

### **Evaluation of biopesticides for managing Phytophthora blight in pepper, 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 labeled for Phytophthora blight in pepper and 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. Pepper seeds were sown on 23 May in the greenhouse. A few days before transplanting, herbicide Devrinol DF-XT at 4 lb/A was applied to the entire 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. Herbicide and fertilizer were incorporated by cultivation. 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. Cutworms were managed by applying Mustang Maxx (4 fl oz/A) on 18 Jun. During the season, weeds in the plots were controlled by hand weeding while weeds between rows were mowed. A completely randomized block design with four replications was used. Plots consisted of 12 plants in a single row with 15-in. plant spacing and 68-in. row spacing. There was 3-ft spacing between plots in a row. Some biopesticides were applied to plants before and/or after transplanting for some treatments. 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. Applications were made using a CO<sub>2</sub>-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 pepper 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 pepper plants were larger. Plants and their fruit were examined every one to two weeks for disease symptoms. Due to very limited disease development through early Aug, a piece of infected zucchini fruit was placed in the center of each plot on 11 Aug before predicted rain. 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 of rain per month falling in Jul, Aug and Sep. Rainfall was at least 1 inch on only 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 ten plots on 12 Aug. Many plants died due to blight following inoculation on 11 Aug and an intense rainstorm on 13 Aug. Control was achieved with two of the three treatments that included an alternation of the conventional fungicides, Revus and Presidio. No dead plants were observed in these treatments on 19 Aug. While effective, 35 and 42% of plants were dead at the last assessment (9 Sep) versus 88% of untreated control plants. Control obtained with these foliar fungicides was not improved by adding soil drench or foliar applications of biopesticides. Similar results were obtained in an adjacent, parallel experiment on acorn winter squash with the same foliar treatments (PDMR 9:V028). Phytophthora blight was effectively controlled in pumpkin (2.3% fruit affected on 9 Oct) by applying the same and additional oomycete fungicides weekly in a nearby research field (PDMR 9:V030).

Treatment and Rate/A (application dates) <sup>y</sup>	Phytophthora blight incidence (% plants dead) <sup>z</sup>				
	19 Aug	26 Aug	2 Sep	9 Sep	AUDPC <sup>x</sup>
Untreated control	7.5	42.5	80.0 a	87.5 ab	1089.0 ab
Double Nickel 2 qt/100 gal (2,5) Cueva 2 qt (6-12)	12.5	37.5	82.5 a	92.5 a	1139.1 ab
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Double Nickel 2 qt (6-12)	17.5	52.5	75.0 abc	95.0 a	1190.3 a
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Cueva 2 qt (6-12)	20.0	45.0	77.5 ab	85.0 ab	1173.1 ab
Actinovate 6 oz/100 gal (1,3) Actinovate 6 oz (5-12) Regalia 1 qt (6-12)	17.5	35.0	82.5 a	87.5 ab	1122.3 ab
Regalia 2 qt/100 gal (1,4) Regalia 2 qt (6-12) + Cueva 2 qt (6-12)	17.5	35.0	65.0 abc	87.5 ab	1008.1 abc
Regalia 2 qt/100 gal (1,4) Serenade Soil 6 qt (2) Regalia 2 qt (6-12) + Cueva, 2 qt (6-12)	22.5	32.5	77.5 ab	90.0 ab	1105.6 ab
Regalia 2 qt/100 gal (1,4) Regalia 2 qt (6,8,10,12) + Revus <sup>w</sup> 8 fl oz (6,8,10,12) Alt w/ Actinovate 6 oz (7,9,11) + Presidio 4 fl oz (7,9,11)	2.5	7.5	35.0 abc	55.0 abc	400.0 abc
Serenade Soil 6 qt/100 gal (2) Cueva 2 qt (6-12)	12.5	35.0	67.5 abc	80.0 abc	945.6 abc
Serenade Soil 6 qt/100 gal (2) Revus <sup>w</sup> 8 fl oz (6,8,10,12) Alt w/ Presidio 4 fl oz (7,9,11)	0.0	5.0	27.5 bc	35.0 c	324.0 bc
Cueva 2 qt (6-12)	12.5	40.0	62.5 abc	82.5 abc	945.6 abc
Revus <sup>w</sup> 8 fl oz (6,8,10,12) Alt w/ Presidio 4 fl oz (7,9,11)	0.0	10.0	25.0 c	42.5 bc	248.1 c
<i>P-value (treatment)</i>	<i>0.3207</i>	<i>0.0865</i>	<i>0.0004</i>	<i>0.0005</i>	<i>0.0005</i>

<sup>z</sup> Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD,  $P=0.05$ ).

<sup>y</sup> 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.

<sup>x</sup> AUDPC values were square root transformed before analysis. Table contains de-transformed values.

<sup>w</sup> Revus applied w/ Induce 0.25 % v/v .