

CUCUMBER (*Cucumis sativus* 'Silver Slicer')
Downy mildew; *Pseudoperonospora cubensis*

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Fungicide sensitivity of the cucurbit downy mildew pathogen population on Long Island, NY, determined using a seedling bioassay, 2021.

A seedling bioassay was used to examine fungicide sensitivity in the local cucurbit downy mildew pathogen population. The cultivar used was selected because of its resistance to powdery mildew and susceptibility to downy mildew. Seeds were sown in 48-cell trays on 12 Jul, 29 Jul, and 13 Aug for three bioassays. They were kept in a growth chamber until 26 Jul, 6 Aug, and 24 Aug when they were moved to a greenhouse and the seedlings were transplanted to 4-in. pots. At approximately the 3-leaf stage, the seedlings were prepared for treatment by removing the growing tip with unexpanded leaves and then sprayed to coverage with one of 11 fungicides at full label rates on 10 Aug, 7 Sep, and 13 Sep. Technical grade zoxamide was used rather than one of the formulated products labeled for cucurbit downy mildew, Gavel and Zing!, because they contain a second active ingredient. Similarly, Orondis Gold 200 was used instead of Orondis Opti or Orondis Ultra to determine sensitivity to oxathiapiprolin. Rates used for zoxamide and Orondis Gold 200 were selected to apply the same amount of active ingredient as in the labeled products. Applications were made with a backpack sprayer (R&D Sprayers, Opelousas, LA) using a TeeJet TP8004 flat fan nozzle delivering 50 gal/A operated at 55 psi. The next day the seedlings were organized into replications, each with one plant of each treatment plus two water-treated control plants. Each replication was placed in a different field location spot next to, but not touching the leaves of, plants naturally affected by downy mildew. In bioassay 1, treated on 10 Aug, four replications of seedlings were put in a commercial planting that had not been treated with fungicides (Location A) and six replications were put in research plantings next to plants that were untreated (Location B). Seedlings for bioassays 2 and 3 were put in research plantings next to untreated plants (Location C, which was similar to B) and in an experiment where Orondis Ultra, Ranman, and Curzate had been applied (Location D). Seedlings were left there for 1-2 days for infection to occur, then the plants were moved into a greenhouse until symptoms developed. Severity of downy mildew was assessed three times at days 5 or 6, 7 or 8, and 11 or 12 after the first night-time infection period. Percent leaf coverage with visible symptoms was estimated for each leaf of each plant, and the values were averaged to obtain a single value per plant for analysis. Data were analyzed with one-way ANOVA and Tukey's HSD to separate means using JMP statistical software.

Water-treated control seedlings in bioassay 1 became substantially more severely affected by downy mildew than those in bioassays 2 and 3. Bioassay 2 seedlings were outside exposed to natural inoculum for only one day because of rain that was not forecast at the time the bioassay was started. However, weather station at the Long Island Horticultural Research and Extension Center recorded humid conditions all nights that plants were outside which should have provided favorable conditions for infection. Relative humidity was above 85%, and usually above 90%, for 12 and 9 hr for bioassay 1, 11 hr for bioassay 2 which was the only period that leaf wetness was also recorded, and 14 and 16 hr for bioassay 3. Results from bioassays 2 and 3 are somewhat similar to bioassay 1, suggesting when severity is very low some meaningful conclusions can be drawn but should not be considered definitive. Conclusions about efficacy were drawn from bioassay 1 results. They were similar for the three ratings. Severity was much lower at the first rating, five days after first infection period (data not shown), than at seven and 11 days. Revus (FRAC code 40), Quadris (11), and Presidio (43) were deemed ineffective because for most ratings downy mildew severity was not significantly or substantially different from the control. Omega (29), Orondis Gold 200 (49), and Ranman (21) were the most effective (94-100% control based on the 23 Aug rating). Zoxamide (22) was equally effective at location A but not B (95 and 86% control). Previcur Flex (28) was similar in efficacy to zoxamide but not as efficacious as the three most effective fungicides (86 and 88% control). Forum (40), Elumin (22), and Curzate (27) were moderately effective (48-78% control). In addition to results from bioassay 1 being more definitive than those from bioassays 2 and 3, they were also most useful being obtained at a time during the growing season that growers could use the results to decide what fungicides to use for subsequent applications. Results did not differ substantially from previous years (2017-2019).

Treatment and rate	Severity of downy mildew at 7, 11, 12, and 12 days after first nightly exposure (%) *						
	Bioassay 1				Bioassay 2 **		Bioassay 3 **
	Location A **		Location B		Location C	Location D	Location C + D
	19 Aug	23 Aug	19 Aug	23 Aug **	20 Sep	20 Sep	27 Sep
Unsprayed control	49.5 a	59.9 a	53.7 a	47.7 a	3.04 a	1.04 ab	8.11 a
Revus 8 fl oz/A	34.0 ab	43.9 ab	48.9 a	52.2 a	1.19 abc	0.01 c	2.29 bcd
Quadris 15.5 fl oz/A	25.6 abc	34.6 b	37.1 abc	42.6 ab	1.98 ab	1.57 a	7.69 ab
Presidio 4 fl oz/A	29.1 ab	36.5 ab	41.7 ab	36.1 abc	0.09 c	0.10 bc	5.11 abc
Forum 6 fl oz/A	16.4 bcd	27.2 bc	27.7 bcd	24.8 bcd	0.72 bc	0.21 abc	2.06 bcd
Elumin 8 fl oz/A	12.6 bcde	22.3 bcd	17.9 cde	19.8 cde	0.42 bc	0.01 c	1.61 cd
Curzate 5 oz/A	7.3 cdef	12.9 cde	15.4 de	15.3 def	0.03 c	0.05 bc	0.15 d
Previcur Flex 19.2 fl oz/A	6.1 def	8.5 de	3.8 e	5.9 fg	0.22 bc	0.23 abc	0.96 cd
Zoxamide 400 ppm	1.0 fg	3.0 ef	3.1 e	6.8 ef	0.42 bc	0.25 abc	2.08 bcd
Omega 24 fl oz/A	1.9 efg	3.9 ef	0.3 e	0.4 gh	0.04 c	0.01 c	0.17 d
Orondis Gold 200 1.36 fl oz/A	0.2 fg	0.2 f	0.1 e	0.1 h	0.07 c	0.00 c	0.29 d
Ranman 2.75 fl oz/A	0.0 g	0.0 f	0.0 e	0.0 h	0.06 c	0.23 abc	0.41 d
<i>P-value (treatment)</i>	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

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

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