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Fig. 1. Oregon evergreen blackberries, when affected by redberry mite, turn bright red instead of ripening normally like berry on left.
Controlling Insect Pests of Small Fruits

By E. P. Breakey, David H. Brannon and Paul M. Eide

Growing small fruits—blackberries, raspberries, loganberries, strawberries, currants and gooseberries—in Washington can be more profitable if the grower learns to control insects that may damage his plantings. The insect must be identified if control measures are to be effective and damage to plants prevented. This can be done by relating the injuries appearing on the plant to the insect causing the damage. After the insect is known, the most effective insecticide and cultural methods can be used to control the pest.

Residue Tolerances

An effort has been made in preparing these recommendations to suggest practices that will not result in excessive residue. Nevertheless, all tolerances are subject to change from time to time, and unusual local conditions may affect the persistence of residues. Therefore, the State College of Washington and its employees cannot be responsible for crops condemned for excessive residues even when these recommendations are followed.

For recent information on the status of permissible residues contact your County Extension Agent, or write for Station Circular 284, March, 1956, "Federal Pesticide Tolerances."

1 Entomologist, Extension Entomologist, and Associate Entomologist, Washington Agricultural Experiment Stations.

2 These recommendations are for 1957. Recommendations will be revised and released annually. Revisions are available from County Extension Agents.
### Symptoms of Injuries and Insects Causing Damage

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**Raspberries and Loganberries**

Larvae in core of berries; blossoms injured, berries distorted

Larvae in picked fruit

Plant stunted; canes wilt; mines and tunnels in crowns

Young shoot wilt; purple discoloration on cane

Round holes in leaves

Lower leaves wither and turn brown

Young fruits dry and die; mature fruits "scalded"

**Strawberries**

Fruit small, seedy; leaves red; plants wilt

Plant wilts suddenly, large grubs at roots

Leaves curl, become discolored

Young leaves dark green, stunted and dwarfed. Runners rough, often with thorn-like growths

Small round holes in leaves, leaves red; fat grubs in crown

Larvae in berries

Plants become weakened or die; tunnels in crown

Plants stunted; little foliage; small miner in crown

Spittle masses on plants; leaves distorted; berries small, seedy

**Currants and Gooseberries**

Maggots in fruit; fruit turns red, drops

Leaves eaten

Leaves undersized, yellow; canes die

Leaves have cup-like bulges, often bright red

Strawberry Root Weevils

Raspberry Bud Weevil

Ten-Lined June Beetle

Two-Spotted Spider Mite

Cyclamen Mite

Strawberry Fruitworm

Orange Tortrix

Strawberry Crown Moth

Strawberry Crown Miner

Strawberry Crown Borer

Strawberry Fruittworm

Orange Tortrix

Imported Currant Worm

Currant Borer

Currant and Gooseberry Fruitfly

Imported Currant Worm

Currant Borer

Currant Aphid
Blackberreis

Redberry Mite

*Acacia essigi* (Hassan)

This mite feeds between the drupelets and the core of the berry, causing the *redberry disease* of blackberries. Instead of ripening in the normal manner, affected berries become a brighter red than normally unripened fruit, hardened and roughened, and the berries remain on the plants until the old canes die during the winter. The *redberry* condition may vary from a single red drupelet in a blackberry to a single black drupelet in a red berry (see Fig. 1 on page 2). This mite is a pest primarily of the Evergreen and Himalaya varieties.

**LIFE HISTORY.** The redberry mite is microscopic with a tapering body, worm-like in general outline, and two pairs of legs at the front end (see Fig. 2). The piercing mouth is slightly forward of the first pair of legs.

A number of overlapping generations appear during the spring and summer, the low point in population coming in February. Egg laying starts in late February or early March and continues until December, when mature mites hibernate under the bud scales or where the bud and compound leaf develop. These mites are most common in September, when as many as 683 mites were counted in a single berry.

**CONTROL MEASURES.** Two applications of lime-sulfur in spring have given most satisfactory control. The first should be applied in March when the buds begin to open, using 8 gallons (32° Baumé) liquid lime-sulfur to 100 gallons of water. The second spray should be applied in early May when the fruiting arms are about a foot long, using 1 gallon of lime-sulfur to 40 gallons of water. A satisfactory substitute for the second spray is 5 pounds of wettable sulfur to 100 gallons of water.

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Rose Leafhopper

*Edwardsiana (Typhlocyba) roae* (Linn.)

These insects, which growers often call *white flies*, insert their sucking mouths into leaf tissues and extract plant juices, causing many small white areas on the leaf (see Fig. 3). The white adults, about \( \frac{1}{8} \) inch long, are common in blackberry plantings. The nymphs,
with their long antennae and pink to reddish eyes, are first seen in April and May on the lower surfaces of the leaves.

LIFE HISTORY. This leafhopper winters as eggs mostly in blackberry and rose canes. The eggs hatch in spring and the young nymphs feed on the lower surfaces of the leaves until they have passed through five nymphal stages (see Fig. 4). The adults are migratory and may be seen on many kinds of plants, especially on the blackberry. With

Fig. 3. Blackberry leaves develop small white areas when rose leafhoppers suck plant juices from leaves. Insects are seen on undersides of leaves.

Fig. 4. Rose leafhopper. Two younger stages and mature insect.
several generations each year, the insects become most numerous in the blackberry fields about picking time.

CONTROL MEASURES. Apply a DDT spray when the nymphs appear in spring. Ordinarily 1 pound of DDT spray powder (50 per cent wettable) in 100 gallons of water is enough. If applications are needed within 30 days of harvest, use methoxychlor instead of DDT at the same concentration. A 5 per cent DDT or methoxychlor dust may be used in place of the sprays. Malathion dusts and sprays may also be used. Follow the manufacturer’s directions.

Other Insect Pests

The orange tortrix, raspberry root borer, raspberry sawfly, and raspberry cane maggot may also occasionally attack the blackberry. All are referred to in the section on raspberries.
Raspberries

Western Raspberry Fruitworm

*Byturus bakeri* Barber

This insect has been responsible for heavy losses to both raspberries and loganberries. A number of loganberry plantings have been abandoned because of severe infestations. The raspberry fruitworm also breeds in wild blackberries, thimbleberries, and salmonberries. The larvae are found in the cores of raspberries and loganberries. Some remain in the harvested fruit and may contaminate the preserved fruit.

![Western raspberry fruitworm larva](image)

Fig. 5. Western raspberry fruitworm larva, the stage found in berry cores.

When mature, the larvae are $\frac{1}{3}$ inch long (see Fig. 5), with light brown areas on the back of each segment. The adult yellowish-brown beetles, $\frac{1}{6}$ inch long (see Fig. 6), feed on fruit buds and unfolding leaves. This injury may be serious in the spring when the beetles eat into the fruit buds and destroy them. When the flowers open, the beetles feed on the stamens, pistils, and around the base of the stamens. Some of the injured blossoms show only a brownish discoloration, while other buds and blossoms may be completely destroyed. Distorted berries often result from the injured blossoms (see Fig. 7).

LIFE HISTORY. The eggs are fastened to the flower buds, flowers, or stems of the plant, and the young larvae work into the center of the developing fruits. They tunnel the cores, often working into the drupelets. The larvae feed on or in the fruit for 30 days or more. Loganberries may be heavily infested during the first 2 weeks of commercial picking. Later, the degree of infestation is about the same for both loganberries and red raspberries. When the larva finishes feeding in the fruit it drops to the ground, burrows into the soil, and changes to the pupal stage.

Most of the larvae remain in the top three inches of the soil. The winter is spent in the adult stage, and the beetles emerge during March, April, and May. Ordinarily the life cycle is completed within a year.

CONTROL MEASURES. Rotenone, applied to kill the beetles
before they deposit their eggs, avoids any objectionable insecticide residue on the fruit. The control for this pest is well established.

1. Spray or dust with rotenone 1 week following the opening of the first raspberry blossoms.
2. Spray or dust with rotenone 10 days following the first application.
3. A third spray or dust of rotenone may be necessary in fields where fruitworms have been common the previous year. Apply 10 days after the second application.

A suitable spray should contain 34 ounces of 4 per cent ground rotenone-bearing root; or 27 ounces of 5 per cent root per 100 gallons. The dust should contain 3/4 of one per cent rotenone.

Fig. 6. Mature western raspberry fruitworm adult feeds on fruit buds, flowers, leaves.

Fig. 7. Raspberries injured by western raspberry fruitworm. Showing damage to receptacles and fruits. Normal Cuthbert raspberries at right.
Orange Tortrix

Argyrotaenia citrana (Fern.)

While the larvae feed on buds and tender leaves, the fact that they often get into the picked fruit is more serious, because processors cannot accept berries contaminated in this manner.

When disturbed, the caterpillars leave their shelters and drop to the ground. If a berry picker has placed his stand underneath foliage badly infested with the caterpillars, they may drop into the picked fruit, hide among the berries, and be taken to the processor.

LIFE HISTORY. The greenish caterpillars of the orange tortrix stay in the field during the whole year. By preference they feed on the buds and tender leaf growth. In summer they occur commonly in the tip growth of the canes, where they usually tie some of the leaves together, forming a shelter, where most of the feeding is done.

Several generations of the orange tortrix develop in a year. Because the rate of growth varies greatly, even from a mass of eggs deposited all at the same time, there are no clean-cut generations of the insect.

When full grown, the larva is $\frac{1}{2}$ inch long, straw to greenish-white in color, and has a light brown head. The moth is buff-colored.

HOST PLANTS. The orange tortrix is known to feed on more than fifty plants, including various weeds and shrubs. The list includes raspberry, blackberry, loganberry, boysenberry, strawberry, blueberry (flowers and tender spring growth) Pyrocanthus (firethorn), apple, peach, grape, holly, rose, Oregon grape, salmonberry, pigsweed, lambsquarter, and many others.

CULTURAL CONTROL. Keep young canes tied up. Canes allowed to lean out between the rows and interfere with machinery and pickers and may be broken off or otherwise injured. Canes leaning over pickers' stands make it easy for orange tortrix larvae to drop into the berry cups.

Remove all unnecessary fences so the land can be clean-cultivated if not actually planted to berries. Cut out weedy or brushy growth along fence rows, ditch banks, and roadsides. Such areas serve as reservoirs for the orange tortrix moths which may fly to nearby berry fields to deposit their eggs.

CONTROL. In fields where the orange tortrix was known to be common the previous year, an application of TDE (Rhothane or DDD), 2 pounds (50 per cent wettable) per 100 gallons, is recommended about May 15. At least 150 gallons are needed for an acre of raspberries.

If an efficient ground duster is available, the TDE may be applied in dust form. At least 30 pounds of a 5 per cent dust are necessary for an acre of berries.
Where the orange tortrix has been kept well under control, this first treatment may be delayed until about June 1. Should larvae become common after this date, an application about June 15 will be necessary. Allow 3 weeks, however, between the time of the last application and the date of the first picking. This avoids any excess residue on the picked fruit.

Where the Willamette mite becomes a problem, it is advisable to use an acaricide, such as TEPP or malathion, with the TDE spray or dust. If an acaricide is used, do not use oil as a sticker. Follow the manufacturer’s directions.

**Raspberry Aphid**

*Amphorophora rubi* (Kalt.)

This is the most common aphid that feeds upon raspberries. It is a rather large species, the mature wingless female measuring $\frac{1}{8}$ inch long. The insect seldom causes serious injury in raspberry plantings, although under favorable conditions the aphids may concentrate upon the younger growing tips (see Fig. 8). This aphid is the principal

*Fig. 8. Raspberry aphids on stems seldom become a serious problem.*
insect in spreading the virus disease, raspberry mosaic, from infected to healthy plants. Studies, however, show that the disease is relatively slow in its spread to nearby plants.

LIFE HISTORY. The aphid passes the winter on the canes in the egg stage. These eggs are very small, light yellowish-white when first laid, later turning black. They are deposited during November when the sexual forms appear, and by late February or March well-developed embryos are present within the eggs. The population builds up slowly because of the activities of predatory insects and other natural enemies. Ladybug beetles and a parasitic fungus are the main natural enemies.

CONTROL MEASURES. Infestation by this aphid is seldom serious enough to warrant using insecticides. Raspberry mosaic control by controlling aphids is not generally considered practical.

**Raspberry Root Borer**

*Bembecia marginata* (Harris)

The raspberry root or crown borer is found throughout the berry-growing districts of Washington. The adult is a moth resembling a yellow jacket.

The mature larvae are about an inch long, white, with brownish heads. They feed upon raspberry, loganberry, and occasionally on blackberry plantings. Affected plants lack vigor, with some portions becoming stunted and weakened. Lateral growth, starting in the spring, may be followed by a sudden wilting and death of the entire cane. Fruits are small and scanty.

LIFE HISTORY. Two years are required for this insect to complete its life cycle. Moths are on the wing during August and September, and the females deposit their eggs on leaves and stems of the plants. Young larvae feed on the cane, later building a small cell just under the bark in which they pass the first winter. The following spring, the borer becomes active and by early summer is about one-third grown (see Fig. 9). By mid-summer, the larva reaches the base of one of the new season’s canes and bores into this cane.

By late summer, the grub, now a year old, works its way back down into the crown and root, where it passes the second winter. By this time, the borers are about \( \frac{3}{4} \) inch long. In the spring and summer of the second year, the larvae prepare to come out, often boring into stubs of old canes, where they change to the pupa stage. Later, in August and September, the insect comes out as an adult.

CONTROL MEASURES. Infested canes are weakened by the borers and often break off or are easily broken off by the grower when putting them up. Remove and burn old canes as soon after harvest as possible. In removing old canes or in thinning new canes, cut them close to the ground.
Fig. 9. Raspberry canes tunneled and weakened by raspberry root borers.

Parathion, when applied as a spray containing 4 pounds of 25 per cent wettable powder per 100 gallons, gives control. Apply the spray in early September and repeat if infestation is bad. Direct spray against the lower part of the canes and the crowns. This is a strong spray. Use with care.

Raspberry Cane Maggot

*Pegomyia rubivora* (Coq.)

The cane maggot attacks the young canes of raspberry, loganberry, and occasionally blackberry. Raspberry canes are usually from 1 to 3 feet long when attacked. The symptoms are a sudden wilting of the young shoot with a purple discoloration where the maggot girdles the cane (see Fig. 10).

LIFE HISTORY. Wintering over in the soil, the adult flies come out late in April, and the female deposits her eggs near the tops of the young shoots or canes. After hatching, the young maggot burrows into the pith of the tender young shoots and tunnels downward. After
Fig. 10. Raspberry shoots wilt when attacked by raspberry cane maggot feeding inside the cane. Normal raspberry cane on left.

feeding and growing to a fair size and traveling down the inside of the cane a short distance, the maggot works outward to just under the bark and girdles the tip of the shoot. After finishing the girdling and feeding for a time, the maggot continues working down through the pith. The adults emerge the following spring.

CONTROL MEASURES. Remove and burn wilted canes as soon as they are seen in the spring. Cut them off near the ground, since the injured canes are no longer useful and this insures getting the maggot. In the case of blackberries and raspberries, canes often recover from injury caused by the maggot within. In fact, the rapid growth of the cane often appears to crush the maggot within its tunnel.
Raspberry Sawfly

*Priophorus morio* (Lep.)

The raspberry sawfly attacks the raspberry, loganberry, and blackberry. The larvae feed on the undersurface of the leaves, leaving round holes in the leaves. The injury is most noticeable in May and June and again in late summer.

**LIFE HISTORY.** The adult sawfly emerges from the soil in late April and May, and the females lay their eggs in the leaves (see Fig. 11). Immediately after hatching, the larvae (see Fig. 12) start to feed upon the leaves. They mature rapidly, but are usually unnoticed until the injury becomes severe. After completing their feeding, they drop to the ground and spin small silken cocoons in the soil and repeat the life cycle. The majority, however, remain in their cocoons until the following spring.

**CONTROL MEASURES.**

Derris or cube dust containing \( \frac{3}{4} \) of 1 per cent rotenone, applied as soon as the larvae appear, is recommended. A liquid spray containing rotenone, such as is recommended for the raspberry fruitworm, may also be used. Direct the spray or dust against the undersides of the leaves.

Spider Mites

*Eotetranychus willamettei* McG., *Tetranychus bimaculatus* (Linn.) and others

The Willamette mite became a serious pest of raspberries in the Puyallup Valley in 1947. The general use of DDT on raspberries was a contributing factor.

The injury appears as a drying or burning of the leaf, first around the margin. Later, the entire leaf withers and dries, the result of the mites taking plant juices from the leaves. The lower leaves are affected first, others as the infestation develops.

**LIFE HISTORY.** The mites spend the winter in colonies in the folds of old leaves on the ground, in cracks in the posts, and similar
places where they can find some protection. The mite population begins to build up on the undersides of the lower leaves in April. As the season advances, the mites move upward on the canes. By mid-summer, injury to foliage may be severe. By the middle of August, the population usually begins to decline. The Willamette mite goes into hibernation about this time and the effect of enemy insects also becomes noticeable.

CONTROL MEASURES. Tetraethyl pyrophosphate (TEPP) is effective against adult mites. Apply a 1 per cent dust, preferably during the warmest part of the day. It can also be used as a spray. Dilute the concentrate according to the manufacturer’s directions. A second application may be necessary in 10 days or 2 weeks. Malathion sprays or dusts may also be used.

**Dryberry Mite**

*Phyllocoptrum gracilis* (Nal.)

Loganberry growers have suffered heavy losses from the "dryberry disease", the dying and drying of the fruits soon after the petals fall. The earliest fruits are most seriously affected, while later fruits often escape injury. Losses have often mounted to as much as 50 to 60 per cent of the crop. No disease organism has been associated with the condition and all evidence points to the mites as the direct cause of this "dryberry" condition (see Fig. 13).

More recently, red raspberries, especially the Washington and Willamette varieties, have been affected by a condition called *sun scald*. This injury is also caused by the mites and is the dryberry disease as it affects the red raspberry. Some growers have had losses amounting to as much as 40 per cent. The disease as it affects the red raspberry has been most common in the Skagit and Snohomish valleys.

LIFE HISTORY. The mites are microscopic and overwinter in colonies partly concealed by the buds (see Fig. 13). These colonies often contain as many as fifty to sixty mites. The mites live on the outside of the plant, in contrast to the redberry mite of the black-
berry, which seeks concealment beneath bud scales and between the
drupelets of the berries.

CONTROL MEASURES. The most satisfactory control has been
obtained from two applications of lime-sulfur in spring. The first
should be applied in March before the buds open, using 8 gallons
(32° Baumé) liquid lime-sulfur to 100 gallons of water. The second
spray should be applied in early May as soon as the blossom buds
have formed, but before any have opened, using 1 gallon of lime-
sulfur to 40 gallons of water. An added benefit from the use of lime-
sulfur is its ability to suppress or control cane blights.

Strawberries

Most important in determining the future productivity of a new
strawberry planting is the original planting stock selected. The Wash-
ington State Department of Agriculture offers a certification service
for strawberry-planting stock. Certified plants must be free from in-
sect pests and virus diseases. These plants are superior to runner plants
selected at random from old plantings. Certified stock produces plants
of more uniform size and type, and a higher yield. Some growers
maintain foundation plantings on their own farms.

Two of the more important pests often distributed with planting
stock are the strawberry aphid and the cyclamen mite. Methyl bro-
mide fumigation of strawberry plants before planting is desirable to
get rid of insect pests from the original planting. This is particularly
true of the strawberry aphid, which carries the yellows disease from
infected plants to healthy plants. Since no planting stocks are en-
tirely free of virus infection, the need to eliminate or control the
insect which spreads it is evident.

Strawberry Aphid

Pentatrichopus (Capitophorus) fragaefolii (Ckll.)

This small, pale yellowish-green aphid feeds on leaves and stems
in the crown of the plants, but seldom becomes numerous enough to
cause direct injury.

The yellows disease is one of the limiting factors in profitably
producing strawberries in the Pacific Northwest. Since the straw-
berry aphid is the disease spreader, the control of this aphid is im-
portant.

LIFE HISTORY. The strawberry aphid passes the winter on straw-
berry plants, where it finds protection by crawling well down into the
crowns. Winged forms appear during April and May and spread to other strawberry plantings, carrying the disease with them.

This period corresponds to the fruiting period of the strawberry. Winged aphids appear soon after blossoming starts and are present until harvest, but have usually disappeared by the end of harvest.

CONTROL MEASURES. Use certified planting stock or stock as free from disease as possible. Remove and destroy all diseased or weak plants as soon as they appear. Dust all plantings, mature and new, as soon after the strawberries start to bloom as possible. Dust all plantings again after 2 weeks.

Dust new plantings every 2 weeks until after strawberry harvest. Dust both mature and new plantings soon after harvest. If the mature planting is to be destroyed, plow under instead of dusting. Use a dust containing either 1 per cent tetraethyl pyrophosphate (TEPP), 4 per cent malathion, or 2 per cent parathion.

New plantings require from 8 to 10 pounds of dust per acre per application for at least six applications. Mature plantings require an average of 40 pounds of dust per acre per application for at least three applications. These should be separated by 2 weeks and should be made in the spring as soon after blossoming starts as possible. If the planting is to be kept, dust again after harvest.

Avoid dusting, when possible, during the blossoming period because of the danger of killing honey bees and other pollinators. These insecticides are poisonous. Read the labels.

Strawberry Root Weevils

Strawberry root weevils are among the most common and important pests attacking strawberries in Washington. When numerous, these insects can destroy a strawberry planting in one season. Injury from the beetles feeding on the leaves and fruit is relatively unimportant. Most of the damage results from the feeding of the larvae or grubs on the roots of the plants. Plants become stunted, the foliage turns a red color, and the fruit is small and seedy. Injured plants wilt and die during dry periods in summer.

There are three main kinds of weevils attacking strawberries in Washington. The adult and larval forms of these three weevils are similar in appearance except for size. They all have snouts or beaks and none are able to fly. Since all are females, only one weevil is needed to start an infestation.

Strawberry Root Weevil

Brachyrhinus ovatus (Linn.)

The strawberry root weevil is the most common weevil attacking strawberries. It is brownish-black and about ½ inch long (see Fig. 14).

LIFE HISTORY. The insect hibernates both in the larval and
adult stages, with most passing the winter in the soil as larvae. In spring they become active, start feeding, and develop rapidly. The adults emerge late in May or during June. Egg-laying does not begin until 2 weeks after the insects emerge and continues for 2 months, most of the eggs being laid in June and July. The strawberry root weevil deposits as many as 300 eggs, though the average is between 150 and 200.

The eggs are laid on the soil near the strawberry plants during the summer months and hatch in about 10 days, the small larvae working into the soil to feed upon the fibrous roots. The number of larvae infesting a single plant may vary from 1 to 150. Vigorously growing plants are able to withstand attacks of a few larvae without serious damage.

Fig. 14. Strawberry root weevil. Mature insect appears during June.

Fig. 15. Strawberry roots injured by root weevils. Normal plant at right.
Black Vine Weevil

*Brachyrhinus sulcatus* (Fabr.)

The black vine weevil is the largest of the weevils attacking the strawberry, $\frac{3}{4}$ inch long, brownish-black, often with small flecks of yellow or white (see Fig. 17). It is much less common on strawberries than the ordinary strawberry root weevil, and is more serious in damaging ornamental nursery and greenhouse plants.

**LIFE HISTORY.** The seasonal history of the black vine weevil is similar to that of the strawberry root weevil. Emergence and egg-laying are somewhat later in the season. There is one generation of this weevil each year. Adults emerging late in the summer, however, lay some eggs and hibernate, laying the rest of their eggs early the next summer. This results in an overlapping of generations.

It has been shown that adults lay up to 488 eggs during the first season, with an average of 216. One adult deposited 863 eggs in two seasons.

**CONTROL MEASURES.** Poison bait has been recommended to control root weevils. Most growers have used commercial preparations containing dried apples or other fruits and sodium fluosilicate. Spraying the foliage with a stomach poison such as lead arsenate is not effective since the beetles are not heavy eaters and probably do not consume enough poison to kill them.

---

**Rough Strawberry Root Weevil**

*Brachyrhinus rugostriatus* Goeze

This species is brownish-black. Larger than the strawberry root weevil, it is about $\frac{1}{2}$ inch long (see Fig. 16). It emerges about 2 weeks later than the strawberry root weevil, and egg-laying is delayed until August and September. Some of the adults overwinter and finish their egg-laying the following season.

*Fig. 16. Rough strawberry root weevil. Mature insect is about $\frac{1}{2}$ inch long.*
METHOD OF APPLICATION. Scatter about 1 teaspoonful of bait around the crowns of the plants in hills or at the base of each individual plant. For matted row plantings, the bait should be broadcast among the plants. When baiting strawberries, each treatment requires 50 to 100 pounds of bait per acre, depending on the number of plants. For best results the bait should fall on the ground close to the crowns or bases of the plants rather than on the foliage.

When baiting new plantings of considerable size, pay particular attention to the margins—remember the weevils must crawl into the field from the outside. An exception would be where plantings have been made on land in clover, strawberries, or some similar crop the previous summer.

TIME AND NUMBER OF APPLICATIONS. Watch the plantings for signs of root weevils, beginning about the first of April and on throughout the season. Make the first application when or soon after the first adult weevils are found. Most of the adult weevils emerge from the ground during the latter part of May and June. This period may vary slightly from year to year and with localities, but usually coincides with the development of the red coloring of the ripening Marshall strawberry.

The strawberry root weevil is the first to appear and is followed in about 2 weeks by the rough strawberry root weevil. The black vine weevil is the last to appear, and has been found in numbers the first
week in July, which is the end of strawberry harvest. The number of bait applications varies, depending on how soon the weevils appear in the spring and the occurrence of rains. If it rains soon after the bait is applied, the treatment should be repeated.

Three to four applications a year may be necessary. The earliest application is made in April if overwintering weevils are found at that time. Another application is usually made just before or during the strawberry harvest, and another just following harvest. Additional applications may be required during the summer if live weevils are still found around the plants.

SOIL TREATMENTS. Recent developments in the use of insecticides have largely replaced poison baits in the control of root weevils, particularly the three species just mentioned. When preparing the soil for planting distribute $7\frac{1}{2}$ pounds (actual) heptachlor or aldrin or 15 pounds chlordane evenly over the surface of each acre and immediately mix with the soil to a depth of about 4 inches. This requires 75 pounds of 10 per cent dust or 300 pounds of 2.5 per cent dust for each acre. If chlordane is used, double the amount. Distribute the dust, cross disc, then harrow. Rotary tilling will also provide satisfactory mixing of the insecticide in the soil.

When treating established plantings, apply $2\frac{1}{2}$ per cent heptachlor or aldrin dust during the first half of April. Make a general application and rake into soil between rows without delay. Dust will kill adult weevils and form a protective barrier. Do not apply these dusts later because of danger from accumulated residues on fruit. Dusts should be applied after harvest also.

**Raspberry Bud Weevil**

*Nemecostes incomptus* (Horn)

The raspberry bud weevil is about the same size and shape as the rough strawberry weevil, but is covered with scales which give it a rusty gray color with irregular brown markings on the back (see Fig. 18). The larvae or grubs are practically indistinguishable from strawberry root weevil larvae except that they are more active.

The weevil was found feeding on the buds of raspberries in a few locations in the Puyallup Valley in years past. It was regarded as a minor pest at that time. Since the use of the insecticide soil treatments for the control of the common species of weevils has become a general practice, several serious outbreaks of this pest have been observed in the strawberries in the northwest counties of Washington. It is not controlled by adding aldrin, heptachlor, or chlordane to the soil as are the other root weevils. Damage caused by the grubs is the same as that of the other species; the adults, however, do more feeding on the buds.

**LIFE HISTORY.** Little is known of the seasonal history of this
pest at present. The eggs, which are cemented in neat rows on the undersides of leaves and partially covered, have been found in the spring and late in the fall. A great many adults emerge late in the fall and pass the winter in that stage. Others apparently go through the pupal stage during the winter and emerge early in the spring. Eggs laid late in the fall hatch into grubs which spend the winter in a very immature state.

CONTROL MEASURES. Soil treatments developed for the control of the common strawberry weevils are not effective for this pest. The adults are readily killed by applications of weevil bait, but the irregular periods of emergence make complete control difficult. Applications of bait in April and October are necessary, with several applications at intervals during the growing season.

Some method of killing the grubs in the soil would be very desirable with this species, but no practical treatments to do this have yet been found.

**Ten-Lined June Beetle**

*Polyphylla decimlineata* (Say)

Large, white grubs, some of them nearly 2 inches long when mature, are the larvae of the ten-lined June beetle. They are most injurious to strawberry plantings in sandy soil. The first symptom of an infestation is a sudden wilting of the plants. Frequently injury is limited to part of the planting.

LIFE HISTORY. White grubs usually have a 3-year life cycle and most of the damage to roots takes place during the second year. The adult insect is a stout, brownish beetle, an inch or more long, with white lines on the wing covers.

CONTROL MEASURES. Fields that have been treated for the control of root weevils will probably be free of white grubs. In fields or areas where white grubs have been a problem, apply aldrin
or heptachlor to the land at the rate of 7½ pounds actual per acre. Apply the dust evenly over the soil and disc or harrow into the soil without delay. The insecticide dust should be applied to the land when preparing to plant. It remains in the soil several years and should protect the strawberries for the life of the planting.

Two-Spotted Spider Mite

*Tetranychus bimaculatus* (Linn.)

This spider mite feeds on the undersurface of strawberry foliage, causing a curling and discoloring of the leaves (see Fig. 19).

**LIFE HISTORY.** The eggs are laid on the undersides of the leaves among silken threads spun by the adult. This species hibernates in protected locations under the bark of trees, around buds, or in debris.

It is widely distributed and feeds on a variety of plants, including truck crops, fruit trees, forest and native trees and shrubs, and many ornamentals. In the Puget Sound district, infestations in a strawberry planting may be general throughout the field, but severe injury is usually limited to a few plants.

**CONTROL MEASURES.** Apply a dust containing either 1 per cent tetraethyl pyrophosphate (TEPP), 2 per cent parathion, or 4 per cent malathion as soon as the mite population starts to build up. If within 2 weeks of harvest, use the tetraethyl pyrophosphate dust in place of the parathion to avoid the accumulation of toxic residues on the fruit.

![Fig. 19. Strawberry leaves curled and discolored by spider mites.](image-url)
Fig. 20. Stunted and dwarfed leaves on strawberry plants injured by cyclamen mites. Everbearing varieties are most susceptible.

Cyclamen Mite

*Steneotarsonemus (Tarsonemus) pallidus* (Banks)

This is a small, white to light brown mite barely visible to the unaided eye. It feeds on the young unfolding leaves in the crowns, and causes them to become stunted and dwarfed (see Fig. 20). The runners from infested plants are rough to the touch and many will have thorn-like growths. Young leaves are often a darker green color while those in an advanced stage are more yellowish. Mature leaves are often dark red.

Many greenhouse plants are attacked by this mite, especially cyclamen, snap dragons, and chrysanthemums. Strawberry plantings in
irrigated regions in the Pacific Northwest have suffered heavy losses because of the cyclamen mite.

VARIETAL RESISTANCE IS EVIDENT IN WESTERN WASHINGTON, THOUGH THE CHARACTERISTICS THAT PRODUCE SUCH DIFFERENCES IN THE STRAINS ARE NOT KNOWN. IN WASHINGTON THE STANDARD COMMERCIAL VARIETY, MARSHALL, IS LESS SERIOUSLY AFFECTED THAN THE NORTHWEST. EVERBEARS AS A CLASS SEEM TO BE THE MOST SUSCEPTIBLE.

LIFE HISTORY. The females lay large numbers of eggs on the developing leaves in the crown. During the summer months reproduction slackens. Spring and early fall seem to be particularly favorable for an increase in numbers. The entire life history is spent on the host plants.

CONTROL MEASURES. Field control of the mites is complicated because they are protected in the buds and folded leaves of the plant. Preliminary investigations so far have not shown effective control with insecticide sprays. Some materials show promise and a control program will be developed as soon as possible.

In starting new plantings it is desirable to use mite-free stock. Avoid contamination from shipped in crates or equipment from infested fields. Immersion in water heated to 110°F for 30 minutes frees the plants of mites and aphids without injuring the plants. The plants should be placed loosely in the water, as the heat will not penetrate packed or tied bundles evenly. Controlled conditions are essential. It is suggested that strawberry growers use similar equipment to that developed by bulb growers for hot-water treatments. Cool the plants without delay following treatment, and set them in the field as soon as possible.

Strawberry plants can also be fumigated with methyl bromide for the control of mites and aphids. Use two pounds of methyl bromide per 1000 cubic feet of fumigator space for an exposure of two hours at 70°F. The fumigating chamber should be gas tight and equipped with a fan and thermostatically controlled electric heater. Allow the plants time to warm up to 70°F before introducing the methyl bromide. Ventilate the chamber immediately following fumigation and set the plants in the field without delay.

Strawberry Crown Borer

*Tyloderma morbillosa* Lec.

The small, black weevils feed upon the leaves, stems and flowers of the strawberry (see Fig. 21). Feeding on the leaves produces many small round holes about ¼ inch in diameter, a type of injury unlike that produced by other species of weevils. The principal injury, however, results from the small, white grubs or larvae feeding in the crowns of the plants. Affected plants are characterized by red pig-

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ment in the leaves. The insect also feeds on the native strawberry in the region.

The black beetles are about $\frac{1}{6}$ inch long (see Fig. 22), with the female somewhat larger than the male. They do not have functional wings, so must depend on crawling or being carried for transportation.

The strawberry crown borer is a pest of strawberries primarily in the Grand Mound section of Thurston County. Apparently the insect is native to that region.

LIFE HISTORY. The beetles hibernate in debris in strawberry fields or in crowns of strawberry plants. Egg-laying starts in April and continues into June. Eggs are deposited in cuts made in the crown, leaf, or flower stems. The small grub that hatches eats into the crown of the plant and causes stunting.

CONTROL MEASURES. Control measures in western Washington have not been investigated but recommendations or suggestions are available for a closely related species in the East.

1. When starting a new planting, use clean stock or fumigate the stock with methyl bromide at the rate of 2 pounds per

![Fig. 21. Small round holes left by strawberry crown borers feeding on leaves. Cuts on leaf stems were made for deposit of eggs by beetles.](image-url)
Fig. 22. Strawberry crown borer. Mature insect.

1,000 cubic feet of fumigator space for 2 hours at 70° F., and plant.

2. Crop rotation is essential in infested areas.

3. Do not destroy the old planting until late July or early August, thereby permitting the female to complete the egg-laying period before the plants are plowed under or burned.

4. Some of the new insecticides such as heptachlor may be effective. Do not apply after berries start to form. See under spittle bugs for more detailed information.

5. If the infestation is light, infested plants can be removed and destroyed.

Strawberry Fruitworm (Omnivorous leaf tier)
Cnephasia longana (Haw.)

Larvae of this insect have attracted attention in southwestern Washington, where they have been observed tunneling into ripe and even green strawberries. Affected berries contain the excrement left by the larvae in the tunnels. Mature larvae are dirty-white in color, \( \frac{1}{2} \) inch long, and quite active. Moths are \( \frac{3}{4} \) inch long, grayish-yellow or gray with brown markings.

LIFE HISTORY. Moths from these larvae appear in June and July, and deposit eggs on the bark of the trees and other rough surfaces. The young larvae overwinter in silken cases near where the eggs were laid. These tiny larvae are carried to hosts on silken threads by air currents in early spring. The larvae first eat the leaves of low growing plants such as clover and plantain. The insect is a general feeder on twenty known food plants, including such crops as Dutch iris, hops, filberts, peas and strawberries. Injury to the strawberry consists first in webbing together the leaves and flower parts and feeding in this nest. Later, the larvae bore into the bases of the rippest fruit between the green cap and berry itself.
CONTROL MEASURES. Use DDT-sulfur dust or methoxychlor-sulfur dust. The dust should be prepared to contain 15 to 25 per cent sulfur, 5 per cent DDT or methoxychlor, and the remainder, a suitable diluent such as a neutral talc. Dusts containing the higher sulfur content may produce shock or burning. Apply when the first strawberry blossoms appear and again in 10 days or 2 weeks. The second and last application should be made at least 30 days before harvest. Dusting for the control of the strawberry aphid will also control this pest.

Orange Tortrix

*Argyrotaenia citrana* (Fern.)

Orange tortrix larvae are often found feeding in strawberries. Injury from this pest seems to be limited primarily to western Washington, north of Chehalis. If wormy strawberries are found south of Chehalis, the pest is most likely the strawberry fruitworm; if north of Chehalis, the orange tortrix; and if the infested fruits are obtained in the general vicinity of Chehalis, the pest may be one or the other or both.

CONTROL MEASURES. The control of the orange tortrix is dependent on the timely application of TDE (Rhothane or DDD) sprays or dusts. Apply a 5 per cent dust 3 weeks before the first berries show color.

Strawberry Crown Moth

*Ramosia bibionipennis* (Bdv.)

The white to yellowish-white larvae of the strawberry crown moth bore into the crown of the plant, causing the plant to appear sickly and often killing it outright. Infested transplants may die before they become established. Older plants are weakened, although they may stand up under the infestation.

Several borers may feed in the crown of a single plant. Reduced yields follow such heavy infestations.

LIFE HISTORY. The nearly mature larvae are ¾ inch long when they hibernate in the crowns of the strawberry plants. Pupation occurs in May, and the moths, which resemble yellow jackets, emerge in June and July. The female lays eggs on the lower surfaces of the leaves. After hatching, the young larvae work down to the crown, where they feed for a few days before going directly into the crown. As development continues, the tunnels are enlarged and extended. There is one generation a year.

CONTROL MEASURES. Infested plants should be pulled and burned in spring before the moths emerge. Topping strawberry plants by cutting off the leaves, stems, runners, and old fruit spurs immediately after harvest has reduced damage by the insect in Oregon.
The main benefit is reported to be the stimulation of new growth and the subsequent invigoration of the plants.

Efforts to develop a control program based on the use of insecticides have not yet produced one that can be recommended. However, no infestation of appreciable numbers is known when growers have followed the program recommended for the control of the strawberry aphid. Apparently growers who consistently follow such a program obtain control of other insects as an extra dividend.

**Strawberry Crown Miner**

* Aristotelia fragariae Busck *

The reddish larvae of the strawberry crown miner burrow into the crowns of the plants, causing them to become stunted and to develop poor foliage. Older plants are more seriously injured. The larva tunnels the crown in all directions, permitting moisture and disease organisms to enter. The crown miner may readily be distinguished from the strawberry crown moth by its reddish color and smaller size. It is only occasionally, however, that this pest reaches sufficient numbers to cause injury comparable to that of the strawberry crown moth.

**LIFE HISTORY.** The larvae winter in silk-lined burrows in the crowns changing to pupae and then to moths which emerge in June and July. Eggs are deposited on leaf sheaths about the crown, on the undersurface of leaves and along leaf petioles. As many as twelve larvae have been found in 3-year-old crowns. The larvae are full-grown by October.

**CONTROL MEASURES.** Crop rotation has been the only practical means recommended to control the strawberry crown miner. Old infested plantings should be plowed under immediately after harvest; deep enough to effectively bury the plants. Following the program recommended for the control of the strawberry aphid apparently will also control this pest.

**Spittlebugs**

* Philaenus leucophthalmus* (Linn.)

There are several color varieties of spittlebugs common to strawberries, all belonging to one species and distinguished by their color markings. The adults are about ¼ inch long and rather long in shape (see Fig. 23). The insects are more injurious to plants in the younger stages, since they feed upon leaves and stems by inserting their mouth parts into the tissue and drawing away the plant juices, which they pass through their bodies to produce the spittle. The principal objection to these insects comes from the pickers, who dislike becoming smeared and often wet with this spittle.

Great injury occurs, when there is a concentration of spittlebugs feeding on a single leaf, flower or leaf stem. Berries forming on af-
fected plants may be small and seedy. Most reports of injury from spittlebugs come from southwest Washington.

LIFE HISTORY. The spittlebug winters in the egg stage on strawberries and other plants. Eggs are laid in compact groups attached to the stems and leaves of the plants. The eggs hatch in late March and April.

Soon after hatching, the small nymphs move to the tender new growth on the upper parts of the plant where they begin to feed. After feeding for a few hours they create a clear liquid which resembles a drop of dew. As this enlarges in size, air is mixed with it and it becomes the "spittle" in which the nymphs hide.

The nymphs usually mature in June and emerge from the spittle masses as winged adults about $\frac{1}{4}$ inch long and gray or brown, and spotted.

CONTROL MEASURES. One application of 2.5 per cent heptachlor or 5 per cent chlordane dust thoroughly applied in early spring will adequately control spittlebugs. Apply with a power or rotary hand duster at the rate of 25 to 30 pounds per acre on average fields one year old. Older fields with wider rows will require relatively more material. Use enough dust to obtain good, though not necessarily heavy, coverage.

Make the application when the first clusters of fruit spurs separate. Note that the fruit spurs, consisting of developing flowers on short stems, grow in tight clusters. Until these separate it is mechanically impossible to blow dust on the nymphs within the clusters. The opening of the first clusters usually coincides with the hatching of the last spittlebug eggs. This usually happens in April or early in May, depending on the season.

One per cent parathion may be added to either aldrin, heptachlor, or chlordane dust for early strawberry aphid and mite control. Since

Fig. 23. Spittlebugs. Immature stages at right; mature insect at left.
Fig. 24. Spittlebugs form drops of foamy liquid on strawberry leaves.

the recommended insecticides are applied early in the season, residue is not a problem. Where growers have followed the recommended control program for aphid control, spittlebugs have also been controlled.
Currants and Gooseberries

Currant and Gooseberry Fruitfly

*Epochra canadensis* (Loew)

This is the most serious pest of currants and gooseberries in western Washington. The white maggots feed inside the berry, causing the fruit to turn red or drop from the cluster.

**LIFE HISTORY.** The insects pass the winter as puparia in rubbish on the ground or in soil under the bushes. The flies emerge over a period of 40 to 45 days, starting in the middle of April (see Fig. 25). The peak of emergence is likely to occur during the last few days of April and the first of May. Oblong white eggs are inserted under the skin of the fruit by the female insect. The maggots may burrow for some distance just beneath the skin before penetrating the fruit. Once inside, the larvae feed on the seeds and the pulp until mature, when they are about \( \frac{1}{4} \) inch long. Mature larvae leave the fruits through a jagged hole in the skin, usually after the fruit has fallen to the ground. There is one generation each year.

**CONTROL MEASURES.** Apply a spray containing DDT or methoxychlor or malathion as soon as the first blossoms start to drop. Pollination is complete by then and the flies emerge soon, usually about April 15. Use DDT or methoxychlor at the rate of 2 pounds of the 50 per cent wettable spray powder per 100 gallons. If malathion is the choice, use 1 to 2 pounds of the 25 per cent wettable spray powder in each 100 gallons. Spray thoroughly, wetting all the foliage. If the flies caused trouble the previous season, a second application 10 days to 2 weeks later may be advisable.

![Fig. 25. Currant fruitfly. Mature female above, mature male below.](image)
The above spray schedule should provide maximum protection with a minimum of spray residue on the mature fruit. Residues on gooseberries to be processed for canning are not a problem because they are washed at the plant. It is a problem, however, on gooseberries for the fresh market and on currants. Currants cannot be adequately washed at the plant since they are soft and would be crushed.

**Imported Currant Worm**

*Nematus ribesii* (Scop.)

The imported currant worm is first seen as a small, white larva early in spring. Later the larvae are green with numerous dark spots and a black head. They are ½ inch long when full grown.

**LIFE HISTORY.** The insect passes the winter in a capsule-like cocoon in the soil. The female sawfly, ½ inch long, black with the abdomen dull yellow, deposits its eggs on the underside of the leaf near the midrib. The eggs hatch about the time the plants come into full foliage. The larvae feed along the margin of the leaf, often causing defoliation. After feeding upon the plant from 2 to 3 weeks, they enter the soil and spin a cocoon. A partial second generation appears in June and July.

**CONTROL MEASURES.** Spraying to control the currant and gooseberry fruitfly will also control this pest. Follow the same schedule to avoid having a residue of insecticide on the mature fruit.

**Currant Borer**

*Ramosia tipuliformis* (Clerck)

Infested canes have yellow, undersized leaves and later die. The dead canes may show burrows running nearly their entire length, with part of both pith and wood eaten out (see Fig. 26).

**LIFE HISTORY.** This insect passes the winter as a nearly full-grown larva, about ½ inch long. It continues feeding in spring, making a small exit hole in the cane for the adult to emerge. The adult clear-winged moth emerges during June or July. The female de-
posits its eggs on the bark. The small larvae that hatch from these eggs work into the cane to feed.

CONTROL MEASURES. Canes that show signs of infestation during spring should be cut out and burned by the middle of May.

**Currant Aphid**

*Capitophorus ribis* (Linn.)

The currant aphid feeds on the undersurface of the leaves, causing the upper surface to become elevated in bright red cup-like formations (see Fig. 27).

These aphids hatch from eggs that overwintered on the canes as the foliage starts to develop in the spring. They crawl to the leaves and start their feeding. If the infestation becomes severe, leaf distortion and foliage-dropping may occur.

CONTROL MEASURES. Apply a malathion spray containing 2 pounds of 25 per cent wettable powder per 100 gallons just as the leaves start to grow out of the buds in early spring. The object is to
Fig. 27. Leaves become curled and puckered when currant aphids feed on lower surface. If injury is severe leaves will drop from plant.

kill the aphids as soon as they hatch, thus preventing damage to the leaves. Once they are protected by the leaves, they are much more difficult to reach.

Tetraethyl pyrophosphate (TEPP) sprays and dusts are also effective. Apply a 1 per cent dust, preferably during the warmest part of the day. Prepare sprays according to the manufacturer's directions.