

# CODLING MOTH

Integrated Pest Management for Home Gardeners

Codling moth, *Cydia (Laspeyresia) pomonella*, is a serious insect pest of apples, pears, and English walnuts.

## IDENTIFICATION

Codling moth adults are about 1/2 to 3/4 inch long with mottled gray wings that are held tentlike over their bodies. Their appearance blends well with most tree bark, making them difficult to detect. If you are trapping the adults, codling moths can be distinguished from other moths by the dark, coppery brown band at the tip of their wings.

The larvae are white to light pink

“worms” with a dark brown head. They are one of the few worms that are likely to be found inside pear or apple fruit. Navel orangeworms may also be found in walnuts, but these can be distinguished from codling moth larvae by the crescent-shaped markings on the second segment behind the orangeworm head and by the excess webbing that they leave in the nut.

## LIFE CYCLE

Codling moths overwinter as full-grown larvae within thick, silken cocoons under loose scales of bark and in soil or debris around the base of the tree. The larvae pupate inside

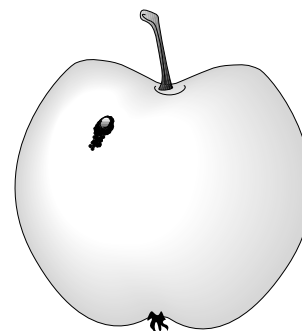


Figure 2. Entry hole of codling moth larva is often marked by a small pile of frass (a mixture of feces and food fragments).

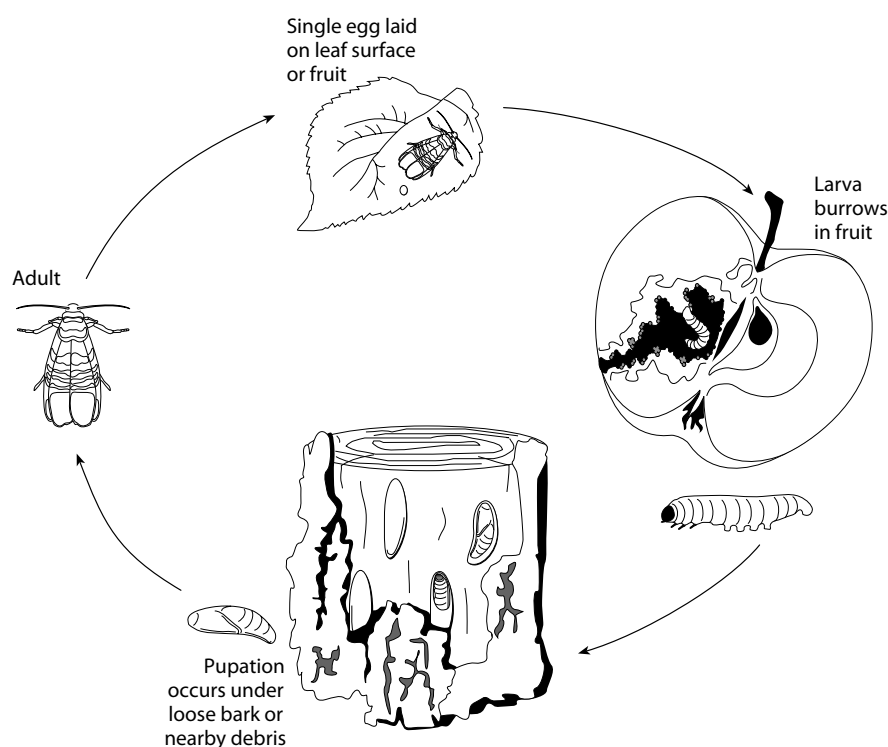


Figure 1. Life cycle of the codling moth

their cocoons in early spring and emerge as adult moths mid-March to early April (Fig. 1). The moths are only active a few hours before and after sunset and they mate when the sunset temperatures exceed 62°F. After mating each female deposits 30 to 70 tiny, disc-shaped eggs singly on fruit, nuts, leaves, or spurs. After the eggs hatch, young larvae seek out and bore into fruit or developing nuts. After completing development they leave the fruit and drop from the trees to search out pupation sites and continue the life cycle in the soil or on debris under the tree; some crawl back up the tree to pupate in bark crevices. The rate of development will vary with temperature, proceeding more rapidly in warmer weather and climates. Depending on the climate, codling moth can have two, three, and sometimes four, generations per year.

## DAMAGE

On apples and pears, larvae penetrate into the fruit and tunnel to the core, leaving holes in the fruit that are filled with reddish-brown crumbly

# PEST NOTES

University of California  
Division of Agriculture and Natural Resources

Publication 7412

Revised December 2005

droppings called frass (Fig. 2). If left uncontrolled, they can cause substantial damage, often infesting 20 to 90% of the fruit, depending on the variety and location.

In walnuts, the larvae feed on the kernels. Nuts damaged early in the season when the nuts are quite small will drop off trees soon after damage occurs. Nuts damaged later in the season will remain on trees, but their kernels are inedible. Walnuts are not as favored a host as apples and pears and untreated trees may incur very little to modest damage (10 to 15% of the nuts), depending on variety and location.

## MANAGEMENT

Codling moth can be very difficult to manage, especially if the population has been allowed to build up over a season or two. It is much easier to keep moth numbers low from the start than to suppress a well-established population. In trees with low to moderate levels, codling moth can often be kept to tolerable levels by using a combination of nonchemical management methods; however, it is important to begin implementing these measures early in the season.

Where populations are high and many infested trees are nearby, insecticide applications may be necessary to bring populations down to low levels. However, to be effective, the timing of insecticide spray applications is critical and are difficult to time accurately. In most backyard situations, the best course of action may be to combine a variety of the nonchemical and/or low toxicity chemical methods discussed below and accept the presence of some wormy fruit.

### Nonchemical Control

There are several methods for reducing codling moth that do not require the use of insecticides. Selecting varieties that are less susceptible to damage, such as early maturing apples and pears and late leafing walnuts, can greatly reduce the potential for damage. This can be especially important in the hot Central Valley climates that have additional generations and result in higher population pressure.

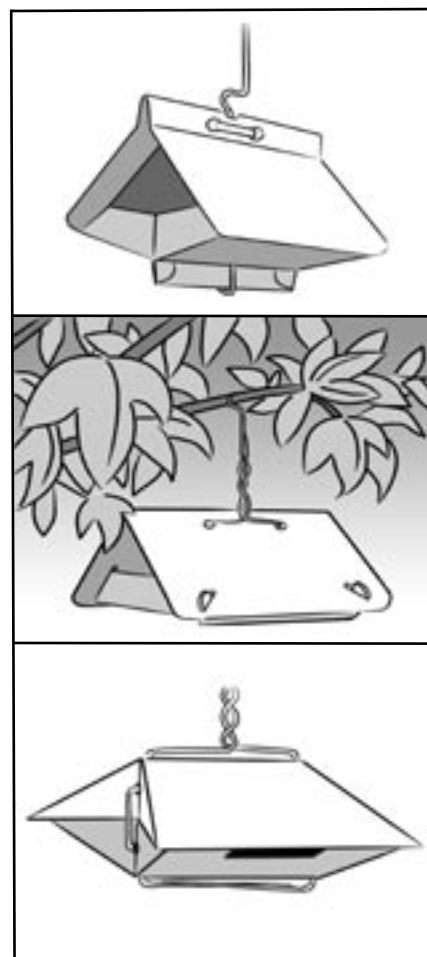
Once trees are planted, the most effective nonchemical control methods include sanitation, mass trapping, trunk banding, and fruit bagging. All of these methods are described below. Pruning trees to a height where the canopy is easy to reach also will facilitate nonchemical management of this pest.

If a backyard tree or orchard has a very high moth population, it may take several seasons diligently practicing these nonchemical control methods to reduce codling moth damage to about 10 to 20% of fruit infested. Nearby orchards or backyard trees in which no control program is in place can serve as a continual source of codling moths, thus making it even more difficult to limit damage through nonchemical means alone.

**Sanitation.** Sanitation should be the first step in any codling moth control program and it is even more important for those wishing to use primarily nonchemical management approaches. Combining sanitation with mass trapping (see below) may be all that is required in an isolated site with low codling moth populations. However, in areas with high populations or nearby unmanaged host trees, sanitation will probably need to be combined with more aggressive methods to achieve satisfactory control.

Every week or two, beginning about 6 to 8 weeks after bloom, check fruit on trees for signs of damage. Remove and destroy any infested ones showing the frass-filled holes. Removing infested fruit before the larvae are old enough to crawl out and begin the next generation can be a very effective method for reducing the population. Thinning out the infested fruit has the added benefit of encouraging the remaining fruit on the tree to grow larger. It may also improve spray coverage, if sprays are used.

It is also important to clean up dropped fruit as soon as possible after they fall because dropped fruit may have larvae in them. Removing infested fruit from the tree and promptly picking up dropped fruit from the



**Figure 3.** Several different pheromone trap styles can be used to monitor moths or mass trap males. Mass trapping is only partially effective.

ground is most critical in May and June, but should continue throughout the season.

**Mass Trapping.** Hanging traps in each susceptible fruit or nut tree can help to reduce codling moth populations but won't completely eliminate damage. This method works best where trees are isolated from other trees harboring codling moth (apple, pear, English walnut). It should be used in combination with sanitation and other control methods for the best effect.

Codling moth traps are available from many commercial sources, such as hardware stores, garden centers, or online. These traps usually have a

sticky cardboard bottom and are baited with a pheromone (sex attractant) lure (Fig. 3). The lure mimics the scent of a female moth, attracting males to the trap. Capturing the males reduces mating and the number of eggs that are laid.

Traps should be put up in mid-March in the Central Valley and by the end of March in coastal areas. Use 1 to 2 traps for each small tree and 2 to 4 traps for each large tree. They should be hung as high as possible in the tree canopy.

In large trees you may want to rig up a simple pulley to make it easier to check and service the trap from the ground. You can do this by looping a length of rope or sturdy twine over a high branch leaving the ends long enough to hang down 3 to 4 feet off the ground; knot the ends together to form a continuous loop and tie the trap to the knot; pulley the trap up to the high branch and secure the end of the loop to a low branch or nail so the trap will stay aloft.

Check the traps every week or two to remove dead moths and stir the adhesive to maintain its sticky quality. Refresh pheromone lures according to the manufacturer's recommendations, and change the sticky bottoms every 4 weeks or sooner if they become too dirty to capture moths.

You can also make a homemade bait trap consisting of a 1-gallon plastic milk jug containing the following: 1 cup cider vinegar, 1/3 cup dark molasses, 1/8 teaspoon ammonia, and enough water to make 1-1/2 quarts of liquid. Cut a 2-inch diameter hole just below the shoulder of the jug. Leave the cap on the jug. Hang the jug in the tree using a wide strip of cloth to disperse the weight of the jug and protect the tree branch. As an attractive food source this trap will capture both male and female moths. While research is not available on the effectiveness of these traps, backyard gardeners have reported success with this method. You can use up to 3 of these bait traps per large tree or you may want to use both bait and pheromone traps in the same tree to maximize capture.

**Trunk Banding.** A traditional, non-chemical method for controlling codling moth is to trap mature larvae in a cardboard band as they climb the trunk seeking a place to pupate. Banding works best on smooth-barked varieties such as Red Delicious apple, which don't provide good alternative pupation sites; scaly-barked varieties like Newtown Pippin and most types of pears have so many crevices on the trunk that many larvae will pupate before they get to the banded area. Even in the best situations, banding will only control a very small percentage of the codling moths because many pupate elsewhere on the tree or in the ground. This is the least effective of the nonchemical control measures and is best used as a supplement to sanitation and mass trapping to help reduce very high populations.

If you would like to try this as a supplemental control, use a 4-inch-wide strip of large-core corrugated cardboard which is smooth on one side and has wavy, 1/8" wide corrugations (size A flutes) on the other. Wrap it around the trunk with the corrugated side snug against the tree and the corrugations oriented in a vertical direction. Place it on the smoothest part of the trunk about 18 inches or more

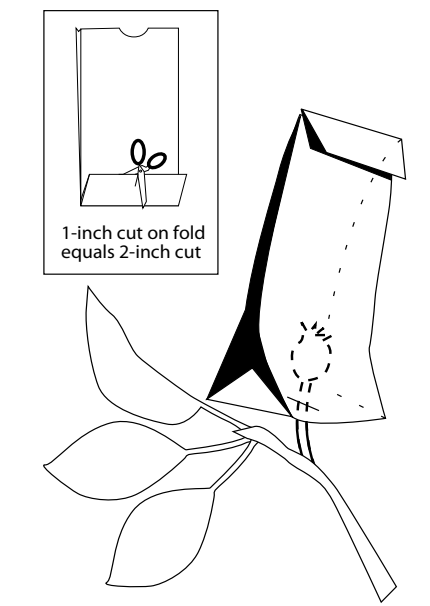
from the ground and staple the band to the tree.

For the first summer generation, place bands on the trunks just before the larvae drop from the trees to seek pupation sites: by early May in the Central Valley and by the end of May in coastal regions. Some of the codling moth larvae will crawl the tree and into the corrugations to pupate. Leave the bands on for about a month to capture as many larvae as possible before the earliest ones start to emerge as adults. By the end of May (in the Central Valley) remove and destroy the bands to kill any larvae and pupae trapped inside. By the last week of June (in coastal areas) the bands must be removed and destroyed. Be sure to crush and kill any pupae remaining on the trunk after you remove the band. Release any spiders that may be in the bands back into the orchard as they are good generalist predators and should not be destroyed.

To help control the overwintering generation, put new trunk bands up in mid-August and remove and destroy them between November and January.

**Bagging Fruit.** Excellent control can be achieved by enclosing young fruit in bags right on the tree to protect them from the codling moth. This is the only nonchemical control method that is effective enough to be used alone and in higher population situations. However, it is quite time consuming to apply the bags so this method is most manageable on smaller trees with fewer fruit. You may bag all the fruit on the tree or just as many fruit as you think you will need. Keep in mind that any unbagged fruit is likely to serve as a host and increase the pest population so it would be prudent to employ sanitation and mass trapping to keep the population in check.

Bagging should be done about 4 to 6 weeks after bloom when the fruit is from 1/2 to 1 inch in diameter. Prepare No. 2 paper bags (standard lunch bag size that measure 7-1/4 inches by 4 inches) by cutting a 2-inch slit in the bottom fold of each bag (see Fig. 4).



**Figure 4. Bagging the fruit to protect it from codling moth larvae**

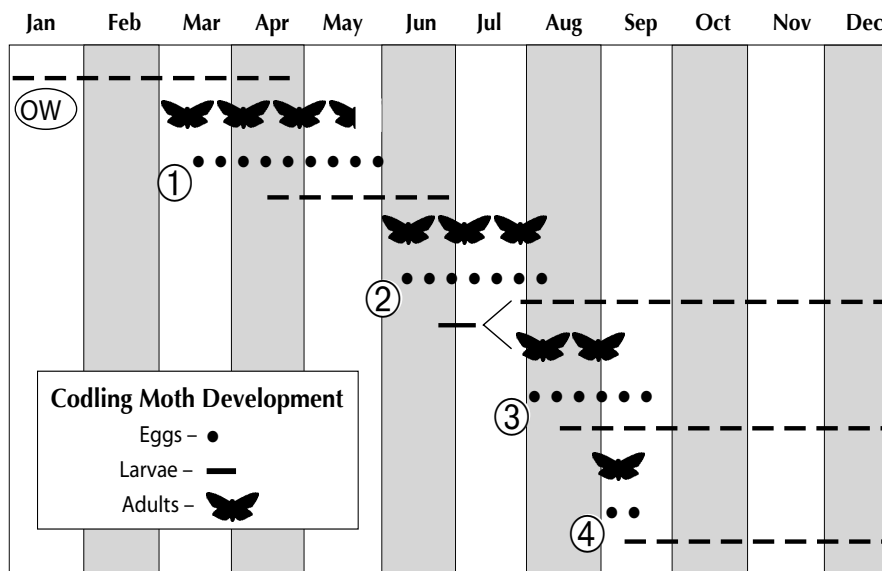
Thin the fruit to one per cluster. Slip the thinned fruit through the 2-inch slit so that it forms a seal around the stem and staple the open end shut.

This technique won't affect the maturity or quality of the fruit, but it will prevent full color development on red varieties. You'll need to open some bags to check for ripeness as harvest time approaches. Don't forget to re-close the bags if the fruit is not ready to harvest to keep them protected from codling moth attack. Other benefits to bagging include protection from sunburn and larger fruit as a result of diligent thinning.

**Biological Control.** Although a few predators such as spiders or carabid beetles may feed on codling moth larvae or pupae, naturally occurring biological control is not effective. In commercial orchards, releases of the tiny wasp, *Trichogramma platneri*, has been used successfully to manage codling moth in combination with mating disruption or soft pesticides, but this method has not been tested in backyards.

### Chemical Control

**Timing.** The proper timing of insecticide sprays is critical if they are to be effective against codling moth; they should be applied before or just as eggs are hatching. Once the worm has gone into the fruit or nut, it is protected from pesticides. The most effective way to time insecticide sprays is with a pheromone trap and a degree-day calculation. This is what commercial growers use. The trap lets them know when each generation or flight begins. The degree-day calculation lets them know just when egg hatch will occur and when the next generation should begin to fly. You can calculate degree-days with a maximum-minimum thermometer and a degree-day chart or you can use the automated weather stations and degree-day calculator on the UC IPM website. Links to these tools and complete details on using degree-days to time sprays can be found online in the Codling Moth Pest Note at [www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7412.html](http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7412.html).



**Figure 5. Generalized description of the codling moth's seasonal development. Moth flights and developmental times vary with temperature and location. Designated are (OW) overwintered population; (1) first generation in spring; (2) second generation in summer; and (3) third generation in late summer. A portion of the second generation larvae stop developing and become part of the overwintering (OW) larval population, except in very warm locations where most of the second generation completes development and, even some third generation larva can pupate and emerge as moths in late summer to create a (4) fourth generation.**

Though timing sprays is best done with the use of degree-day calculations, it may be more convenient for home gardeners to simply monitor their trees to detect the beginning of egg hatch. Starting 3 to 4 weeks after bloom, check fruit at least twice a week looking for the first "stings" (tiny mounds of reddish-brown frass, about 1/16 inch in diameter). If you scrape the frass away you will see the tiny entry hole where the newly hatched larvae has just entered the fruit. Be sure to examine the fruit where it touches another fruit, as this is a common place to find an entry hole. Spray the tree as soon as you see the first sting but first remove any fruit with stings, as the insecticide won't kill any larva that have already entered the fruit. Expect to have more damage with this monitoring method than the degree-day method since it can be difficult to find the very first sting.

Home orchards may be able to achieve an acceptable level of control by spraying the first spring generation and us-

ing nonchemical methods to maintain a low population for the rest of the season (see Fig. 5). However, if heavy infestations have occurred in previous years, or there are unmanaged host trees nearby, or if tolerance for damage is very low, the summer generation(s) may also need to be treated.

In cooler **coastal areas** look for the first stings from the spring generation in early to mid-May, about a month after bloom. Look for new stings from the single summer generation beginning in mid-July to mid-August, about 10 to 13 weeks after the spring hatch begins. Coastal areas usually have just 2 generations per year.

In the warmer **Central Valley area** look for the spring generation stings in mid to late April, about a month after bloom. Look for new stings from the first summer generation beginning in early to late June, about 8 weeks after the spring hatch began. In the Sacramento and northern San Joaquin Valleys, a second and last summer generation will begin in early to mid-August. In the very hot southern San

Joaquin Valley, look for the second summer generation stings to begin in mid July and the third summer generation to begin in mid August.

**Spinosad.** Only a few insecticides are available to home gardeners for managing codling moth. A moderately effective material for controlling codling moth and other caterpillars is spinosad. This is a biological product made from a naturally occurring bacterium called *Saccharopolyspora spinosa*. It is a low-toxicity material that is safe for most beneficial insects as well as for people, pets, and the environment. However, it only lasts for about 10 days. The first spring generation may require 2 to 3 sprays applied at 10 to 14 day intervals and beginning at egg hatch (250-300 degree-days or when the first stings are found). For any subsequent summer generations, a single spray applied at the beginning of each new egg hatch should suffice. Second sprays, applied 10 to 14 days later, may be required for high populations. No more than 6 sprays should be applied per season and it should not be applied within 7 days of harvest. The addition of a 1% summer oil (see below) to the spray tank will further enhance the effectiveness of this material. This is a relatively new material, but it is available through retail outlets under various trade names, including Monterey Garden Insect Spray or Green Light Spinosad Lawn & Garden Spray.

**Carbaryl.** One of the more effective materials against codling moth is the broad-spectrum insecticide carbaryl (Sevin). However, this material has drawbacks. It remains effective for 14 to 21 days, but it is very disruptive to natural enemies as well as honey bees. Applying more than one carbaryl spray per season may lead to an outbreak of pest mites. Also carbaryl has been associated with water quality problems. If more than one spray is needed, it may be prudent to alternate this material with spinosad or oil. Carbaryl should never be sprayed during bloom or when bees are present. It should also not be used on apples within one month of bloom as it can cause the fruit to drop; use one of the

other materials if a spray needs to be applied at this time. The homeowner should not apply carbaryl within 3 days of fruit harvest or 14 days before walnut harvest.

Carbaryl should be applied at 250-300 degree-days or as soon as you see the first sting in spring. A second application may be needed at 650 degree-days or 21 to 28 days later to cover the prolonged spring emergence. If later summer generations require treatment, a single carbaryl application should suffice for each subsequent generation as the insect develops more quickly during the warm weather of summer. Refer to the online degree-day guidelines for timing these later sprays or visually monitor for each new generation using the timing guidelines above.

**Summer Oil.** The other spray option for home gardeners is summer oil, which works by suffocating the eggs before they hatch. Oil has no residual activity and is less toxic than a broad-spectrum material like carbaryl. A pheromone trap is very useful for helping to directly time oil sprays without the need to calculate degree-days. An application of oil should be applied whenever a significant number of moths have been trapped the previous week or when the first stings are found. Because it has no residual activity, three to five applications of oil are usually required to treat each egg hatch period. Oil used alone is not very effective at controlling codling moth, and it may injure leaves or fruit if applied within 30 days of a sulfur application or during very hot weather.

**Other materials.** *Bacillus thuringiensis*, cryolite, pyrethrum, ryania, insecticidal soap, and pyrethrin/rotenone combinations are low toxicity materials that have been tested and have not been found to be effective at controlling codling moth. Mating disruption products that employ large quantities of pheromone to prevent mating, or pheromone plus an insecticide to attract and kill male moths, have proven effective for large commercial plantings but are NOT effective on small

orchards of less than 5 acres. In fact, mating disruption can increase damage if used on small plantings or individual trees.

## COMPILED FROM:

Flint, M. L. 1998. *Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide*, 2nd ed. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 3332.

Ohlendorf, B. 1999. *Integrated Pest Management for Apples & Pears*, 2nd ed. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 3340.

Both of these publications are available for purchase online at [www.anrcatalog.ucdavis.edu](http://www.anrcatalog.ucdavis.edu). ❖

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Produced by IPM Education & Publications,  
 UC Statewide IPM Project, University of  
 California, Davis, CA 95616-8620

This Pest Note is available on the  
 World Wide Web (<http://www.ipm.ucdavis.edu>)



This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Pest Management.

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This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

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Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down sink or toilet. Either use the pesticide according to the label or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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