Insect Pests and Diseases of Strawberry in Oregon

W. D. Edwards
S. M. Zeller
Illustration on cover—

Figure 1. A vigorous strawberry planting in the Willamette Valley photographed shortly before harvest.
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3
Insect Pests and Diseases of Strawberry in Oregon

W. D. Edwards and S. M. Zeller

INSECT PESTS OF STRAWBERRY

The total strawberry acreage in the Northwest in 1938 has been estimated to exceed 24,000 acres. Production of high yields and fancy packs is necessary to overcome freight differentials to compete with other strawberry-producing sections in the large midwestern and eastern markets.

This bulletin presents a discussion of the more common insect pests and diseases of strawberries for the use of growers in maintaining high quality and yields.

SPITTLE BUGS

The spittle bugs attract the most attention of strawberry growers since they are feeding on the plants while the crop is ripening. Two species* (Figure 2) are found on the plants in numbers ranging from 50 to 300 per plant.

The overwintering eggs start hatching in late March or early April and continue for about 6 weeks, depending on weather conditions. The growing period lasts 5 or 6 weeks when the adult winged froghopper appears (Figure 4). The adults feed on succulent host plants during the summer and lay eggs during the early fall generally upon perennial plants, especially strawberries.

Spittle bugs have sucking mouthparts, in both the immature and the adult stages, and feed by injecting the beak into the foliage of the plant and withdrawing juices. This causes general devitalization of the plant and unevenly developed fruit (Figure 3). These sucking insects may carry virous diseases.

Experimental tests conducted from 1931 to 1938 have resulted in the use of dusts for control of spittle bugs.

Rotenone dusts for control. The most effective material for spittle-bug control is "rotenone" combined with inert carriers such as talc or diatomaceous earth, preferably the latter. Rotenone is found in the roots of tropical or subtropical plants such as cubé, derris, timbo, and devil's shoe-string. Commercial dusts made from these roots appear to be equally effective when applied at the same amount of rotenone per acre.

A strength of one-half of one per cent actual rotenone in a completed dust is suggested for the control of spittle bugs on strawberries.

Other dusts for control. Other materials have been used for controlling spittle bugs, but as each of these has one or more disadvantages their use is not recommended on strawberries.

* Philaenus spumarius L.
Aphrophora permutata Uhl.
Nicotine-hydrated lime: Used at a strength of 2 per cent actual nicotine. Not as effective as rotenone dust and costs approximately the same.

Powdered quicklime: Not as expensive as rotenone dust but does not give as good control. May cause some injury to plants.

Hydrated lime: Cheap but least effective of dusts mentioned. May also injure plants when heavily applied.

Figure 2. Spittle bug adults (Froghoppers). Left—Strawberry spittle bug. Right—Rhubarb spittle bug. The smaller form being more numerous causes greater injury to strawberries. (Magnified 7 times.)
Amount of dust per acre.

The amount of dust to be applied per acre for the control of spittle bugs depends on the size of the plants, the planting distance, type of duster, and methods used by the operator. Generally the dust is applied at the rate of 50 to 60 pounds per acre. Thoroughness of application is important as the dust must be brought into contact with the insects to secure control.

Figure 3. The feeding of spittle bugs on the fruit clusters causes a shortening of the stems and unevenly developed fruit which may make it unmarketable. Left—Injured clusters. Right—Normal clusters.

Type of dusting equipment. Either hand or power dusters may be used to apply the dust, depending on the acreage of the plantings. Hand dusters are more commonly used, but power equipment is equally effective when hoods are used to confine the dust. Hoods should be attached flexibly to the machine so that they may rise or fall as the ground surface requires (Figure 5).

Time and number of applications. Dusting should start as soon as the insects appear in numbers. One application, if timed correctly, may give satisfactory control.

Cautions. In the use of dust for spittle-bug control the following cautions should be observed:

1. Dust should be applied only when the weather outlook is fair, as rain destroys to some degree the effectiveness of the material, while higher temperatures increase its effect.

2. Dust thoroughly, especially on the under side of the leaves and on the fruit-bud clusters, which support most of the pests.
3. Careful dusting will pay dividends on the crop. Indifferent dusting is a waste of time and material.

4. Rotenone dust should not be stored from year to year as it may deteriorate.

Figure 4. The damage has been done. Spittle bugs after feeding about six weeks change to the adult froghopper before taking flight.
THE STRAWBERRY ROOT WEEVILS

Six common weevils have been found feeding on strawberries in Oregon. The most important forms are found in two groups; namely, Gray Weevils* and Black Weevils†. There is a fundamental difference in the life history of these two groups of root weevils from the standpoint of control. The members of the group of gray weevils overwinter in the adult stage in the ground, first appearing in the spring during March and April, and feed on the leaves of strawberries. The members of the black weevils (Figure 6) pass the winter principally in the grub stage, though in some parts of Oregon at higher elevations than the Willamette Valley the adults also overwinter. These overwintering grubs of the black weevils resume feeding in the spring and then change to adults at the time of berry harvest.

Control for weevils. Control measures involve the use of poison bait to control the adult weevils before they lay eggs and reinfect the planting. The application of bait for the weevils belonging to the “gray group” is made usually during early April and should be applied preferably when good weather is expected as the poison will wash away from the bait during heavy rains. The date of application for the black group is near the time of harvest, and usually it is not complicated by rainy weather. In higher elevations it is necessary to bait in April for the latter group to kill the overwintering adults.

* Genus Dyslobus.
† Genus Brachyrhinus.
Figure 6. 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)
The following baits have been used for controlling the weevil with marked success:

No. 1. Dried apple pomace and calcium arsenate. This bait is the most effective material for the control of either group of weevils,

Figure 7. Strawberry root-weevil adults feed on the edge of the leaves causing "ragging." Compare this injury with Figure 12. The more severe injury, however, is caused by the larvae feeding on the roots during the summer and early fall.
particularly for the early-spring group of gray weevils. This is true, as mentioned above, because of the rainfall during April. The apple-poison bait is a patented product that may be obtained from commercial dealers in insecticides.

No. 2. Bran and calcium arsenate. This is a bait developed by entomologists of the Agricultural Experiment Station and is of the following formula:

Bran—60 pounds

Figure 8. Strawberry root-weevil grubs in heavy infestations may tunnel in the crown. The more common injury is destruction of the fibrous roots.
Water—5 gallons  
Sugar—10 pounds  
Calcium arsenate—5 pounds  

This bait is mixed as follows: The sugar is dissolved in water and the solution mixed thoroughly with the bran. As soon as the bran is uniformly moistened, add the poison and again mix thoroughly.

Either of these baits is applied at the rate of about one teaspoonful of the material on the crown of each plant. One hundred pounds of bait will treat from 1 to 2 or 3 acres, depending on how closely the plants are set and on the size of the plants.

Injury caused by strawberry root weevil. The strawberry root weevil feeds on the strawberry plants in both the adult or weevil stage and the grub or worm stage. The adults emerge from the ground and feed on the strawberry leaves, causing an injury called “ragging” (Figure 7). The feeding is done always on the edge of the leaves and there is never a hole or a circular area cut from within the leaf itself. The more serious injury to strawberries is caused by the grub stage. These feed directly on the small roots and crowns. Very serious injury can be done to the crown itself by the tunneling activities of the grub (Figure 8). The injury caused by the grub is most apparent during the warm summer weather as by their feeding on the rootlets of the plants they cut off the water and food supply.

For more complete information on the life history and control of strawberry root weevils, the reader can refer to Station Circular 115.

OMNIVEROUS LEAF TIER OR STRAWBERRY FRUIT WORM

The omniverous leaf tier (Cnephasia longana Haw.) was discovered in the Northwest in 1929, and subsequently has become a matter of concern to strawberry growers throughout the Willamette Valley and also some portions of western Washington. The larval or caterpillar stage of this insect attains a length of approximately one-half inch. It is a vigorous feeder on a large number of host plants aside from strawberry.

On strawberries the insect causes two distinct types of damage. Early in the larval season, which occurs during late April or early May, the worms or larvae appear on the blossoms of strawberries. There they feed on the pollen of the developing berry and are protected by the petals of the flower which they have webbed together tightly over them. Later in the larval period and after the strawberries have set, the larvae are capable of tunneling or boring within both the green and the thoroughly ripened strawberries (Figure 9). This injury results in the fruit being contaminated and unmarketable. Larvae have also been observed to feed as typical leaf rollers on foliage of new strawberry sets.

Life history and habits. The first appearance of these insects on strawberries comes shortly after the strawberry plants begin to bloom. The larvae feed and grow by successive molts, finally reaching a total length of approximately one-half inch in late May and June. The larvae then pupate and emerge as adult moths. These moths are seen in the field during late June, and generally well into July. Mating takes place within a few days after emergence of the adults, and eggs are laid one to three
days later. The very minute larvae, so small that they can be barely discerned with the naked eye, emerge from the egg shells and spin silken hibernacula or overwintering cases constructed of webbing, to which are fastened minute soil particles. The larvae remain within these cases throughout the balance of the summer and throughout the winter, resuming activity during late April and early May.

Figure 9. The Omnivorous Leaf Tier may tunnel in either green or ripe berries.
Control suggestions. The habit of the larva in webbing the foliage or petals as a protection makes it extremely difficult to contact the larva with insecticidal sprays, or dusts. Considerable reduction in the number of insects present in a given locality may be secured, however, by mowing and burning wild flowers adjacent to commercial plantings during late May or early June, to destroy the larvae and pupae before the adults emerge and lay eggs. Contaminated fruit may be removed if the pickers are careful in selecting fruit as it is obvious during the picking operation that the berry is infested, especially if the berries are stemmed. The numbers of this pest have also been reduced by natural enemies, such as insect parasites and predators, as well as birds and possibly fungous diseases, which occasionally attack the larvae.

STRAWBERRY LEAF ROLLERS

There are two species of insects found on strawberry leaves that may in some cases be mistaken for the omnivorous leaf tier. The two species found on strawberries in the Willamette Valley are the strawberry leaf roller, Ancylis comptana (Frohlich), and the western strawberry leaf roller, Anacampsis fragariella Busck. The larvae or caterpillar stage of the first-named species are variable in color, from reddish brown to green, and the larvae of the latter species are creamy-pink. They characteristically web a strawberry leaf together, and then feed within the protection afforded by the leaves and webbing. The injury of the omnivorous leaf tier is rarely on the leaves of mature plants and the larvae of the strawberry leaf rollers may be distinguished on this basis. The leaf rollers found on strawberry in the Willamette Valley are only occasionally numerous enough to cause serious damage. Where outbreaks have occurred, control of the insects is extremely difficult, especially when the fruit is present on the plant. If after the crop has been harvested numbers of the larvae are present, it may be advisable to spray with lead arsenate, using the following formula:

\[
\text{Lead arsenate, 3 pounds to 100 gallons of water. To this should be incorporated from one-half to one pound of calcium caseinate to act as a spreader.}
\]

Mowing the foliage of the plants immediately after harvest, as suggested for control of strawberry crown moth, may also serve to reduce the numbers of leaf rollers.

THE CYCLAMEN MITE

In the Willamette Valley very little injury has been caused by the cyclamen mite (Tarsonomus pallidus Banks) except where everbearing varieties are grown. In irrigated sections, however, extremely heavy losses have been sustained. These mites require a high humidity and a medium high temperature for maximum rate of reproduction. The entire life history of the mite is spent on the host plant. The eggs hatch into larvae, which then feed and pass into a quiescent stage before becoming adults. There is a slackening in the rate of growth and reproduction of the mite during the warmer summer days. Ideal conditions for the mites prevail during the spring and early fall.

After the mites have once infested the strawberry plants no control is possible. Experiments have shown that fumigation, spraying, or dusting
the strawberries give little or no results. The only satisfactory treatment so far developed consists of treating the plants in a hot-water bath before setting out in the field. This treatment consists of holding the bath at 110°F. for 20 minutes or 108°F. for 30 minutes. Care must be taken to keep the temperature of the water bath within these points or injury to the plants may result. Tanks such as are used for hot-water-bath treatment of narcissus bulbs are admirably suited for treating strawberry plants. The tank should be equipped with an adequate agitator to insure even distribution and flow of the water from one portion of the tank to the other. This will avoid high temperatures at the surface and low temperatures at the bottom of the tank. During the treating process adequate sanitary measures must be kept in mind. The operator attending the treating of the plants must carefully wash his hands with soap and water between handling trays of infested or untreated plants and those that have been treated, so as to avoid subsequent reinfection. It has been demonstrated that growers in the field can readily carry mites on their clothing, shoes, or on equipment such as hoes and other farm machinery. The infestation is thus carried from one plant to another and assists in a more or less rapid spread of mites in strawberry plantings.
The strawberry crown moth (*Syncinthedon bibionipennis* Boisd.) is a major strawberry pest in Oregon, particularly in the Willamette Valley. The adult moths, both male and female, resemble the common yellow jacket, although they are somewhat smaller and are not related. Moths are found resting on the foliage or flying somewhat erratically about the planting, close to the ground. The larva when first hatched is 1.5 mm. in length and white in color. The full-grown larva is about 20 mm. (4/5 inch in length), the head is dark brown, the rest of the body white, although during the growing season when the larva is actively feeding, the abdomen takes on a pinkish color from the food within.

**Life history and habits.** Adult moths emerge from strawberry crowns, depending on seasonal conditions, from the end of the first week in June. In backward seasons they may be seen as late as the tenth of August. During the early flight period mating takes place, and the eggs are laid singly on the under side of living or dead leaves near the crown of the plant. These eggs hatch and the minute larvae move down to the scales on the crown, where they feed superficially for several days. Early feeding is generally near the cambium layer of the crown until the larvae reach an age of about 30 days, when they enter the inside of the crown and here make long tunnels up and down, hollowing out a considerable portion of the tissue (Figure 10). Active feeding continues throughout the summer and until cold weather sets in. At this time the larvae have attained approximately three-fourths of their full growth. They then spin a thin silken resting cell within the burrow, providing a tight covering for protection, in which they overwinter. In the spring the larvae leave the silken cell and resume feeding, ultimately reaching full larval growth when they begin building a cocoon preparatory to pupation, which occurs during May and June. From the pupa, as stated before, the adults emerge and repeat the life cycle.

Primary injury, as may be indicated by the life history, occurs during the summer months when the young larvae in the latter stages are actively feeding during the warm summer weather. The destruction within the crown of the food-and-water-conductive tissue at this time, when water is particularly required by the foliage, results in serious weakening or death to the plants.

**Suggestions for control.** The life habits of this insect are such that satisfactory control is extremely difficult. Taking advantage of the fact that the moth flies very close to the ground, it has been found that removing the tops of the plants of the majority of the planting, while leaving certain rows untouched to act as trap rows, will give fair control. The females in flying over the field thus come in contact with the trap rows more frequently, and as a result lay the majority of their eggs upon these. These rows, of course, must subsequently be destroyed.

In cases where a new planting is set out adjacent to an old, heavily infested patch, a barrier strip of grain, such as barley, rye, or oats, planted between the two patches has been found effective in confining the flying moths to the old planting (Figure 11). These barrier rows should not be mowed until the middle of August, when the flight period is over.

Old infested plantings should be plowed under immediately after harvest before the moths emerge and lay eggs.

For more specific information on strawberry crown moth see Bulletin 296, Oregon Agricultural Experiment Station.
STRAWBERRY CROWN MINER

The strawberry crown miner (Aristotelia fragariae Busck.) is another insect that is present in the majority of strawberry sections of Oregon. It is only occasionally, however, that this pest reaches sufficient numbers to cause injury comparable to the strawberry crown moth mentioned above. The life history of this insect parallels fairly closely that of the strawberry crown moth.

Figure 11. The movement of the low-flying strawberry crown moths to new plantings is largely reduced by barrier strips of grain. Mowing of the foliage (left) after harvest reduces egg laying and subsequent injury.

The larvae of this pest are readily distinguished from the strawberry crown moth in that they never attain a length of more than ½ inch. The location of the larvae within the plant is generally higher in the crown than the strawberry crown moth, and the larval tunnels are much smaller and not as long. In some cases the larvae feed a short distance into the stems of the strawberry plants.

The eggs are deposited on shafts about the crown on the under side of the leaves and along the leaf petioles. They are usually pushed well down among the fine hairs. The egg is white with a dull luster, a slight area at the smaller end being transparent.

Control suggestions. No specific control for this insect has been developed for strawberries. It has been observed, however, that if the suggestions outlined for the crown moth are followed, the infestations are somewhat reduced.
STRAWBERRY APHID

The strawberry aphid (*Capitophorus fragaefolii* (Ckll.)) is important in strawberry plantings in Oregon because of its ability to transmit viral diseases such as the crinkle disease of strawberries. It seldom occurs in large numbers on strawberries except in the cool, rainy weather in the spring, although in certain localities where the humidity is kept high by irrigation, the insects may be more numerous. Throughout the growing season the role of the aphid as a transmitting agent of disease is complicated by the fact that it not only feeds on cultivated strawberries, but on three kinds of wild strawberries, several kinds of cultivated rose, two species of wild rose, and on two species of *Potentilla* (five finger). It is also suspected to have further hosts that ultimately may act as carriers of infection of such diseases as crinkle.

Life history. The life history in the Willamette Valley is as follows: The oviparous (egg-laying) females deposit the overwintering eggs on strawberries and *Potentilla* shortly after the first fall frosts. Oviposition may extend through February. The eggs hatch in March and April, giving rise to the first generation, known as "stem mothers." After attaining full growth, these "mothers" produce young nymphs. These ultimately grow into the wingless viviparous females. Reproduction of this stage can continue under mild weather conditions in western Oregon on strawberry plants throughout the entire year. During April and May winged females are produced, and these may fly to cultivated and wild roses or to other strawberry plantings. These in turn give birth to wingless females. The migration of the winged forms is of major importance in dissemination of crinkle disease. During the fall, winged females appear on the alternate host plants. These may return to strawberries where with the coming of cold weather mating takes place with the appearance of the males and the overwintering eggs are produced.

Control suggestions. Because of the relatively low numbers of the strawberry aphid on strawberry plants, control measures do not appear warranted except as a preventive for crinkle disease. It has been noted that cultural practices such as topping strawberry plants for the control of crown moth have materially reduced the numbers of aphid in plantings. There is probably some benefit secured from the application of rotenone dust for spittle bugs. This observation has been made by a number of growers who have reported a reduction in the spread of crinkle disease following dusting for spittle bugs on strawberries. In cases of extreme aphid infestation a special application of rotenone-bearing dust may be tried to reduce their numbers.

MINOR PESTS OF STRAWBERRIES

I. White grubs or June beetles. Occasionally the common white grubs (or, as they are known in the adult stage, the May or June beetles) cause serious injury to strawberry plantings. The most destructive stage so far as strawberries are concerned is the larval or white-grub stage. These pests in some species attain a length of 1 1/2 to 2 inches and by their vigorous feeding are capable of destroying numbers of strawberry plants per individual. Other species that run smaller in size are frequently injurious because of their numbers in the fields.
The majority of the June beetles require three years for development from the adult through the egg, larval, pupal, and adult stages. The adult beetles appear in the field about the first of May and continue to be present until approximately the middle of June, the period of greatest abundance being during the latter part of May. The adults feed on a large

Figure 12. Cutworms and the strawberry leaf beetle may feed on the edge or center of the leaves. Compare with Figure 7.
number of host plants from the hours of dusk until just before dawn, when they return to the soil to appear again the following evening. Egg laying continues throughout the adult flight period and most of the eggs are deposited in sod lands or weedy patches. The larvae upon hatching feed when very young on decaying vegetation but later attack living roots. The grubs stay in the ground during the rest of the first summer, the second year, and until the spring of the third year, when they appear as adult beetles. In strawberry plantings white-grub infestations are more common in light or sandy-type soils, and generally the heaviest infestations are in plantings that follow grain crops. Subsequent infestations appear to be influenced to a considerable degree by the amount of weed growth present in plantings during the oviposition period. To date no satisfactory control other than digging and destroying the larvae has proved effective in strawberry plantings.

II. Cutworms. The cutworms, larvae of a large family of night-flying moths, are occasionally found in strawberry plantings in sufficient numbers to cause some injury to the foliage. The feeding is generally on the strawberry leaf. In some cases definite holes may result in the center of the leaf surface (Figure 12). This is in contrast with the strawberry-root weevils, which feed always on the edge of the leaf and cause the characteristic "ragging" of the leaves. In extreme cases poison baits may be necessary to secure control. This bait may be made as follows:

- Coarse wheat bran..............................25 pounds
- Salt .................................................. 1 pound
- White arsenic or paris green..................1 pound
- Sirup or brown sugar..............................1 pint
- Water to make a crumbly mash.

It is recommended that the bait be applied over the infested area at the rate of 12 to 15 pounds per acre.

III. Red spider. This mite (*Tetranychus telarius* (Linn.)) occurs occasionally on strawberries in Oregon and during dry summer weather sometimes reaches sufficient numbers to cause injury. This pest is characterized by a webbing that covers more or less the surface of the leaves of the host plant. Within the covering afforded by this webbing are found all stages of the red spider. Reproduction during the warm months reaches its height, and the feeding of these pests results in browning of the foliage. As it is only rarely that red spider causes economic damage to the plants, control is seldom necessary.

IV. Wireworms. The common wireworms in the Willamette Valley have been observed in rare instances to feed directly on strawberry fruit when it is in contact with the ground. The injury consists in tunneling into the berry, which then rots, causing complete loss of the fruit. Instances of this kind are extremely rare, which is fortunate as there is no satisfactory control for these pests on strawberries.

V. Earwigs. The European earwig (*Forficula auricularia* Linn.), which has been common in the urban districts of Oregon for a good many years, has been disseminated into the farming areas. The adult earwigs are quite frequently found hiding among the foliage and debris of strawberry plants. It is not believed that these insects occur in numbers sufficient to cause injury necessitating control.
VI. Strawberry leaf beetle. This insect (*Timarcha intricata* Hald.) belongs to a family of leaf-feeding beetles, and in a few rare cases has been observed to be present in sufficient numbers to cause injury to strawberry plantings. The adult beetle is black, almost round in outline, and without distinctive markings. It is commonly mistaken for the common carabid or scavenger beetle frequently found in strawberry plantings. The larvae is a gray, greasy-appearing grub which is characteristically rounded, giving a somewhat humped-back appearance. Both larvae and adults feed directly on the leaves of strawberry plants (Figure 12) and when numerous are capable of causing considerable damage. Dusting the foliage before the fruit sets with a 10-per-cent lead-arsenate-lime dust, or in cases where the infestation is observed after the fruit is set, dusting with one of the pyrethrum dusts, will probably give satisfactory control.

Figure 13. Greatly enlarged section of a vein in a strawberry leaf, showing cell structure and the penetration of an aphid beak into the sap-conducting tissue. In this way this insect injects the crinkle disease into healthy plants. (*Photo by courtesy of W. C. Whitaker.*)
VIII. Purple finch. Birds known as the common purple finch are to some extent incriminated as a strawberry pest. These birds during the ripe strawberry season feed on the developed seeds of the fruit and cause some mechanical injury to the flesh of the berry itself that results in rotting. As this injury is sometimes attributed by growers to adult strawberry root weevils, the activities of this bird are mentioned in this bulletin.

DISEASES OF STRAWBERRY

The common diseases of strawberry in Oregon are briefly discussed under four general groups according to the causal agents; namely, virous, fungous, nematode, and physiological diseases.

VIROUS DISEASES

Three virous diseases of strawberries have been recognized in Oregon. Of these the crinkle disease is most important and widespread, especially throughout the Willamette Valley. Witches' broom has been found scatteringly in the Willamette Valley, while yellows has been met with in the Rogue River Valley only.

Crinkle. The crinkle disease has caused the gradual degeneration of the Marshall variety of strawberry, and is a serious limiting factor in the propagation of the Corvallis and Ettersburg No. 121. It also affects most other varieties to some extent. The Redheart is seldom found with high percentages of infection.

Affected plants yield less than 50 per cent as much crop as that produced by healthy plants, and are more easily winterkilled.

The disease is transmitted and doubtless disseminated by the strawberry-leaf louse (aphid), which sucks infective juice from diseased plants.

Figure 14. Marshall strawberry plants of the same age. Healthy plant (left) and one (right) to which crinkle has been transmitted through the strawberry aphid, *Capitophorus fragaefoli* C. Notice the runner plants are also infected (see Figure 15).
and may inject it into healthy plants (Figure 13). As the crinkle virus is in
the juice of the infected plants, the chief spread is from the mother to
runner plants, which perpetuate the disease in planting stock.

The symptoms of crinkle are mosaic-like, beginning as yellowish, pin-
point spots in the leaves. Such leaves soon become crinkled and unevenly
streaked and spotted with yellowish tissue in contrast to the smooth deep

Figure 15. Runner plant potted while still attached to mother having crinkle. Symptoms on
first leaves are severe; when well-rooted, a leaf (largest) was produced without symp-
toms, but the youngest leaf showed primary symptoms as the plant became pot-bound.
Young plants in the field in the same way show no symptoms during the first few months
after planting.

green of healthy leaves (Figure 14). The symptoms are usually not seen
during the first few months after planting. Healthy plants may therefore
be selected successfully only from plantings a year or more old (Figure
15). For a more complete description of this disease see Station Bulletin
319.

The elimination of the disease from planting stock is best brought
about through the selection of outstanding, high-yielding, healthy plants
in plantings more than a year old. Runners from these are planted in an
isolated propagation plot according to a plant-unit system, in which all
runner plants from one mother are planted together in a row and not
mixed with those from other mother plants. In this fashion one mother-plant unit may be followed after another in the rows of the propagation plot, and each unit numbered the same as the mother plant from which it was taken. In case crinkle occurs anywhere in any plant unit the whole unit is destroyed, particularly should the mother develop crinkle symptoms during the first few months after plant-unit selections are made. Healthy stock may also be obtained by the purchase of Oregon-certified strawberry plants. For the plan of strawberry certification in Oregon reference should be made to Extension Bulletin 481.

![An Ettersburg No. 121 plant in which the baby plants have been pulled away from the parent to show the shortened runners, and Witches' Broom of the individual plants.](image)

**Yellows.** Strawberry yellows is a viral disease common on the Marshall variety in central California and southern Oregon. It has been found in Josephine and Jackson counties. The characteristic symptoms are: (1) cupping of the leaflets, which usually have yellow margins and glazed green centers, and (2) shortening of the leaf stems (petioles) and general dwarfing of the entire plant. Control is by selection of healthy plants as described above for crinkle.

**Witches'-broom.** This is another viral disease that is transmitted in the same ways described under the crinkle disease above. Its main symp-
toms are illustrated by Figure 16. The leaves are smaller and lighter green, and the stems more slender than healthy ones. The runners are very short so that the runner plants take root close beside the mother. The whole clump becomes broom-like. Affected plants do not yield and growers naturally hoe them out. High percentages of infection of this less important disease have not been found.

Figure 17. Leaf Spot of strawberry.

**FUNGOUS DISEASES**

**Leaf spot.** One of the most familiar diseases of strawberry in Oregon is leaf spot. At first the spots caused by infection of the fungus* are a dark reddish or purplish color, but as they grow older the center of each spot becomes grayish or almost white. Fully developed spots are usually not more than $\frac{1}{4}$ inch in diameter, with a whitish center and a distinct reddish border. (Figure 17). The spots are irregularly scattered over the leaf surface and sometimes may destroy considerable of the functioning leaf tissue. The usual damage due to this disease, therefore, results from the loss of needed leaf surface.

Infection takes place during a rainy or very foggy period. Leaf spot, therefore, usually does not show up seriously during the height of the season in Oregon strawberry fields because of the lack of summer rains. As a rule the effects of the disease are so slight that no spray is recommended in the Willamette Valley. If a thorough job is done when the leaves are removed for the control of crown moth, the grower will have gone a long way toward keeping the disease to a minimum. Along the Coast, where rains and fogs are more frequent during the growing months, it is desirable to spray with bordeaux mixture 3-3-50 as soon as growth is well started in the spring and repeat as often as necessary to keep the foliage well covered until the first berries are about one-third grown. Another application of bordeaux 4-4-50 before the first rains in the fall is also beneficial. (For the preparation of sprays see Bulletin 336, Oregon Agricultural Experiment Station.)

*Mycosphaerella fragariae* (Tul.) Lindau.
Scorch* and leaf blight† are two other fungous leaf spots abundant on wild strawberries in Oregon, but they seldom infect cultivated varieties. Scorch is commonly found affecting the Clark Seedling and Improved Clark (Ulrich) in the Hood River Valley, and sometimes the Redheart in the Willamette Valley. Neither disease does enough damage, however, to call for control by sprays.

Mildew. Strawberry wildew is locally destructive in Oregon. It is most easily recognized by the curling upward of the sides of the leaves. This exposes the underside, which usually is grayer in color than the upper side. This grayness and the whitish Mildew powder (fungus) on the leaves give to the whole patch a distinctly grayish appearance. Affected leaves later turn purplish or reddish. Where strawberries are irrigated not only does mildew attack the leaves, but in such varieties as the Clark Seedling, Improved Clark (Ulrich), and some everbearers the fruit may be seriously mildewed. Some of the common varieties grown in Oregon listed in order of susceptibility to mildew are: Narcissa, Clark Seedling, Improved Clark, Ettersberg No. 121, Marshall, Corvallis, Redheart, etc.

No systematic experiments for the control of strawberry mildew have been conducted by the Oregon Agricultural Experiment Station, but field observations have shown lime sulphur to be effective. Where strawberries are grown in orchards under irrigation, for example, lime sulphur applied to the trees may be sufficient to keep mildew in check.

The New York Experiment Station has demonstrated that four applications of 85-15 lime and copper sulphate dust will give practical control of mildew even during seasons of maximum infection. Applications are about every 12 days, beginning when the first leaves begin to expand. Sanitary measures such as destruction of the old leaves after harvest are beneficial.

Armillaria crown rot. Plants infected with Armillaria crown rot become dwarfed, the leaves yellowish, and the whole plant wilts early in the summer. The cambium layer of infected crowns is usually replaced by a fungous "felt," and the core of the crowns is grown through with fungus. Interspersed in the fungous felt are islands of brownish plant tissue.

Scattering individual plants may be infected on recently cleared land, but usually circular areas where oak trees previously stood are killed by Armillaria. Infected areas should not be replanted with crops susceptible to the disease. Such crops are usually trees or shrubs.

Root rots. Strawberry growers have sustained heavy losses in various parts of the state from root diseases. The generally common condition which has been designated as "root rot" or "black root" has been studied, and two fungi in particular have been isolated from diseased roots. These two fungi that seem to be responsible for black root lesions in Oregon are Rhizoctonia and Verticillium. Without culturing out the causal organism it would usually be impossible to distinguish between the two diseases.

The usual symptoms common to the two diseases are the black lesions on the roots (Figure 18). Affected plants have an unhealthy appearance, usually lacking in greenness of the leaves, and when most moisture is needed about fruiting time the plants are liable to wilt, especially in sunlight.

* Caused by Diplodacron eariiiana (E. and E.) Wolf.
† Caused by Dendrophoma obscuros (E. and E.) Anderson.
There is no remedy for such a disease except (1) selection of planting stock from fields with little or no infection, and (2) crop rotation. Strawberries should not be planted on land where crops susceptible to these

Figure 18. Black Rhizoctonia lesions on secondary roots of Marshall strawberry. (2x)
diseases have been grown at least for two intervening years. Other susceptible crops are potatoes, tomatoes, egg plants, black raspberries, etc.

Fruit rots. The shipment of fresh strawberries from Oregon is almost negligible. The crop from smaller plantings is used locally and that from the large commercial acreages is immediately canned or preserved in barrels. Thus, the Oregon crop does not suffer losses from many of the fruit rots as often experienced in other localities after the berries are picked. There are several fruit rots however that are known to be serious in the field. Of these the grow mold (Botrytis) rot is most important in Oregon. It occurs in the field during and immediately following cool, damp periods. Due to this rot, losses are heavy when it rains during ripening season. Even green berries decay during cool, wet weather.

Since this fungus grows well in warm or cool temperatures berries on local markets are subject to considerable loss through gray mold if picked when wet.

Spraying or dusting methods that are successful in controlling fruit rots in most tree fruits have not proved practicable for strawberry rots. Year after year fruit rot in the field is not of sufficiently regular occurrence to justify regular applications of spray or dust.

NEMATODE GALL

Nematode-gall disease of strawberries is known only in the Pacific Coast states. The nematode causing the disease may affect hyacinths, red clover, alfalfa, and false dandelion. It is especially prevalent on the wild coast strawberry (Fragaria chiloensis). The disease, caused by very small wormlike animals in the affected plant tissues, appears as galls on leaves and stems (Figure 19). The plants are usually dwarfed and do not have a healthy color.

Fortunately, the commercial varieties of strawberry commonly grown in Oregon are seldom affected by these nematodes. It is a wise precaution, however, not to plant strawberries in fields in which affected crops have been grown, and not to plant stock from infested fields.

The disease of southern states known as “dwarf" or “crimps," caused by another species of nematode, has never been found in Oregon.

ALKALI YELLOWS

Strawberry plants thrive best in rich loamy soils that are rather acid in reaction. On the other hand most varieties are very sensitive to soils that are neutral or alkaline in reaction. A yellow color of the leaves is the most striking symptom. Such plants in very slightly alkaline soil may bear quite normally for a year or two but gradually dwarf. For the most part the “alkali yellows" occurs in irrigated lands of eastern and southern Oregon. Any practical treatment to increase the acidity of alkaline soil will be helpful.
Figure 19. Nematode Galls on leaves and stems. This is one of the less important diseases of strawberry in Oregon.
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