CUCUMBER, SLICER (*Cucumis sativus*, 'Marketmore 76')
Downy mildew; *Pseudoperonospora cubensis*

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Efficacy of biopesticides applied with conventional fungicides for managing downy mildew in cucumber, 2021.

A field experiment was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, on Haven loam soil. The objective was to evaluate programs with biopesticides applied with or in place of conventional fungicides for some applications. The field was moldboard plowed on 6 Apr and urea fertilizer (46-0-0) was applied at 80 lb/A N on 7 Apr. For management of Phytophthora blight, caused by *Phytophthora capsici*, a mustard biofumigant cover crop (cv. Rojo Caliente) was seeded at 10 lb/A by drilling on 9 Apr. On 14 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface; the field could not be irrigated to initiate biofumigation as usually done, but soil was moist. Controlled-release fertilizer (N-P-K, 19-10-9) at 525 lb/A (101 lb/A N) was broadcast over the bed area and incorporated on 13 Jul. Beds were formed with drip tape and covered with black plastic mulch on 13 Jul. Seeds were sown on 28 Jun in the greenhouse. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer (9-18-9). All plants were placed outdoors to harden for a few days and then transplanted by hand into the holes in the beds on 16 Jul. During the season, water was provided as needed via drip irrigation lines. Weeds were managed between the mulched beds by covering the soil with landscape cloth and by hand weeding. The primary source of initial inoculum of *Pseudoperonospora cubensis* in this area is long-distance wind-dispersed spores from affected plants. Plots were single 18-ft rows with 9 plants at 2-ft spacing. Rows were 4 ft apart. The plots were 6 ft apart within the row initially until plants began to vine partly filling the area. Vines were moved as needed to maintain plot separation. A randomized complete block design with four replications was used. Treatments were applied seven times on a 7-day schedule beginning on 28 Jul using a backpack boom sprayer equipped with one TwinJet (TJ60-8004VS) nozzle that delivered 31 gal/A at 55 psi and 2.2 mph. For the last four applications, two passes were made treating each plot side separately because plants had grown too large to obtain complete coverage with one pass. Severity of downy mildew was assessed weekly by estimating incidence of symptomatic leaves in each plot and rating severity on nine representative affected leaves. Canopy severity was calculated by multiplying incidence by average severity. Area under the disease progress curve (AUDPC) values were calculated from 30 Jul through 7 Sep using the formula: $\sum_{i=1}^{n}[(R_{i+1} + R_i)/2]\,[t_{i+1} - t_i]$, where R = disease severity rating (% of leaf surface with symptoms) at the *i*th observation, t_i = time (days) since the previous rating at the *i*th observation, and n = total number of observations. Defoliation, which was due to downy mildew, was assessed on 30 Aug, 7 Sep, and 22 Sep. Fruit were harvested and counted when time permitted (18 and 31 Aug; and 10 and 27 Sep), rather than more frequently as fruit reached marketable size, because experiment focus was disease control. Mis-shaped fruit but not over-sized fruit were considered unmarketable. Average monthly high and low temperatures (^{o}F) were 82 and 67.4 in Jul, 83.4 and 68.4 in Aug, and 77.1 and 62.5 in Sep. Rainfall (in.) was 6.2, 9.0 and 4.9 for these months, respectively. Data was analyzed with one-way ANOVA and Tukey's HSD to separate means using JMP statistical software.

Symptoms of downy mildew were first observed in this experiment in two of the 32 plots on 30 Jul, which was two days after the first application. All the treatments were effective based on canopy severity ratings and provided 69 – 95% control based on AUDPC values. Severity was numerically but not statistically lower for the programs with Howler or Theia applied in rotation with two conventional fungicides (Orondis Ultra and Ranman) on a 7-day schedule than similar programs with just these conventional fungicides applied on the same dates (14-day schedule) or with another conventional fungicide (Curzate) applied in place of the biopesticides. Severity was numerically but not statistically lower for Ranman applied with the low rate of Timorex ACT than Ranman applied alone or with the high rate of Timorex ACT. All the treatments had numerically less defoliation than the control on 30 Aug, and most values were significantly lower. Impact of managing downy mildew on reducing defoliation subsequently declined with only the Ranman alone and Ranman plus Timorex ACT treatments having significantly less defoliation than the control on 7 Sep and no significant differences on 22 Sep (data not shown). All treatments resulted in significantly more fruit per plant than the control and numerically more marketable fruit. No phytotoxicity was observed.

Treatment and amount/A (application dates) [y]	Canopy severity of downy mildew (%) [z,x]				Defoliation (%) [z]	Fruit/plant [z]	
	17 Aug	30 Aug	7 Sep	AUDPC	30 Aug [x]	No.	Marketable (%)
Untreated control	30.7 a	45 a	38 a	846 a	39 a	8.2 c	66
Orondis Ultra 8 fl oz (1, 7) Howler 5 lb (2, 4, 6) Ranman 2.1 fl oz (3, 5)	1.2 b	14 bcd	12 bc	165 bcd	8 b	17.5 ab	75
Orondis Ultra 8 fl oz (1, 7) Theia 3 lb (2, 4, 6) Ranman 2.1 fl oz (3, 5)	0.4 b	12 bcd	11 bc	142 bcd	11 ab	16.0 ab	77
Orondis Ultra 8 fl oz (1, 7) Ranman 2.1 fl oz (3, 5)	1.6 b	21 ab	15 b	262 b	15 ab	15.0 b	74
Orondis Ultra 8 fl oz (1, 7) Ranman 2.1 fl oz (3, 5) Curzate 5 oz (2, 4, 6)	0.5 b	17 bc	16 b	199 bc	1 b	17.4 ab	73
Ranman 2.1 fl oz (1-7)	1.5 b	7 bcd	7 bc	104 bcd	5 b	20.5 a	75
Ranman 2.1 fl oz + Timorex ACT 13.5 fl oz (1-7)	0.7 b	3 d	3 c	41 d	2 b	19.5 ab	77
Ranman 2.1 fl oz + Timorex ACT 18 fl oz (1-7)	1.0 b	5 cd	6 bc	75 cd	2 b	20.8 a	72
P-value (treatment)	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0834

[z] Numbers in each column with a letter in common or no letters are not significantly different from each other (Tukey's HSD, *P*=0.05)

[y] Rate of formulated product/A. Application dates were 1=28 Jul, 2=3 Aug, 3=11 Aug, 4=18 Aug, 5=25 Aug, 6=31 Aug, and 7=7 Sep. All applied with Dyne-Amic at 0.38% v/v.

[x] Values were square root transformed before analysis because raw data were not distributed normally. Table contains de-transformed values.