

**Evaluation of organic and conventional biopesticides applied with organic coppers for downy mildew in sweet basil, 2020.**

An experiment with field-grown basil was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, in a field with Haven loam soil. A sweet basil cultivar bred to be resistant to downy mildew, Rutgers Passion DMR, was used. Organic products tested previously were ineffective when applied to susceptible and partially resistant cultivars (PDMR 9:V026 and 10:V033). Rutgers Passion DMR was selected because it exhibited good but not sufficient suppression of downy mildew in a cultivar evaluation in 2019 (PDMR 14:V071). LifeGard and Stargus are biopesticides acceptable for organic production (OMRI-listed). K-Phite is a conventional (synthetic) biopesticide. All three biopesticides induce host plant resistance. Actigard, a conventional plant activator, was included for comparison. All were tested tank-mixed with either Cueva (copper octanoate) or Kocide 3000-O (copper hydroxide); both are OMRI-listed. An alternation program with four organic fungicides was also evaluated. The field was mold-board plowed on 14 May. Controlled-release fertilizer (N-P-K, 19-10-9) was broadcast at 525 lb/A (101 lb/A N) over the bed area and incorporated on 1 Jul. Beds were formed with drip tape and covered with black plastic mulch on 1 Jul. Weeds between mulched beds were managed by applying Devrinol DF (4 lb/A) before transplanting, cultivating, covering the soil with landscape cloth, and by hand weeding. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer. Basil for the experiment was seeded in trays in a greenhouse on 11 Jun. All plants were placed outdoors to harden for a few days and then transplanted in the field by hand on 14 Jul. A late planting date was used to increase the likelihood of downy mildew developing during the experiment. The primary source of initial inoculum in this area is considered to be sporangia dispersed by wind from infected plants potentially a long distance away. A randomized complete block design with four replications was used. Each plot had 8 plants in 6-ft rows with 9-in. in-row plant spacing. The plots were 3 ft apart in the row. Fungicides were applied weekly, over a 9-week period, with a backpack CO<sub>2</sub>-pressurized sprayer and hand-held boom with TJ60-4004EVS nozzle(s) operated at 55 psi and 2.3 mph. Applications 1-4 were made using a boom with a single nozzle delivering 32 gal/A. Starting with application 5, plants were large enough to use a boom with two drop nozzles directed to the side of plants as well as a nozzle delivering spray over the top of the plant that delivered 73 gal/A. Downy mildew was assessed in each plot weekly from 31 Aug through 1 Oct. Incidence of plants with symptoms and signs (sporulation of the pathogen visible on the underside of leaves) was recorded and percentage of leaves per plant with symptoms was estimated for each plant in each plot. Area under disease progress curve (AUDPC) values were calculated from 31 Aug to 1 Oct using the formula:  $\sum_{i=1}^{n-1} [(R_{i+1} + R_i)/2] [t_{i+1} - t_i]$ , where R = disease incidence rating (% leaves with symptoms on affected plants) at the *i*th observation, *t*<sub>*i*</sub> = time (days) since the previous rating at the *i*th observation, and *n* = total number of observations. Data were analyzed with one-way analysis of variance and Tukey's honest significance test (HSD) to separate means using JMP statistical software. Average monthly high and low temperatures (°F) were respectively, 86.3 and 69.6 in Jul, 84.3 and 68.2 in Aug, and 75.7 and 60.9 in Sep. Rainfall for Jul, Aug, and Sept was 3.80, 3.33, and 2.70 in., respectively. Plants lost many leaves due to heavy wind from tropical storm Isaias on 4 Aug but recovered.

Symptoms of downy mildew were first observed at LIHREC on 17 Aug in an adjacent experiment. At the first and second assessments (31 Aug and 4 Sep), only 1% of leaves in untreated plots had symptoms (data not shown). All treatments had a significantly lower percentage of symptomatic leaves on affected plants than the control for the other four assessments (17-18 Sep data not shown). Based on AUDPC values, treatments were providing 63 – 88% control. All treatments had a numerically lower percentage of symptomatic plants than the control; this difference was statistically significant for K-Phite + Kocide and both treatments with Actigard. Based on both AUDPC values, Actigard or K-Phite applied with Kocide were more effective than Stargus + Cueva. Treatments with Kocide tended to have numerically lower AUDPC values than treatments with Cueva. The difference was only significant for AUDPC for incidence of affected leaves for the treatments with Stargus. No phytotoxicity was seen.

Treatment and Rate/A (application dates) <sup>y</sup>	Incidence of downy mildew <sup>z</sup>						
	Affected plants (%)			Affected leaves on affected plants (%)			
	31 Aug	4 Sep	AUDPC	11 Sep <sup>x</sup>	24 Sep <sup>wx</sup>	1 Oct	AUDPC <sup>x</sup>
Untreated	43.8 a	97 a	2970 a	5.6 a	15.9 a	16.0 a	274 a
Actigard 0.3 oz + Cueva 2 qt (1-9)	0.0 b	28 b	2178 bcd	0.6 b	1.7 c	3.3 b	39 c
K-Phite 7LP 0.6 qt + Cueva 2 qt (1-9)	0.0 b	50 ab	2442 abcd	0.6 b	1.7 c	3.3 b	40 c
LifeGard 2 oz + Cueva 2 qt (1-9)	0.0 b	50 ab	2564 abc	0.6 b	3.0 bc	5.0 b	60 bc
Stargus 4 qt + Cueva 2 qt (1-9)	15.6 b	66 ab	2742 ab	1.2 b	6.3 b	6.8 b	101 b
Actigard 0.3 oz + Kocide 3000-O 0.75 lb (1-9)	3.1 b	13 b	1948 d	0.5 b	1.5 c	2.6 b	36 c
K-Phite 0.6 qt + Kocide 3000-O 0.75 lb (1-9)	0.0 b	28 b	2138 cd	0.6 b	1.4 c	2.9 b	33 c
LifeGard 2 oz + Kocide 3000-O 0.75 lb (1-9)	13.4 b	55 ab	2617 abc	0.6 b	3.6 bc	5.3 b	59 bc
Stargus 4 qt + Kocide 3000-O 0.75 lb (1-9)	3.1 b	41 b	2446 abcd	0.6 b	1.7 c	4.5 b	40 c
Regalia 4 qt + Stargus 4 qt (1, 3, 5, 7, 9) alt							
EcoSwing 1 qt + Badge X2 0.75 lb (2, 4, 6, 8)	9.4 b	56 ab	2556 abc	0.6 b	3.0 bc	5.0 b	57 bc
<i>P</i> -value (treatment)	<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

<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. Application dates: 1=28 Jul, 2=3 Aug, 3=11 Aug, 4=18 Aug, 5=25 Aug, 6=1 Sep, 7=8 Sep, 8=15 Sep, 9=21 Sep.

<sup>x</sup> Values for these variables were square root transformed before analysis because raw data were not distributed normally. Table contains de-transformed values.

<sup>w</sup> Assessments done over 2 days.