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Managing Leafrollers on Caneberries in Oregon

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Two species of leafrolling caterpillars—the orange tortrix and the obliquebanded leafroller—infest caneberries in the Pacific Northwest. While they cause little direct damage to the fruits or canes, economic loss occurs because the larvae are often the main insect contaminant at harvest.

This is particularly true of the orange tortrix on red raspberries; it's occasionally true of the obliquebanded leafroller on trailing berries. Machine-harvested berries often display the worst contamination.

Another "worm" that commonly rolls leaves and attacks buds very early in the season is the larva of the winter moth. This worm is never a contaminant at harvest, and although it's often confused with these two leafrollers, it seldom causes enough damage before bloom to justify control.

Identification

(Color figures 1, 2, 3, 4, 5, 7, 8, and 9 appear on pages 4-5. Figure 6 appears on page 2.)

Timely identification and monitoring of the "worms" present in your fields determine the need for, and effective timing of, insecticide applications. For example:

1. orange tortrix can be a major problem for all varieties of caneberries during the season;
2. obliquebanded leafroller is usually a problem only for the later season varieties such as marion-, boysen-, and evergreen blackberries; and
3. winter moth larvae are not present in fields during harvest, but a high population density in spring (8 or more larvae per hill) can cause economic damage through extensive feeding on the developing buds.

Orange tortrix and obliquebanded leafroller larvae can be easily separated based on three characteristics: body color, color of head and shoulders, and size of full-grown larvae:

Orange tortrix

- body color ranges from straw to yellow green;
- head and shoulders are tan to light brown; and
- full-grown larvae may reach ¾″ (figure 1).

Obliquebanded leafroller

- body color ranges from pale to deep green;
- head and shoulders are brown to black; and
- larvae may reach 1″ (figure 2).

Larvae of both species wiggle vigorously backward when disturbed, often hang from silk threads, and do not crawl in a looping manner.

Winter moth larvae are distinctive from leafrollers. They are lime-green loopers with yellow to cream-green stripes along each side of the body. They have green heads, and their body length may reach 1″ when full grown (figure 3). The larvae have only two pairs of stubby legs on their abdomen, but leafroller larvae have five pairs—four in the middle of the abdomen and one on the end. Larvae of winter moth usually crawl in a looping manner and do not wiggle backward when disturbed.

Orange tortrix adults are small moths, about ½″ long with a wingspan of 5/8″. Both sexes are brownish or buff colored with a saddle- or V-shaped darker brown area

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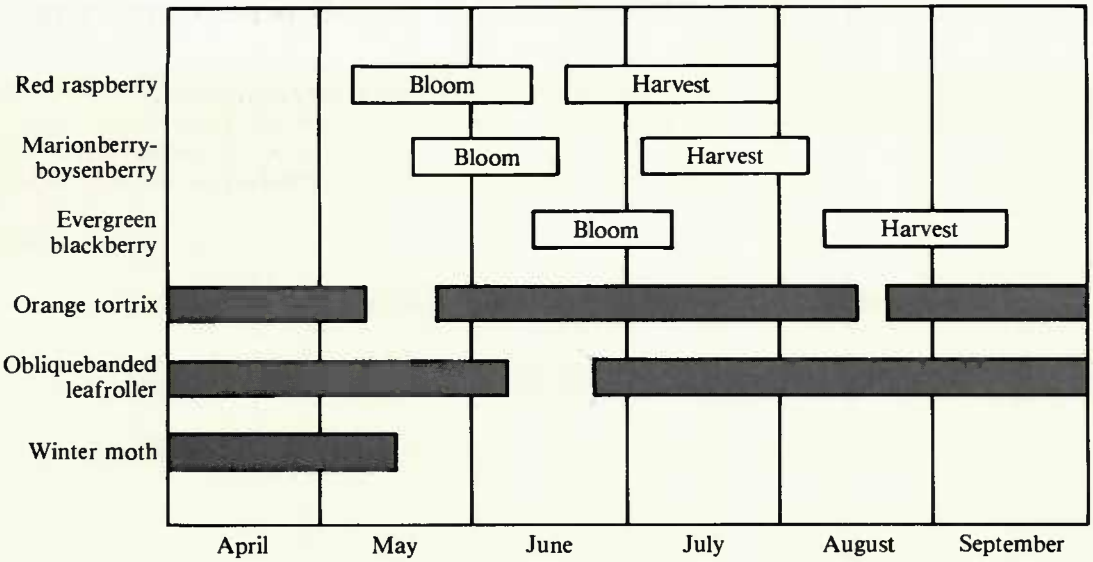

Figure 6.—Caneberry harvest and appearance of leafroller larvae.

across the folded wings (figure 4). Males are smaller than females and have a pair of crescent-shaped dark markings on the wing margins.

Obliquebanded leafroller adults look like orange tortrix adults, but they tend to be larger, with a wingspan ranging from ⅞″ to 1¼″. The moths have a bell-shaped silhouette at rest (figure 5). Their forewings are reddish brown with two oblique bands, and their hindwings are light yellowish tan. Males are smaller than females and have narrower abdomens. Wing patterns of older adults for both species may be worn and indistinct.

Winter moth adults are never encountered during the growing season. This species has one generation a year with the adults alive from November through January.

Leafroller biology

In the Pacific Northwest, orange tortrix has two to three generations a year (figure 6). Larvae may feed and overwinter on a variety of plant species in and surrounding caneberry fields, but *the vast majority overwinter* in commercial caneberry fields.

In caneberry, orange tortrix overwinters in a range of larval stages. The larvae are usually found wrapped in dead leaves on canes tied on trellises (figure 7). During the winter and spring months, larvae feed on dead leaves, living canes, and buds.

Larvae are susceptible to low temperatures and ice storms that can occur during the winter months. Only individuals in the most protected habitats survive these periods of cold and frost. These habitats are most often found in the mats of dead leaves either tied up with or covering the canes. It appears that larvae don't survive among dead leaves on the ground at the base of canes.

Variation in susceptibility to winter temperatures among larval stages has been found to affect the numbers of larvae that survive to be adults and the timing of adult emergence in the spring. Analysis of winter temperature patterns and pheromone trap records suggests that the occurrence of a cold winter can delay adult emergence considerably by selectively killing the older, more developed larvae.

If warm spring temperatures follow a mild winter, orange tortrix moths may first emerge as early as March. If a cool spring follows a severe winter, they may emerge as late as April. Peak spring emergence can range from late April to mid-May (table 1). Generations during summer and fall tend to overlap, but distinct peaks in moth flight occur during spring and in August-September.

The large variation in timing of adult emergence in spring causes an equally large variation in timing of egg hatch. If the winter was mild and spring temperatures are warm, egg hatch may peak during May. If the winter was severe and spring temperatures cold, egg hatch may not peak until mid-June (table 1).

During summer, larvae are solitary feeders on new plant growth, rolling the terminals and lateral leaf clusters (figure 8). When populations are large, larvae may also

Table 1.—Average degree-day totals and approximate seasonal occurrence of key events in the life history of orange tortrix

	Mild winter and spring		Cold winter and spring	
Peak event	Total degree days[a]	Approximate date	Total degree days[a]	Approximate date
Pheromone trap catch[b]	850	4/30	950	5/15
Female adult emergence	940	5/10	1,040	5/25
Egg laying	1,000	5/15	1,100	5/30
Egg hatch	1,270	5/27	1,370	6/15
Density of large larvae	2,070	7/15	2,170	7/20

[a] Degree days are calculated with a lower threshold of 41°F from January 1.
[b] Note that a second peak in trap catch may occur in some fields later in June. This is unrelated to female activity in fields.

feed on ripe fruit. On red raspberry, larvae may be found within the cup of the berry (figure 9). On boysenberry, larvae may bore into the fruit through the calyx.

Obliquebanded leafroller in the Northwest has two generations a year (figure 6) and overwinters as an inactive larva on canes under loose bud and bark scales. An important pest of tree crops and caneberry, it develops on a large number of hosts.

It's usually a more serious problem on trailing berries than on red raspberry—presumably because of the later timing of harvest for these fruits compared to raspberry (figure 6). Behavior and habits of larvae are similar to those of orange tortrix.

Natural control

A number of beneficial insects and spiders play an important role in reducing populations of leafrollers. Mortality of eggs and small larval stages may be extremely high in some caneberry fields. Parasite levels up to 60% may occur in overwintering orange tortrix populations.

During the summer generation, parasite levels may be high for both species of leafrollers. In general, all life stages of parasites and predators are sensitive to insecticides; unfortunately, these sprays reduce the parasites' ability to control leafroller populations.

Cultural practices

After harvest, when you decide when and how to cut out old fruiting canes and tie up new primocanes, you consider a number of factors, including labor availability, avoiding frost damage, and controlling plant pathogens (for example, *Septoria* sp.). But consider this one, too: good cane maintenance can really cut down populations of orange tortrix.

Where will you likely find the largest populations of orange tortrix? Fields where leaves are caught by, and stick to, canes and trellises. They increase winter survivorship of larvae by protecting them from drying out, frost, and low temperatures.

In fields where orange tortrix has been a problem, you can do a better control job if you remove old canes in the fall, delay cane tying until the majority of leaves have dropped, and *loosely* tie canes on the trellis. Furthermore, most obliquebanded leafroller larvae overwinter on the old canes, so removing these canes after November 1 and before March 1 may be a good way to reduce their populations.

Controlling primocanes may be another cultural approach useful in reducing leafroller infestations, especially in alternate-year fields. Newly hatched larvae experience high mortality and reduced growth rates when developing on mature caneberry leaves. During summer, larvae feed primarily within leaf terminals of new canes.

Removing these canes increases yield and cane quality, and it reduces labor costs associated with pruning. Adjust your timing of these practices in the spring to increase mortality of young orange tortrix larvae.

Monitoring leafroller infestations

Late March through April is the time to inspect canes in each field. This will establish the presence of leafrollers and other potential pests of caneberry. Pry off dead leaves wrapped to canes and open leaf rolls and webbed leaf terminals to determine which species is present and if they are alive. *Don't confuse winter moth larvae with leafrollers.* The number of leafroller larvae you find during a timed search can provide a rough estimate of field populations.

Older orange tortrix larvae that overwinter among dead leaves usually remain and pupate in this habitat. Therefore, detecting this pest in the spring is difficult unless you search through the dead leaves. If few dead leaves were tied up on the trellis, inspect rolled terminal leaves of new spring growth.

Obliquebanded leafroller larvae usually move from their overwintering sites on the canes to feed on new leaves in the spring—so searching canes for rolled leaves is an adequate technique to detect their presence. Note that if you find only a few leafroller larvae during your field search, you may not need to control leafrollers before bloom.

Sample your fields again for leafrollers, from 10 days to a week before harvest, to determine if insect contamination will be a problem. Place a white cloth on the ground beneath canes and shake them vigorously. Leafrollers and other contaminants (spiders, weevils, and lygus bugs) will readily fall to the ground, particularly on warm, sunny days.

Do this in a number of areas within each field. The presence of a few leafroller larvae in your samples before harvest suggests control action may be needed, particularly if you use a mechanical harvester.

Using and interpreting sex pheromone traps

Pheromone traps offer another approach to monitoring methods. They have been used successfully in caneberries to decide whether and when leafroller control is needed.

To reduce variability in trap results and to allow reliable interpretation of trap-catch data, it's important to follow a standard program when you use pheromone traps. This includes the concentration and type of synthetic lure, the type of trap design, the regular maintenance of traps and lures, and the best density and placement of traps.

The following recommendations have been based on research using the Trece (Zoecon) Pherocon pheromone bait with a white, delta-shaped sticky trap.

Place pheromone traps for orange tortrix in fields by April 1 and traps for obliquebanded leafroller by May 15. However, in warmer than average years, monitoring the entire flight period for orange tortrix may mean you'll need to place traps earlier.

Text continues on page 6.

Figure 1.—Orange tortrix, larva.

Figure 2.—Obliquebanded leafroller, larva.

Figure 3.—Winter moth, larva.

Figure 4.—Orange tortrix, adults.

Figure 5.—Obliquebanded leafroller, adult. (Figure 6 appears on page 2.)

Figure 7.—Overwintering site on caneberry for orange tortrix larva.

Figure 8.—Rolled leaf indicates presence of either orange tortrix or obliquebanded leafroller larva.

Figure 9.—Occasionally, orange tortrix larvae invade fruit.

Hang traps on the top trellis wire near canopy height. Be sure that trap openings are not covered by vegetation. A trap density of one trap per 5 acres is recommended.

Place traps in the center and borders of each field; however, the best placement involves wind direction and possible sources of immigrants—for example, brushy areas along the edge of woods and rivers. Place traps on high points in the field when possible.

Inspect traps once or twice weekly. Count the moths and scrape them out. Replace liners every 4 weeks—sooner if stickum coverage is poor or becomes covered with moths or dirt and debris. When replacing a liner, remember to spread the stickum evenly across its surface.

Store pheromone lures in a sealed plastic bag in a freezer until you use them. Replace lures at recommended intervals. Remove old lures and wrappers from fields so they won't compete with the new lure in attracting male leafrollers.

Occasionally place *guard traps* between your field and a known source of infestation like an abandoned field. These traps intercept male moths from other areas. Otherwise, these moths would be caught in the traps placed in your caneberry field, and they'd cause much larger trap catches—a distorted indication of your field's infestation.

Pheromone trap catches of male moths have been used to determine the pest levels at which control measures are needed, which may include insecticide sprays to prevent pest damage in caneberry. A strong relationship exists between cumulative trap catch of orange tortrix early in the season (before bloom) and overwintering population density in fields.

Fields without an overwintering larval population may have widely varying trap catches. As we've mentioned, movement of male moths from surrounding fields and habitats is an important factor affecting the magnitude of trap catches.

Furthermore, the relation of trap catch with leafroller population density during summer is affected by a number of factors, including the level of biological control present within each field. Results over the last 8 years, however, suggest pheromone traps can be used successfully to provide a conservative estimate of the potential for leafroller infestations during harvest.

Orange tortrix

Three classes of pheromone trap catch have been established to determine the need for an insecticide application before harvest.

Factors to consider. However, you should be aware of additional factors that can help you successfully evaluate the need for chemical control. These include:

a. previous field records of leafroller problems,
b. the severity of the previous winter,
c. the potential for immigration of moths from the surrounding environment,
d. the degree of correct trap maintenance practiced,
e. whether the field will be mechanically harvested, and
f. current signs of larval populations.

Class 1. Peak pheromone trap catch of less than 20 moths/week or total catch of less than 60 moths before bloom suggests that later counts of larval populations will be low—consequently, the need for chemical control is low.

Class 2. Maximum trap catch between 20 and 70 moths/week or total catch between 60 and 200 moths before bloom means you must especially consider factors *a* through *f* (above) to determine whether to use chemical control specifically for this leafroller.

Class 3. Peak trap catch of more than 70 moths/week or total catch of more than 200 moths before bloom strongly suggests a local orange tortrix population is present in or surrounding your field. Therefore, control action is usually recommended.

Obliquebanded leafroller

Keep in mind that these are generally not a problem on red raspberry because of the crop's relatively early harvest in relation to larval development. On trailing berries, however, egg hatch may occur during harvest and cause serious contamination problems.

Determine the need for control based on the presence of obliquebanded leafroller larvae, past experience with this pest, and whether trap catches exceed 50 moths/week in your fields before and during early bloom.

Prediction models

Models for predicting pest development have been widely developed and implemented in agriculture. Understanding the timing of insect pest development is essential in designing effective management programs.

Insects pass through several life stages that vary in their susceptibility to control measures. Targeting control towards the susceptible stage(s) requires the ability to predict when that susceptible stage is likely to occur.

Temperature largely controls the rate of insect development (phenology). Many researchers assume that a direct relationship exists between temperature and the rate of insect development (higher temperature, higher rate), across the temperature range to which insects are exposed in the field. Degree-days are a convenient way to measure this time/temperature relationship.

Pheromone traps have been successfully used together with phenology models to time the occurrence of susceptible stages and improve pest control. For orange tortrix, use the peak weekly trap catch as a marker of female emergence in fields with overwintering populations.

You can then either use a fixed interval of time after this to spray (2 to 3 weeks) or keep track of degree-days and use the orange tortrix model to more closely time their sprays.

Table 1 lists the average degree day totals (counting from January 1) for peak female moth emergence, pheromone trap catch of male moths, egg laying, egg hatch, and density of large larvae. Because orange tortrix overwinters in a range of larval stages that are affected differently by severity of the winter, values are listed for these peak events under both mild and cold winters.

Note: There are two situations when the model, used with trap-catch data, may *not* provide an accurate measure of female emergence and egg laying: Your fields don't have overwintering orange tortrix populations, or they're subject to a large immigration of males. In commercial fields, a later peak in trap catch may occur during June, unrelated to female activity and egg laying.

Control measures

Your major goal is to improve the effectiveness of leafroller control on caneberry. Careful monitoring for leafrollers in caneberry fields can eliminate unnecessary insecticide sprays. Additional benefits can include avoiding bee kills and mite problems, enhancing biological control and fruit set, reducing risks of illegal chemical residues on fruit, and lowering production costs.

Insecticides are registered and available for leafroller control on caneberry. However, because of constantly changing State and Federal regulations, we're not including an insecticide list.

Consult the annually revised *Pacific Northwest Insect Control Handbook* (see the box on page 8), your county Extension agent, a field representative, or an agricultural consultant for information on specific materials to apply under the situations discussed below.

The selection of which insecticide to apply is affected by a number of factors, including its preharvest interval, the ambient temperature, the presence of bees, and the stage of the crop.

Control strategy is divided into five decision periods: prebloom, bloom, preharvest (after bloom), during harvest, and postharvest. Base your decision—whether or not to apply an insecticide during any one of these periods—on the considerations in the next five sections.

1. Prebloom

Spray is usually unnecessary if:

- you can't find any leafroller larvae during visual searches, or
- trap counts of orange tortrix are less than 20 moths/week or 60 moths total before bloom.

Spray may be necessary if:

- you find many leafroller larvae during visual searches, or
- trap counts of orange tortrix exceed 70 moths/week or 200 moths total before bloom.

Considerations

- Be sure to properly identify insects. Are leafroller larvae orange tortrix or obliquebanded leafroller? Control of obliquebanded leafroller before bloom is usually not needed. Don't confuse winter moth larvae with leafrollers.
- A prebloom spray may be effective as an adulticide, but it may be less effective in killing larvae. Before bloom, orange tortrix may be mostly large larvae and pupae, which are less susceptible to pesticides than adults and young larvae.
- Delay placing bees in fields until the recommended waiting period is over for the insecticide.

2. Bloom

Spray is unnecessary if:

- you can't find any leafroller larvae during visual searches, or
- trap counts of orange tortrix continue to remain below 20 moths/week.

Spray may be necessary if:

- leafroller larvae are present in the field,
- trap counts of orange tortrix exceed 70 moths/week during early bloom,
- trap counts of obliquebanded leafroller exceed 50 moths/week, or
- you find small green or brown cutworms while searching for leafrollers.

Considerations

- Peak egg hatch for orange tortrix occurs after May 20. So the best control timing usually occurs during bloom.
- If you use a bloom spray, delay until majority of bloom is pollinated; remove bees from field; and use insecticides, rates, and application times that are least toxic to pollinators.
- The safest strategy while bees are present is to apply a bacterial insecticide in combination with fungicide sprays.

3. Preharvest (after bloom)

- A specific spray for leafrollers is unnecessary if you don't find larvae during visual searches and if trap counts remain less than 20 moths/week. However, a general "clean-up" spray is usually applied on berries sold to processors to reduce contaminants (spiders, lygus bugs, aphids, etc.).
- When leafrollers are present or when trap counts of orange tortrix exceed 70 moths/week or 50 moths/week for obliquebanded leafroller—or both—using a bacterial insecticide together with the "clean-up" spray has enhanced control of leafrollers.

Considerations

- The presence of very small leafroller larvae at this time suggests a major egg hatch is occurring. Repeated spray applications may be necessary just before harvest.
- Follow very carefully the required preharvest interval listed on the pesticide label.

Use pesticides safely!

- **Wear** protective clothing and safety devices as recommended on the label. **Bathe or shower** after each use.
- **Read** the pesticide label—even if you've used the pesticide before. **Follow closely** the instructions on the label (and any other directions you have).
- **Be cautious** when you apply pesticides. **Know** your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

4. Harvest

- Leafroller egg hatch may continue well into the harvest period. Follow the preharvest guidelines suggested in section 3, "Preharvest (after bloom)."
- Selecting an insecticide with a short (1- to 5-day) preharvest interval is critical.
- Repeated applications may be necessary to achieve acceptable control.

Consideration

- Proper adjustment of your mechanical harvester can significantly reduce problems with insect contamination.

5. Postharvest

- If leafrollers were a major problem during the season, delay tying up canes until the majority of leaves have dropped off the new canes (probably late fall or winter). For trailing berries, however, this may increase the likelihood of *Septoria* infestations. Carefully follow a fungicide spray program for this pathogen.

Consideration

- Using insecticides to control leafrollers in the fall is not recommended. Natural and biological control can kill enough pests to achieve the same population reduction by the following spring. If necessary, a prebloom spray the following year can achieve the same control as a postharvest spray—and it may not be necessary, thanks to natural control.

Pacific Northwest Insect Control Handbook

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