

## INSECT MANAGEMENT

### Insecticides

Follow the label specifications for application rates. **If the rate suggested in this guide does not agree with the current label, follow the label recommendations.** Amounts of pesticides are in lb/A (pounds per acre) of commercial formulation, not a.i. (active ingredient), unless otherwise stated. The percentage by weight or concentration of a.i. varies with different brands of pesticides. The label gives pounds of a.i. in each commercial preparation. For example, Lorsban 4E has 4 lb active ingredient/gallon of formulated material.

The amount of insecticide recommended per acre should not be changed when varying the gallonage of water per acre. Make sure a pesticide is labeled for concentrate application before using a low volume sprayer, air or mist sprayer, aircraft or other concentrate application equipment.

### INFORMATION ABOUT INSECTICIDES AND MITICIDES

<i>Common Name</i>	<i>Trade Name and Formulations</i>
abamectin	Agri-Mek 0.15EC
acephate	Orthene 75S, 75WSP
azadirachtin	Neemix 4.5, 0.25
azinphosmethyl*	Guthion 2L, 3, Solupak 50% WP, Sniper 2E
<i>Bacillus thuringiensis</i>	Biobit MP & XL, Dipel 4L, ES, DF, Raven, M-Trak, Javelin WG, Crymax, Condor, MVP, Novodor, Agree WG, XenTari
carbaryl	Sevin 50W, 80WSP, 80S, 4F, XLR Plus; Adios
chlorothoxyfos	Fortress 5G
chlorpyrifos	Lorsban 4E, 15G Chlorfos 15G, Chlorpyrifos 4E AG
cryolite	Kryocide, Prokil Cryolite
cyfluthrin*	Baythroid 2
cypermethrin*	Ammo 2.5EC, WSB
cyromazine	Trigard
diazinon	D-Z-N*, 50W, AG500, AG600, WBC; Diazinon 500-AG
dicofol	Kelthane MF, 35, 50 WSP, Dicofol 4E
dimethoate	Dimethoate 4EC, 400
endosulfan*	Thiodan 50WP, WSB, 3EC, Phaser 3EC, 50WSB
esfenvalerate*	Asana XL
ethoprop	Mocap 10G, EC
fenbutatin-oxide	Vendex 50WP
imidacloprid	Admire 2F, Provado 1.6F
insecticidal soap	M-Pede
lamda-cyhalothrin*	Warrior, Karate
malathion	Malathion 57EC
methamidophos*	Monitor 4
methomyl*	Lannate LV, SP
nuclear polyhedrosis virus	
<i>Helicoverpa zea</i>	Gemstar
oxamyl*	Vydate L
oxydemeton-methyl*	Metasystox-R
permethrin*	Ambush 25W, WP, 25W WSP, Pounce 3.2EC, 25WP, WSB
phorate*	Thimet, 20G, Phorate 20G
piperonyl butoxide	Butacide, PBO-8
spinosad	SpinTor 2SC
tebufenozide	Confirm 2F
tefluthrin	Force 3G
terbufos	Counter 15G, CR
thiodicarb	Larvin 3.2
zeta-cypermethrin	Mustang 1.5 EW, Fury 1.5 EC

\*Federally restricted-use pesticide

TABLE 13. *Bacillus thuringiensis*-based Bioinsecticides: Sources, Components, and Labeled Crops and Pests

Trade Name	<i>B. t. kurstaki</i>							<i>B. t. aizawai</i>		Bta + Btk	<i>B. t. tenebrionis</i>		Btt + Btk
	Crymax	Condor	Cutlass	Dipel	Biobit	Javelin	Lepinox	Agree	Xentari	Matth	M-Trak	Novodor	Raven
<b>Formulation(s)</b>		WP, XL	WP	2X, DF, ES	HP, XL	WG	WDG	WG					
<b>Cry toxins</b>	1Ac 1C 2A 2B	1Aa 1Ac 2A 2B	1Aa 1Ab 1Ac 2A 2B	1Aa 1Ab 1Ac 2A 2B	1Aa 1Ab 1Ac 2A 2B	1Aa 1Ab 1Ac 2A 2B	1Aa 1Ac 1F 2A	1C 1Aa 2B	1Aa 1C 2B	1Ac 1C	3A	3A	1Ac 3A
<b>Crop &amp; Pest</b>													
<b>Broccoli, Cabbage and Cauliflower, other brassicas</b>				Dipel 2X, Df									
Cabbage looper		X	X	X	X	X	X	X	X	X			
Diamondback moth		X	X	X	X	X	X	X	X	X			
Imported cabbageworm		X	X	X	X	X	X	X	X	X			
<b>Sweet Corn</b>				Dipel ES									
Armyworms (general)		X		X	X		X			X			
Fall armyworm													
Corn Earworm				X		X	X			X			
European corn borer		X		X	X	X	X	X		?			
<b>Eggplant</b>													
Colorado potato beetle											X	X	X
<b>Lettuce, endive, escarole</b>				Dipel 2X, DF									
Cabbage looper		X	X	X		X	X	X	X	X			
<b>Pepper</b>													
European corn borer		X	X		X	X							
<b>Potato</b>													
Colorado potato beetle											X	X	X
European corn borer		X	X			X	X			?			
<b>Spinach</b>													
Cabbage looper		X	X	X	X		X	X	X	X			
<b>Tomato</b>													
Colorado potato beetle												X	X
Cabbage looper		X	X	X	X	X	X	X	X	X	X		
Tomato fruitworm		X	X	X	X	X	X	X	X	X			
Tomato hornworm		X	X	X	X	X	X	X	X	?			

Note: product labels may include additional pests or crops not listed here.

## Alphabetical Listing by Trade Names

*\*Federally restricted-use pesticide*

**Admire (imidacloprid):** Soil applied systemic insecticide for controlling aphids, flea beetles, Colorado potato beetle, leafhoppers, thrips, and whitefly.

**Agree:** *Bacillus thuringiensis aizawai* (Cry 1C, 1Aa & 2B toxins)

**Ambush\* (permethrin):** A pyrethroid insecticide.

**Ammo\* (cypermethrin):** A pyrethroid insecticide.

**Asana\* (esfenvalerate):** A pyrethroid insecticide. May be less effective at high temperatures.

***Bacillus thuringiensis*:** Available as different subspecies as wettable powders and liquid concentrates. Marketed as microbial pesticides that contain toxins produced by the microorganism *Bacillus thuringiensis*. Useful for control of caterpillars and loopers on broccoli, cabbage, cauliflower, lettuce, tomatoes, spinach, etc. or Colorado potato beetle on eggplant, potato and tomato. Check label for dosage rate and other information.

**Baythroid\* (Cyfluthrin):** A pyrethroid insecticide.

**Biobit:** *Bacillus thuringiensis kurstaki*, Cry 1Aa, 1Ab, 1Ac toxins)

**Butacide (piperonyl butoxide):** A synergist used with synthetic pyrethroids to enhance insecticide activity. See PBO.

**Condor:** *Bacillus thuringiensis kurstaki* (Cry 1Aa, 1Ac toxins)

**Crymax:** *Bacillus thuringiensis kurstaki* (Cry 1Ac, 1C toxins)

**D-Z-N\* (diazinon):** For control of leaf miners, aphids, thrips, flea beetles and root maggots on onion, cabbage and turnip. DO NOT use on pumpkins. Restricted use in CT and VT.

**Dimethoate (dimethoate):** Useful against aphids, leafhoppers, plant bugs, leafminers, thrips, other insects and mites. Kills by contact and by systemic action. Especially effective against leaf miners and pepper maggot. Check label for days to harvest (dh). Restricted use in VT.

**Dipel:** *Bacillus thuringiensis kurstaki* (Cry 1Aa, 1Ab, 1Ac toxins)

**Guthion\* (azinphosmethyl):** For flea beetles, Colorado potato beetles, hornworms, tarnished plant bug and thrips. Check label for other uses. Handle with care.

**Javelin:** *Bacillus thuringiensis kurstaki* (Cry 1Aa, 1Ab, 1Ac toxins)

**Lannate\* (methomyl):** A carbamate approved for use against European corn borer, corn earworm and armyworm on corn; aphids on tomato; cabbage looper on broccoli, cabbage, cauliflower and head lettuce. Handle with care.

**Larvin (thiodicarb):** A carbamate for the control of European corn borer, corn earworm and armyworms on fresh market sweet corn.

**Lepinox:** *Bacillus thuringiensis kurstaki*

**Lorsban (chlorpyrifos):** An organophosphate pesticide applied to the soil to control root maggots. Restricted use in CT.

**Malathion:** (malathion) A useful organophosphate because of its safety. Most useful against aphids and leafminers. DO NOT use on wet plants under poor drying conditions. May be used closer to harvest than many other pesticides; follow directions on labels.

**M-Pede:** An insecticidal soap containing potassium salts of fatty acids used to control aphids, whiteflies, leafhoppers, plant bugs, spider mites and thrips.

**M-Trak:** *Bacillus thuringiensis tenebrionis* (Cry 3A toxins)

**Metasystox-R\* (oxydemeton-methyl):** Kills by contact and systemic action. When applied to foliage, it is absorbed and translocated to aerial parts of the plant; also protects new growth. Note: Use only on labeled crops; check preharvest intervals before use.

**Monitor\* (methamidophos):** An organophosphate pesticide. Registered for potatoes to control aphids. Follow label directions strictly. Highly toxic.

**Mustang (zetamethrin):** A pyrethroid insecticide active against caterpillars, beetles, and thrips.

**Neemix (azadirachtin):** A natural product extracted from the neem tree. Wide range of activity, including aphids, caterpillars, Colorado potato beetles and whiteflies.

**Novodor:** *Bacillus thuringiensis tenebrionis* (Cry 3A toxin)

**Orthene (acephate):** An organophosphate pesticide. Registered for the control of green peach aphid and European corn borer on sweet peppers, and leafhoppers and Mexican bean beetle on beans.

**PBO (piperonyl butoxide):** A synergist intended for use as a tank mix with synthetic pyrethroids.

**Pounce\* (permethrin):** A pyrethroid insecticide.

**Provado (imidacloprid):** Represents new chemistry referred to as nitroguanidines. Used as a foliar spray to control Colorado potato beetle, aphids, leafhoppers, thrips and whitefly.

**Raven:** *Bacillus thuringiensis kurstaki/tenebrionis* (Cry 1A and 3A toxins)

**Sevin (carbaryl):** For control of leafhoppers and Mexican bean beetle on beans; borer and earworm on corn; flea beetles on tomatoes, eggplant and pepper; cucumber beetles on squash and cucumbers; leafhoppers on lettuce; cutworms. Check label for other use. Repeated treatment may encourage aphid and/or mite infestations. Highly toxic to bees.

**Thiodan\* (endosulfan):** Useful against caterpillars and aphids on cole crops; aphids and striped beetle on cucumber; aphids on eggplants, pepper, squash and tomato; flea beetles on eggplant, pepper and tomato.

**Trigard (cyromazine):** Highly effective at controlling leafminers.

**Vendex (fenbutatin-oxide):** An organotin. Controls mites on eggplant. Restricted use in CT.

**Vydate\* (oxamyl):** Controls certain insects, mites and/or nematodes on many vegetable crops.

**Warrior\* (lambda-cyhalothrin):** A pyrethroid insecticide.

**XenTari:** *Bacillus thuringiensis aizawai*, (Cry 1Aa, 1C toxins)

### What is a *B.t.* insecticide?

There are several different genera of bacteria that infect insects. However, the only commercially-available products are in the genus *Bacillus*. The most important species is *Bacillus thuringiensis*.

*B. thuringiensis* produces a protein crystal (protein toxin) and a spore during sporulation. After the ingestion of spores and protein crystals (delta-endotoxin) by susceptible larvae, the crystals are dissolved in the insect gut to form toxic subunits. The toxic subunits bind to receptor sites on the gut wall within minutes of ingestion, causing a cessation of feeding. Although the spores germinate and replicate in the insect, this only occurs after the insect is effectively dead from starvation. This bacterium can be produced in large quantities using commercial fermentors. Because it is the protein toxin that kills the insect and not an epidemic resulting from applications of the bacteria, formulations can be applied to foliage or other larval substrates in the same manner as most insecticides.

There are several subspecies (=varieties) of *B. thuringiensis* based on the serotype of flagellar antigens. These subspecies tend to be host specific. For example, *B.t.* subsp. *israelensis* is effective only against flies, *B.t.* subsp. *kurstaki* and *aizawai* against caterpillars and *B.t. tenebrionis* against leaf-feeding beetles (such as Colorado potato beetle). Because these bacteria are so host specific, they can be quickly integrated into an IPM program where biological control agents are an integral component of the program. However, there are several operative factors affecting the effectiveness of these biorational insecticides.

*B.t.s* are most effective against small larvae; their effectiveness is very dependent on daytime temperatures; the protein toxin is not very persistent, so thorough coverage of foliage is necessary; and they are host specific. In many cropping systems, there is a complex of insect pests to control which often need to be controlled at the same time. Because most *B.t.s* are so host specific, they cannot be effectively used when a complex of pest species is to be controlled unless they are used with other insecticides. Because *B.t.s* are most effective against young larvae, the timing of applications is very critical. Generally, this means sprays must begin earlier than when using synthetic insecticides. Because the protein endotoxin is not very persistent and because the amount of toxin ingested is dependent on the amount of food consumed by the larvae, which in turn is dependent on temperature, the *B.t.s* are generally not very effective at low temperatures. New formulations and genetically engineered strains are being produced commercially that are more effective than commercial products in the past.

Field studies have shown the same amount of toxin formulated as an oil is more effective than when formulated as a wettable powder or aqueous flowable. The gene of *B.t. tenebrionis*, which controls the production of the toxin used in M-Trak (kills the Colorado potato beetle), has been inserted into the bacterium *Pseudomonas fluorescens*. After the fermentation has been completed, the broth is chemically treated and heated to kill the bacteria. During this process, the protein toxin becomes encapsulated by the cell wall. This encapsulation process appears to protect the protein against rapid degradation in the field, making it more persistent. In another case, the *B.t. tenebrionis* (kills Colorado potato beetle) toxin gene and the *B.t. kurstaki* (kills European corn borer) toxin gene have been placed within the same bacterial cell to produce both toxins (Raven). This product then can be used for controlling both of these pests.

### **How can *B.t.s* be used most effectively?**

Target small larvae, DO NOT wait until large larvae are present. Make applications just before or during warmest time of day when larvae are actively feeding. Use the right nozzles and pressure to obtain thorough coverage.