

### **Efficacy of biopesticides for managing downy mildew in organically-produced cucumber, 2010.**

The objective of this study was to evaluate biopesticides using a cucumber cultivar that has exhibited relatively low susceptibility to downy mildew compared to other cultivars in cucumber evaluations conducted at North Carolina State University since 2005. This integrated approach was taken because downy mildew is considered a difficult disease to manage organically. K-Phite was the only biopesticide evaluated that is not approved for organic production. The biopesticides were compared to an organic standard treatment, the copper fungicide NuCop, and a conventional fungicide standard program of Manzate Pro-Stick during the vegetative period followed by Bravo Ultrex during the harvest period. The conventional fungicide program consisted of protectant (contact) products because most of the biopesticides evaluated also lack targeted activity and mobility. Most biopesticides were tested alone. Organocide was tested at a low label rate tank-mixed with NuCop at a low label rate. Organic production practices were used when feasible. A spring cover crop was grown for organic matter and nitrogen, as well as to keep the ground covered and protected until cucumbers were planted. The field was plowed and disked. Pro-Grow 5-3-4 organic fertilizer was spread at 1000 lb/A and incorporated. An oat plus spring pea cover crop was seeded on 8 Apr. The unusually hot and dry summer conditions resulted in the non-irrigated cover crop growing poorly and desiccating before it could be incorporated. It was chopped and then disked to incorporate on 23 Jul. SoilBuilder was applied and incorporated at 1 gal/A. Due to the condition of the cover crop when incorporated, it was assumed that it would provide an insignificant amount of nutrients. On 2 Aug Pro-Grow 5-3-4 fertilizer (500 lb/A) and peanut meal 8-1-2 fertilizer (625 lb/A) were spread over rows to be planted and incorporated by disking, then plastic mulch and drip tape were laid. A transplanter with a waterwheel was used to prepare holes for seeding, plus apply fertilizer in the process. Neptune's Harvest hydrolyzed fish emulsion fertilizer was used at 2 oz/gal. Cucumber was direct-seeded by hand on 13 Aug. Three seeds were placed in each hole and thinned to one plant once established. Each plot was a single, 27-ft row with 18 plants at 18-in. spacing. Plots within a row were spaced 9 ft apart. Rows were spaced 8.5 ft apart or 14.2 ft apart to accommodate driveways. A randomized complete block design with four replications was used. Two outbreaks of insect pests occurred during the experiment. Conventional insecticides were selected because of the perceived need for fast-acting chemistry considering the quantity of insects present when detected and potential impact on the experiment. Asana XL (9.6 fl oz/A) was applied for cucumber beetles on 18 Aug. Assail 30SG (2.5-4 oz/A) was applied for melon aphids on 22 Sep. Weeds were controlled between rows with a cultivator, and along the plastic edge with a hand-operated rototiller and by hoeing. A preventive, 7-day schedule was used for all treatments. Fungicides were applied for 6 weeks beginning on 25 Aug using a CO<sub>2</sub>-pressurized backpack sprayer equipped with a single-nozzle boom operated at 45 psi. A twinjet 8002E nozzle delivering 28 gal/A was used on 25 Aug, 1 Sep, and 8 Sep. An 8006E nozzle delivering 28 gal/A was used on 17, 22, and 30 Sep and 7 Oct. Rates were applied lower than intended on the first three dates due to a calculation error. Downy mildew severity was assessed by estimating incidence of symptomatic leaves and then rating average severity on the affected leaves. These measurements were used to estimate canopy severity. Assessments were done weekly. Area Under the Disease Progress Curve (AUDPC) was calculated for severity from 24 Sep through 13 Oct. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Yield data was not obtained due to the late onset of downy mildew and the impact on plant condition of aphids and storms with strong wind. Average monthly high and low temperatures (°F) were 87/70 in Jul, 83/67 in Aug, and 77/62 in Sep. Rainfall (in.) was 3.46, 2.02, and 2.87 for these months, respectively. Drip irrigation was used as needed to supplement rainfall.

Downy mildew began to develop on cucumbers on Long Island, NY, later in 2010 than in previous recent years. Environmental conditions were less favorable for pathogen dispersal and infection in the region due to the unusual dry conditions. Cloudy conditions with rain or high humidity are needed for successful pathogen dispersal and infection. Symptoms of downy mildew were first detected on Long Island in the cucumber sentinel plots at LIHREC for the downy mildew forecasting system on 7 Sep 2010. Symptoms were not observed in the experimental plots until 17 Sep. Rain fell on 8 days during September: 0.26 in. on 3 Sep, 0.77 in. on 4 Sep, 0.92 in. on 17 Sep, 0.03 in. on 23 Sep, 0.08 in. on 27 Sep, 0.36 in. on 28 Sep, 0.08 in. on 29 Sep, and 0.37 in. on 30 Sep. None of the treatments evaluated suppressed downy mildew to a detectable level compared to the non-treated control in this experiment, including the conventional fungicide treatment. Treatments are listed in the table based on AUDPC for canopy severity summed over the season with the exception of the non-treated control, which is listed first. Suppression did not occur as expected with the one integrated treatment consisting of a biopesticide (Actinovate) applied preventively then combined with mobile conventional fungicides (Previcur Flex and Ranman) that have targeted activity for downy mildew and have been documented to be highly effective in other evaluations. Lack of treatment effect likely is at least partly due to the fact downy mildew remained at a low level in this experiment due to environmental conditions. At the last assessment, only 28% of leaves had symptoms of downy mildew in the non-treated control, and severity on these leaves averaged only 13%. At two assessments the non-treated control had the highest values for downy mildew suggesting that many of the treatments tested were providing some suppression. Additionally, plants were damaged by high winds during storms and aphids.

Treatment (rate/A) (application dates) <sup>y</sup>	Downy mildew canopy severity (%) <sup>z</sup>				
	24-Sep	29-Sep	6-Oct	13-Oct	AUDPC
Nontreated.....	0.07	2.80	5.34	3.86 ab <sup>v</sup>	20.48 abc
Taegro (3.5 oz/100 gal) (1-5), Companion (1 gal) (6-7) .....	0.01	0.47	1.15	2.89 ab	58.55 a
Regalia (1% v/v) (1-7) .....	0.04	0.39	4.91	10.48 a	54.97 ab
Serenade MAX (3 lb) + Biolink 2 fl oz/gal (1-7) .....	0.07	0.65	0.28	6.92 ab	42.67 abc
K-Phite (2 qt) (1-7) .....	0.06	1.57	0.53	2.56 ab	37.44 abc
Sporatec AG (1 qt) + Biolink 2 fl oz/gal (1-7) .....	0.02	0.17	1.85	4.07 ab	27.82 abc
Companion (1 gal) (1-7) .....	0.12	2.67	1.35	3.64 ab	26.69 abc
Organocide (1 oz/gal) + NuCop HB (1.0 lb) (1-7) .....	0.11	0.21	1.46	3.61 ab	23.19 abc
Actinovate (12 oz) (1-7) .....	0.05	0.63	1.38	1.97 ab	22.43 abc
Sonata ASO (4 qt) + Biolink 2 fl oz/gal (1-7) .....	0.06	0.90	0.91	9.00 ab	19.05 abc
Timorex Gold (0.75% v/v) (1-7) .....	0.11	2.06	0.31	2.53 ab	18.30 abc
NuCop HB (2.0 lb) (organic standard) (1-7) .....	0.00	0.28	0.45	2.13 ab	11.07 abc
Actinovate (12 oz) (1-7) + conventional mobile fungicides (5-7) <sup>x</sup> ..	0.21	0.48	0.22	0.69 b	3.29 c
Manzate Pro-Stick 3 lb (1-3), Bravo Ultrex 1.8 lb (4-7) <sup>w</sup> .....	0.00	0.09	0.09	0.73 b	6.04 abc
<i>P</i> -value (treatment)	0.2658	0.0710	0.2346	0.0175	0.0076

<sup>z</sup> Percent leaf tissue with symptoms of downy mildew was estimated and severity was assessed for affected leaves. Canopy severity was calculated from these values. Table contains de-transformed values when square root transformation was used.

<sup>y</sup> Rate of formulated product/A. Applications dates were 1=25 Aug, 2=1 Sep, 3=8 Sep, 4=17 Sep, 5=22 Sep, 6=30 Sep, and 7=7 Oct.

<sup>x</sup> After downy mildew was detected, Actinovate was tank-mixed with Previcur Flex (1.2 pt/A) (5, 7) or Ranman (2.75 fl oz/A) (6).

<sup>w</sup> Conventional fungicide standard was Manzate early season and Bravo during fruit production.

<sup>v</sup> Means in a column followed by the same letter or no letter are not statistically different from each other (Tukey's HSD, *P*=0.05).