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Colorado Potato Beetle: Organic Control Options

CURRENT TOPIC

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Introduction

Colorado potato beetle (CPB), *Leptinotarsa decemlineata*, is native to the United States. Its original range was restricted to the eastern part of the Rocky Mountains, where it fed on the buffalo bur, a plant of no economic importance. Once the potato was introduced to this region, the beetle quickly moved into the crop and began spreading eastward from potato patch to potato patch, reaching the East Coast by 1874. The pest is now found throughout North America, except in parts of Florida, Nevada, California, and eastern Canada.

The CPB is the most economically damaging pest to potatoes in most areas of the United States. If left uncontrolled, it can completely defoliate a potato crop. Although the potato is its favorite food, the beetle may also feed on tomato, eggplant, tobacco, pepper, ground cherry, petunia, and even cabbage crops. It also attacks a number of common weeds including jimson weed, henbane, horse nettle, belladonna, thistle, and mullein (1). CPB has developed resistance to most registered pesticides, making it one of the most difficult insect pests to control (2).

The life cycle of the CPB varies according to where it is found. In northern Maine, it completes one generation per year; farther south it completes three generations per year. The adult beetles overwinter 12–18 inches below the soil surface in the potato field, and in protected sites around the field. The adults emerge in late spring, move into the field, establish themselves on a plant, and mate. Females lay egg masses on the undersides of leaves in batches of approximately 25 eggs. A single female may lay up to 500 eggs. Because the eggs are laid in clumps, the larvae tend to be found in clumps as well (2).

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NCAT

Cultural and Physical Controls

A combination of several strategies can help keep CPB populations under control. Crop rotation can delay CPB population buildup, but will not prevent an infestation unless fields are fairly well isolated. The effects of crop rotation and field proximity on populations of CPB and incidence of early blight (*Alternaria solani*) were quantified in a study done in the early 1990s (3). The researchers noted that the infestations of both these pests were inversely related to the distances between rotated fields and the nearest locations where potatoes were planted the previous season. In other words, the farther this season's potato field is from last season's potato field, the fewer the pest problems.

Research at Cornell University demonstrated the efficacy of flame technology in controlling overwintering CPBs. The most effective time for flaming is between plant emergence and 8 inches in height. Taller plants are less heat-tolerant and the canopy shields many of the pests. Best control is achieved on warm, sunny days when beetles are actively feeding on top of the plants. In trials, flaming resulted in 90% control of overwintering adult CPB, whereas chemical insecticides provided only 25–50% control. Flaming also reduced egg hatch by 30% (4).

For more information on propane flame weeding, including specifications and sources of flame weeders, see the ATTRA publications *Flame Weeding for Agronomic Crops* and *Flame Weeding for Vegetable Crops*.

CPB can be excluded from crops with the use of "floating row covers," a thin fabric spun from a synthetic material. The product allows air and moisture to travel through it, while preventing pest species access to the plants. For more information on row covers, see the ATTRA publication *Season Extension Techniques for Market Gardeners*.

Another exclusion strategy is the use of plastic-lined trenches as a barrier to CPBs entering a potato field (5). Beetles can walk on clean plastic mulch at an angle, but once the plastic is coated with fine soil particles, this becomes impossible. Trenches with walls sloping at greater than 46° will retain an average of 84% of all adults caught under field conditions. A potato field surrounded by plastic-lined trenches might see its population of overwintered adult beetles reduced by nearly half. Small numbers of beetles escape from the trenches during periods of rain, but once the plastic dries, footing again becomes impossible for the insects. Further details on this strategy are presented in the 16-minute video from Cornell Cooperative Extension, mentioned above.

In a similar vein, Canadian researchers have developed a portable field-edge trap to keep CPBs from entering potato or tomato fields after overwintering (6). The first prototype was constructed from sheet metal, and a subsequent version was made of extruded plastic. The design, which received a U.S. patent, makes it easy for beetles to crawl up the sides, where they eventually fall into the trap. Dozens of CPBs per linear foot were trapped during field tests.

According to another study, mulching with wheat or rye straw may reduce the CPB's ability to locate potato fields, and the mulch creates a microenvironment that favors CPB predators (7). In the first half of the season, soil predators—mostly ground beetles—climb potato plants to feed on second- and third-instar larvae of the CPB. In the second half of the season, ladybird beetles and green lacewings are the predominant predators, feeding on eggs and on first and second instars. Mulched plots supported greater numbers of predators compared to non-mulched plots, resulting in significantly less defoliation by CPB. Tuber yields were increased by a third.

A mechanical strategy that stimulated considerable interest in the late 1980s and early '90s was the bug vacuum. These were rather large, tractor-drawn machines that sucked insects from the crop plants and killed them, usually by shattering them against the fan housing. One particular unit—the beetle eater—was intended for use on CPB in potatoes. Interest in insect vacuums was not long-lived. Problems were noted with soil compaction, loss of beneficial insects, and lack of efficacy on heavier pests deep within crop canopies (8). A few machines, however, remain in com-

mercial use (9). For further information, request the ATTRA publication *Bug Vacuums for Organic Crop Protection*.

Varietal Resistance

Several genetically-engineered potato varieties are available to commercial growers, but these are not permitted in certified organic production. A few traditional potato varieties (e.g., 'Russet Burbank') seem to be more tolerant of CPB than others, but none of them can be considered "resistant."

The April 1989 issue of *National Gardening* highlighted research on planting early-maturing varieties that develop potato tubers before CPB populations explode (10). It lists seven varieties that mature in 75 to 88 days—Caribe, Norland, Pungo, Redsen, Sunrise, Superior, and Yukon Gold—and illustrates the growth stage of the potatoes versus CPB emergence and larval development. This practice may prove especially beneficial to growers in northern regions, where cooler temperatures slow insect development.

Biological Control

CPB has several natural enemies, but they are rarely seen in commercial potato fields because of heavy pesticide use and lack of habitat to support them. Even under organic growing conditions, where natural enemies are more abundant, they will probably not completely control the CPB. The generalist predators—ladybird beetles, lacewings, predatory stink bugs, spiders, etc.—provide some control. There are also a number of CPB parasites. *Doryphorophaga doryphorae* and *D. coberrans* are two species of fly that parasitize CPB larvae; a wasp, *Edovum puttleri*, parasitizes eggs.

Increasing habitat for natural enemies by providing pollen and nectar sources along field borders or by planting insectary strips in the field can increase the effectiveness of these biological controls. ATTRA has more information on this technique in the *Farmscaping to Enhance Biological Control* publication. As mentioned above under "Cultural and Physical Controls," mulching also favors CPB predators.

Botanicals

A few commercial botanical preparations are available for use on CPB. Rotenone is derived from the roots of a South American plant. Since it is somewhat slow at killing pests, it is often combined with pyrethrum for a faster "knockdown." Plant protection is relatively brief, usually lasting two days or less. Rotenone must be used with caution as it is quite toxic to fish and swine. Rotenone is a restricted material, one that should be used only when other, less severe options fail to exert adequate control. Be certain to read the label directions for specific instructions and cautions.

Various products with the active ingredient azadirachtin (from neem tree seeds) have some efficacy against CPB in the early crop stages. These include Neemix™, BioNeem™, and Margosan-O™. However, spray concentrations of 1% and greater may cause phytotoxicity on potato plants (11). Furthermore, though they were once considered benign to beneficial insects, neem products have demonstrated some negative impacts. Washington State research has found neem to be toxic to ladybeetles, especially in their early larval stages (12). Meanwhile, research in Maine found neem less effective than *Bacillus thuringiensis* (see "Biopesticides" on page 4) (13).

Pyola™ is a natural insecticide product that combines canola oil with pyrethrins. It is recommended for use on cucumber beetles, flea beetles, Mexican bean beetles, squash bugs, aphids, mites, and CPB (14). However, since much of the canola oil on the market is derived from genetically engineered plants, this product may or may not be acceptable for organic production. Growers should contact their certifying agent before purchase and use.

A number of herbs and herbal extracts are also reputed to repel or inhibit CPB, though research has been far from thorough. Among the plants believed to have some effect are: catnip, tansy, sage (15), hemp (16), oak extract (17), wild potato (*Solanum chacoense*) (18), and citrus oils (19).

Biopesticides

Several biopesticide products based on the bacterium *Bacillus thuringiensis* (Bt) have become available in recent years. M-One™, made from *B. thuringiensis* ssp. *san diego*, is genetically engineered and therefore is not allowed in certified organic production. Novodor™, produced by Valent USA Corp. (20), contains *B. thuringiensis* ssp. *tenebrionis*, a form of Bt that is not genetically engineered and can be used by organic producers in most states. One source of Novodor is Peaceful Valley Farm Supply (21).

Bt is effective only if ingested by the pest, and then only in the larval stage. Furthermore, Bt sprays are generally effective only against *newly hatched* CPB larvae. Applications should be made within one to two days whenever one or both of two criteria are met:

- densities of egg masses reach or exceed 4 per 50 vines and at least 25% of the oldest masses have hatched or are hatching;
- densities of small larvae reach the treatment threshold of 76 per 50 plants or stems (22).

Bt is most effective if applied when daytime temperatures reach or exceed 75°F, because larval feeding is then increased (22).

Another biopesticide, Mycotrol™, is based on the fungal agent *Beauveria bassiana*. Like Bt, *B. bassiana* is a naturally occurring organism. Unlike Bt, *B. bassiana* is effective against all larval and adult stages of CPB. Furthermore, once *B. bassiana* is applied, it can continue to propagate and provide a significant level of CPB control throughout the remainder of the season. The most significant limitation of *B. bassiana* appears to be its sensitivity to high temperatures. Mycotrol works best between 70 and 80°F. Growth of the organism is much slower at warmer temperatures (23). As a result, this may be a poor option for growers in southern states during much of the growing season.

Emerald BioAgriculture Corp. (24), the manufacturer of Mycotrol™, recommends spraying when hatching occurs in 20–25% of the egg masses—timing similar to that for Bt. A possible strategy involves combining Bt with *B. bassiana* for optimum efficacy. While Bt is effective at killing early-instar larvae, it will also slow the growth of larger larvae and make them more susceptible to the fungus (23).

Parasitic nematodes are another control option. Commercial formulations of *Heterorhabditis* species are available and have been shown to be more pathogenic (25) to the CPB than *Steinernema* species of nematodes, which are also commercially available.

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Additional Resources

Alternative Methods for Controlling the Colorado Potato Beetle
West Virginia University Extension Service
http://www.wvu.edu/~exten/infores/pubs/pest/altmeth.pdf

Provides information on the life cycle of CPB and offers alternative control strategies.

Colorado Potato Beetle Management
Compiled by Ralph DeGregorio
http://www.fuzzylu.com/greencenter/q39/beetle.htm

Describes several methods of managing CPB.

Colorado Potato Beetle
University of Minnesota
http://www.vegedge.umn.edu/vegpest/cpb.htm

Describes biology and life cycle of CPB, as well as management options. Includes a chart identifying resistant potato varieties.

Colorado Potato Beetle
University of Rhode Island
http://www.uri.edu/ce/factsheets/sheets/colpotbeetle.html

Describes the CPB and offers cultural and biological control options.

Colorado Potato Beetle in the Home Garden
Ohio State University Extension
http://ohioline.osu.edu/hyg-fact/2000/2204.html

A factsheet providing useful information to help growers identify and manage CPB.

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