

Chapter 19. Biopesticides and Alternative Disease and Pest Management Products¹

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Table 1. Biopesticides labeled for management of arthropod pests of many crops.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
Aphids	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	3A, -	Azera (pyrethrins, azadirachtin)	1.0–3.5 qt	0	12	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle. May be used in greenhouses.
	3A, -	BotaniGard Maxx (<i>Beauveria bassiana</i> strain GHA, pyrethrins)	Up to 2 quarts per 100 gallons water.	0	12	No	
	-	Des-X (soap, insecticidal)	2% v/v	0	12	Yes	
	-	Grandevo WDG (<i>Chromobacterium subtsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	

1. This document is CV295, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date August 2013. Revised April 2020. This is Chapter 19 of the *Vegetable Production Handbook of Florida, 2020–2021 edition*. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
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Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	M-Pede 49% EC (soap, insecticidal)	1%–2% v/v	0	12	Yes	
	-	Mycotrol ESO (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	Yes	
	-	Mycotrol WPO (<i>Beauveria bassiana</i> strain GHA)	0.5–1.0 lb per 100 gallons water; maximum 3 lb per 100 gallons for high insect pressure or dense foliage.	0	4	Yes	
	-	Neemix 4.5 (azadirachtin)	4–16 fl oz	0	12	Yes	IGR and feeding repellent. Greenhouse and field.
	-	Suffoil-X (mineral oil)	1%–2% v/v	0	4	Yes	Thorough coverage is essential.
	-	Trilogy (extract of neem oil)	0.5%–2% v/v	0	4	Yes	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment.
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
Beetles	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	3A, -	Azera (pyrethrins, azadirachtin)	1.0–3.5 qt	0	12	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	5	Entrust SC (spinosad)	See label for specific crops	See label	4	Yes	See label for resistance management and for maximum allowed amount per season.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
Caterpillars (including cabbage looper, corn earworm, imported cabbageworm, larvae, tobacco budworm, tomato fruitworm); armyworms and cutworms	3A, -	Azera (pyrethrins, azadirachtin)	1.0–3.5 qt	0	12	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	5	Entrust SC (spinosad)	See label for specific crops	See label	4	Yes	See label for resistance management and for maximum allowed amount per season.
	5	Seduce Insect Bait (spinosad)	20–44 lb	See specific crops on label	4	Yes	
	11A	Agree WG (<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>)	0.5–2.0 lb	0	4	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	11A	Biobit HP (<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>)	0.5–2.0 lb	0	4	Yes	Treat when larvae are young. Good coverage is essential. Can be used in the greenhouse.
	11A	Deliver (<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>)	0.25–1.5 lb	0	4	Yes	Use higher rates for armyworms.
	11A	DiPel DF (<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>)	0.5–2.0 lb	0	4	Yes	Treat when larvae are young. See label for rates for specific pests. Good coverage is essential.
	11A	Javelin WG (<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>)	0.12–1.50 lb	0	4	Yes	Treat when larvae are young. Thorough coverage is essential. See label for crops (most cole crops).
	11A	Xentari DF (<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>)	0.5–2.0 lb	0	4	Yes	Treat when larvae are young. Thorough coverage is essential. May be used in the greenhouse.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
Corn earworm, <i>Helicoverpa zea</i>	-	Gemstar LC (<i>Helicoverpa zea</i> NPV)	4–10 fl oz	0	4	Yes	Naturally occurring insect virus
	-	Grandevo (<i>Chromobacterium subtsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	Grandevo WDG (<i>Chromobacterium subtsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	
	-	Neemix 4.5 (azadirachtin)	4–16 fl oz	0	12	Yes	IGR and feeding repellent. Greenhouse and field.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	
Earwigs	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	5	Seduce Insect Bait (spinosad)	20–44 lb	See specific crops on label.	4	Yes	
Leafhoppers	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle. May be used in greenhouses.
	-	Captiva (Capsicum oleoresin extract, garlic oil, soybean oil)	8 oz per 100 gallons water	0	4	No	
	-	Captiva Prime (Capsicum oleoresin extract, garlic oil, canola oil)	1–2 pints	0	4	Yes	
	-	JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	No	
	-	Organic JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	Yes	
	-	M-Pede 49% EC (soap, insecticidal)	1%–2% v/v	0	12	Yes	
	-	Suffoil-X (mineral oil)	1%–2% v/v	0	4	Yes	Thorough coverage is essential.
Liriomyza leafminers	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	3A, -	Azera (pyrethrins, azadirachtin)	1.0–3.5 qt	0	12	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	3A, -	BotaniGard Maxx (<i>Beauveria bassiana</i> strain GHA, pyrethrins)	Up to 2 quarts per 100 gallons water.	0	12	No	
	-	Neemix 4.5 (azadirachtin)	4–16 fl oz	0	12	Yes	IGR and feeding repellent. Greenhouse and field.
	-	JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	No	
	-	Organic JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	Yes	
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
Mealybugs	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle. May be used in greenhouses.
	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	
Mites (including broad mites and two-spotted spider mites)	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	Captiva (Capsicum oleoresin extract, garlic oil, soybean oil)	8 oz per 100 gallons water	0	4	No	
	-	Captiva Prime (Capsicum oleoresin extract, garlic oil, canola oil)	1–2 pints	0	4	Yes	
	-	Trilogy (extract of neem oil)	0.5%–2% v/v	0	4	Yes	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment.
	-	Des-X (soap, insecticidal)	2% v/v	0	12	Yes	
	-	JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	No	
	-	Organic JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	Yes	
	-	Grandevo WDG (<i>Chromobacterium subtsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	
	-	Met52 EC (<i>Metarhizium anisopliae</i> strain F52)	Drench: 40–80 fl oz Foliar: 0.5–2 quarts	0	0	No	Composed of spores of insect pathogenic fungus <i>Metarhizium anisopliae</i> strain F52.
	-	M-Pede 49% EC (soap, insecticidal)	1%–2% v/v	0	12	Yes	
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
	-	Suffoil-X (mineral oil)	1%–2% v/v	0	4	Yes	Thorough coverage is essential.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	
Plant bugs	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle.
	-	Des-X (soap, insecticidal)	2% v/v	0	12	Yes	
	-	Grandevo WDG (<i>Chromobacterium subsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
Planthoppers	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle.
Psyllids	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
Soil insects (including grubs, symphylans, rootworm)	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying. For organic production.
Stinkbugs	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	
Thrips (check label for species controlled)	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	5	Entrust SC (spinosad)	See label for specific crops	See label	4	Yes	See label for resistance management and for maximum allowed amount per season.
	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle.
	3A, -	BotaniGard Maxx (<i>Beauveria bassiana</i> strain GHA, pyrethrins)	Up to 2 quarts per 100 gallons water.	0	12	No	
	-	Captiva (Capsicum oleoresin extract, garlic oil, soybean oil)	8 oz per 100 gallons water	0	4		
	-	Captiva Prime (Capsicum oleoresin extract, garlic oil, canola oil)	1–2 pints	0	4	Yes	
	-	Met52 EC (<i>Metarhizium anisopliae</i> strain F52)	Drench: 40–80 fl oz Foliar: 0.5–2 quarts	0	0	No	Composed of spores of insect pathogen fungus <i>Metarhizium anisopliae</i> strain F52.
	-	Met52 granular (<i>Metarhizium anisopliae</i> strain F52)	1.5–3.0 lb/yd ³	0	0	No	Product is incorporated into growing medium for management of thrips pupae.

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	M-Pede 49% EC (soap, insecticidal)	1%–2% v/v	0	12	Yes	
	-	Suffoil-X (mineral oil)	1%–2% v/v	0	4	Yes	Thorough coverage is essential.
	-	Trilogy (extract of neem oil)	0.5%–2% v/v	0	4	Yes	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment.
Weevils	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	
	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
Whitefly	-	Aza-Direct (azadirachtin)	1–2 pt, up to 3.5 pt if needed	0	4	Yes	Antifeedant, repellent, insect growth regulator.
	3A, -	Azera (pyrethrins, azadirachtin)	1.0–3.5 qt	0	12	Yes	Apply when larvae are small for best control. Can be used in greenhouse.
	-	BotaniGard ES (<i>Beauveria bassiana</i> strain GHA)	0.25–1 quart per acre. Apply in sufficient water to thoroughly cover foliage, typically 5 to 100 gallons per acre.	0	4	No	Works by contact. Spores attach to insects, germinate, and penetrate insect cuticle. May be used in greenhouses.
	3A, -	BotaniGard Maxx (<i>Beauveria bassiana</i> strain GHA, pyrethrins)	Up to 2 quarts per 100 gallons water.	0	12	No	
	-	Captiva (Capsicum oleoresin extract, garlic oil, soybean oil)	8 oz per 100 gallons water	0	4	No	
	-	Captiva Prime (Capsicum oleoresin extract, garlic oil, canola oil)	1–2 pints	0	4	Yes	
	-	Des-X (soap, insecticidal)	2% v/v	0	12	Yes	

Insect or Mite Pest	MOA Code ¹	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	OMRI-Listed	Remarks ²
	-	Grandevo WDG (<i>Chromobacterium subtsugae</i> strain PRAA4-1)	1.0–3.0 lb	0	4	Yes	
	-	JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	No	
	-	Organic JMS Stylet oil (paraffinic oil)	3–6 quarts per 100 gallons water	0	4	Yes	
	-	M-Pede 49% EC (soap, insecticidal)	1%–2% v/v	0	12	Yes	
	-	Met52 EC (<i>Metarhizium anisopliae</i> strain F52)	Drench: 40–80 fl oz Foliar: 0.5–2 quarts	0	0	No	Composed of spores of insect pathogenic fungus <i>Metarhizium anisopliae</i> strain F52.
	-	Neemix 4.5 (azadirachtin)	4–16 fl oz	0	12	Yes	IGR and feeding repellent. Greenhouse and field.
	-	PFR-97 20% WDG (<i>Isaria fumosoroseus</i> Apopka Strain 97)	Foliar and soil: 1–2 lb	0	4	Yes	Can be used on vegetables grown for transplant. Do not mix with fungicides or apply within 5 days of fungicide applications other than copper. Dust/mist respirator must be used for mixing and applying.
	3A	Pyganic 5.0 (pyrethrins)		0	12	Yes	Harmful to bees. Can be used in greenhouses.
	-	Suffoil-X (mineral oil)	1%–2% v/v	0	4	Yes	Thorough coverage is essential.
	-	Trilogy (extract of neem oil)	0.5%–2% v/v	0	4	Yes	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment.
	-	Venerate XC (heat-killed <i>Burkholderia</i> spp. strain A396 cells and spent fermentation media)	1–8 quarts per acre	0	4	Yes	

¹ Mode of Action (MOA) codes for plant pest insecticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification v. 8.2 March 2017. Number codes (1 through 29) are used to distinguish the main insecticide mode of action groups, with additional letters for certain subgroups within each main group. All insecticides within the same group (with same number) indicate the same active ingredient or similar mode of action. This information must be considered for the insecticide resistance management decisions. - = unknown, or a mode of action that has not been classified yet.

² Information provided in this table applies only to Florida. Be sure to read a current product label before applying any product. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by UF/IFAS Extension nor discrimination against similar products or services not mentioned. OMRI-listed: Listed by the Organic Materials Review Institute for use in organic production.

Table 2. Biopesticides and other alternative products labeled for plant disease management.

Product (Active Ingredient) Fungicide Group ¹	Crops	Pertinent Diseases or Pathogens	Minimum Days to:		OMRI-Listed	Remarks ²
			Harvest	Reentry		
Labels change frequently. Be sure to read a current product label before applying any pesticide. Refer to crop-specific tables for conventional pesticides labeled for disease and pest management.						
Actinovate ActinoGrow (<i>Streptomyces lydicus</i> WYEC 108), NC	Vegetables & Strawberries	<i>Alternaria</i> spp., Anthracnose, <i>Aphanomyces</i> , Botrytis, Charcoal Rot (<i>Macrophomina phaseolina</i>), Club root (<i>Plasmodiophora brassicae</i>), Downy Mildew, <i>Erwinia</i> spp., <i>Fusarium</i> spp., <i>Gaeumannomyces</i> , Powdery Mildew, <i>Pseudomonas</i> spp., <i>Phytophthora</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Sclerotinia</i> spp., Southern Blight, <i>Verticillium</i> spp., <i>Xanthomonas</i> spp.	0	1 hr	Yes	See label for specific rates and application recommendations.
Afla-guard GR (<i>Aspergillus flavus</i> NRRL 21882), NC	Sweet Corn	Aspergillus	-	4 hr	No	Do not exceed 20 lb/acre per growing season. See label for specific application instructions.
AgriPhage (bacteriophage), NC	Tomato, Pepper	Bacterial spot, Bacterial speck	0	0	No	Bacterial strains must be characterized periodically by manufacturer to correctly formulate the bacteriophage mixture.
(potassium bicarbonate), NC Many brands available: Armicarb 100, Armicarb "O", Carb-O-Nator, Eco-mate, Kaligreen, Milstop	Vegetables & Strawberries	Broad-spectrum fungicide	0	4 hr	Yes	See label for specific rates and application recommendations.
Ballad Plus (<i>Bacillus pumilus</i> strain QST 2808), NC	Legumes & Sweet Corn	Bacterial blight, Brown spot, Cercospora leaf spot, Common Rust, Downy mildew, Northern and Southern leaf blight, <i>Pseudomonas</i> spp., <i>Xanthomonas</i> spp.	0	4 hr	No	See label for specific rates and application recommendations.
BioCover (Oil, petroleum), NC	Vegetables & Strawberries	Powdery mildew, Rust	0	4 hr	No	See label for specific rates, application recommendations, and precautions regarding use with other pesticides.
BIO-TAM (<i>Trichoderma asperellum</i> strain ICC 012 + <i>Trichoderma gamsii</i> strain ICC 080), NC	Vegetables & Strawberries	<i>Fusarium</i> spp., <i>Phytophthora</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Sclerotinia</i> spp., <i>Sclerotium rolfsii</i> , <i>Thielaviopsis basicola</i> , and <i>Verticillium</i> spp.	-	1 hr	Yes	See label for additional rates and recommendations for transplant production and details for specific diseases. Check label for product incompatibility with certain chemical fungicides.
Botector (<i>Aureobasidium pullulans</i> strain DSM 14940, 14941)	Tomatoes & Strawberries	Anthracnose, Botrytis, Phomopsis, Rhizopus	0	4 hr	Yes	See label for specific rates and application recommendations. Check label for precautions regarding incompatibility with fungicides.
BotryStop (<i>Ulocladium oudemansii</i> U3 strain), NC	Vegetables & Strawberries	Botrytis, Sclerotinia	0	4 hr	No	See label for specific rates, application recommendations, and precautions regarding fungicide compatibility.

Product (Active Ingredient) Fungicide Group ¹	Crops	Pertinent Diseases or Pathogens	Minimum Days to:		OMRI-Listed	Remarks ²
			Harvest	Reentry		
Cease (<i>Bacillus subtilis</i> strain QST 713), 44	Vegetables & Strawberries	Bacterial spot, Bacterial speck, Botrytis, Early blight, Late blight, Powdery mildew, Target spot, <i>Rhizoctonia</i> spp., <i>Pythium</i> spp., <i>Fusarium</i> spp., <i>Verticillium</i> spp., <i>Phytophthora</i> spp.	0	4 hr	Yes	For foliar applications, mix with copper compounds or other effective fungicides. Compatible with soil drench and in-furrow applications. See label for specific rates and application recommendations.
Cinnerate (cinnamon oil), NC	Vegetables & Strawberries	Powdery mildew, Botrytis, Rusts	0	0	Yes	See label for specific rates and application recommendations.
Contans WG (<i>Coniothyrium minitans</i> strain CON/M/91-08)	Vegetables & Strawberries	<i>Sclerotinia sclerotiorum</i> and <i>Sclerotinia minor</i>	0	4 hr	Yes	See label for specific rates and application recommendations.
Cyclops (olive and cinnamon oils), NC	Vegetables & Strawberries	Broad-spectrum fungicide	0	0	Yes	See label for specific rates and application recommendations. Ingredients are exempt from FIFRA.
Debug (fats and glyceridic oils Mongosa, Azadirachtin), NC	Vegetables & Strawberries	Powdery mildew, Rust, <i>Rhizoctonia</i> , <i>Sclerotinia</i> , <i>Sclerotium rolfsii</i>	0	4 hr	Yes	See label for specific rates and application recommendations.
Double Nickel 55 Double Nickel LC Triathlon BA (<i>Bacillus amyloliquefaciens</i> strain D747), 44	Vegetables & Strawberries	<i>Alternaria</i> spp., Anthracnose, Bacterial diseases, Botrytis, Early blight, <i>Fusarium</i> spp., Late blight, <i>Phytophthora</i> spp., Powdery mildew, <i>Pythium</i> spp., <i>Rhizoctonia</i>	0	4 hr	Yes	See label for additional rates and recommendations for foliar and soil application rates and details for specific diseases. Use as a soil drench at transplant and periodically throughout the season. Can also be used as a seed treatment. See label for details.
EcoSwing (extract of <i>Swinglea glutinosa</i>), NC	Vegetables & Strawberries	<i>Alternaria alternata</i> , <i>Monilinia fructicola</i> , <i>Monilinia laxa</i> , <i>Botrytis cinerea</i> , <i>Erysiphaceae</i> spp., <i>Erwinia carotovora</i> subspp., <i>Aspergillus niger</i> , <i>Alternaria tenuis</i> , <i>Cladosporium herbarum</i> , <i>Rhizopus arrhizus</i> , <i>Penicillium</i> spp.	0	4 hr	Yes	See label for specific rates, application recommendations, and greenhouse use.
Glacial Spray Fluid (Oil, petroleum), NC	Vegetables & Strawberries	Powdery mildew, Rust	0	4 hr	Yes	See label for specific rates, application recommendations, and precautions regarding use with other pesticides.
GreenClean PRO PerCarb (sodium carbonate peroxyhydrate), NC	Vegetables & Strawberries	Broad-spectrum fungicide/bactericide	0		No	See label for specific rates and application recommendations.
(Hydrogen peroxide + peroxyacetic acid), NC Many brands available: Jet-Ag, OxiDate 2.0, Rendition, SaniDate 12.0, SaniDate WTO, SaniDate 5.0, SaniDate FD, SaniDate 15.0, StorOx 2.0, TerraStart, TerraClean 5.0, ZeroTol 2.0	Vegetables & Strawberries	Broad-spectrum fungicide	0	1 hr for enclosed areas; until spray dries in open-field areas.	No	See labels for specific rates, application recommendations, and precautions regarding use with other pesticides. Some formulations can be used as a soil drench at transplant and periodically throughout the season. Can also be used as a seed treatment or for postharvest treatments.

Product (Active Ingredient) Fungicide Group ¹	Crops	Pertinent Diseases or Pathogens	Minimum Days to:		OMRI-Listed	Remarks ²
			Harvest	Reentry		
JMS Stylet-Oil Organic JMS Stylet-Oil (paraffinic oil), NC	Vegetables & Strawberries	Potato Virus Y, Tobacco Etch Virus, Cucumber Mosaic Virus	0	4 hr	Yes, but only for one label	See label for specific rates, application recommendations, and precautions regarding use with other pesticides.
LEAPES (<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i> , strain ABTS-351 and methyl salicylate)	Tomato & Pepper	<i>Xanthomonas</i> spp.	0	0.5	No	Apply before disease is observed in the field; should be used as part of a plant pathogen control program. See label for details regarding insecticidal activity.
Lifeguard (<i>Bacillus mycooides</i> isolate J)	Vegetables	Broad-spectrum fungicide		4 hr	Yes	See label for specific rates and application recommendations.
Mildew Cure (cotton, corn, and garlic oils), NC	Vegetables & Strawberries	Powdery mildew	0	0	Yes	See label for specific rates and application recommendations. Ingredients are exempt from FIFRA.
Nutrol (potassium phosphate), NC	Cucurbits, Peppers & Tomatoes	Powdery mildew	0	0	No	Do not mix with copper fungicides or other products affected by low pH (<5.5). See label for specific rates and application recommendations.
OxiPhos (mono- and dipotassium salts of phosphorus acid + hydrogen peroxide), 33 + NC	Vegetables & Strawberries	<i>Alternaria</i> spp., Anthracnose, Bacterial diseases, Botrytis, Early blight, <i>Fusarium</i> spp., Late blight, <i>Phytophthora</i> spp., Powdery mildew, <i>Pythium</i> spp., Rhizoctonia	0	1 hr for enclosed areas; until spray dries in open-field areas.	No	See label for additional rates and recommendations for transplant production and details for specific diseases. Use as a soil drench at transplant and periodically throughout the season. Can also be used as a seed treatment.
PlantShield HC (<i>Trichoderma harzianum</i> Rifai strain KRL-AG2), NC	Vegetables & Strawberries	<i>Fusarium</i> spp., <i>Pythium</i> spp., Rhizoctonia	0	4 hr	Yes	Can be applied to plant as a direct drench, furrow spray, chemigation, or in transplant starter solution. See label for details.
(potassium phosphite; mono- and dipotassium salts of phosphorous acid), 33 Many brands available: Alude, Appear, Confine Extra T&O, Fosphite, Fungi-Phite, Helena Prophyt, K-Phite 7LP AG, Phiticide, Phorcephite, Phostrol, Rampart, Reveille	Vegetables & Strawberries	<i>Alternaria</i> spp., Anthracnose, Bacterial diseases, Downy mildew, <i>Fusarium</i> spp., Late blight, Leaf blights caused by <i>Cercospora</i> and <i>Septoria</i> spp., <i>Phytophthora</i> spp., Powdery mildew, <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., Root rots	0	4 hr	No	See label for details, specific recommendations, and precautions for tank mixing with copper-based fungicides.
Prev-Am (sodium tetraborohydrate decahydrate), NC	Vegetables & Strawberries	Downy mildew, Botrytis, Powdery mildew, Late blight, White rust, White mold	0	0.5	No	See label for details, crop-specific recommendations, and precautions.
Procidic (citric acid), NC	Vegetables & Strawberries	Broad-spectrum fungicide	0	0	No	See label for specific rates, application recommendations, and precautions regarding use with other pesticides.

Product (Active Ingredient) Fungicide Group ¹	Crops	Pertinent Diseases or Pathogens	Minimum Days to:		OMRI- Listed	Remarks ²
			Harvest	Reentry		
Purespray Green (oil, petroleum), NC	Vegetables & Strawberries	Powdery mildew, Rust	0	4 hr	Yes	See label for specific rates, application recommendations, and precautions regarding use.
Pvent (<i>Gliocladium catenulatum</i> strain J1446), NC	Vegetables & Strawberries		0	4 hr	Yes	See label for specific rates and application recommendations in field and greenhouse production.
Regalia SC (extract of <i>Reynoutria sachalinensis</i>), P	Vegetables & Strawberries	Bacterial canker, Bacterial speck, Bacterial spot, Botrytis, Early blight, Late blight, <i>Phytophthora</i> spp., Powdery mildew, Target spot	0	4 hr	Yes	Tank-mix with other effective fungicides for improved disease control under heavy pressure. See label for details.
RootShield Granular (<i>Trichoderma harzianum</i> Rifai strain T-22), NC	Vegetables & Strawberries	<i>Cylindrocladium</i> spp., <i>Fusarium</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Thielaviopsis</i> spp.	0	0	Yes	See label for specific rates, application recommendations, and precautions regarding use and fungicide compatibility
RootShield WP (<i>Trichoderma harzianum</i> Rifai strain KRL-AG2), NC	Vegetables & Strawberries	<i>Cylindrocladium</i> spp., <i>Fusarium</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Thielaviopsis</i> spp.	0	0	Yes	See label for specific rates, application recommendations, and precautions regarding use and fungicide compatibility
RootShield Plus Granular RootShield Plus WP (<i>Trichoderma harzianum</i> Rifai strain T-22 and <i>Trichoderma virens</i> strain G-41), NC	Vegetables & Strawberries	<i>Cylindrocladium</i> spp., <i>Fusarium</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Thielaviopsis</i> spp.	0	4 hr	Yes	See label for specific rates, application recommendations, and precautions.
Serenade ASO Serenade Max Serenade Opti Serenade Optimum Serenade Soil (<i>Bacillus subtilis</i> strain QST 713), 44	Vegetables & Strawberries	Bacterial speck, Bacterial spot, Botrytis, Early blight, <i>Fusarium</i> spp., Late blight, <i>Phytophthora</i> spp., Powdery mildew, <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., Target spot, <i>Verticillium</i> spp.	0	4 hr	Yes	For foliar applications, mix with copper compounds or other effective fungicides for improved disease control. See label for details regarding specific foliar and soil applications and target diseases.
Serifel Biofungicide (<i>Bacillus amyloliquefaciens</i> strain MBI 600), NC	Vegetables & Strawberries	Broad-spectrum fungicide	0	4 hr	Yes	See label for details, crop specific recommendations, and precautions.
Sil-Matrix (potassium silicate), NC	Vegetables & Strawberries	Broad-spectrum fungicide	0	4 hr	No	Must be used in a rotational program with other fungicides when conditions are conducive for disease development. See label for details.
Soilgard (<i>Gliocladium virens</i> GI-21), NC	Vegetables & Strawberries	<i>Fusarium</i> root and crown rot, <i>Phytophthora capsici</i> , <i>Pythium</i> spp., <i>Rhizoctonia</i> , <i>Sclerotinia</i> spp., <i>Sclerotium</i> spp.	0	0	Yes	For best results, apply to transplants or as a drench during transplanting. Subsequent applications can be made as drench, directed spray, or by chemigation. See label for precautions regarding use and fungicide compatibility.
Sonata (<i>Bacillus pumilus</i> QST 2808), NC	Vegetables & Strawberries	Early blight, Downy mildew, Late blight, Powdery mildew, Rust	0	4 hr	Yes	Mix or alternate with other effective fungicides for improved disease control. See label for details.

Product (Active Ingredient) Fungicide Group ¹	Crops	Pertinent Diseases or Pathogens	Minimum Days to:		OMRI- Listed	Remarks ²
			Harvest	Reentry		
Sporatec (oils of clove, rosemary and thyme), NC	Vegetables & Strawberries	Bacterial spot, Botrytis, Early blight, Gray mold, Late blight, Powdery mildew	0	0	Yes	Exercise care when applying. Begin applications once disease is observed. Use of a spreader and/or penetrant adjuvant recommended for improved performance. Do not apply when temps are above 90°F. See label for details. Ingredients are exempt from FIFRA.
Timorex Gold (tea tree oil), NC	Vegetables & Strawberries	Broad-spectrum fungicide	2	1	No	See label for specific rates and application recommendations.
SuffOil-X TriTek (mineral oil), NC	Vegetables & Strawberries	Powdery mildew	0	4 hr	Yes	See label for specific rates, application recommendations, precautions, and fungicide compatibility.
Taegro ECO (<i>Bacillus amyloliquefaciens</i> strain FZB24), NC	Vegetables	Foliar diseases: Downy mildew, Powdery mildew, <i>Pseudomonas</i> spp., <i>Xanthomonas</i> spp. Soilborne diseases: <i>Fusarium</i> spp., <i>Phytophthora</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., <i>Sclerotinia</i> spp.	-	1	No	See label for specific instructions regarding soil injected, spray, or incorporated applications. Maximum of 12 applications per season. For best efficacy, product should be applied prior to disease or disease establishment. May be applied to greenhouse produced crops.
Trilogy (clarified hydrophobic extract of neem oil), NC	Vegetables & Strawberries	<i>Alternaria</i> spp., Anthracnose, Botrytis, Early blight, Powdery mildew	0	4 hr	Yes	See label for specific rates, application recommendations, and precautions regarding use with other pesticides.
Thyme Guard (thyme oil extract), NC	Vegetables & Strawberries	Broad-spectrum bactericide and fungicide	-	-	Yes	See label for specific rates and application recommendations.
Ultra-Pure Oil (mineral oil), NC	Vegetables & Strawberries	Powdery mildew	0	4 hr	Yes	See label for specific rates, application recommendations, precautions, and fungicide compatibility.
Vacciplant (laminarin), P	Vegetables & Strawberries	Anthracnose, Bacterial speck, Bacterial spot, Early blight, Phytophthora blight, Powdery mildew	0	4 hr	No	Start applications preventatively, when weather conditions are favorable for disease development. Repeat applications until disease conditions end. Add a labeled copper product to VacciPlant if the disease symptoms appear.
Veg'Lys (garlic oil), NC	Vegetables & Strawberries	Broad-spectrum bactericide and fungicide				See label for specific rates and application recommendations and precautions. Do not apply when temps are above 90°F. Ingredients are exempt from FIFRA.

¹FRAC code (fungicide group): Number (33 and 44) and letters (NC and P) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with same number or letter) indicate the same active ingredient or similar mode of action. This information must be considered for the fungicide resistance management decisions. However, products with NC or P are considered low risk and don't require any rotation unless specifically directed on the label. NC = not classified, includes mineral oils, organic oils, potassium bicarbonate, and other materials of biological origin; P = host plant defense inducers. Source: FRAC Code List 2019; <http://www.frac.info/> (FRAC = Fungicide Resistance Action Committee).

²Information provided in this table applies only to Florida. Be sure to read a current product label before applying any product. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by UF/IFAS Extension nor discrimination against similar products or services not mentioned.

Table 3. Biopesticides labeled for management of arthropod pests of many crops.

Pest	MOA Code	Trade Name (Active Ingredient)	Rate	Days to Harvest	REI (Hours)	Remarks
Nematodes	n/a	Majestene (<i>Burkholderia rinojensis</i>)	4–8 qt	0	4	OMRI-listed.
	n/a	Melocon (<i>Purpureocillium lilicanum</i>)	2–4 lb	0	4	OMRI-listed.
	n/a	Dazitol (mustard oil + capsaicin)	6.25 gal	0	4	OMRI-listed. Apply 3–5 days preplant or 1/4 rate postplant.
	n/a	Ecozin Plus (azadirachtin)	15–30 oz/acre	0	4	OMRI-listed.
	n/a	Nemakill (cinnamon oil, clove oil, thyme oil)	32–48 oz	0	4	OMRI-listed.

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