] AUDPC values were square root transformed before analysis. Table contains de-transformed values.

[w] Revus applied w/ Induce 0.25 % v/v .