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Microbial Pesticides for Commercial Nursery and Residential Landscapes

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What are Microbial Pesticides?

Microbial pesticides are naturally occurring or genetically modified microorganisms such as fungi, protozoa, viruses or bacteria used as the active ingredient in plant arthropod pest and disease (hereafter "pest") control products. Microbial pesticides are composed of living or killed strains of microorganisms, which directly or indirectly impact pest survival.

Microbial products can be used as an alternative to synthetic chemical pesticides in organic production, or as a rotational product in conventional production systems. Microbial products work best as preventative treatments or when pest pressure is low. Microbial pesticides are generally less toxic to the environment, humans, and other animals due to their target specificity. Microbial products generally impact a narrower range of pests, thereby limiting non-target effects. These products are considered a sustainable solution to control pest outbreaks, while also improving worker and environmental safety. Most microbial pesticides usually are considered reduced-risk pesticides, generally making them safer for use by homeowners. The microbial product label should still always be followed to ensure safe application.

A range of pests can be managed using microbial products. There are currently products labeled for use in greenhouse and field production, nursery, landscapes and interiorscapes. Many products are available to professional

applicators, and some are available to homeowners at big box stores.

How do Microbial Pesticides Work?

Microbial pesticides available today work one of several ways. A live microbial product can kill its target directly by infecting a species of insect, mite, nematode, fungi or bacterial pathogen with a fatal disease **(Figure 1)**. Additionally, a microbial product can release a toxic substance that kills other microbes in the vicinity. A third way that live microbes can control diseases is by outcompeting them for space in the soil substrate, root, or leaf tissue. Microbes in root or leaf tissue become endophytic (living inside the plant tissue), thereby preventing pathogenic microbes from infecting and killing the plant. Other formulations of microbial products include heat-killed microbes. These formulations rely on the toxic products of the microbes to kill the target pests.

The most well-known and widely used microbial products on the market are those made with the soil-dwelling bacterium, *Bacillus thuringiensis* (Bt). After infecting an insect, Bt produces a protein toxin in the insect gut, which punches holes through the digestive tract, causing the

Figure 1. Spotted wing drosophila and flatheaded wood borer larva infected with microbial pathogens.

insect to starve to death. Different strains of Bt can be selected to target larvae of different insect groups such as mosquitos, moths, flies, and beetles while leaving others unaffected.

What are the Advantages and Disadvantages of Microbial Pesticides?

Microbial pesticides usually have a narrower range of toxicity compared to chemical pesticides. Research suggests that microbial products are less likely to harm beneficial insects, honeybees, and other pollinators than chemical alternatives. The use of microbial products can potentially reduce industry reliance on synthetic chemical

pesticide sprays that may pose higher risk for negative environmental impacts. In addition, microbial products are often reduced-risk for worker handling compared to chemical alternatives. Microbial products often can be effective in smaller quantities and most decompose more quickly than synthetic pesticides. Moreover, the self-replication properties of live microbes may avoid the need for repeated application once the microbes are established in the system.

There are some disadvantages to using microbial pesticides. Live microbes require specific environmental conditions to establish and proliferate. Direct exposure to sunlight when applied as spray or liquid formulations can rapidly reduce their viability. Performance also can vary by site due to biotic and abiotic factors such as soil type, humidity, and the microbial community in the environment. Products with a narrow range of target organisms may not be useful if there is a need to control multiple pests simultaneously. As with synthetic pesticides, pest populations can develop resistance toward microbial products if they are used continuously without rotation. Lastly, some microbial products have shorter residual activity, which may reduce pest control duration or require repeated applications.

How are Microbial Pesticides Applied?

Microbial pesticides are best applied as preventative treatments or when arthropod pest populations are at low population levels. Microbial pesticides are formulated in a similar manner to chemical pesticides as dusts, liquid concentrates, wettable powders, or granules. These products can be applied by spray, media incorporation or soil drench using the same type of equipment a grower would use to apply chemical pesticides. The most common ways microbial pesticides can be applied is by spraying over the foliage or as soil drenches. Spray applications can be applied through crop dusting, tractor mounted sprayers or backpack sprayers. Sprayers can be used to augment the application of the microbial pesticide formulation by altering droplet sizes. Soil application/injections are best used for below ground pests to transfer the beneficial microbes to the root zone as quickly as possible. Microbial products may be formulated as granules for broadcast application and require water to become activated. If equipment that was previously used to apply conventional pesticides is also being used to apply microbial pesticides, the equipment should be thoroughly washed before use to prevent harm to the beneficial microbes. For example, do not apply living

microbial pesticides with equipment dedicated for chemical fungicide applications since the residues also can kill the beneficial microbes. Examples of products available for commercial nursery growers (**Table 1**) and homeowners (**Table 2**) are provided.

For additional information, contact your local nursery specialist at:

Tennessee State University, Otis L. Floyd Nursery Research Center
472 Cadillac Lane McMinnville, TN 37110
http://www.tnstate.edu/agriculture/nrc/
931-668-3023

Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

Disclaimer

This publication contains microbial pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific microbial pesticide being used. The label always takes precedence over the recommendations found in this publication. Use of trade, brand, or active ingredient names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar and suitable composition, nor does it guarantee or warrant the standard of the product. The author(s) and Tennessee State University assume no liability resulting from the use of these recommendations.

Table 1. Microbial Products Available for Management of Pests by Commercial Nursery and Landscape Professionals

Insecticides					
IRAC[1] Group	**Primary Site of Action**	**Class**	**Active Ingredient**	**Trade Name[2]**	**Target**
5	Nicotinic acetylcholine receptor modulator	Spinosyns	Spinosad	Blackhawk, Bonide Colorado Potato Beetle Beater, Captain Jack's Deadbug, Conserve SC, Conserve Naturalyte, Entrust SC[#], GF-120 NF Naturalyte[#]	Beetles, caterpillars, fire ants, leafminers, spider mites, thrips
11A	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis* and insecticidal proteins	*Bacillus thuringiensis* var. *aizawai*	Agree WG, XenTari[#]	Caterpillars
			B. thuringiensis var. *israelensis*	Gnatrol WDG[#], Teknar SC	Black flies, fungus gnats, immature flies, larval stages of mosquitoes
			B. thuringiensis var. *kurstaki*	Bactospeine, BT Now[#], Caterpillar Killer[#], Crymax, Deliver[#], Dipel Pro DF[#], Javelin WG[#], Monterey B.t.[#], Thuricide BT[#], Foray 76B	Most caterpillars
			B. thuringiensis var. *tenebrionis*	Novodor, Trident	Colorado potato beetle larvae, elm leaf beetle

			B. thuringiensis var. *galleriae*	beetleGONE!, grubGONE!, grubHALT!	Beetles, fungus gnats, white grubs
Unclassified	Unclassified MOA	Bacteria	*Chromobacterium subtsugae*	Grandevo CG[#], Grandevo WDG[#]	Colorado potato beetle larvae, white grubs
				Grandevo PTO[#]	Aphids, broad mites, caterpillars, eriophyid mites, lace bugs, plant bugs, spider mites, thrips, whiteflies, white grubs
			Paenibacillus popilliae (*Bacillus popilliae*)	Milky Spore Granular, Milky Spore Powder	Larvae (grubs) of Japanese beetle
			Burkholderia spp. (A396 strain)	Venerate XC[#]	Aphids, leafhoppers, mites, stink bugs
		Fungi	*Beauveria bassiana*	Botanigard ES	Aphids, flea beetles, lace bugs, leaf beetles, leafhoppers, plant bugs, psyllids, spider mites, thrips, weevils, white grubs, whiteflies
				Botanigard 22WP	Aphids, foliar feeding mealy bugs, lace bugs, psyllids, thrips, weevils, white grubs, whiteflies
				Mycotrol, Naturalis-L	Aphids, broad mites, caterpillars, eriophyid mites, flea beetles, leaf beetles, leafhoppers, plant bugs, psyllids, shore flies, spider

					mites, thrips, weevils, white grubs, whiteflies
			Metarhizium anisopliae (F52 strain)	Met52, Tick-EX EC	Spider mites, thrips, weevils
			Isaria fumosorosea (*Paecilomyces fumosoroseus*)	NoFly	Aphids, leaf beetles, leafhoppers, plant bugs, psyllids, thrips, white grubs, whiteflies
				Ancora[#], Preferal[#]	Aphids, broad mites, caterpillars, flies and midges, moths, plant bugs, psyllids, spider mites, thrips, weevils, white grubs, whiteflies
		Nematode	*Heterorhabditis bacteriophora*	B-Green, NemaSeek Pro Hb[#], Nemasys G, Nemashield HB, Terranem	Black vine weevil, caterpillars, Colorado potato beetle, white grubs
				ExhibitlineH, LarvaNem	Weevils, white grubs
			Steinernema carpocapsae	Millenium, NemAttack Pro SC[#]	Armyworms, caterpillars, clearwing borers, shore flies, weevils
				Capsanem, Carpocapsae System, Exhibitline SC, Nematac C	Caterpillars, thrips, white grubs
			S. feltiae	EntoNem, Nemasys, NemAttack Pro Sf[#], NemaShield, Steinernema System	Beetles, caterpillars, fungus gnats, thrips

			S. kraussei	Kraussei-System, Nemasys L	Weevils
Fungicides					
FRAC[3] Group	**Primary Site of Action**	**Class**	**Active Ingredient**	**Trade Name**	**Targets**
Biological Microbial	Multiple MOAs including competition, mycoparasitism, antibiosis, membrane disruption by fungicidal lipopeptides, lytic enzymes, induced plant defense	Bacteria	*Bacillus subtilis* QST (713 strain)	CEASE[#], Companion (GB03 strain), Rhapsody[#]	Alternaria leaf spot, anthracnose, bacterial leaf spot, black spot, fire blight, powdery and downy mildew
			B. amyloliquefaciens	Double Nickel, Monterey Complete Disease Control[#], Serifel, Stargus[#], Triathlon BA[#]	Cercospora leaf spot, gray mold, powdery and downy mildew, root and crown rot
			B. pumilus (QST 2808 strain)	Sonata	Blights, mildews, mold
			B. mycoides isolates J	LifeGard WG[#]	Blights, cercospora leaf spot, mildews, white mold
			Streptomyces spp.	Actinovate SP[#], Mycostop[#]	Alternaria leaf spot, common scab disease, damping off, gray mold, powdery and downy mildew, root and crown rot, verticillium wilt
		Fungi	*Gliocladium virens* (GL-21)	SoilGard[#]	Damping off, root rot
			Ulocladium oudemansii (U3 Strain)	BotryStop[#]	Gray mold, white mold

			Trichoderma spp.	RootShield Plus-Granules[#], RootShield-WP[#], RootShield Plus-WP[#]	Damping off, fruit rot, root and crown rot, wilt

[1]*IRAC = Insecticide Resistance Action Committee*

[2]*Tennessee State University does not endorse the use of any product. Trade names are provided for informational purposes only. The trade names include all of the products we were able to locate. However, other products may exist with these active ingredients that have not been listed. In addition, manufacturers sometimes change trade names, but the listed names on this list are current as of the date of this publication. It is the pesticide user's responsibility to always read the pesticide label (if available for the microbial pesticide being used) to ensure you know all the legal requirements to safely apply the microbial pesticide. The microbial pesticide label is the law and supersedes all other recommendations including those in this publication*.

[3]*FRAC = Fungicide Resistance Action Committee*

[#]*OMRI (Organic Materials Review Institute) listed products*.

Table 2. Microbial Products Available for Homeowners

	Active Ingredient	Trade Name*	Targets
Insecticides	*Bacillus thuringiensis sp. kurstaki*	Monterey B.t.[#], Thuricide BT[#], Caterpillar Killer[#]	Caterpillars
	Spinosad	Monterey Garden Insect Spray[#], Captain Jack's Deadbug	Beetles, borers, caterpillars, leafminers, thrips
	Bacillus popilliae	Milky Spore Powder	Larvae (grubs) of Japanese beetle
Fungicides	*Bacillus subtilis* (QST 713 strain)	CEASE[#], Serenade Garden Disease Control (Ready to use and Concentrate)	Alternaria leaf spot, anthracnose, bacterial leaf spot, black spot, fire blight, powdery mildew
	Bacillus amyloliquefaciens (D747 strain)	Monterey Complete Disease Control[#], Southern AG Garden Friendly Fungicide[#], Revitalize Biofungicide, Garden Sentinel Biofungicide	Anthracnose, brown patch, downy mildew, gray leaf spot, gray mold, powdery mildew, root and crown rot

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