

## Growers' Guide to Bt

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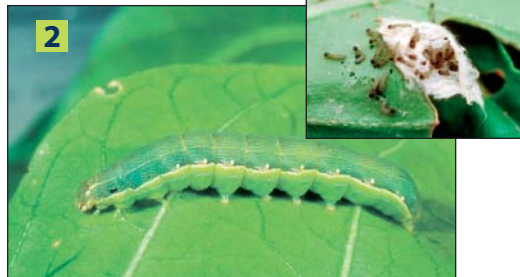


Bt is most effective when caterpillars are small.

“Bt” is the common name for a type of microbial insecticide that contains living spores and toxic crystals from a soil bacterium called *Bacillus thuringiensis*. Bt is used mostly against larvae (caterpillars) of the diamondback moth, imported cabbageworm, cabbage looper, armyworms, and tomato fruitworm. Many liquid and dry forms of Bt are available and these have different brand names (see Table 1). Brands of Bt that have *Bacillus thuringiensis aizawai* on the label are usually best for diamondback moth and beet armyworm (*Spodoptera exigua*) or small larvae of cluster caterpillar (*Spodoptera litura*)<sup>1</sup>. It is very important that Bt is used *while the caterpillars are still small*. Bt is not very effective against large larvae.



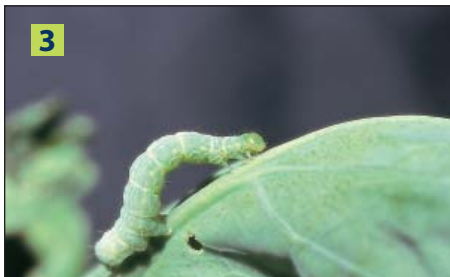
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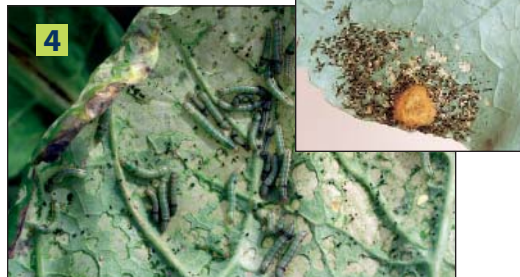
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**1) Diamondback moth**  
*(Plutella xylostella)*

**2) Beet armyworm**  
*(Spodoptera exigua)*  
 Inset: egg mass with newly hatched larvae



3



4

**3) Cabbage looper**  
*(Trichoplusia ni)*

**4) Cluster caterpillar<sup>1</sup>**  
*(Spodoptera litura)*  
 Inset: egg mass with newly hatched larvae



5



6

**5) Imported cabbageworm**  
*(Pieris rapae)*

**6) Tomato fruitworm**  
*(Heliothis/Helicoverpa spp.)*

Common vegetable pests controlled by Bt

<sup>1</sup> Cluster caterpillar (*Spodoptera litura*) occurs only in Asia and the Pacific region, including Australia and New Zealand.

**Table 1.** Commercial Bt products available for cabbage and other vegetable crop pests (2005).

	<b>Bt subspecies</b>									
	<b>Bt <i>kurstaki</i><sup>2</sup></b>							<b>Bt <i>aizawai</i></b>		<b>Bt <i>tenebrionis</i></b>
	<b>DiPel</b>	<b>Crymax<sup>1</sup></b>	<b>Condor</b>	<b>Lepinox</b>	<b>Biobit HP</b>	<b>Javelin</b>	<b>Deliver</b>	<b>XenTari</b>	<b>Agree<sup>1</sup></b>	<b>Novodor</b>
Trade Name	Valent	Certis	Certis	Certis	Valent	Certis	Certis	Valent	Certis	Valent
Manufacturer	DF, ES	WDG	F	WDG	WP	WG	WG	DF	WG	FC
Formulation(s) <sup>3</sup>	17600-32000	na	na	na	32000	53000	na	35000	25000	15000
Potency <sup>4</sup>	yes	no	no	no	yes	yes	yes	yes	yes	no
OMRI approved (for organic) <sup>5</sup>										

**Crop & Pest<sup>6</sup>**

**Broccoli, Cabbage, Cauliflower, other brassicas**

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	
Armyworms (general)	X	X	X	X	X	X	X	X	X	

**Sweet Corn**

Armyworms (general)	X	X	X	X	X	X	X	X		
Corn earworm	X (ES)						X	X		
European corn borer	X	X	X	X			X	X	X	

**Lettuce, endive, escarole**

Cabbage looper	X	X	X	X		X	X	X	X	
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**Pepper**

European corn borer		X	X	X		X	X			
Armyworms (general)	X	X	X	X	X	X	X	X	X	

**Spinach**

Cabbage looper	X	X	X	X	X	X	X	X	X	
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**Tomato**

Colorado potato beetle										X
Cabbage looper	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	X	
Tomato pinworm		X	X	X	X	X	X			

**Eggplant**

Armyworms (general)	X	X	X	X	X	X	X	X		
Colorado potato beetle										X

**Potato**

Colorado potato beetle										X
European corn borer	X (ES)	X	X	X		X	X			

<sup>1</sup> These products contain crystal proteins from both *Bt kurstaki* (Cry 1Ac) and *Bt aizawai* (Cry 1C).

<sup>2</sup> Another *Bt kurstaki* product, Thuricide HPC, is sold by several companies including Bonide, American, etc.; it is intended primarily for the home garden market and not intended for use by commercial growers.

<sup>3</sup> DF = Dry flowable, F = oil flowable, FC = water-based flowable concentrate, ES = oil-based emulsifiable suspension, WP = wettable powder, HPC = high potency concentrate in water, WDG or WG = water dispersible granules.

<sup>4</sup> Number of effective killing units (crystal proteins, spores, etc.) per milligram of the product as determined by bioassay; potency for Novodor is expressed as units per gram. These data should not be used to compare products that use different test insects (see text); "na" = information not available.

<sup>5</sup> OMRI status as of 2005; check current label.

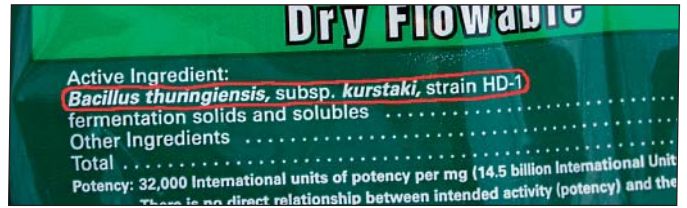
<sup>6</sup> An 'X' in the table indicates that these specific crop and pest combinations appear on the product label; see current product labels for additional labelled crops and pests.

The use of trade names in this publication does not imply endorsement of the products named nor criticism of similar products not mentioned. This guide is for reference only; the most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information.

**Bt** is very safe and causes no harm to humans, fish, wildlife, or beneficial insects. One of the greatest advantages of using Bt is that it does not kill insect natural enemies which help control many pests. Many types of Bt are also approved for use in organic vegetable production.

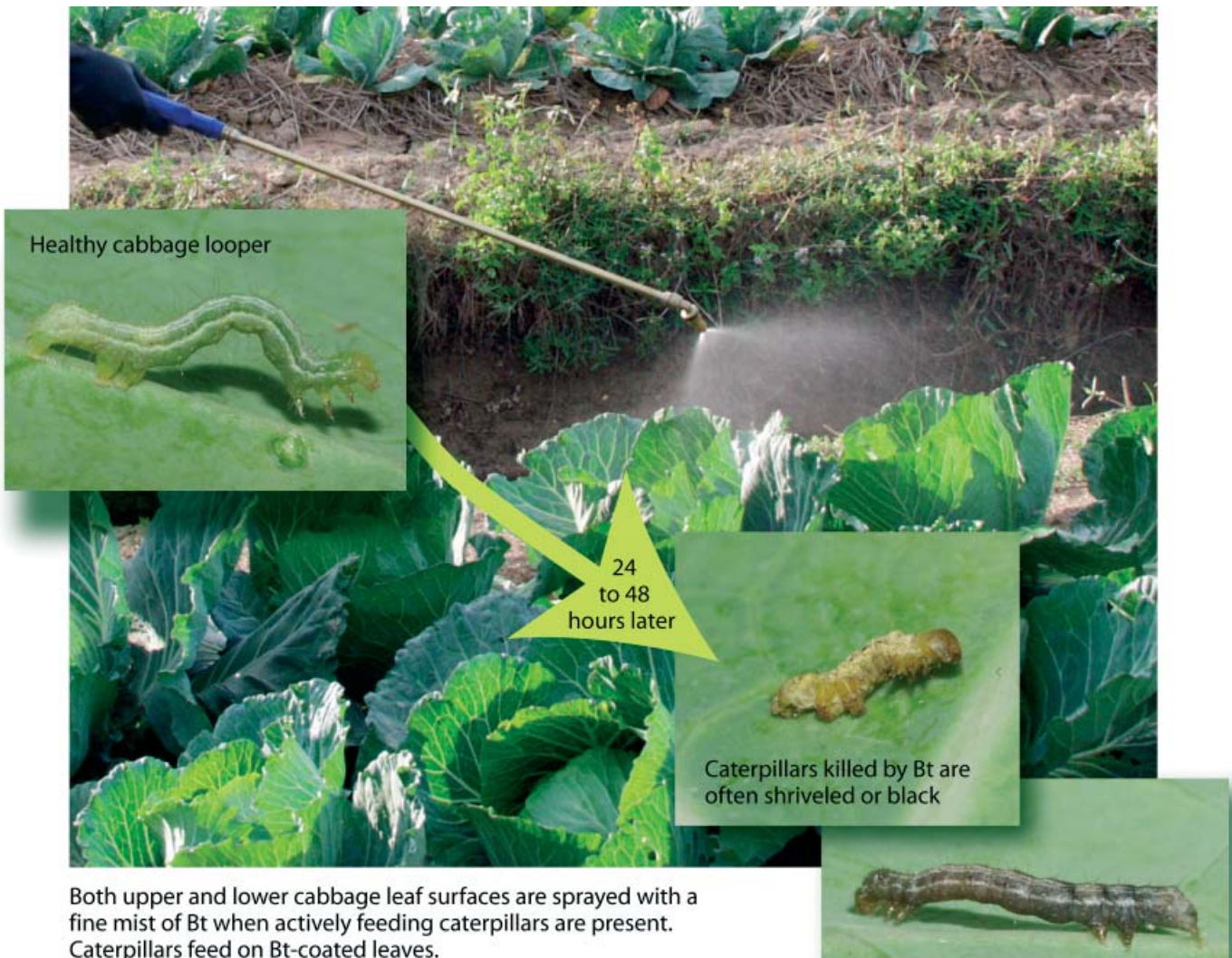
Bt works differently than most insecticides. Pest caterpillars must eat very small amounts of the Bt-sprayed leaves before they will die. After eating Bt, the insects will not die quickly *but will get sick and will stop feeding almost immediately*. It may take one to two days for the larvae to die after eating Bt (Figure 1). It will take longer for larger larvae. Very large larvae and larvae already inside cabbage heads are not likely to be killed by Bt.

In several tropical countries and in parts of Florida and Hawaii, diamondback moth has at times developed resistance to brands of Bt that contain “*Bacillus thuringiensis kurstaki*” as the main ingredient. Both types are still effective in most states. Check the product label to see if it contains Bt *aizawai* or Bt *kurstaki* (Table 1.)



This Bt product contains *Bacillus thuringiensis kurstaki*.

**Figure 1.** Caterpillars stop feeding almost immediately after eating very small amounts of Bt-sprayed leaves; they die of blood poisoning and/or starvation within one or two days.



Both upper and lower cabbage leaf surfaces are sprayed with a fine mist of Bt when actively feeding caterpillars are present. Caterpillars feed on Bt-coated leaves.

## Guidelines

1. **Inspect fields twice per week.** Check at least 20 plants/field and spray when IPM treatment thresholds are reached. If you or someone else cannot scout your fields, it may be necessary to spray Bt every three to seven days. Use the correct dosage on the product label. Use higher rates of Bt if larvae are large or when heavy infestations occur. Remember, **Bt is most effective against small, newly hatched caterpillars.** Treat immediately when the first feeding damage is observed.
2. **Apply Bt late in the afternoon.** Bt loses some of its effectiveness if exposed to periods of strong sunlight.
3. Be very careful to **spray the undersides of leaves** as well as the tops. This is where diamondback moth and most other cabbage worms begin feeding.
4. Use **good quality nozzles** on your sprayer that will produce a fine mist of spray. Higher pressure from your sprayer will also mean better coverage and improved control.
5. **Always mix Bt with a spreader-sticker** on cabbage and other crucifer crops. This is very important. Otherwise the spray will not remain on the leaves.
6. **Use drip or furrow irrigation.** Sprinkler irrigation and hand watering washes off Bt after it is applied. Reapply Bt if heavy rains occur within 48 hours after application.
7. **Use a fresh mixture of Bt for each application.** Do not try to save the leftover mixture in the sprayer to use another day. It will start losing effectiveness if left standing for more than a day. For best results, use it only on the same day it was mixed. Also, do not use any water-based liquid Bt that was saved from last year. Buy a new bottle or package each year and ask the age of the product. Buy well-known brands from reputable dealers rather than just the cheapest product.
8. If weekly sprays are necessary for three weeks or more, **do not use Bt every time.** Use neem or another reduced-risk insecticide after every two to three sprays of Bt. Neem is also approved for organic production but may do more harm to some beneficial insects than Bt.

### Acknowledgement

The authors would like to thank Ruth Hazzard, Ph.D., University of Massachusetts, for permission to use an adaptation of her "Bt Product List" in Table 1.

### Photo credits

Photo of a tomato fruitworm (*Heliothis/Helicoverpa* spp.) on page 1 courtesy of Alton N. Sparks, Jr., The University of Georgia <[www.ipmimages.org](http://www.ipmimages.org)>. All other photographs by the authors.

### For further information

See ID-156, *Bt Basics for Vegetable Integrated Pest Management* available on the Web at <<http://www.ca.uky.edu/agc/pubs/id/id156/id156.pdf>>.



Field scouting for pest infestations.



Both upper and lower leaf surfaces should be sprayed with a fine mist for best results.



Drip irrigation enhances pest control as it minimizes Bt wash-off.

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