Fungicides for Managing Phytophthora Blight in Cucurbits and Other Vegetables

Margaret Tuttle McGrath, Plant Pathology and Plant-Microbe Biology Section, Cornell University
Long Island Horticultural Research and Extension Center, 3059 Sound Avenue, Riverhead, NY 11901
mtm3@cornell.edu; http://blogs.cornell.edu/livegpath/; www.vegetables.cornell.edu/pest-management/disease-factsheets/

Fungicide	FRAC group	Application + other use restrictions			REI (hr)	PHI (day)	Other labeled vegetables	Comments
		sequential [1]	max [2]	other				
Orondis Gold	49	NA	1 application at planting		4	0	pepper, eggplant, tomato	Use either Orondis Gold applied to soil or Orondis Ultra applied to foliage
Orondis Ultra [3]	49 + 40	2	4 or 33% of sprays, whichever is fewer		4	0		
Omega	29	no limit	4-7	4 at high rate	12	7/30	pepper, eggplant	PHI is 30 days for cucumbers and melons
Gavel	22 + M3	no limit	8		48	5		
Zampro [4]	40 + 45	2	3	no LI use	12	0	pepper, eggplant, tomato	Same FRAC 40 AI as Forum
Forum [4]	40	2	5	tank-mix	12	0	pepper, eggplant	Best used when downy mildew is not a concern (e.g. early season)
Revus [3]	40	none	4	use surfactant	12	0	pepper, eggplant	
Tanos	27	none	4	tank-mix	12	3	pepper	Must be tank-mixed with contact fungicide (copper)
Ranman	21	3	6	use organo-silicone surfactant	12	0	bean, pepper, eggplant	Resistance found in southeast where testing done
Presidio	43	none	2	tank-mix	12	2	pepper, eggplant	Resistance common in southeast where testing done
Ridomil Gold SL	4	no limit	3 including 1 at planting		48	5	pepper, eggplant	Resistance detected where extensively used
phosphorous acid fungicides	P 07	no limit	none		4	0	pepper, eggplant	Recommend applied at low rate mixed with another fungicide
biopesticides		no limit	none			0	varies	See section below
copper fungicides	M1	no limit			48	2		2(ee) in NY to use tank-mixed with other fungicides: Champ, Champion, Cuprofix Disperss, Kocide

[1] Maximum number of sequential applications that can be made before must switch to other fungicide(s) in different FRAC group. This restriction is for resistance management, which is a major concern with this pathogen. Switch for at least as many applications; this is a stated requirement on the Ranman label. So if Ranman is applied 3 times in a row, the maximum allowed, the next 3 applications must be different chemistry. No sequential applications permitted with Presidio (recent label change), Revus and Tanos.

[2] Max refers to the maximum number of applications that can be applied to a cucurbit crop. See also next column.

[3] Orondis Ultra and Revus have an active ingredient in common (mandipropamid). Using both in a fungicide program necessitates using less than the max of each listed in the table. When Orondis Ultra is applied at highest label rate (8 fl oz/A), then max number applications of Orondis Ultra plus Revus is 4 total. When Orondis Ultra is applied 4 times at 6 fl oz/A, then Revus can be applied once.

[4] Zampro and Forum both have dimethomorph. Using both in a fungicide program necessitates using less than the max of each listed in the table. When Zampro is applied 3 times (label max), Forum can be applied twice. Zampro is not permitted used on Long Island, NY.

Additional information about these fungicides

Classified for "restricted use" in New York: Gavel, Omega. Presidio, Zampro, and some phosphorous acid fungicides.

Not Classified for "restricted use": biopesticides, Forum, Ranman. Revus, Tanos, and most phosphorous acid fungicides.

Conventional fungicides that can be applied directly to soil:

Omega. first application may be made at 1.5 pt/A as a banded soil drench at transplant or when the plants have first true leaves.

Orondis Gold. Can be applied once either in furrow at planting, in transplant water, or through drip irrigation. Note that Orondis Ultra cannot be applied subsequently.

Phosphorous acid fungicides. There are several products; not all labeled for soil applications. Check the label carefully as use directions vary a lot. ProPhyt is labeled for application to cucurbit and pepper seedlings before transplanting (1 pint/25 gal water) and in furrow during seeding (5 fl oz/1000 row ft). Rampart can be applied as a root dip to pepper and eggplant. Several phosphorous acid fungicides, including K-Phite and Rampart, also can be applied through drip irrigation after planting.

Presidio. Can be applied through drip irrigation.

Ridomil Gold SL. Can be applied as directed soil spray and through drip irrigation. Resistance detected commonly following years of use on a farm. Ridomil Gold Copper and Ridomil Gold Bravo are not labeled for *Phytophthora*.

Zampro. Can be applied as soil drench at planting and through drip irrigation. No LI use.

Fungicide resistance and its management. Conventional fungicides are generally at risk for resistance developing to them in pathogens because of their targeted activity. A standard recommendation for managing resistance is to use multiple fungicides that have not yet been affected by resistance and that are chemically different (in different FRAC groups), applied in alternation or combination in an integrated management program with cultural management practices. Since *Phytophthora capsici* surviving in soil on a farm is the most important source of inoculum for disease outbreaks in subsequent years, it is important to consider past usage of fungicides on a farm when developing a fungicide program for the current season. Knowledge about resistance detected elsewhere is valuable as it documents the pathogen's capability to develop resistance, but needs to be considered it context of usage on your farm in contrast with pathogens like those causing the cucurbit mildews which produce wind-dispersed spores enabling these resistant pathogens to easily spread throughout large areas. Unfortunately, there is not an on-farm test to detect resistance, and inefficacy of a fungicide due to resistance is difficult to detect in a commercial crop when effective fungicides are being used with it, plus there are other reasons for poor control.

Resistance to the active ingredient in Ridomil (mefenoxam) was first reported in 1997 in New Jersey, North Carolina, and Michigan, and has since been confirmed in New York and other states. In a recent study in Tennessee (2018 and 2019), 4% of the 184 *P. capsici* isolates tested

were resistant to Ridomil, 46% to fluopicolide (AI in Presidio), 7% to cyazofamid (Ranman), and one isolate (0.5%) was resistant to oxathiapiprolin (Orondis). Some isolates were resistant to both Ridomil and Presidio. None were resistant to dimethomorph (Forum and Zampro) or mandipropamid (Revus). In a study conducted in Georgia also in 2018 and 2019, 43% of the isolates were resistant to Presidio and their fitness and competitive ability were not reduced compared with sensitive isolates.

Laboratory studies have been conducted to determine if it is possible to induce resistance in pathogens, such as by using ultraviolet irradiation or by growing the pathogen on fungicide-amended media plates to generate resistant mutants. Potential for resistance to develop in fungicide-treated crops sometimes has been correctly predicted from this research, but not always. With *P. capsici,* resistance to Presidio was predicted, and the resistant mutants generated in the lab were generally as fit as their sensitive parents. Mutants resistant to zoxamide (an active ingredient in Gavel) with good fitness and mutants resistant to oxathiopiprolin (main AI in Orondis fungicides) have also been created.

Biopesticides. There are several products with a microbial organism (bacterium or fungus) as the active ingredient that are labeled for application to soil and/or foliage to manage *Phytophthora*, some specifically for the blight pathogen, *P. capsica*, others for root rot caused by *Phytophthora*. They are approved for organic production. In a crop that will be treated with conventional fungicides, more effective control might be achieved by adding applications of these early in production to soil and the crown area of pepper, eggplant, and cucurbit crops. Biopesticides are recommended applied at low rate frequently rather than high rate once. They are also suggested used in combination based on the organism: *Bacillus* (AVIV, Companion, Double Nickel, Serenade, Stargus, Taegro 2), *Gliocladium* (LALSTOP G46, Prestop, PVent, SoilGard), *Streptomyces* (Actinovate, Mycostop), and *Trichoderma* (Bio-Tam, RootShield Plus). Many are also labeled for managing *Fusarium*, which has caused root and crown rot in pumpkin in some fields, as well as *Pythium* and *Rhizoctonia*.

Products listed by labeled use pattern:

1. soil treatment before planting: Bio-Tam (broadcast apply to soil up to 7 days before planting; immediately incorporate with irrigation (best) or light cultivation), TerraClean 5.
2. seed treatment as a spray or dry coating: Actinovate, LALSTOP K61 WP, Mycostop.
3. drench to seedlings before transplanting: Bio-Tam, LALSTOP K61 WP, RootShield Plus (in greenhouse), Serenade ASO (pepper), SoilGard, Taegro 2.
4. foliar spray in greenhouse: Companion.
5. soil drench during or soon after planting: AVIV, LALSTOP K61 WP, Mycostop, Prestop, PVent, Regalia, Stargus, TerraClean 5.
6. in-furrow during seeding: Actinovate, AVIV, Bio-Tam, Double Nickel, Regalia, RootShield Plus, Serenade ASO, Taegro 2.
7. plant dip before transplanting: AVIV, LALSTOP K61 WP, Mycostop, Regalia.
8. in transplant water: RootShield Plus, SoilGard.
9. banded over the row: Bio-Tam, Companion, Taegro 2.
10. basal directed spray: Bio-Tam, SoilGard, Taegro 2.
11. through drip irrigation: Actinovate, AVIV, Bio-Tam, Companion, Double Nickel, LALSTOP K61 WP, Mycostop, Prestop, PVent, RootShield Plus, SoilGard, Taegro 2, TerraClean 5.
12. foliar spray: Actinovate, AVIV, Companion, Double Nickel, OxiDate 2, Regalia, Serenade, Stargus.

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