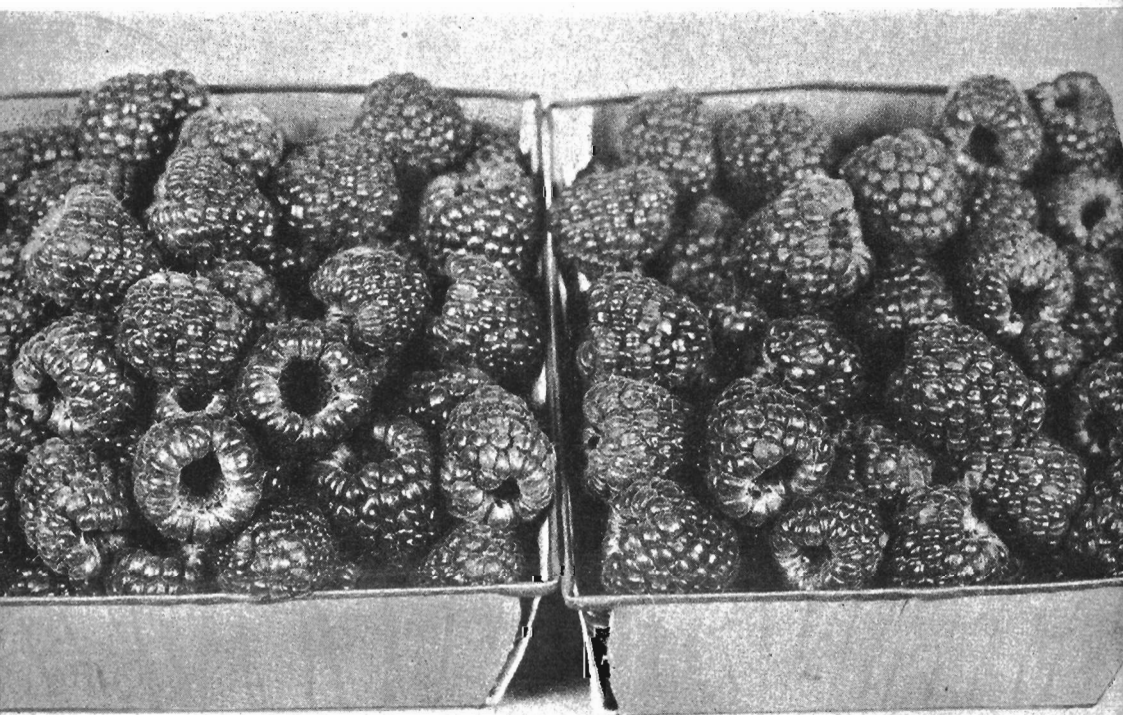


Diseases and Insect Pests of **Cane Fruits in Oregon**

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Cover illustration—

Baskets of the Willamette red raspberry.

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FOREWORD

Cane fruits are grown in Oregon for processing and for fresh fruit purposes. Cane-fruit production in 1944 brought a cash farm income estimated at about \$3,091,000, or approximately 2.5 times as much as in 1940. Successful cane-fruit production depends to a great extent on the control of diseases and insect pests attacking these crops.

This bulletin presents descriptions and suggestions for control of the various cane-fruit diseases and insect pests occurring in Oregon.

WM. A. SCHOENFELD
Dean and Director

Diseases and Insect Pests of **Cane Fruits in Oregon** *

by

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THE cash farm income from cane fruits grown in Oregon has almost tripled since 1940. With the interest in Victory gardens and home production of fruits, cane fruits will doubtless be greatly increased.

This bulletin presents a discussion of the more common diseases and insect pests of cane fruits for the use of gardeners and commercial growers in maintaining high quality and profitable yields of berries.

DISEASES OF CANE FRUITS

The common diseases of cane fruits in Oregon are briefly discussed under four general groups according to the causal agents, namely: bacterial, virous, fungous, and physiological or deficiency diseases.

BACTERIAL DISEASES

Cane gall

Agrobacterium rubi Hildebrand

Cane gall may appear on fruiting canes as small rough ridges or elongated protuberances of whitish granular gall tissue. The enlargement of the galls frequently causes the canes to split open. (Figure 1.) Injured canes usually produce small, seedy fruit, depending on the severity of the disease. When this disease affects the roots it has the appearance of crown gall. Infection takes place through cane injuries.

The cane gall disease affects blackberries, black raspberries, purple raspberries, occasionally red raspberries, boysenberries, loganberries, and young-berries.



Figure 1. Cane gall breaking out through a blackberry cane.

* This revision is based on the original Station Bulletin 418, by S. M. Zeller, Plant Pathologist, and Joe Schuh, Assistant Entomologist.

Crown gall

Agrobacterium tumefaciens (E.F. & M. & Towns.) Conn

Crown gall is prevalent and causes considerable damage to all types of cane as well as tree fruits. Irregular, warty galls develop at

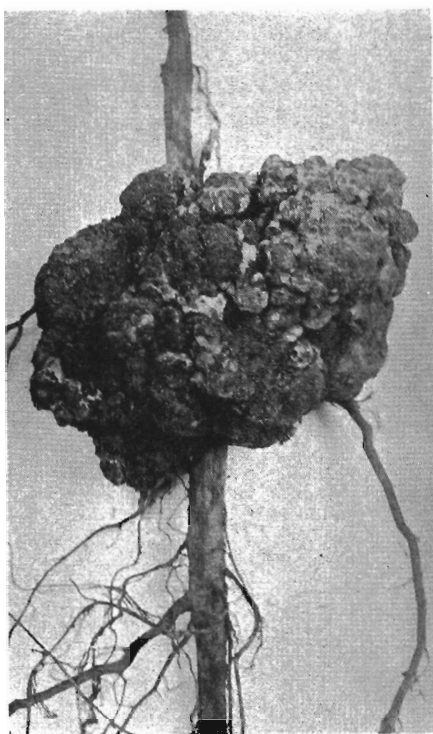


Figure 2. Crown-gall tumor choking a young loganberry plant. Tips grown in a yard where galls are present may transmit the disease.

the base of the canes or on the roots (Figure 2), and since they are hidden from view the cause of the devitalized and unproductive condition of the plants resulting from this bacterial infection may not readily be detected. Crown gall is becoming more common in cane fruit plantings.

Hairy root

Agrobacterium rhizogenes
(Riker et al.) Conn

Hairy root is another bacterial disease that attacks the roots of all types of cane fruits. Both hairy root and crown gall are often found on the same plant. The chief root symptom of the former is the production of large quantities of very fine roots at the expense of larger leader roots. For this reason, the root system does not en-

large and reach out into a large volume of soil, and consequently affected plants lack nutrition.

The crown-gall and hairy-root diseases are caused by bacteria that are able to persist in the soil about affected plants. They enter the plant through wounds and abrasions and stimulate the tissues to an excessive and abnormal cancerous or hairy growth. The diseases are spread for the most part by cultivation with tools that have become contaminated by contact with galls or germ-infested soil.

These bacterial diseases cannot be cured. Diseased plants should be removed completely as soon as discovered and carried

away to be burned. Some cases of cane gall may be corrected, however, by cutting out infected canes when the galls appear. As a further precaution the contaminated soil about the plant may be removed and replaced by clean soil. Avoid injury to the crowns of healthy plants in cultivation or putting new plants in the places once occupied by badly diseased ones. If a planting is found to be severely infected so that control measures are impracticable, fair yields of fruit may sometimes be had for a few years by liberal use of nitrogenous fertilizers and by practicing the best approved culture.

The diseases may readily be introduced into a new planting by means of planting stock obtained from fields harboring them even though the young plants may show no signs of galls or hairy roots when set out. Nursery stock should be obtained, therefore, only from healthy yards and planted in soil free from crown gall or hairy root. The bacteria causing these diseases will persist in soil for 5 or 6 years after susceptible trees or shrubs are removed.

The best control is through the planting of nursery stock free from bacterial diseases.

VIROUS DISEASES

Among the most serious diseases of cane fruits is the viroous group. In Oregon there are three such diseases: the *Decline* disease of raspberries in the Willamette Valley, *Red-raspberry Mosaic* in eastern Oregon, and *Dwarf* of blackberries in western Oregon. These diseases have certain characteristics in common. An infected bush never recovers and should be dug out and destroyed. No sprays or outward treatment will cure or prevent viroous diseases, since the infective substance is carried in the sap of the plant. These diseases are transmitted from diseased to healthy plants by means of sucking insects. (See Figure 3.)

Decline disease

Virus

Much damage has been observed in red raspberry yards from a disease that causes the eventual death of individual hills. Plants first show a reduced growth and inferior crop. The next year the number of new canes is reduced and their length often cut down. The new foliage generally presents a somewhat unnatural appearance. By the third year the hill is often dead. A plant that has had the disease for one full season is almost valueless. Relatively large infected areas in a planting therefore may reduce yields below a profitable basis.

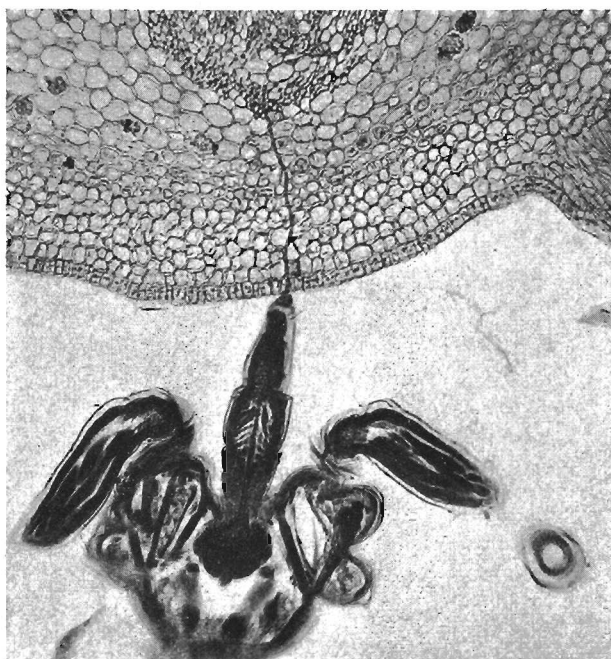


Figure 3. Greatly enlarged section of a vein in a leaf, showing cell structure and the penetration of the vein by an aphid's beak. In this way aphids inject virous diseases into the sap-conducting tissues of healthy plants.

The decline disease seems to be increasing in extent. It occurs often in the best cared for and most vigorous yards and has no relation to soil or other environmental conditions. It is transmitted in some way from hill to hill, and young plants propagated from diseased plants carry the disease.

Unfortunately there are no consistent or continuous symptoms by which alone the decline disease may be identified on the Cuthbert raspberry, which is generally grown commercially in Oregon. Diagnosis depends more on chronological performances than on concrete symptoms. This is truly a "running-out" disease.

Symptoms of
decline disease

If infection takes place late in the season, the first indication of the disease the following spring is the retarded appearance of the new succulent shoots. These have more of a reddish color than the earlier healthy canes. During the growing season, however, the

leaves show no abnormalities until growth slows down in the autumn. Leaves of diseased plants produced after this time have considerable downward leaf roll and more definite fluting along the veins as compared with the flatter leaf blades on normal plants. (Figure 4.)

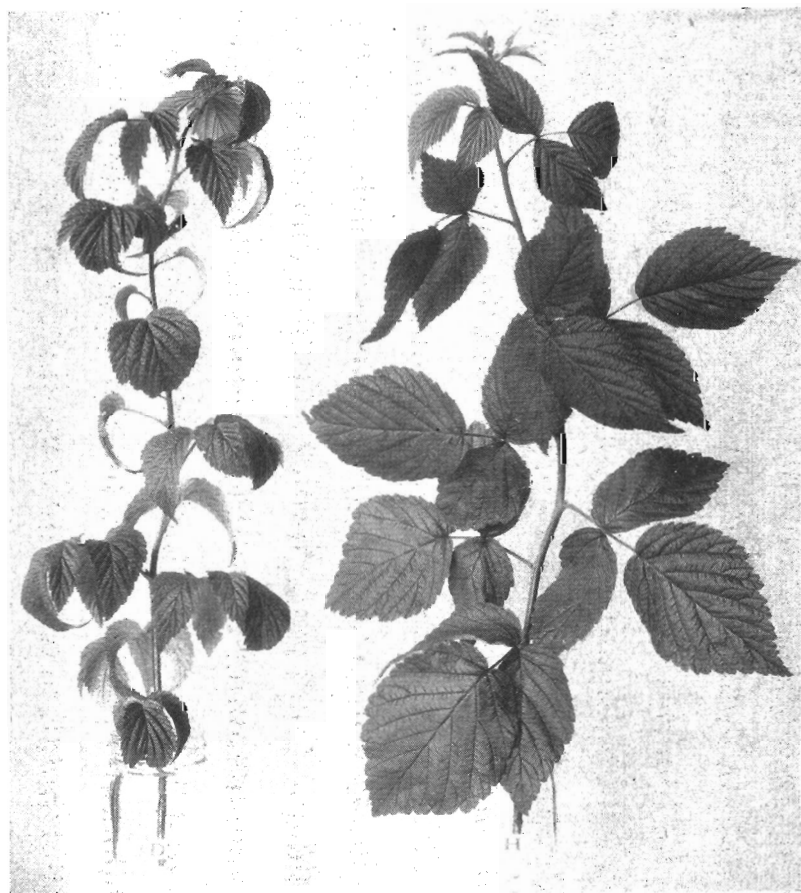


Figure 4. Decline disease. Tips of current season's growth of Cuthbert raspberry canes taken from the field in October. Cane on left infected by decline disease shows leaf rolling and fluting symptoms. Healthy cane at right.

These rolled leaves toward the tips of affected canes possess somewhat less interveinal greenness than normal leaves, and are slightly bronzed along the margins and crests between the veins. The internodes in these tip areas are foreshortened. This condition, as suggested above, does not usually occur at other times during the grow-

ing season under field conditions. Canes of affected plants do not attain the height and diameter of normal growth and are otherwise weakened and unhardy, as indicated by the fact that they may die in the winter or the buds lack the vitality to produce lateral growth the following spring. A general decrease in size and abundance of the root system parallels the depletion of the canes. The smaller roots and feeder rootlets gradually become less numerous as the disease progresses. The influence of all of these retarding factors results in a progressive deterioration of the whole plant over a maximum of about 3 years.

The raspberry decline disease of Cuthbert has no leaf or cane symptoms similar to those that characterize other described virous diseases, but some other raspberry varieties, such as Chief, Latham, Lloyd George, Washington, and Viking, affected by decline, may show a yellow, blotchy mottling in the leaves. Fruit symptoms are similar to those of raspberries infected with mosaic. The fruits are small, irregular, and tend to be globose rather than ovoid. When the ripe berries are picked, the drupelets fall apart readily, producing a condition commonly referred to as crumbliness. The berries, therefore, are considered worthless and are not harvested from infected portions of the fields.

The disease usually forms circular areas of devitalized plants by spreading from single or groups of infected plants. The effects of the disease in this respect are quite similar to those resulting from root-weevil infestation.

For the protection of the other plants, it is the safest procedure to remove hills that show indications of the trouble. Particular care should be taken in establishing new plantings to obtain planting stock from yards known to be free from any trace of the disease.

Control of
decline disease

Dwarf disease

Virus

In the Willamette Valley is to be found the dwarf disease of blackberries, affecting loganberry plants in particular.

The damage in some plantings affected by the disease is slight while in others 80 to 90 per cent of the plants may be infected. Few plantings of the Phenomenal berry are without dwarf, but loganberries planted alone, that is, without Phenomenal berries near, may exist for years without the disease. Boysenberry and youngberry bushes are very resistant to the disease and recover from infection.

Infected plants are a source of infection and a menace to healthy plantings.

The symptoms consist principally of an abnormal yellowish-green color of the leaves accompanied by certain malformations and a general dwarfing. In advanced stages of the disease the canes are stiff and short. They usually grow quite erect.

**Symptoms of
dwarf**

Even infected laterals have an erect growth unnatural to loganberries. The buds come at close intervals on the stem so that there may be as many leaves on a cane 4 feet long as usually occur on a normal cane 12 to 16 feet long. In older plants only parts like laterals on the canes may show the disease the first year but it gradually spreads throughout the plant. After 2 or 3 years of infection the canes of a plant may not grow more than 1 or 2 feet high. Once infected, a loganberry plant seldom, if ever, recovers. (Figure 5.)

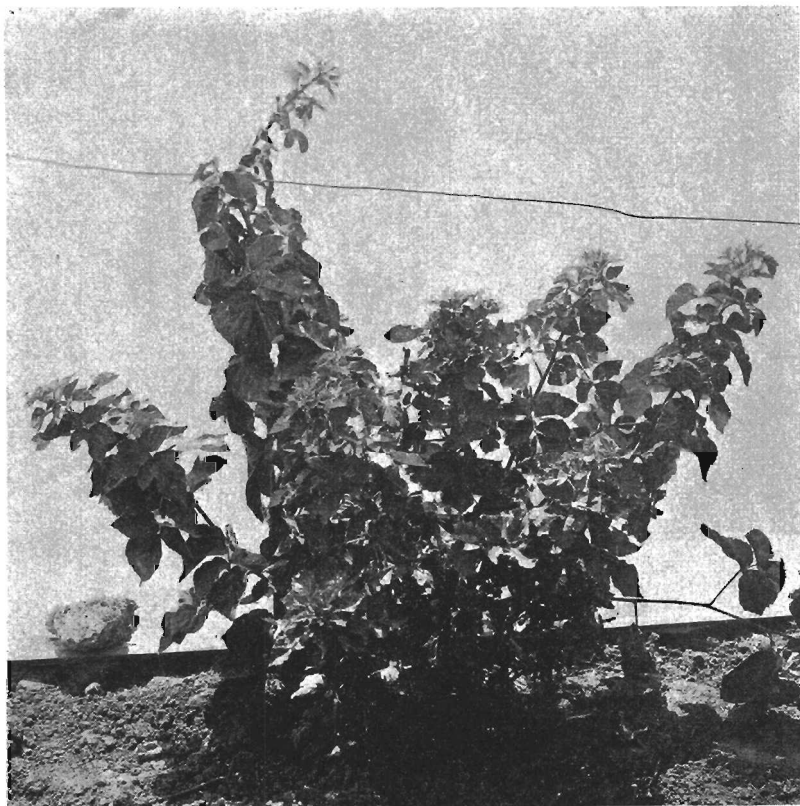


Figure 5. Dwarf disease. A loganberry plant in the second or third year of dwarf has short stubby canes.

The young leaves at the tips of the canes show some yellowish mottling. As they age, the mottling disappears, but the leaves are never as deep green as on normal plants. Affected leaves usually curl under somewhat at the margins while normal leaves are spreading and flat with a rich green color.

Fruit from dwarfed plants is usually crumbly and ripens unevenly.

Plants that have had the disease for several years will not root at the tips and so the only spread through nursery stock would be possible from the transplanting of rooted tips from affected plants still having some long trailing canes. Plants that show no symptoms, however, may have had late current season infection.

One of the most practical means of dwarf prevention, therefore, is to plant stock from fields that are apparently free of the disease. Where the disease shows less than 5 per cent, it is practical and advisable to rogue out the affected plants. The job must be done thoroughly, however, and the affected plants burned *immediately*. *Rogued plants should never be allowed to lie around for any length of time.*

The Phenomenal berry should never be grown near loganberries. (See Oregon Agricultural Experiment Station Circular of Information 177—Mimeo.)

Red raspberry mosaic

Virus

Fortunately raspberry mosaic has not been found disseminated in those districts of Oregon where raspberries and other bramble fruits are grown commercially. East of the Cascade Mountains in Oregon, the red raspberry mosaic is widely distributed.

Diseased plants are noticeable because of the dwarfed canes, thin growth and yellowish, mottled foliage. New growth from diseased plants is shorter than that of the previous year. The leaves are small and somewhat deformed, resulting in a progressive stunting from year to year. Fruit from thoroughly infected bushes is usually worthless, being dryish, seedy, crumbly, and insipid.

The foliage on young shoots has a green mottled and blistered distortion, with a downward arching of each leaflet. The tissue around the green blisters is yellowish. (Figure 6.) These symptoms show best in the spring, gradually becoming less distinct in leaves produced in the summer.

The control of raspberry mosaic in eastern Oregon will involve the elimination of diseased plants from districts wishing to grow raspberries and the introduction of planting stock from districts that are naturally free from the disease, such as the Willamette Valley, or from districts that have made a systematic effort to produce and certify clean nursery stock. Healthy stock introduced into an infected area will

Control of
mosaic

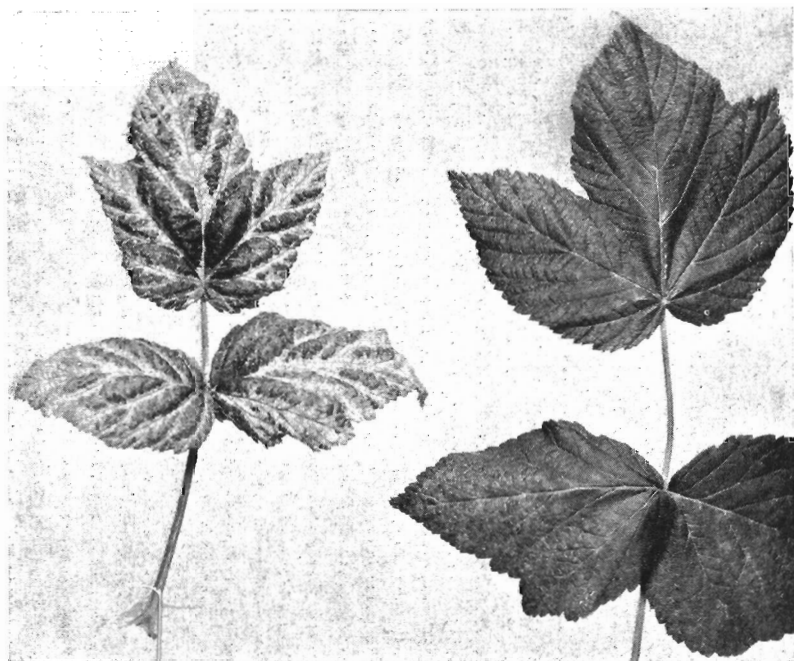


Figure 6. Red raspberry mosaic. Leaves from fruiting laterals become mottled, like the one above. Healthy leaf at right.

have a better chance to remain healthy the farther it is planted from infected plants.

FUNGIOUS DISEASES

Leaf and cane spot

Septoria rubi Westendorp

The common leaf spot of cane fruits in Oregon affects especially trailing blackberries. Trailing blackberries as used here include loganberry, youngberry, boysenberry, Mammoth, Lucretia, the wild

dewberry, and cultivated selections of our common wild trailing blackberry. The latter goes under the name of wild blackberry, certain selections of which are sometimes designated at Zelinski, Santiam, or Ideal Wild. Such varieties as Himalaya, Evergreen, and erect cane blackberries are sometimes affected but are more resistant than the trailing blackberries mentioned above. The leaf- and cane-spot disease is found in almost every locality, especially in western Oregon, where these fruits are grown. The disease is common and is usually quite serious in the Willamette Valley, especially during years of rather continuous rain in the fall and spring; and along the

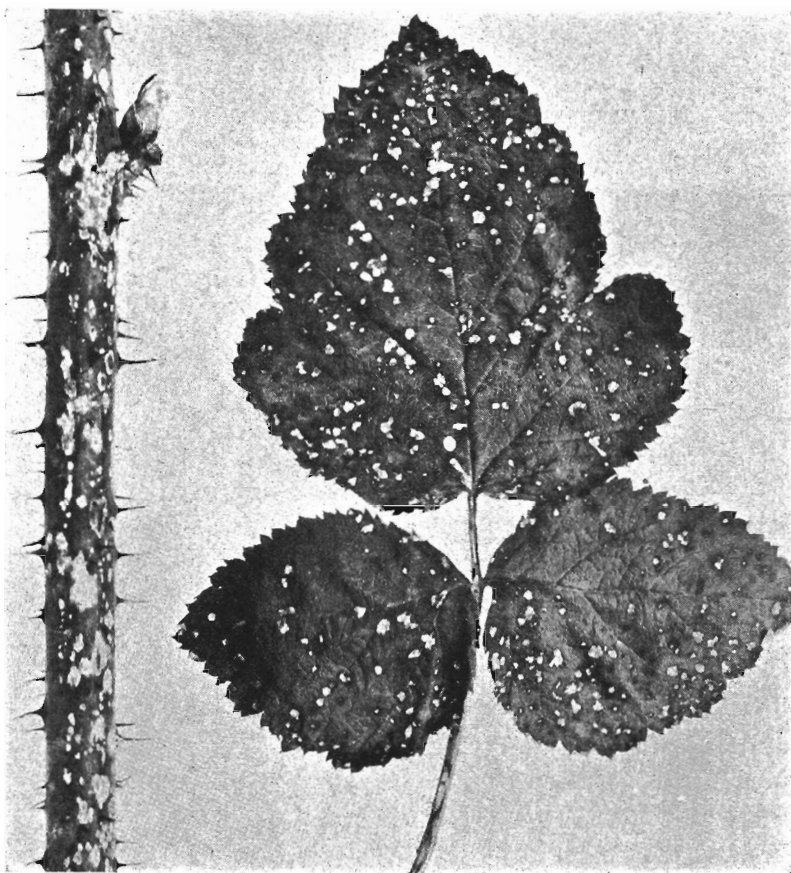


Figure 7. Leaf and cane spot of loganberry.

coast, where there are heavy fogs. In the drier sections very little damage is ordinarily done.

The appearance of the disease varies somewhat on different varieties. On some varieties the spots on the leaves are light brown, while on others they are dark brown. These spots are comparatively small, measuring about $\frac{1}{8}$ inch in diameter. The diseased portion is at first purplish, although a brown color is assumed as the affected tissues die. In older spots the center is whitish and the border is brownish or reddish. The spots on the canes are very similar to those on the leaves. (Figure 7).

Symptoms of leaf
and cane spot

The fungus forms tiny black fruiting bodies just beneath the upper surface of the leaf cuticle. As these mature they break through the cuticle and are exposed in the affected areas. There are usually two or three of these fruiting bodies in each spot, each capable of producing myriads of tiny spores. The spores at maturity ooze out under moist weather conditions and are scattered to other leaves by means of the splattering effect of raindrops. Here they germinate in water and the result is new leaf spots, each from a single spore. During the winter other fruiting bodies producing the perfect-stage spores are found on the old leaves on the ground and on the spots on the canes, providing the old fruiting canes of the previous year are allowed to remain. This special type of spore, which is shot out from the fungous fruiting body sometimes from February to the later months in the spring, infects the new leaves and canes. Infections, however, take place only during continuous damp weather due either to rainfall or continuous fog.

Since the sources of infection are the spots on the leaves and canes, it is recommended that as a sanitary measure the old canes be removed as soon as the crop is harvested, especially in years of severe infection.

Control of leaf
and cane spot

The spray that has proved most satisfactory for cane-spot and leaf-spot control is lime sulphur (10 gallons to 100 gallons of spray) applied once during February or March after the old canes have been cut out and the fruiting canes have been trellised. (See Oregon Experiment Station Circular of Information 320—Mimeo.)

Anthracnose

Elsinöe veneta (Speg.) Jenkins

Anthracnose in recent years has been responsible for considerable damage to canes of black raspberries in western Oregon. It also may be found on certain varieties of red raspberry, such as

the Washington, Latham, Lloyd George, Chief, and hybrids of these, but the Cuthbert is seldom if ever infected under weather conditions prevailing in western Oregon. All varieties of the black raspberry and purple sorts grown here are susceptible to anthracnose. Blackberries and loganberries for the most part are not infected with this disease, but they are usually infected with the leaf and cane spot disease described on pages 13-15.

On young shoots the disease may be recognized by circular sunken spots about $\frac{1}{8}$ inch or more in diameter. These are purplish at first, turning grayish. As the canes age, the anthracnose spots become deeper and the margins become raised and purplish. This disease is particularly serious providing rains continue late in the spring, when spots on the canes may be plentiful enough to cut off considerable sap flow. Look for the symptoms near the ground on the canes produced this year. They will be the fruiting canes of next year. Most of the

**Symptoms of
anthracnose**

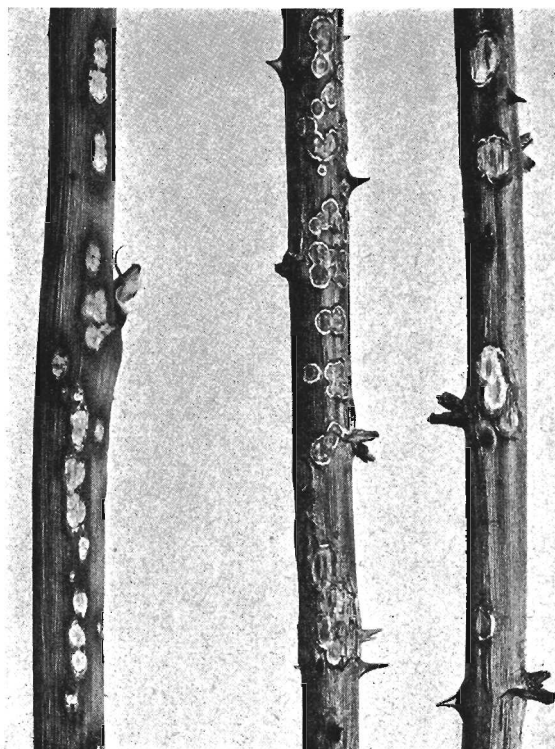


Figure 8. Anthracnose on red and black raspberry canes.

infection spots will be on the side of the cane toward the center of the plant. In very severe cases they may be scattered 6 to 30 inches up the canes. (Figure 8.)

When anthracnose is prevalent in black-cap plantings, the grower will notice an uneven ripening of the berries and that especially the tops of the berries dry up or have whitish spots on the top of each drupelet. These whitish, dried spots are usually caused by anthracnose infections and constitute one of the indications that the disease is altogether too prevalent and needs control measures.

For the control of raspberry anthracnose in Oregon the following recommendations are made: (1) Use clean planting stock. Disease-free stock should be used for new plantings. Cut away enough of the stub of the old cane on the black raspberry tips so that what remains of it will be completely buried when planted. (2) All old fruiting canes should be cut out and burned as soon as practical after harvest. (3) Although anthracnose sometimes is not severe enough to warrant the cost of a spray program, where sprays are needed the following schedule is recommended:

Control of
anthracnose

(a) *Lime sulphur*. Apply lime sulphur preferably as a dormant spray, but it may be applied at least not later than when the buds *just begin to open*. All canes should receive a thorough covering of spray, which is made up by using 10 gallons of 32° Baumé lime sulphur diluted with enough water to make 100 gallons of spray material.

(b) *Bordeaux mixture* (6-6-100). This spray should be used in the spring when the new succulent canes are 8 to 12 inches high. If rainy weather prevails, repeat the latter when the canes are 14 to 20 inches high. Plants should not be sprayed, however, later than a week before the blossoms open because of possible spray injury. Only the bases of young canes should be sprayed with bordeaux mixture, care being taken to avoid spraying the foliage of old canes. Even with the best of care one might get some foliage injury using bordeaux in the spring.

Orange rust

Gymnoconia interstitialis (Schl.) Lagh.

Orange rust disease is of little consequence in Oregon. An occasional plant of some black raspberry varieties and plants of some varieties of blackberry, like Kittatinny, Stuart, Texas, and Brainard, have been discovered in the state.

Orange rust is carried systemically in affected plants. If a young tip or set is infected when planted, the new canes that grow up will be weak and spindling and soon the pale green leaves will be *completely covered on the under side with a heavy powdery coating of orange rust spores*. This is in marked contrast to the common yel-

low rust of the Cuthbert red raspberry, which has separate pustules of yellow spores on the upper surface of the leaves.

Control of
orange rust

Since orange rust is systemic, all infected plants should be dug out and burned. Growers should start new plantings with stock free of orange rust.

Yellow rust

Phragmidium rubi-idaei (DC) Karst.

The disease known as yellow rust occurs wherever raspberries are grown in western Oregon. The disease develops to serious proportions, particularly in seasons when the spring rains continue late or humidity is high. Under such conditions the infections become so numerous on the leaves that part defoliation in badly infected plantings is frequent.

The leaf infections in the spring and summer months cause a yellowish spotting of the leaf tissues and become very dusty yellow above and below because of the millions of yellow spores of the rust fungus. (Figure 9.) Berry pickers frequently have their clothing almost covered with this yellow dust. The infected leaves, especially those lower down on the canes, turn yellow and drop off during the early summer. In seasons of severe leaf infection the disease has a devitalizing influence on the current season's crop and on the production of canes that will bear the crop of the following year. The actual amount of loss from this source, of course, would be difficult to ascertain.

Symptoms of
yellow rust

The black winter sports, which are hardy enough to carry the rust through the severest winter weather, appear during the autumn on the under sides of the same leaves that showed the yellow stages during the summer. The under surface of the infected leaves becomes sooty black. These leaves drop to the ground in the fall and early winter and become the main source of infection the following year.

All parts of a plant are subject to infection during succulent growth. The infections near the ground on the canes are most frequent and present the most serious aspect of the disease. If they are numerous they not only hinder the normal rise of sap, resulting in wilting, but also produce brittleness in the canes. Many of the brittle canes are accidentally broken off when the old fruiting canes are thinned out and many more are broken out when the canes are trellised. Frequently also berries dry on the bushes before they reach maturity.

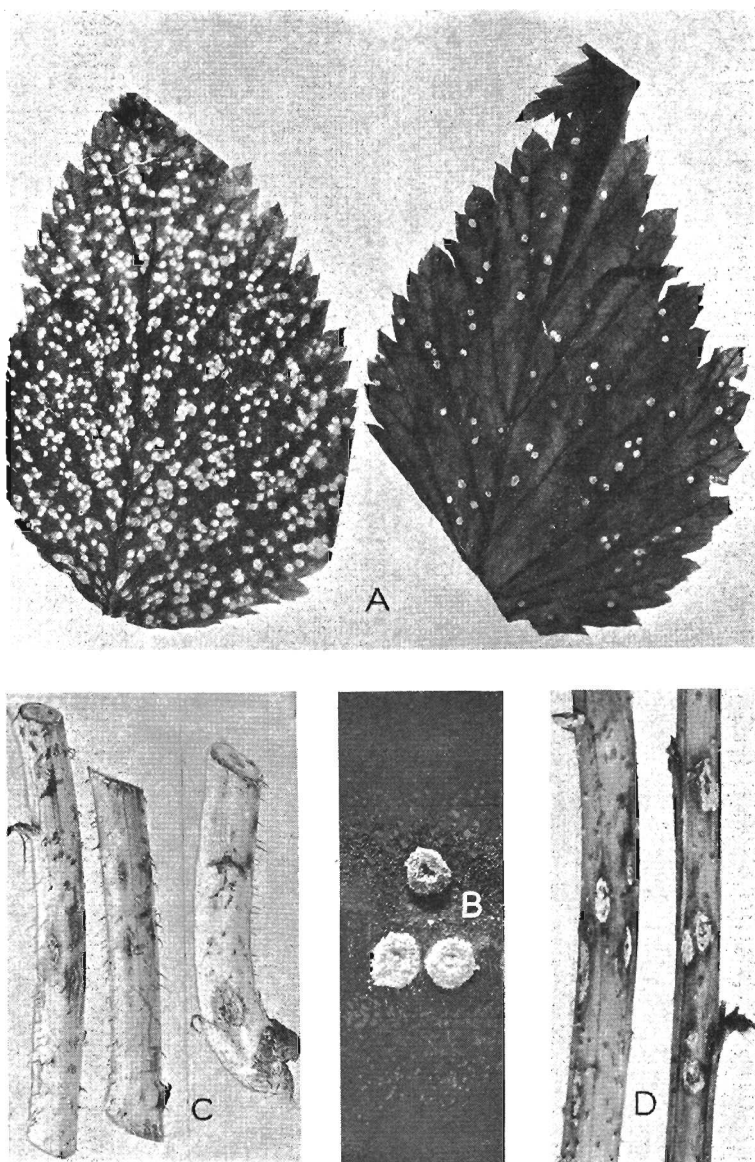


Figure 9. Yellow rust of Cuthbert red raspberry.

- A. Pustules of early spores on the upper surface of leaflets.
- B. Same greatly enlarged.
- C. Pustules of summer spores on newly grown canes, showing early stages of cane lesions beginning as dark water-soaked areas.
- D. Same as C late in summer.

The most practical and satisfactory means of control of yellow rust on the Cuthbert variety are to be found through extreme sanitary methods. These measures consist of the removal of all the sources of infection that may be eliminated. *Late fall or early spring plowing to cover fallen leaves and refuse before the leaves come out offers the most practical method of control, since the chief source of infection is from the old leaves.* The old fruiting canes should be removed as soon after harvest of the fruit as practicable because this will remove much of the source of late summer infection from the spores on the leaves. Old stubs should be removed flush with the ground and all of the canes cut in the future should be removed so as to leave no stubs. The stubs catch the infected leaves and other refuse and this dead wood and leaves in the hills become the chief source of infection during the spring. When plowing, the soil should be thrown toward the rows and worked down into the hills in such a way as to cover completely all remaining leaves and stubs. When the plowing suggested above is impracticable because of wet weather, all the leaves, canes, and stub refuse should be cleaned completely from the ground and burned or buried. This can be done in small garden patches.

The practice of all these measures in a planting will not only keep the rust down to a minimum but will also eliminate the infection courts through which cane blight gains entrance. Yellow rust occurs particularly on Cuthbert and Washington raspberries and is often found on overwintering leaves of blackberries. (See Oregon Experiment Station Circular of Information 71—Mimeo.)

Cane blight

Leptosphaeria coniothyrium (Fuckel) Sacc.

Cane blight is a very serious disease in localities in Oregon, and one that has not been readily controlled. On the Cuthbert red raspberry it is perhaps more serious than on any other cane fruit. On canes of the Cuthbert it infects through yellow rust lesions, usually within 6 or 8 inches of the ground. From the rust spot the purplish cane blight infection spreads up and down the cane about 3 to 8 inches. This long infection area becomes flattened, may crack, and creates a very weak area in the cane. Such canes readily break off. (Figure 10.)

In black raspberries cane blight usually infects through the cut where canes are pruned off to force laterals. If infection extends down the cane far enough, one or two laterals may be killed.

Boysenberry, loganberry, and youngberry canes are seldom infected with cane blight except where canes are frosted or pruned. The surface of such blighted canes turns gray and the gray portions become covered with black specks. These specks are the fruiting bodies of the cane blight fungus.

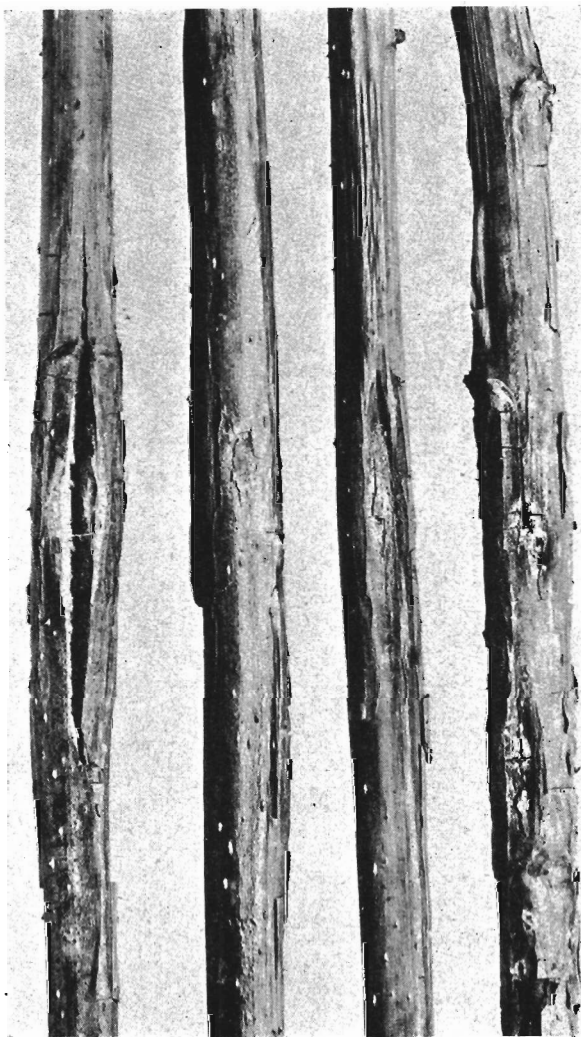


Figure 10. Cane blight. Raspberry yellow-rust spots infected with cane blight. Note the long sunken areas that sometimes split open.

There are several other causes of cane blight. Freeze injury is a most common one in plantings of blackberry and raspberry. (See Winter Injury, p. 28.) Discolored areas on the stem may be caused by several fungi, such as spur blight (see below) and *Ascospora* blight.

Other causes of
cane blights

The *Ascospora* cane blight is common on Cuthbert raspberry, on new canes of loganberry and on those of the Himalaya and Evergreen blackberries. This fungous disease appears during the first winter as large brown patches that finally turn gray. These infections may girdle the canes.

To control cane blight, cut canes showing much of the disease and practice clean cultivation. In Cuthbert red raspberry, control consists almost wholly in the control of yellow rust infections on the young canes. (See p. 20.)

Control of
cane blights

Dormant lime sulphur spray is very beneficial in the control of cane and spur blights of all sorts.

Mildew

Sphaerotheca humuli (DC) Burrill

Powdery mildew of cane fruits is not a serious disease in Oregon except on certain varieties of purple and black raspberry, especially Munger and Plum Farmer. Certain red raspberries, such as Latham and Chief, are sometimes infected, and occasionally thin-leaved varieties of blackberry, such as Himalaya and Brainard. Individual plants of the Evergreen blackberry seem to mildew exceptionally; such plants, however, are usually worthless and should be replaced by normal plants. Mildewed leaves are grayish and usually the margins roll upward. (Figure 11.)

Control of mildew is effected by an application of any dusting sulphur as soon as infections first appear on the leaves. Lime sulphur applied as a dormant or delayed dormant spray to black raspberries for the control of anthracnose will also clean up hold-over mildew infection on the stems.

Control of mildew

Spur blight

Didymella applanata (Niessl.) Sacc.

Spur blight is of common occurrence throughout western Oregon, affecting mostly the Cuthbert raspberry, loganberry, and young-berry bushes. Since we do not have intermittent summer rains, it seems at no time to reduce greatly the yield of berries. In the Wil-

lamette Valley its infection results in spur blight, as named, but in the Ashland district of the Rogue Valley this disease becomes a cane blight.

During the development of the new canes, brown spots appear about the bases of the leaf stems. (Figure 12.) The bud may shrivel and die, or if it lives overwinter it yields only small yellowish leaves, but no fruiting lateral. Where the disease assumes the nature of a cane blight, the whole surface of the young cane turns brown from

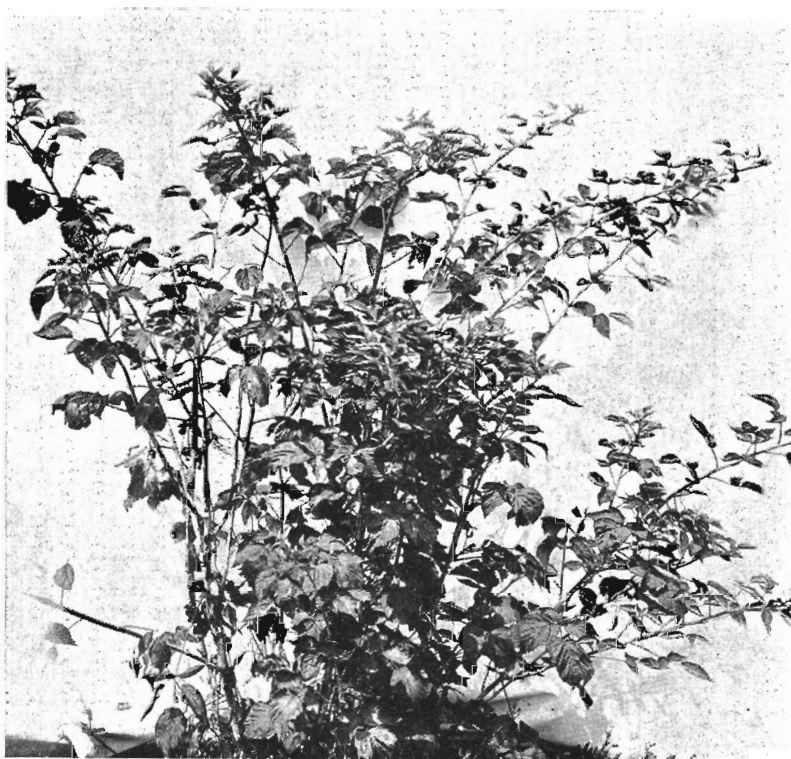


Figure 11. Mildew on black raspberry, showing the cupping of the leaves. So much of the under surface of the leaves is in view that the plants appear gray.

the base up to 20 or more inches. This is due to many infections that coalesce, and doubtless is aggravated by irrigation. Infected areas turn gray during the fall and winter.

The old canes should be pruned out and burned before the fall rains begin. In the Ashland district, applications of bordeaux mix-

ture 6-6-100 when the green canes are (1) 8 to 12 inches high, and (2) 14 to 20 inches

Control of
spur blight

high, have resulted in control and allowed a much greater increase in caliper of canes. In cases of serious infection an application of lime sulphur (10 gallons to 100 gallons of spray) should be given in the winter.

Verticillium wilt

Verticillium alboatrum R. & B.

This fungus disease is particularly serious to the black raspberry. It also affects purple raspberries and such red varieties as Lloyd George, Ranere (St. Regis), Chief, Red Antwerp, and J.atham. The Cuthbert is very resistant to infection. Among the blackberries some infection has been noted in loganberries, youngberries, Lucretia, Mammoth, and Phenomenal, while the Evergreen, Himalaya, and wild Northwestern trailing blackberries seem to show high resistance.

The disease causes dwarfing and wilting of the new canes. (Figure 13.) Bluish stripes or ribbons of infected tissues may extend up the canes from the ground.

Infection usually takes place through the small roots and thus remains in the soil following an infected crop. The more common crops and weeds that may be regarded as carriers are potatoes, tomatoes, eggplant, strawberries, pigweed, and groundsel or old-man-of-spring. Among nursery trees, maples have been found infected.

(1) Crop rotation trials indicate that 3- or 4-year rotations with two or three nonsusceptible intervening crops, between infected raspberries and black raspberries again on the same soil, were effective in eliminating the fungus from the soil. Crops, therefore, should be rotated to rid the soil of wilt contamination.

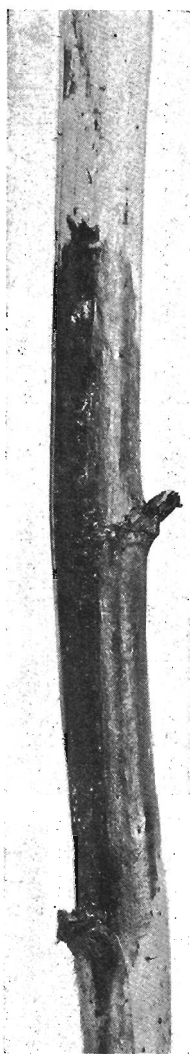


Figure 12. Spur blight, showing brown area near spur on a young raspberry cane. These areas become gray on the 1-year-old fruiting canes.

Control of verti-
cillium wilt

(2) Healthy stock from nurseries or other plantings that are free of wilt should be planted.

(3) Infected plants should be rogued to eliminate spread of wilt where the disease is less than about 5 per cent. (See Oregon Station Bulletin 344.)

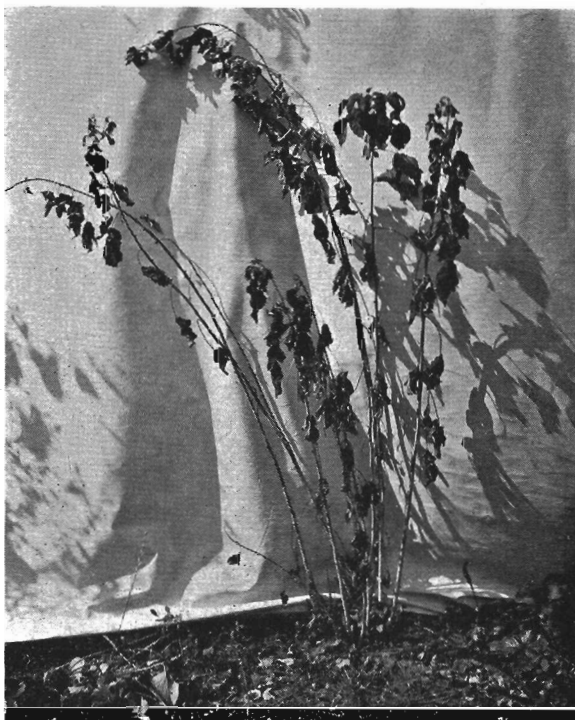


Figure 13. Typical symptoms of a black raspberry plant affected with verticillium wilt.

Mushroom root rot

Armillaria mellea Fries

Mushroom root rot usually is not a serious factor in growing cane fruits. It has been discovered doing damage to individual plants on land recently cleared of oak grub. Varieties affected have been black and red raspberries and loganberries. Affected plants are a total loss.

As a rule, however, the mushrooms found commonly in raspberry and loganberry crowns are not those associated with the root rot. They are merely living on the dead refuse of cane stubs, etc., the natural byproduct of healthy plant crowns.

Stamen blight

Hapalosphaeria deformans Sydow

Stamen blight has very recently been discovered in Oregon affecting boysenberry, youngberry, Evergreen, and the wild trailing blackberry (*Rubus macropetalus*). The disease was first discovered on a wild blackberry in Germany in 1907 and then again in British Columbia, Canada, on loganberries about 1933. It is well distributed through the Umpqua and Willamette valleys in Oregon, and it spreads rapidly in a planting once infected.

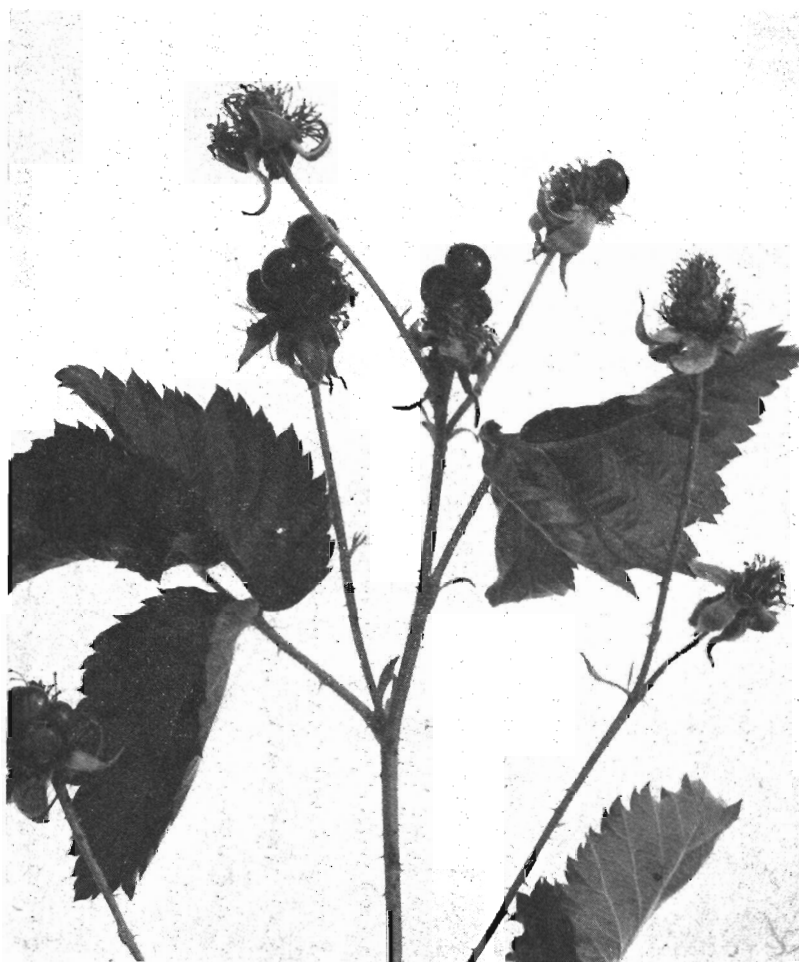


Figure 14. Poorly developed berries from blossoms of youngberry infected with stamen blight.

The disease affects only the stamens of the flower, completely preventing the production of pollen by that flower. Affected stamens have a gray powdery, mildewed appearance. Infection takes place through the buds in the axils of the leaves on green canes sometime between May and March, and once the winter bud is thus infected all the flowers produced by that bud are completely devoid of functioning pollen. The pistils, however, are not damaged by the disease, and infected flowers may produce berries, providing bees are plentiful enough for cross pollination. In most cases, however, bee pollination is imperfectly done, resulting in malformed fruit from infected flowers. (Figure 14.)

The exact time of infection by the stamen-blight fungus is yet to be determined in order that a successful preventive spray may be found. Lime sulphur (2 gallons per 100 gallons of water) applied to youngberries in August nevertheless has given about 60 to 75 per cent control the following season.

Fruit molds

Various mold fungi

In Oregon most of the yields from cane fruits are canned locally or sold on the local fresh markets, so that refrigeration and long-distance shipping are usually unnecessary. As a rule, therefore, the delay between picking and canning or sale on the market is so short that little opportunity for the development of fruit rots and molds is afforded.

If, however, the berries are to be held for several hours, they should be chilled or kept under cool conditions. Overripe or moldy berries in the boxes will usually introduce infection by molds. Pickers should be instructed to discard such berries and to pick without bruising the berries. Berries picked early in the day and kept cool will withstand rots longer than those allowed to heat in the sun or without chilling.

TROUBLES OF NONPARASITIC OR UNKNOWN ORIGIN

There are serious losses caused in many yards annually by conditions that result in the dying out of hills, dying back of the canes, death of individual buds or spurs, and an unhealthy condition at the base of the canes accompanied often by a grayish color and sloughing or splitting of the bark. These troubles need careful investigation to determine the various causes involved and to devise preventive measures, but some of the suspected causes may be mentioned here.

Winter injury

It is believed that immaturity of the canes due to imperfect hardening of the tissues at the end of the growing season often renders the plants susceptible to winter injury. This injury may doubtless be controlled, at least to some extent, by cultural practices that bring about normal maturing and prevent late growth or renewed growth in the fall. Cuthbert raspberries appear to be especially susceptible to this type of trouble. Loganberries also frequently suffer from damage due to low temperatures, and a mottled and crinkled condition of early leaves usually results from late frosts in the spring. This injury is often more marked when the canes are trellised in the fall, but under western Oregon conditions it is believed by many that any danger of injury added by having the vines on the wires through the winter is more than counterbalanced by the danger of injury to the buds that is likely to result from leaving the canes down on the wet ground and covered by weeds during the average dormant season.

In certain locations where cold winds prevail from snow-covered mountains, serious freezing and dying of canes may result. If the temperatures are at or just below freezing, the evaporation produced by the winds may lower the temperature of the canes considerably more. At such temperatures the spicules of ice in the plant tissues are much larger than those produced at low temperatures, resulting in severe damage. Dormancy of the canes, therefore, is perhaps of more consequence in the control of frost injury than freedom from low temperatures.

In this connection mention should also be made of frosts late in the spring after the new shoots have attained considerable length. Blackberries such as the Brainard, Evergreen, and Himalaya are more susceptible to late frosts than raspberries in general. Such injury may be recognized by the dark water-soaked appearance of the succulent stem tissues that may shrink and collapse at once, or persist and grow for some time. In the latter case, if the stems are cut open lengthwise, the pith will be found to have crosswise cracks and much brownish discoloration.

Soil conditions

Unsatisfactory soil conditions often lead to a loss of vigor, vitality, and productiveness that can be prevented only by the selection of the right type of soils for cane fruit plantings and the maintenance of abundant fertility and organic matter (decaying vegetable matter) in the soil. Exhausted soils, lacking in nitrogen and deficient in

certain chemical elements and moisture-holding capacity, cannot maintain healthy and productive growth.

Minor-element deficiencies

The essential nature of very small amounts of several of the so-called minor elements has become apparent in recent years. Certain types of yellowness and unhealthy color in plants are corrected or prevented by the presence in the soil of traces of such elements as boron, zinc, copper, and manganese. Not many such deficiencies have been definitely identified in cane fruits. Calico of the raspberry is one that shows lack of nutrition and where this is a symptom of basal leaves only it is readily cleared up by fertilizing with barnyard manure. Calico, however, has never been definitely related to a deficiency in any particular minor (or major) element. The tissues between the veins, however, lack a normal amount of greenness, suggesting a lack of nitrogen.

Too much alkali in soils may cause almost total lack of greenness in the leaves.

Cane fruits are likewise sensitive to "wet feet" due to poor drainage conditions. Shallow soils are also often the cause of trouble. Mention of the causes in such cases suggests the remedy. The County Agricultural Agent upon request will give information on drainage and fertilizers to use on the soil types in his county.

Drouth

Cane fruits are sensitive to excessive drying out of the soil due to prolonged drouth, improper cultivation, etc. The bad effects of such conditions not only are felt in the crop of the same season but may show up in decreased vitality the following year, since for the most part the buds of the canes produced one season yield the fruit of the following season. Care must be taken to avoid injury to feeding roots in cultivation, for excessive root pruning after growth has started results in an inevitable handicap for the plants. Too deep cultivation may do more damage than lack of it. Cover crops, though of great value, if left standing too long may result in greater harm than good by withdrawing too much soil moisture needed by the berry bushes.

Blossom blight of Evergreen blackberry

A blossom blight of Evergreen blackberries is becoming very prevalent in western Oregon. The difficulty seems not to be related to any particular type of soil or location. The cause is unknown. It may be pathological or physiological.

Crumbly raspberries

There are doubtless several causes of crumbliness in raspberries. Virous diseases as a rule cause crumbly berries, but there are crumbly berries produced on many plants that are not infected with known viruses. Some of the causes of crumbliness are obscure, but winter injury and soil deficiencies doubtless play their part. There are indications that a certain strain of Cuthbert red raspberry, which otherwise appears particularly healthy, produces crumbly berries and that new plants from such stock also produce crumbly berries. The Oregon State College plan for raspberry plant improvement has as one of its objects and rules the inspection of fields at fruiting time to rid rules the inspection of fields at fruiting time to rid the planting stock the planting stock of this type of "crumbly berry" as well as the eradication of virous diseases.

INSECT PESTS OF CANE FRUITS

Raspberry root borer

Bembecia marginata (Harr.)

The raspberry root borer is one of the more serious pests of cane fruits in Oregon. It occurs generally over western Oregon and attacks red and black-cap raspberries, loganberries, blackberries and possibly will be found to attack some of the newer varieties of cane fruits.

The adult is a showy, clear-winged, wasp-like, day-flying moth. The body is fuzzy, of a yellowish tinge, and is decorated with black rings. The grub is about 1 inch in length when full grown and is white in color except for the head, which is brown. It has three short legs on the thorax and a series of small, paired, hooked appendages on abdominal segments three, four, five, and six. These small hooks or crotchets are arranged so as to make a pair of oval areas on each of the segments mentioned above. The tenth abdominal segment does not bear these small hooks (compare strawberry crown moth).

The adult moths emerge during the months of August and September. The eggs, which are oval and reddish-brown in color, are deposited singly on the undersides of the leaves near the edge. They hatch during September and October and the young larvae crawl down the canes and gnaw their way into the crown or cane just below the soil surface. At this point they form a small cell in which they overwinter. In the spring the larvae begin to tunnel into the crown and by fall are about three-fourths grown. They spend the second winter in the crown and the following

Description

Life history

spring begin feeding again. When nearly full grown the larvae tunnel up into one of the old canes to transform. They thus take 2 full years to complete their growth.

The injury is manifested by the sickly appearance of the plants and reduced fruit production. The crowns of the plants are often severely tunneled by the larval feeding and injured canes may lop over.

Many methods of insecticidal control have been tried but with little success. Oil sprays applied as ovicides are reported by New Jersey workers to be successful. The spray recommended is a highly-refined white oil emulsion containing 83 per cent actual oil. This emulsion is used at the rate of

1 part to 150 parts of water. The first spray should be applied 2 weeks after the first eggs are noticed and the second spray 2 weeks after the first. No corroborative trials of this recommendation have been made in Oregon.

The removal and destruction of injured canes and the battering down of old stubs have proved of some value in reducing this pest, as the borers enter the old stubs and injured canes to pupate. This procedure of control should be carried out on or before mid-August to prevent any of the adult moths from emerging.

Strawberry crown moth

Synanthedon rutilans

(Hy. Edw.)

The crown moth is mainly a pest of strawberries, but at times it is a serious pest of cane fruits, especially black-cap raspberries and occasionally red raspberries and blackberries. Young plants of cane fruits seem to be attacked more often than older plants. Known cases of infestation are generally near heavily-infested strawberry plantings. This pest occurs throughout the Willamette Valley and in Jackson and Hood River counties.

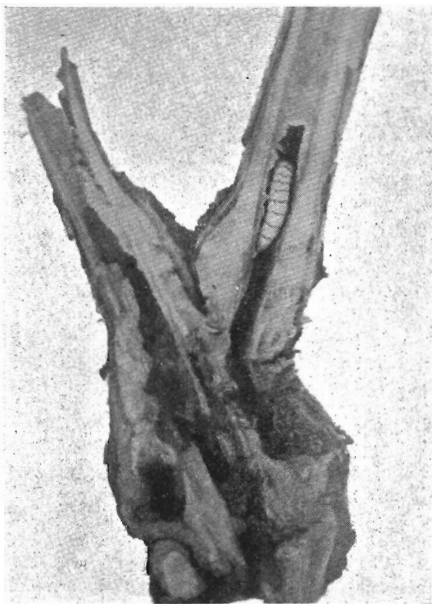


Figure 15. Raspberry root borer grub injury to blackberry crown. Note: For life stages see strawberry crown moth, which resembles the root borer very much. ($\frac{1}{3}$ natural size.)

The grub of this moth resembles the raspberry crown borer very closely except that it is a little smaller when full grown, often pinkish in color, and has a pair of rows of small hooked appendages on the tenth abdominal segment in addition to those found on the raspberry crown borer.

The adult is a clear-winged day-flying moth and resembles the raspberry crown borer except that it is somewhat smaller in size.

The eggs are brown in color, oval in outline, have a reticulate surface, and are about 1/50 inch long and 1/70 inch wide.

The adults begin emerging about the first week in June and may be found in the field as late as the first week in August. The eggs are generally laid on the under side of living or dead leaves. The larval period lasts from midsummer until the following spring. The larvae are about three-fourths grown by late fall and overwinter in this stage. In the spring they complete their feeding and emerge as adults during June and July. There is one generation a year.

If plants are severely injured they may appear weak or sickly and on examination of the crown the larval mines can be found with a copious amount of frass. In young plants the crown of the plant may be entirely destroyed. If the plants are examined near the ground level after the adults have begun to emerge, the empty pupal cases can often be found extruded near the base of the crown.

Many insecticidal control methods have been tried on strawberries. These have been found to be too injurious to the plants to be recommended either on cane fruits or strawberries.

Cane fruits generally are infested because of the proximity of heavily infested strawberry fields. It is therefore suggested that if infested strawberries are to be maintained near cane fruits a 3 to 5 foot barrier of grain be planted between the two plantings. This grain should not be cut until mid-August. The strawberry crown moths are naturally low fliers and tend not to fly over any such obstruction. If infested strawberries are to be destroyed this should not be done until mid-August when all the moths have laid their eggs. If possible, the old strawberry crowns should be removed and destroyed by burning.

Root weevils

Brachyrhinus spp.

The root weevils of the *Brachyrhinus* group (*B. ovatus*, *B. rugosostriatus*, *B. sulcatus*) are undoubtedly the most serious pests of

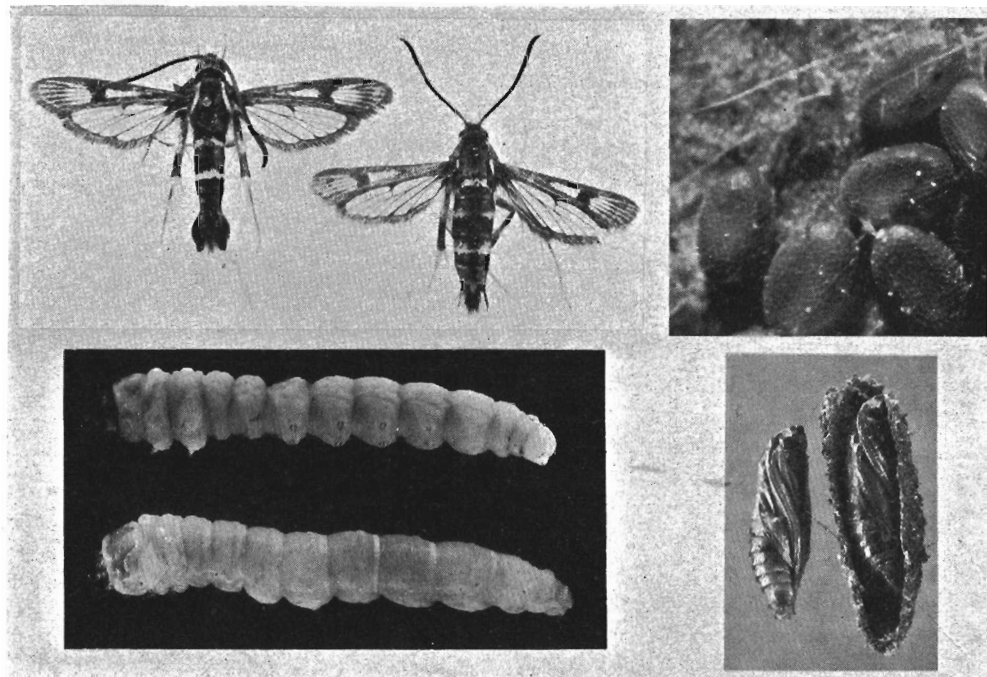


Figure 16. *Upper left*: Male adult, female adult (2.7X). *Upper right*: Eggs (32X). *Lower left*: Larva, dorsal and ventral aspect (3.25X). *Lower right*: Pupa (2.5X). Cocoon cut away to show the pupa inside (2.5X).

cane fruits in Oregon. They are distributed throughout the state and attack all cane fruits as well as a large variety of other hosts.

The root weevils of this group are generally known as the strawberry root weevils. They are evenly sculptured with low, rounded protuberances assuming the appearance of shagreen.

Description

None of these weevils are able to fly. All possess plainly visible snouts or beaks.

The larvae of all three species are legless, half-curved in lateral view, white to pinkish in color, and have a brown head capsule. They vary in length according to age, the full grown larvae measuring $\frac{1}{4}$ to $\frac{1}{2}$ inch in length.

The strawberry root weevil (*B. ovatus*) is the smallest one of the three, measuring about $\frac{1}{5}$ inch in length. It varies from black to light brown in color.

The rough strawberry root weevil (*B. rugosostriatus*) is about $\frac{1}{4}$ inch in length and is generally of an even dark chocolate brown color.

The black vine weevil (*B. sulcatus*) is the largest weevil of this group. It measures about $\frac{2}{5}$ inch in length and is black in color. Some individuals are marked with small flecks of white.

The seasonal life histories of all three species of weevils are very similar. The eggs are laid on the ground, under clods and other objects around the crown of the plants. The heaviest period of egg

Life history deposition is during June and July although many eggs are laid as early as April and May and as late

as August. The eggs usually hatch in about 10 days. The young larvae, on hatching, burrow into the ground and at first feed on the fibrous roots and later transfer to the crowns where they scar the outer surface and also tunnel within, often completely destroying the underground parts.

Generally the larval period lasts from midsummer until June the following year, but during mild winters and springs feeding continues throughout the year. Normally most adults emerge at about the middle of the strawberry harvest but in mild years some adults emerge in late fall and overwinter as adults; others complete development in early spring and emerge during April and May.

The injury of the adults is inconsequential and is manifested by semicircular areas eaten out of the edges of the leaves. This feeding is done at night and is a good way of ascer-

Injury

taining the presence of adult weevils.

The larval injury is quite often very serious and consists of the loss of fibrous roots and the tunneling and scarifying of the crowns as described above.

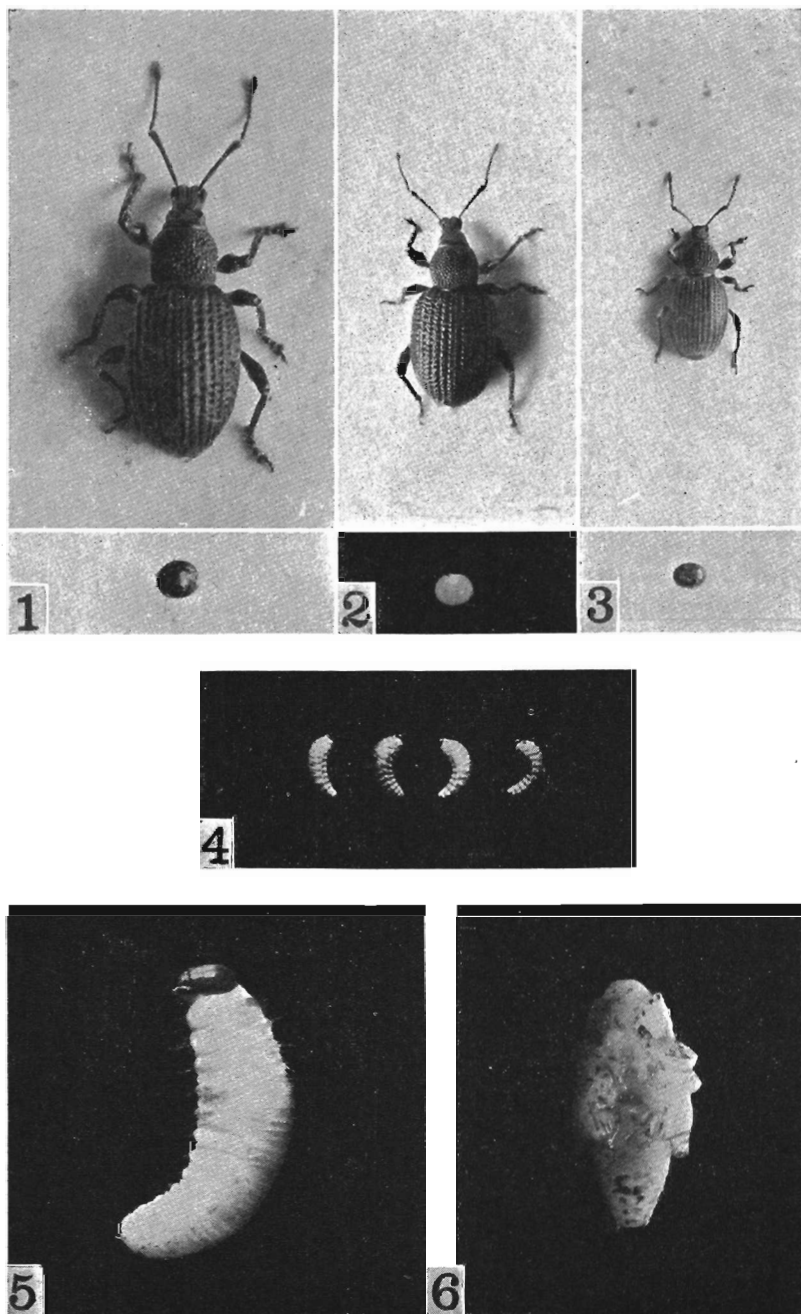


Figure 17. Common representatives of the black weevil group:
 1. Adult and egg of the black vine weevil (3X).
 2. Adult and egg of the rough strawberry root weevil (3X).
 3. Adult and egg of the strawberry root weevil (3X).
 4. Strawberry root weevil larvae (natural size).
 5. Larva or grub of strawberry root weevil (4X).
 6. Pupa of strawberry root weevil (4X).

Control measures consist of poison baits to kill the adult weevils and thus prevent the deposition of eggs.

Control To insure good success when using these baits accurate timing of their application is necessary.

There are several ways in which accurate timing may be accomplished:

1. Examine the soil about the crowns (either cane fruits or strawberries) for the immature forms. If 75 to 90 per cent of the pupae have changed to the adult stage it is time to apply the bait.
2. Examine the top layers of soil and clods around the base of the plants (the weevils hide here during the day); if live weevils are found, baits should be applied.
3. Examine the leaves (cane fruits or nearby strawberries) occasionally for ragging of the leaves. If ragging is evident, weevils can be found in the soil as in (2).

The number of applications of bait to apply will depend largely on the seasonal occurrence of adult beetles. If adult beetles are numerous during April and May, baits should be applied at this time as well as in June when the greatest number of weevils generally are present.

Individual fields will vary greatly as to beetle population either as a whole or in certain parts of the field. Sometimes large populations are encountered adjacent to sources of infestation such as old strawberry plantings, fence rows, and other places where suitable host plants occur. Much bait and time can be saved if these heavily infested areas are located early and baited, as this will prevent spread to the remainder of the field and often obviate the necessity of baiting the entire field.

Several methods of application of the bait may be used. Broadcasting the bait has proved to be satisfactory but is quite wasteful. The placing of a teaspoonful or tablespoonful in the crown of each plant is the most economical and efficient method. The amount of bait applied per acre will depend on the method of application but 100 pounds will usually suffice for 1 to 3 acres.

There are a number of proprietary baits on the market, most of which will give good control. Most of these use some type of fruit waste product as a carrier for the poison. The poisons generally used are sodium fluosilicate or calcium arsenate. Some of these baits contain other substances designed to enhance the value of the bait that may or may not be desirable.

Home-made bran baits can be made on the farm and have proved entirely satisfactory for weevil control. The formula for making such a bait is as follows:

Bran	50 pounds
Water	5 gallons
* Sugar	10 pounds
Calcium arsenate or sodium fluosilicate	5 pounds

The above bait may be mixed by dissolving the sugar in the water, then incorporating this with the bran and adding the poison last and thoroughly mixing, or the sugar and poison can be dissolved in the water together and then thoroughly mixed with the bran. Either method has proved satisfactory.

Raspberry cane maggot

Pegomyia (Phorbia) rubivora (Coq.)

The raspberry cane maggot is generally distributed over the Willamette Valley and attacks red raspberries, black-cap raspberries, loganberries, and blackberries.

Description The adult insect is a brownish humpbacked fly about half the size of a housefly. The larva or maggot is white in color and has no legs or visible head.

The adult flies emerge during April and lay their small white eggs in grooves or protected places on the tips of the young canes.

Life history The eggs hatch in approximately 4 days. The young larvae burrow down the pith of the young shoots for a short distance, then tunnel outward and girdle the cane. From here they continue on down the pith of the cane to near the ground level where the maggots transform and remain until the following spring.

The injury is manifested by the drooping of the cane in a "limberneck" fashion. At the point where the cane bends, a bluish ring can generally be seen where the maggot girdled the cane. The fly attacks canes varying from 8 inches to 3 feet in height. It has been observed that the death of the cane above the girdle is necessary for the survival of the maggot. If the cane survives, the maggot is invariably killed because of the rapid growth of the cane, which crushes the maggot.

* Molasses at the rate of $2\frac{1}{2}$ gallons in this formula may be substituted for the sugar. When molasses is used the amount of water is reduced to $3\frac{1}{2}$ gallons.



Figure 18. Raspberry cane-maggot injury, showing young cane in spring with characteristic "limberneck" droop.

Very seldom do the flies attack all the new canes of any one crown. The injury of this fly is therefore generally minor in importance unless there is a relatively meager growth of new canes.

No insecticidal control measures have been worked out for this pest.

Control It is suggested that infested canes be cut off at the ground level about the middle of May and then destroyed immediately by burning.

The snow tree cricket

Oecanthus niveus (Deg.)

This cricket is widely distributed throughout Oregon and attacks most of the cane fruits although it apparently is most serious on raspberry, loganberry, and blackberry.

The adult insects are rather fragile, sluggish, greenish-white, cricket-like insects, about $\frac{1}{2}$ inch in length. The imma-

ture forms are about the same color and have the same general appearance as the adults except for size and lack of fully developed wings. The eggs are yellowish white in color, about $\frac{1}{8}$ inch long, and are slightly curved.

The winter is passed as eggs inserted in the pith of canes. The eggs hatch in June, and the young crickets feed on various parts of the plant as well as on other small insects such as aphids. In August the crickets become full grown and begin to deposit their eggs.

The main injury of these pests is caused by their egg punctures. From one to many eggs are laid in a vertical row in the canes. These multiple egg punctures often weaken the canes so that a slight wind or other pressure will cause them to break off easily. The nymphs and adults also cause some injury to the foliage and fruit by feeding but this is negligible as compared to the egg puncture injury.

The best and only method of control that has proved of any value is to cut out the canes showing evidence of egg punctures. This

Control can be done any time from late fall till late spring before the eggs begin to hatch. These infested canes should be destroyed by burning as soon as they are cut out.

Poison sprays of various kinds have been suggested from time to time to kill the young and old crickets, but this treatment is not recommended because of the danger of having poisonous residues on the berries.

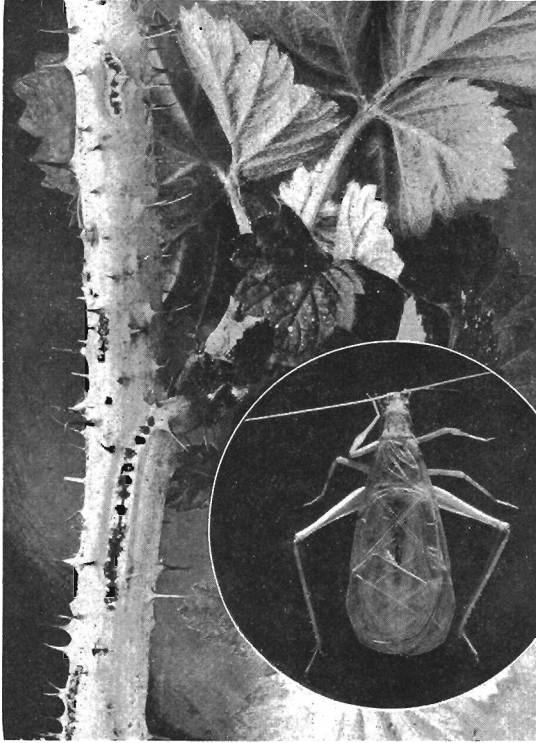


Figure 19. Tree cricket punctures in cane. An egg is laid in each puncture. Insert shows adult male tree cricket. Enlarged 1.5 times.

The blackberry mite

Eriophyes essigi Hassan

The blackberry mite causes what is commonly called "red-berry disease." The fruits of Evergreen and Himalaya blackberries are most noticeably affected because of the red condition of the normally black berries.

This mite is widely distributed in Oregon in the Willamette Valley and in Jackson, Josephine, Douglas, Coos, and Lincoln counties and will no doubt prove to be present in other sections of western Oregon.

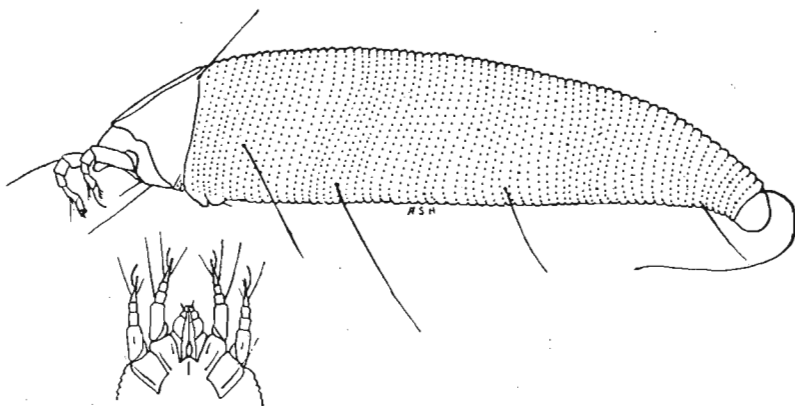


Figure 20. Drawing of *Eriophyes essigi* Hassan. This mite is responsible for the "red-berry disease" of Evergreen and Himalaya blackberries. Drawing from Hassan. (600X)

The mite has been found to infest Evergreen, Himalaya, Lawton, Eldorado, Snyder, Mammoth, Kittatinny, Texas, and Ward blackberries, red raspberries, wild black-cap raspberries, wild dewberries (*Rubus macropetalus*), and loganberries. Mites similar to the blackberry mite (*Eriophyes gracilis* [Nalepa]) are quite often found associated with some of the above fruits.

The mite is generally translucent white in color although it is sometimes yellowish or reddish. It is invisible to the naked eye and averages about 0.15 mm. in length (1/167 of an inch) and about 1/5 as wide. It is pear shaped in general outline and propels itself by two pairs of short legs on the thorax and by a sucker located on the posterior end of the abdomen.

The mites overwinter under the bud scales and between the buds and stems. There are apparently some eggs laid during the winter; reproduction is greatly increased during the growth period of the plants in the spring, but the greatest rate of reproduction is during the summer when Evergreen blackberries begin to ripen.

A large predacious mite, *Seius pomi* Parrot, preys on the blackberry mite throughout the growing season but it seems never able completely to hold it in check.

The injury of this mite is evidenced by the bright red color of the injured drupelets of the berry and has thus come to be known as "red-berry disease." Injured berries are generally slightly more filled out and brighter red in color than are normal green berries. Wild dewberries, black-cap raspberries, and some varieties of bush blackberries exhibit "red-berry disease" at times although mites seem not to be present. So far the Evergreen and Himalaya blackberries only have been seriously affected by this mite in Oregon.

Injury

Studies in the control of the blackberry mite have led to the suggestion of three spray programs, each of which gives satisfactory results in the Willamette Valley:

Control

Program 1. *Fall spray.* Summer oil emulsion (viscosity 55 to 70 seconds Saybolt and 90 per cent unsulphonatable residue) at the strength of 3 gallons and 97 gallons of water. Oils of these specifications may be obtained from local dealers. Application of this spray is made in the fall after the old canes are removed.

Delayed dormant spray. Lime sulphur (30° Baumé) at the strength of 8 gallons and 92 gallons of water. Application in spring after vines are trained and when new shoots are 2 to 6 inches long.

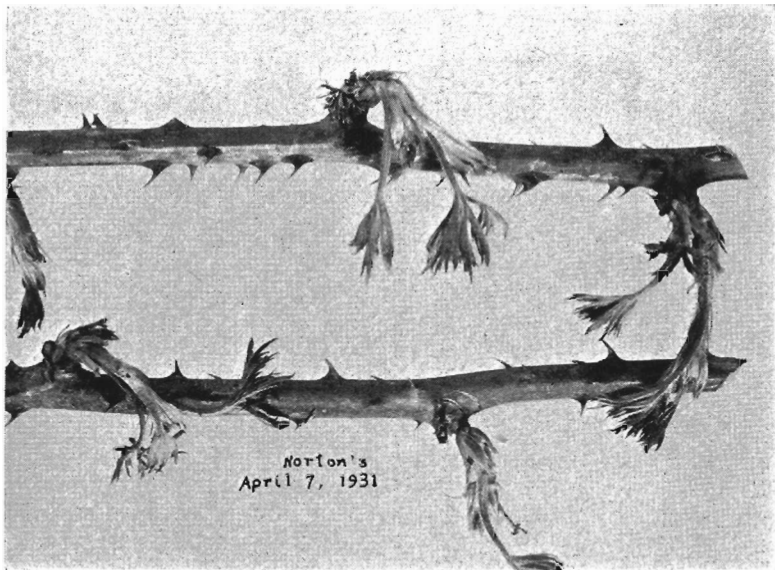


Figure 21. Development of buds at time of delayed dormant spray.

Program 2. *Fall spray.* Lime sulphur (30° Baumé) at the strength of 8 gallons and 92 gallons of water. Application in fall after old canes are removed.

Delayed dormant spray. Same as above.

Program 3. *Delayed dormant spray.* Same as above.

Caution: This single spray is not recommended unless the mites have been satisfactorily controlled in previous seasons, and only if applications are made with efficient spray equipment.

Blackberry foliage is difficult to wet with sprays and, as the mites are present mainly in the buds or other protected places, thorough coverage of the vines is essential for control. Hand sprayers have not proved to be satisfactory. Power sprayers capable of developing 300 pounds pressure at the pump are recommended for satisfactory control.

Application of
sprays

Rose scale

Aulacaspis rosae (Bouché)

The rose scale very often causes alarm to growers but very seldom becomes serious enough to do any material injury. It is widely distributed in Oregon and attacks all varieties of cane fruits.

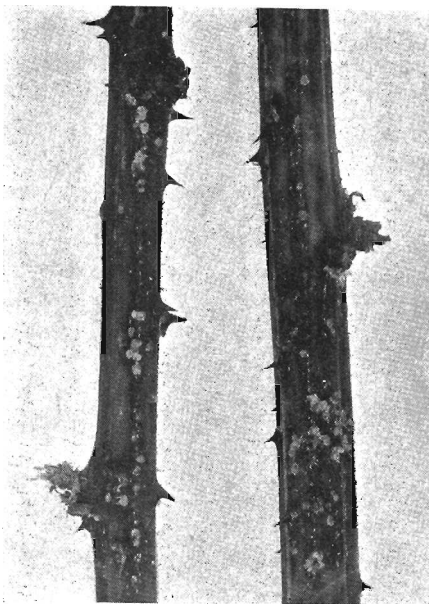


Figure 22. Rose scale on Himalaya blackberry canes.

The female scales are about 1/25 inch in diameter, are circular in outline, and are white in color except for a yellowish raised center. The male scales are oblong in shape and are entirely white. The bodies of both sexes (under the scale cover) are pink to reddish in color. The eggs are reddish-orange in color and are laid in mass under the scale cover of the female.

The eggs of this scale are laid in the fall and hatch in the spring into minute crawlers that distribute themselves on the canes.

Description

Life history

Heavily infested canes are spotted or encrusted with the scale insects giving the canes the appearance of being unevenly whitewashed. The plants show lack of vigor and are generally less productive than uninfested canes.

Lime sulphur sprays applied on the canes during the dormant season will give satisfactory control of this pest. Liquid lime sulphur (32° Baumé), 10 gallons to 90 gallons of water should be used. Light-medium oil sprays used at the rate of 3 gallons to 97 gallons of water also give satisfactory control.

Raspberry sawfly

Monophadnoides rubi (Harr.)

Occasionally outbreaks of this pest are reported in the Willamette Valley. The attacks are generally sporadic in nature but at times there has been considerable injury. It attacks many varieties of cane berries, but loganberries and raspberries seem to be the favorite hosts.

The adult is a wasplike insect about 1/5 inch in length and is black with yellow and reddish markings. The larvae are greenish white in color, about 2/3 inch in length when mature, and are covered with spiny tubercles.

The adults of this sawfly emerge from the ground during the blossoming period of the cane fruits. The eggs are deposited in the tissues of the leaves and the larvae feed on the under sides of the leaves and at first eat out small shot-hole perforations. Later when the larvae are larger the entire leaf is devoured. When full grown the larvae enter the soil to transform and spend the winter.

A lead arsenate spray applied at the rate of 4 pounds to 100 gallons of water at the time the larvae are feeding will give adequate control. This spray should not be applied after fruit has set.

The rose leafhopper

Typhlocyba rosae (L.)

This pest occurs throughout Oregon and attacks all varieties of cane fruits. It seldom becomes very serious.

The adult is a pale whitish yellow insect about 1/6 inch in length that feeds on the under sides of the leaves of the host plants. It is very easily disturbed and leaves the plants at the least provocation. The eggs are deposited in the woody parts of the stems of the host plants. The egg punctures have the appearance of small blisters on the stems and

Injury

Control

Description

Life history
and injury

Control

Description, life
history, and injury

whenever they are numerous enough they may cause a decided weakening of the stems. The winter is spent in the egg stage.

In the spring the eggs hatch about the time young leaves begin to unfold and the young hoppers migrate to the under sides of the leaves where they feed. The injury of the nymphs and adults re-

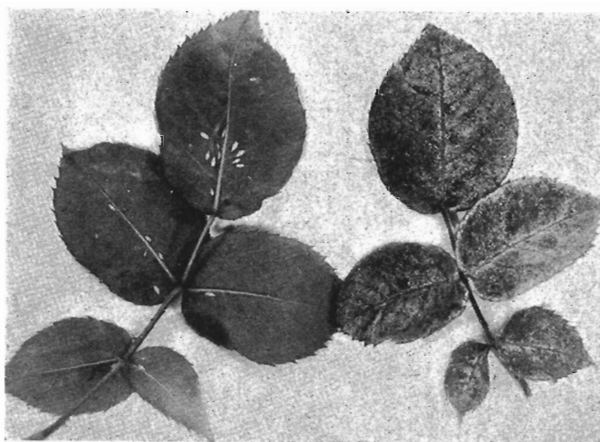


Figure 23. Nymphs and feeding injury of rose leafhopper on rose leaves.

sembles very fine stippling on the upper sides of the leaves. If injury is severe enough the whole leaf may become discolored and yellowish in appearance and may drop prematurely. This injury is a result of the hoppers' sucking juices out of the leaf. There are probably two or more generations a year.

The regular pruning practices employed destroy many of the eggs that are deposited in the canes. Direct control measures consist of spraying the under sides of the leaves, when the hoppers are present, with nicotine sulphate used at the rate of 1 pint to 100 gallons of water to which has been added 3 pounds of whale oil soap.

A 3 per cent nicotine sulphate dust using lime as a diluent also gives excellent control.

Common red spider mite

Tetranychus telarius (L.)

Occasionally in extremely dry years these small mites become seriously injurious to cane fruits. Most reports of damage are reported from eastern Oregon but injury is not uncommon in the Willamette Valley. These mites attack a large variety of hosts on which

they are generally more serious than on cane fruits. They are distributed over all sections of Oregon.

The adult mites average a little less than 1/50 inch in length and vary in color from pale yellow to green, orange, and red. Sometimes the dorsum of the abdomen is marked with two darkish spots. The young mites are generally white to light yellow in color. The eggs are globular and similar in color to the young mites. The adult mites are eight-legged and resemble miniature spiders.

The winter is spent in the adult stage in vegetable debris, cracks of bark, in cracks of soil, and on the under sides of leaves of low-growing plants, such as strawberries. Migration to summer hosts takes place during May and June as a rule.

Life history

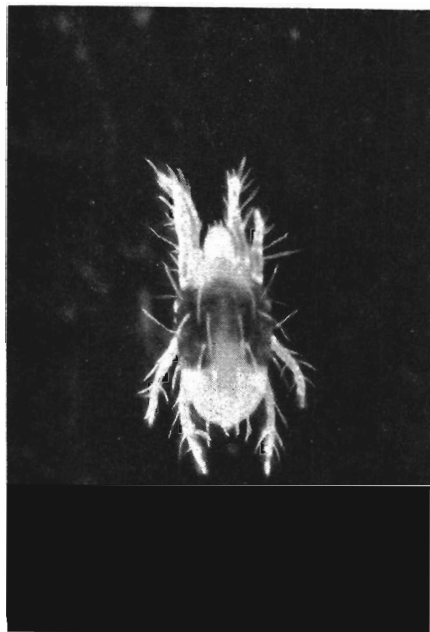


Figure 24. Adult red spider mite. (60X)

The eggs are laid on the under sides of leaves of the host plants under the profuse webs that are generally spun by the adults. The eggs hatch in about 3 or 4 days and develop into adults in about 10 to 12 days during the warmer parts of the summer. There are a number of generations a year, depending on the weather.

A grayish, mottled, unhealthy appearance on the upper sides of the leaves along with dense, unsightly webbing on the under sides of the leaves characterizes the injury of this mite. The plants often show marked lack of vigor when heavily infested.

Injury

The sustension of plant vigor by cultivation, irrigation, and fertilization materially aids in throwing off the ravages of this pest.

Control

Application of a good grade of dusting sulphur when the temperature is fairly high will give fair control. A light summer oil emulsion used at the rate of 1 to 1½ gallons to 100 gallons of water has also proved satisfactory.

(Western) Raspberry fruitworm*Byturus bakeri* Barber formerly *Byturus unicolor* Say

This pest has as yet not become of any importance in Oregon although it is recorded from Columbia County taken on thimbleberry. In Washington it has become very serious in certain parts of the state, and it is therefore deemed advisable to give a brief account of its biology and control to enable growers to have this information on hand in case outbreaks of this pest should occur in Oregon. The hosts reported in Washington are loganberries and raspberries.

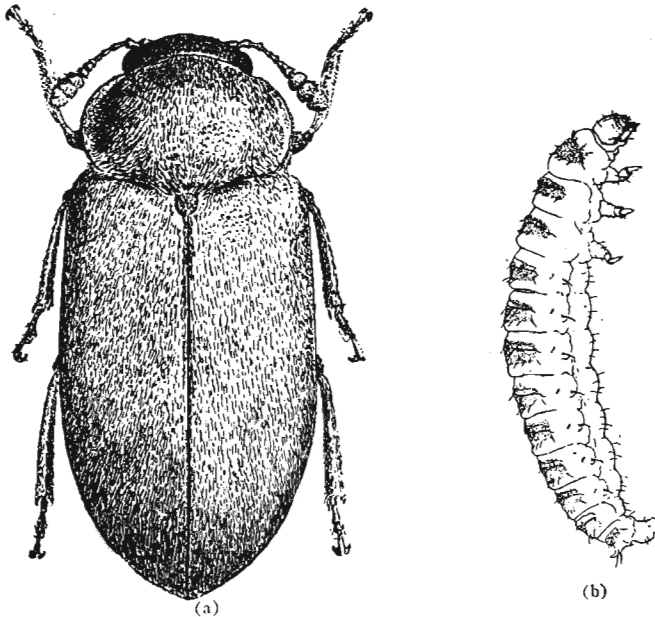


Figure 25. Raspberry or loganberry fruit worm, *Byturus unicolor* Say.

(a) Adult (18X). (b) Larva.

Courtesy, Washington Agricultural Experiment Station

The following information is taken from Washington State bulletins dealing with this pest.

The adult beetles are about $\frac{1}{6}$ inch long, yellowish brown in color, and are covered with a fine pale pubescence. The mature larvae are about $\frac{1}{3}$ inch long with light-brown areas on the back of each segment.

Description

The winter is spent in the soil as adult beetles that emerge about the middle of April. The adults feed on the fruit buds, unfolding leaves, and on the flower parts after blossoming. Some of the flower buds may be destroyed by this feeding, and the injury to the flowers often causes distortion of the berries.

Life history
and injury

The eggs are fastened to the flower buds, flowers, or stems of the host plant, and the young larvae work into the center of the developing fruits. They tunnel the cores and often work into the individual drupelets. They sometimes remain in the harvested fruit, especially in loganberries where the core is part of the fruit. In raspberries the larval injury causes some of the so-called "crumbly" berries. When the larva has completed its development, it drops and burrows into the ground to transform. There is but one generation a year.

Either of the two following insecticidal materials is recommended: (1) Dusts containing $\frac{1}{2}$ per cent rotenone diluted with talc or diatomaceous earth. (2) A spray containing .01 per cent rotenone (34 ounces of 4 per cent root or 27 ounces of 5 per cent root to 100 gallons of water).

1. The first dust or spray should be applied 7 days after blossoms appear.

2. Same treatment 10 days later.

Control schedule

3. Same treatment 10 days after the second treatment.

Oblique-banded leafroller

Archips rosaceana (Harris)

The oblique-banded leafroller often infests the fruits and leaves of red raspberries, black-cap raspberries, loganberries, youngberries, boysenberries, and blackberries. It also attacks a large number of other plants. It is distributed all over the state of Oregon. Normally, it does but very little damage to cane berries, but it has occurred in outbreak numbers in some years.

The moth of the leafroller is reddish brown in color with a darker oblique band across the middle of the forewings. It has a wing expanse of about 1 inch.

Description

The larva is pale yellowish green to dark green, and has a black or brown head capsule. It is very active when disturbed, and measures about $\frac{3}{4}$ inch in length when full grown.

The eggs, when first laid, are apple green in color. Just before hatching, each egg develops a black spot, which is the head of the

young worm. The eggs are laid on the upper surfaces of the leaves. They are disk-shaped, and are laid in masses of about 200. The eggs overlap each other much like the shingles on a roof. When the worms have hatched, the empty egg masses are white and look very much like spit on the leaves.

As far as known, the life history is briefly as follows:

Beginning about mid-June these larvae begin to change to the resting stage. Moths emerge in 10 to 12 days after changing to the resting stage. Egg laying takes place during the latter part of June

and the first half of July. Part of the larvae from this first batch of eggs spin up and remain on the canes until the following spring, and the remainder feed and develop into moths during the latter part of August and the first half of September. The larvae from the eggs laid in August and September develop to the third stage and then spin up on the canes to overwinter. All larvae are in their hibernation quarters by November 1.

There are many natural enemies that attack this pest. The two most important are a tachinid fly (*Phorocera erecta*) and a small wasp (*Oncophanes atriceps*). There are about fifteen other known

parasites, and taken all together they sometimes parasitize as many as 99 per cent of the various forms of this pest.

Insecticidal control consists of the application of DDT to the plants in early May before blossom time. A 3 per cent dust, a pound of 50 per cent wettable powder in 100 gallons of water or a pint of 25 per cent DDT in a refined oil per 100 gallons of water are equally effective in controlling the leafroller. For further information on oblique banded leaf roller see Technical Bulletin 13.

Certain cultural control measures are of value. The removal of old canes and other pruning operations should be delayed until November 1, and should be completed by March 1. All debris should be removed and burned by the latter date. This procedure allows the maximum number of worms to hibernate on old growth and therefore the destruction of a maximum number. When possible, the disking in of pruning debris should be avoided.

The orange tortrix

Tortrix citrana Fern.

The orange tortrix was a serious pest in 1947 and 1948 on red raspberries, Himalaya blackberries, Boysens, Logans and Youngberries. It normally feeds on many different plants in greenhouses in Oregon.

The moth is light tan in color, with darker markings on the fore wings. It has a wing expanse of about $\frac{3}{4}$ of an inch. The adults fly soon after sundown in the summer time. The larvae are green in color and have a tan head capsule.

There are 2 or 3 overlapping generations per year in Oregon fields. The eggs are laid on the underneath sides of the leaves and on smooth canes. They are laid in overlapping fashion in groups of 20-80. The larvae overwinter in assorted sizes beneath dead leaves caught on the canes and in cane galls above the ground.

The pale yellow to green brown headed larvae start to feed on developing buds in mid-May. They eventually web the leaves together and feed on the enclosed foliage. As the fruit ripens some of the larvae tunnel into the base of the berries to feed. They sometimes remain in the berry when it is picked and are taken to canneries.

The use of "D₃" or Rhothane has given excellent results in control trials and community tests on the orange tortrix larvae. The "D₃" may be used at the rate of 40 pounds of the 5 per cent "D₃" powder per acre or at the rate of 1 pound of the 50 per cent wettable powder per 100 gallons of water. The best time to apply "D₃" is in May when the overwintering larvae are feeding but have not yet pupated. In severe infestations a second application could be made at least 10 to 14 days before picking time. The preharvest application should be avoided if possible as the "D₃" may kill many helpful parasites.

See Oregon Station Circular of Information 426 (Revised) for further information on the orange tortrix.

Thrips of cane fruits

Frankliniella moultoni Hood

Frankliniella occidentalis (Perg.)

These two species of thrips, commonly known as flower thrips, along with their immature forms, are very commonly found in the flowers and fruits of all cane fruits. They are generally distributed throughout the berry-growing areas of Oregon.

Both species are very minute insects and measure only about 1/25 inch in length. The adults vary from nearly black (*moultoni*) to a light straw color (*occidentalis*). The immature forms are mostly whitish to pale yellow in color. All forms are very secretive and are seen only when disturbed by shaking the flowers or by examining the fruits.

The winter months are supposedly spent in the soil or in debris near the base of the plants. In the spring they emerge and migrate to the flowers and fruits where they multiply. There are probably several generations a year in Oregon. No noticeable injury has been observed to be done by these insects although they sometimes become very abundant. Their most objectionable trait seems to be that many remain in the fruits on being harvested and thus more or less contaminate fresh and processed foods.

**Life history
and injury**

As the injury done by these insects seems to be negligible, no field control measures are offered at this time. If one wishes to remove them from the harvested fruit, a strong spray from a lawn sprinkler is suggested. This water spray will remove many of the insects if berries are spread out into one layer and sprayed from 10 to 30 seconds on a wire screen.

Control



Figure 26. Adults and injury of rose curculio to thimbleberry flower buds. Note the punctured buds.

Rose curculio

Rhynchites bicolor (F.)

This snout beetle is mainly a pest of roses but has been found to do serious damage to blackberries, raspberries, and wild thimbleberries. It is widely distributed throughout Oregon.

The adult beetle is about $\frac{1}{4}$ inch in length and bears a very conspicuous snout. The wing covers and thorax are bright red and the head, snout, and legs black. Occasional specimens are found that are entirely black.

Description

The larvae are legless, curled, white grubs with a brown head and are about $\frac{1}{4}$ inch long when mature.

The adult beetles appear in the spring about the time that blackberries and other cane fruits are in bud and are just beginning to blossom. The adults feed on the developing buds by making punctures in the sides of the buds. When many punctures are made in one bud these often fail to develop. These buds often shrivel and droop over without producing flowers. The eggs are deposited in these punctures and the grubs develop in the buds and developing fruits. When mature the larvae drop to the soil to transform and remain there throughout the winter.

Life history and injury

No very satisfactory control method has been worked out for this pest. It has been suggested that lead arsenate used at the rate of 5 pounds to 100 gallons of water sprayed on the plants before fruits begin to develop will give some control. This spray should not be used after fruit development. Calcium arsenate dusts (20 per cent diluted with talc) applied at the time of the above spray have also been found to have some value in control.

Control

Spittle bugs

Philaenus leucophthalmus (L.) and

Aphrophora permutata Uhler

The strawberry spittle bug (*P. leucophthalmus*) and the rhubarb spittle bug (*A. permutata*) are quite often found on all varieties of cane berries. They are very common in the Willamette Valley but very seldom do they cause serious damage to cane fruits.

The adults of the strawberry spittle bug are grayish brown in color and are about $\frac{1}{4}$ inch in length. The nymphs are whitish to lemon yellow in color and are always covered with a whitish, frothy spittle, which they secrete and under which they feed. The injury is due entirely to the nymphs. They suck the juices out of the leaves and fruit spurs causing them to be distorted and to produce less.

Description, life history and injury

The rhubarb spittle bug has about the same general characteristics as the strawberry spittle bug except that it is about $\frac{3}{8}$ inch in length and the nymphs are bright red in color.

The eggs of both species are laid in protected places on the host plants and are covered with a white, cottony appearing substance. The eggs of both species hatch during late March, April, and May. There is but one generation a year.

The most efficient method of control developed is the application of a dust containing $\frac{1}{2}$ per cent rotenone diluted with diatomaceous earth. This material should be applied for the nymphs and care taken that all masses of spittle are contacted. Hydrated lime when used alone has given fair control.

Strawberry leaf beetle

Timarcha intricata Hald.

As the name implies, this beetle is a pest mainly of strawberries. It has been found feeding on the wild blackberry (*Rubus macropetalus*), salmonberry (*R. spectabilis*), and on thimbleberry (*R. parviflorus*). It no doubt also occurs on cultivated cane fruits but has not been reported. The distribution seems to be limited to the Willamette Valley and coast counties.

The adult beetle is jet black and is about $\frac{1}{4}$ inch in length. The larvae are hump-backed, greasy, grayish black in appearance. Both the adult and larva feed on the foliage during April and May.

If damage becomes severe, lead arsenate used at the rate of 3 pounds per 100 gallons of water when the feeding is in progress, should give control. This spray should not be applied after fruit has set.

White grubs

Serica spp., *Polyphylla decemlineata*, and others.

Several species of white grubs have been found feeding on the underground parts of cane fruits. This injury generally occurs where cane fruits are planted directly onto land that has been in grass sod, pasture or stump land that was infested with these grubs.

It is suggested that at least one intervening crop using clean culture be planted on land before cane fruits are planted. This will prevent the loss of many young plants and perhaps later injury to older plants.

White grubs are generally dirty white in color, have a brown head, three pairs of legs on the thorax, and are always curled.

There are many different kinds of adults most of which are known as June beetles. The most common species in western Oregon is about 1 inch in

Description, life history, and injury

length and has eight conspicuous complete white strips on the wing covers.

The complete life cycle for some June beetles takes 1 year while many require 2 and 3 years. The eggs are laid in the soil around the host plants and the larvae spend their entire life feeding on the roots and crowns.

There is no direct means of control except to avoid planting cane fruits on soils that harbor the grubs.

Cane miner

Marmara sp.

The larvae of this minute moth mine the canes of blackberries, loganberries, raspberries, and other cane fruits. It seems to be widely distributed in Oregon but has never become of any great importance.

The larvae apparently mine between the outer and inner layers of bark causing grayish, elongated blister-like injuries.

No control measures have been developed.

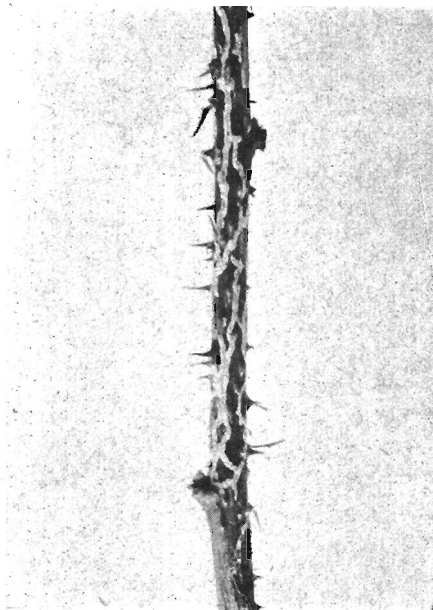


Figure 27. Mines of cane miner on blackberry.

Bud weevils

Thricolepis inornata (Horn)

Nemocestes incomptus (Horn) (Raspberry bud weevil)

Sciopithes obscurus (Horn)

Peritelinus oregonus Van D.

These four species of snout beetles have been observed and reported feeding on the young tender shoots of cane berries. When they occur, they are present in large numbers and often cause considerable damage by destroying the young tender growth. Plantings in the Willamette Valley seem to be attacked most commonly.

All four species are about $\frac{1}{4}$ to $\frac{3}{8}$ inch in length and are either grayish or brownish in color. The adult beetles are apparently the only stage of these pests that cause any damage to cane fruits.

If necessary, it is suggested that a lead arsenate spray (3 pounds to 100 gallons of water) be applied for their control.

Lecanium scale

Lecanium coryli (L.)

This scale insect has been found to attack blackberry and raspberry plants quite severely in Washington and British Columbia, and occasional specimens have been found on raspberry plants in Oregon. It has as yet not become of any importance in Oregon.

The scales when full grown are dark to light brown in color and have a more or less hemispherical hard shell covering. The young have no shell, but are soft and unprotected and are about the same color as the mature forms.

The eggs of this pest are laid during May and hatch in June. The young scales migrate to the leaves for the summer and in the fall crawl back to the canes to overwinter. In the winter and late spring the scales can be easily observed on the canes.

If control measures are necessary, dormant oil or dormant lime sulphur sprays are suggested controls.

Aphids of cane fruits

A number of species of aphids have been collected on cultivated and wild cane fruits in Oregon. As a rule it is not the direct aphid injury that is the concern when aphids occur on these fruits but the possibility that they are carriers of infectious virous diseases.

To date aphids on cultivated cane fruits have been found only sparingly while aphids on wild canes seem to be somewhat more prevalent.

The following aphids have been found on cane fruits in Oregon:

Amphorophora sensoriata Mason

Amphorophora rubicola (Oest.)

Amphorophora rubi (Kalt.)

Amphorophora cosmopolitana Mason

Macrosiphum rubiellum Theob.

These aphids may become of extreme importance in transmission of virous diseases if the right conditions prevail.

Other aphids than those commonly found on cane fruits have been found to be capable of transmitting virous diseases of these fruits.

For further discussions on the relation of aphids to virous diseases see page 7 and Figure 3.

If necessary most species of aphids can be controlled with nicotine sulphate sprays or dusts as discussed under rose leafhopper on page 43.

The strawberry fruitworm*Cnephasia longana* (Haw.)

This pest is widely distributed in the northern part of the Willamette Valley and attacks a large variety of hosts. For unexplained reasons, it is more serious on berries in certain localities than in others. It is of relatively minor importance on cane fruits.

The adult moths have a wing spread of about $\frac{3}{4}$ inch. The male is of an even grayish yellow color while the female is grayish mottled with brown spots.

Description

The full grown larva is about $\frac{1}{2}$ inch in length, dirty yellow in color, and possesses three more or less distinct darker stripes on the back.

The eggs are salmon red in color when first laid and become lighter with age.

The adult moths emerge from late May to late June and deposit eggs through most of July. The eggs are laid on the bark of trees and other more or less rough surfaces. The eggs soon hatch into

Life history

small larvae that spin small silken webs in which to overwinter near where the eggs were laid. In early spring, beginning about the first of March, as a rule, these young larvae are carried to suitable hosts on silken threads by air currents. For a time these minute larvae mine the leaves of plants such as clover, vetch, and plantain. On emerging from the mines they migrate to flowers and the tender tips of various kinds of plants.

The injury to cane fruits is confined largely to the flowers and young tender growing tips. The larvae tie together the petals of the

Injury

flowers and the young leaves and destroy the plant parts below the webbed-over protective cover. The flower feeding habit often results in malformed fruit.

Control

No satisfactory control measures have been found.

Minor pests

The mature forms of wireworms are known as click beetles and are often found feeding on the flowers of cane fruits. The damage caused by these beetles is of minor importance.

Wireworms

The larvae or wireworms have been found to feed on the roots of cane fruits although no cases of serious injury have been reported. To prevent serious injury the planting of cane fruits in land that has been newly broken, from grass sod and other more or less permanent vegetative cover, should be avoided.

The following pests have been found in harvested fruits of cane berries: adult flies (mostly vinegar flies), aphids, spring-tails, hemipterous nymphs (Anthocoridae and Pentatomidae), spiders, mites, adult and immature thrips, adult weevils and smaller beetles, caterpillars, larval Coleoptera, and earwigs.

Miscellaneous pests
in fruits

Many times the entrance of these pests can be prevented with proper care.

Harvested fruit should never be stacked directly on the ground but should be placed on raised platforms in protected places. This prevents the entrance of vermin such as earwigs, weevils, and other forms that crawl on the ground and tend to hide in the daytime.

Overripe, wet, and partly decayed fruits attract scavengers such as the vinegar fly; fruit, therefore, should not be allowed to become overripe and should be processed as soon after harvest as possible.

Many of these pests can be removed by proper washing. (See thrips of cane fruits on p. 49.)

Table 1. DISEASES OF CANE FRUITS
(For more complete information see discussion of individual diseases)

Name	Type of injury produced	Recommended and suggested control	Time to apply control measures
Cane gall	Enlarged galls or ridges on canes	Cut out canes with galls	As soon as the disease is found
Crown gall	Tumors on roots	Grub out affected plants	As soon as found
Hairy root	Many very small, hairy roots produced at expense of larger leader roots	Grub out affected plants	As soon as found
Decline disease	General running-out of plants with curled leaves	Use certified planting stock or stock from fields where the disease does not occur	
Dwarf	Stunted, plants with short, stubby canes	Same as for decline disease	
Red raspberry mosaic	General running-out of plants with mottled leaves	Same as for decline disease	
Leaf and cane spot....	White spots with reddish margins on leaves and canes	Spray with lime-sulphur (10 gallons to 100 gallons of water) (See also Rose scale)	Dormant, in winter
Anthraxnose	Sunken, grayish, or dark spots on canes	Spray with lime-sulphur (10 gallons in 100 gallons of water)	In winter
Orange rust	Dwarfed plants with orange powder covering the whole under surface of leaves	Grub out affected plants	In spring or early summer
Yellow rust	Yellow rust on undersides of leaves in summer, black in fall. Stem lesions with yellow centers	Control stem lesions by covering old leaves by plowing before new growth starts	Early spring
Cane blight	Large sunken purplish lesions, 3 to 10 inches long	Control yellow rust through which blight infects. Also use lime-sulphur (10 gallons in 100 gallons of water)	Cultivate early as for yellow rust control. Spray in winter
Mildew	Grayish, moldy appearance of leaves that tend to roll	Dust with sulphur	As soon as mildew begins to appear
Spur blight	Bark around spurs turns brownish in late summer and grayish during winter	Spray with bordeaux 6-6-100 in spring or use lime-sulphur in winter	
Verticillium wilt	Dwarfing and wilting of new canes. Plants die out	Rotate crops. Use clean planting stock from fields without the disease	
Mushroom root rot	Plants wilt and roots are grown full of white fungus, just under bark	Newly cleared land may have some of disease. Do not plant in places where plants died from this disease	
Stamen blight	The stamens are grayish moldy when the flowers open. Berries are misshapen	Lime-sulphur (2 gallons in 100 gallons of water) gives some control	About mid-August

Note: For the prevention of the following diseases it is best to use certified planting stock or planting stock from fields where none of these diseases occur: Cane gall, crown gall, hairy root, decline disease, dwarf disease, red-raspberry mosaic, or Verticillium wilt.

Table 2. INSECT PESTS ON CANE FRUITS
(For more complete information see Discussion of Individual Insects)

Name	Type of injury and where found	Time of injury	Recommended time of control	Recommended and suggested control
Raspberry Root Borer	Tunneling and destruction of crown and lower parts of canes	Mostly during spring, summer, and fall	First 2 weeks in August or before	Removal of infested canes and destruction of stubs
Strawberry Crown Moth.....	Tunneling and destruction of crown	Late summer, fall, and spring	.....	Avoid planting young canes near infested strawberries; plant grain barriers between young cane plantings and strawberries
Root Weevils	Destruction of feeder roots and crowns	Late summer, fall, and spring	When adult weevils are in evidence	Poison baits
Raspberry Cane Maggot.....	Lopping over of young canes	Spring	Latter part of May	Remove infested canes and destroy
Snowy Tree Cricket.....	Oviposition injury on canes	Late summer and fall	Winter and spring	Remove canes with eggs and destroy
Blackberry Mite	Berries fail to color and remain hard	Fruiting time	Fall, winter, early spring	Lime sulphur or oil sprays
Rose Scale	Lack of plant vigor and whitish encrustations on canes	Growing season	Late fall, winter, or early spring	Lime sulphur or oil sprays
Raspberry Sawfly	Defoliation	Spring	When worms in evidence	Poison sprays
Rose Leafhopper	Discoloration of leaves and weakening of canes by egg punctures	Growing season, especially spring and early summer	When hoppers in evidence	Nicotine spray or dust
Red Spider	Discoloration and webbing of foliage	Summer and early fall	When spiders in evidence	Good culture; sulphur dust; oil spray
Raspberry Fruitworm	Distortion and contamination of fruit	Spring and summer	Spring	Rotenone dusts or sprays
Fruitworms	Contamination of fruits and leaf-tieing	Spring and summer	Nov. to March	Removal of debris and its destruction
Thrips	Contamination of fruit	Harvest time	Harvest time	Sprinkle washing
Rose Curculio	Destruction of flower buds	Spring	When beetles in evidence	Poison spray or dust
Spittle Bug	Distortion of plant parts and spittle masses	Spring	When spittle in evidence	Rotenone dusts
White Grubs	Destruction of feeder roots and scarification of crown	Growing season	.....	Avoid planting in infested soil
Cane Miner	Grayish mines on bark of canes	Growing season	.....	.....
Strawberry Leaf Beetle.....	Defoliation	Spring	When beetles and larvae in evidence	Poison spray
Bud Weevils	Destruction of buds and newest growth	Spring	When beetles in evidence	Poison spray
Lecanium Scale	Lack of vigor	Growing season	Dormant season	Lime sulphur or oil sprays
Aphids	Transmission of virous diseases	?	When aphids in evidence	Nicotine sprays or dusts
Strawberry Fruitworm	Destruction of flowers, new tips, and malformation of fruit	Spring	.....	.....
Wireworms	Destruction of roots	Growing season	.....	Avoid planting in infested soil
Miscellaneous fruit pests.....	Contamination of fruit	Harvest time	At harvest	Proper care of harvested fruit and sprinkle washing

Note: Lime sulphur 10 gallons and water 90 gallons is effective for the following during the dormant period: Rose scale, lecanium scale, blackberry mite, leaf and cane spot, anthracnose, cane blight, and spur blight.

PREPARATION OF SPRAYS

For the preparation of sprays mentioned in this bulletin, reference is given to Oregon Experiment Station Bulletin 393, *Sprays, Their Preparation and Use*.