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Diseases of the Filbert in the Pacific Northwest and Their Control

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Diseases of the Filbert in the Pacific Northwest and Their Control

By
P. W. MILLER*

The rapid expansion of filbert growing in the Pacific Northwest in the past decade has brought with it an intensification of disease problems. It is the purpose of this bulletin to provide the filbert grower with information that will enable him to identify the various diseases affecting the filbert in the Pacific Northwest and to employ effective control measures against them.

DISEASES DUE TO SPECIFIC ORGANISMS

BACTERIAL BLIGHT

Bacterial blight, commonly known as filbert blight, is the most destructive disease of the filbert in the Pacific Northwest. It is widely distributed, occurring to a greater or less extent in practically all filbert orchards in Oregon and Washington. The prevalence and destructiveness of bacterial blight varies with the season. In years when the rainfall is extremely "heavy" in the fall and winter, the damage from blight is severe.

Cause and nature of the disease

This disease is caused by a specific bacterial organism† that lives parasitically within the tissues, causing their death (Figure 1). The buds, leaves, branches, trunk, and occasionally the nuts are attacked by this bacterium (Figures 2 to 5).

The formation of cankers on the tree trunk is the most serious aspect of this disease, especially when they girdle and kill the trees, as is often the case in orchards up to 4 years of age (Figure 6). After the fourth year, the trunk is seldom infected, but many buds and nut-bearing twigs in the tops of older trees are attacked and killed, thus reducing the yield

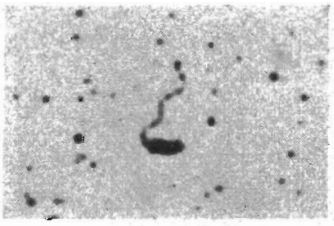

Figure 1. Photomicrograph showing the filbert blight bacterium, x 2300. *Photograph by F. P. McWhorter.*

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† *Xanthomonas corylina* Miller et al.

(Figure 7). The average annual crop loss due to blight of the buds and twigs is estimated to have varied in the past decade from less than 1 per cent to 10 per cent. In certain orchards the loss has been as much as 25 per cent of the crop.

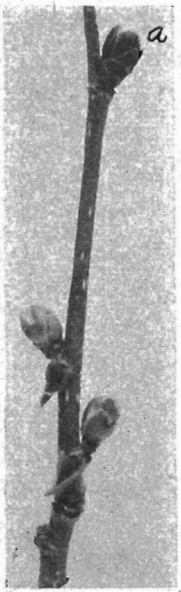

Figure 2. A filbert bud infected with bacterial blight (at *a*).

The original source of infection is chiefly diseased nursery stock from whence it is spread by cultural operations and rain. Shears or knives used in pruning or suckering may be readily contaminated with the bacteria by accidentally cutting through an active canker. Unless a disinfectant is used on the tools, the germs are carried to adjoining trees where centers of infection may be established from which the disease is spread further by rain.

While bacterial blight can and does attack healthy, vigorous trees, the damage is accentuated when the trees have been weakened or injured by sunscald, cold, drought, improper drainage, and other adverse factors. The tissues of devitalized or injured trees offer much less resistance to infection and the subsequent extension of the diseased areas than do those of strong, vigorous trees. It is important, therefore, that the trees be maintained healthy and vigorous to lessen the extent of damage in the event of infection.

Control

Practical measures recommended for control of this disease fall into two categories: (a) disinfection of tools used in pruning and suckering, and (b) spraying with bactericides.

Disinfecting tools: Tree losses from blight traceable to contaminated tools can be prevented by disinfecting the pruning and suckering tools with an efficient bactericide such as bichloride of mercury, 1 part in 1,000 parts of

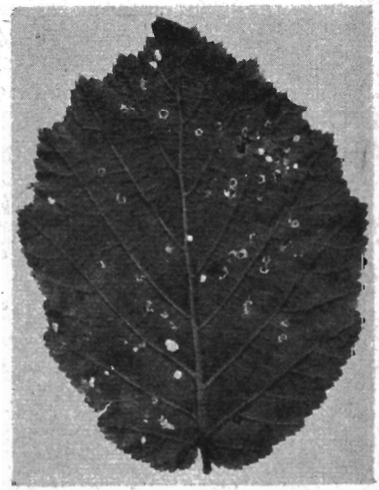
Figure 3. Bacterial blight lesions on a filbert leaf.

Figure 4. A branch of a filbert tree containing a number of "blighted" shoots of current growth: *a*, a young shoot killed by bacterial blight shortly after it emerged from the bud; *b*, an older shoot that broke at a lesion. *Photograph by H. P. Barss.*

water. This chemical may be obtained in tablet form at most local drug stores. The solution should be kept in a glass container as it is corrosive and loses its germicidal effectiveness shortly after coming in contact with metal. CAUTION: BICHLORIDE OF MERCURY IS DEADLY POISON TO MAN OR ANIMALS IF TAKEN INTERNALLY AND SHOULD BE SO LABELED AND KEPT IN A SAFE PLACE AWAY FROM CHILDREN. The use of such a sterilizing agent on the pruning tools is particularly advisable when suckering and pruning young trees, 1 to 4 years of age, as lesions on the trunks during this period frequently girdle the trees and result in their death. After a tree is 4 years of age the use of a disinfectant on the tools is not so necessary as the tissues of the trunk become increasingly resistant with age. While it is impracticable to disinfect the tools between successive cuts they should at least be disinfected between trees.

Spraying:. The incidence of bud and twig blight due to bacterial blight can be materially reduced in both young and old orchards by timely spraying with bordeaux mixture, 6-3-100 formula. The addition of a good wetting and sticking agent, such as rosin-potash soap (see page 23), to bordeaux mixture will increase its effectiveness. In a normal season, one application of bordeaux mixture, made in the late summer (August) before the first fall rain occurs, is generally sufficient to give commercial control of the disease. In seasons of very heavy rainfall during the fall and winter, however, supplementary applications made in the late fall when the leaves are about three-fourths off the trees and in the early spring when the leaf buds are breaking open are necessary to hold the disease in check (Table 1).

It is possible to combine in one mixture the spray material recommended for control of bacterial blight with that recommended for control of the filbert worm and thus save time and labor required to make separate applications. This combination spray consists of bordeaux mixture 6-3-100 plus lead arsenate, 3 pounds in 100 gallons of mixture. To this should be added an efficient compatible spreader-sticker, such as rosin-potash soap or some other spreader-sticker equally as good. In preparing this combination spray, the bordeaux mixture *should always be made up first,* then lead arsenate and the spreader-sticker added in the order named. This spray should be applied after the moths of the filbert worm begin to lay eggs but before any eggs hatch. In a normal season the first moths emerge during the forepart of July and continue doing so for a month or more thereafter.

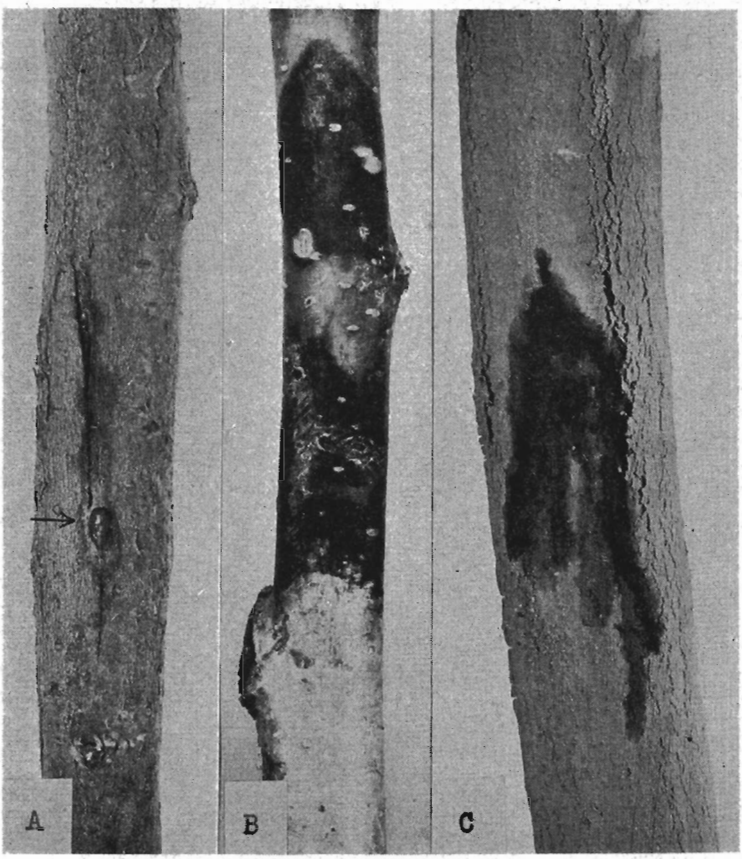

Figure 5. A, bacterial blight canker on the trunk of a young filbert tree; the arrow points to a drop of bacterial exudate that is one of the sources of infection. B, a canker due to sunscald. C, winter injury on the trunk of a young tree. Note "sap" coming from the injured area.

MILDEW

Mildew is caused by a fungus* that appears as a white, powdery growth on the under sides of the leaves (Figure 8). As a general rule, this disease does not develop until relatively late in the season; consequently, it causes little or no economic damage. The upper surfaces of affected leaves generally retain their normal green color, and they persist on the trees until time of normal leaf fall.

This disease could doubtless be controlled by a timely spray program though it has not caused sufficient damage in the past to warrant the application of control measures.

* *Phyllactinia corylea* (Pers.) Karst.

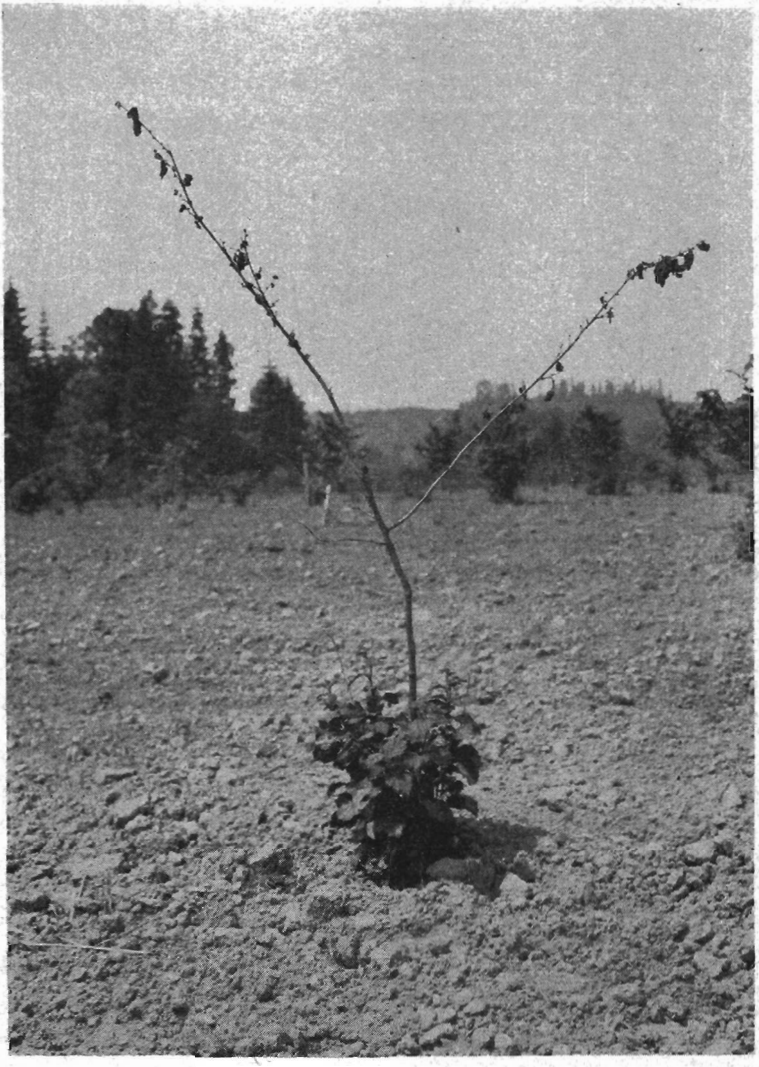

Figure 6. A young filbert tree killed by bacterial blight. The trunk of this tree was girdled by a blight canker.

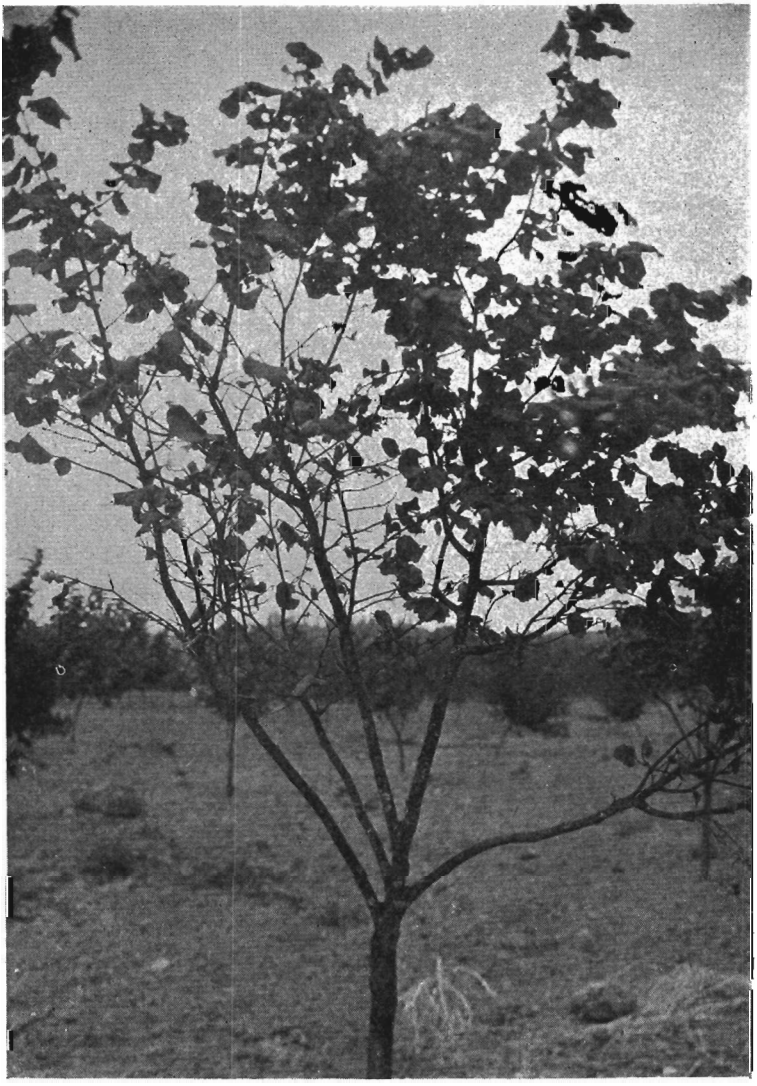

Figure 7. Bud and twig blight in a filbert tree. The killing of the buds and twigs has reduced the bearing area considerably.

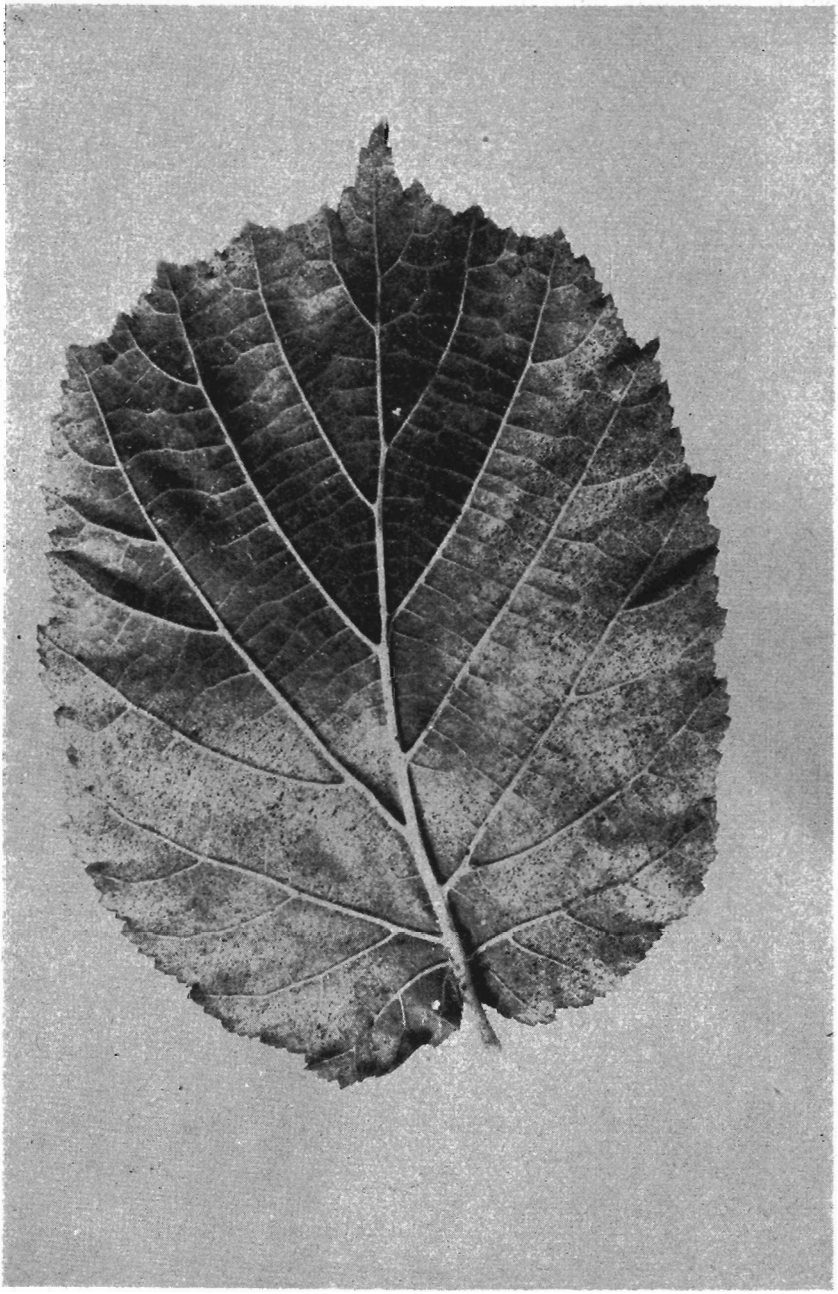

Figure 8. Powdery mildew on mature filbert leaf. Note presence of many small black fruiting bodies.

CROWN GALL

Crown gall, caused by a bacterial pathogen*, produces galls or enlargements on the roots or underground portion of the stem (Figure 9). The disease is rare in filbert orchards in the Pacific North-

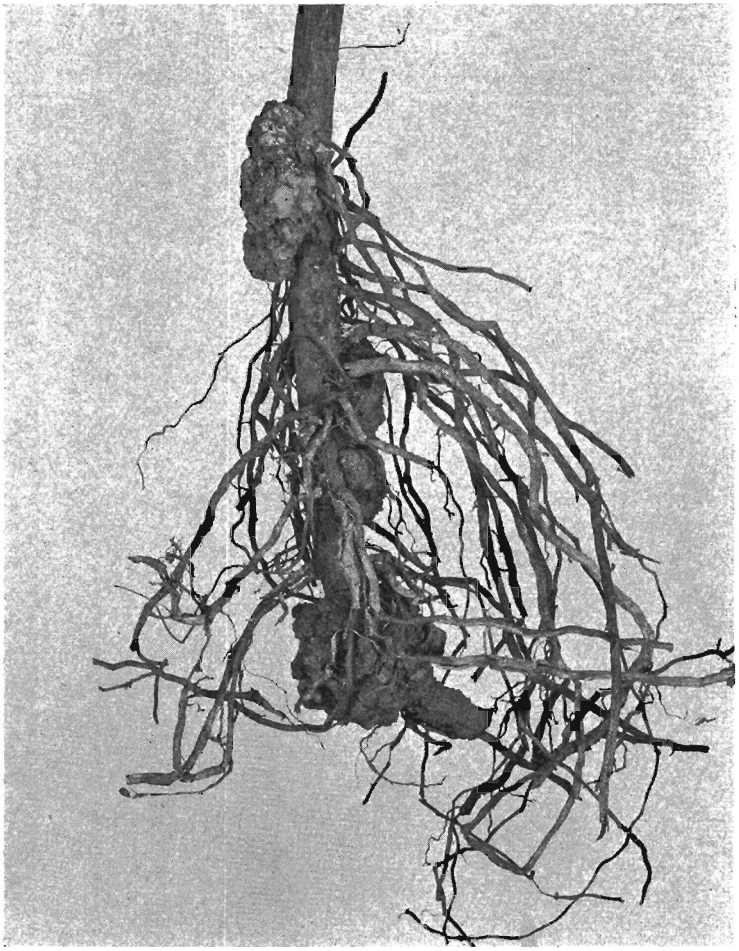

Figure 9. Crown gall on a young filbert tree in the nursery.

west but is found occasionally in the nursery where it is seen on young trees as they are dug. Nursery trees should be inspected and those with galls should not be planted.

* *Agrobacterium tumefaciens* (E.F.S. and Town.) Conn.

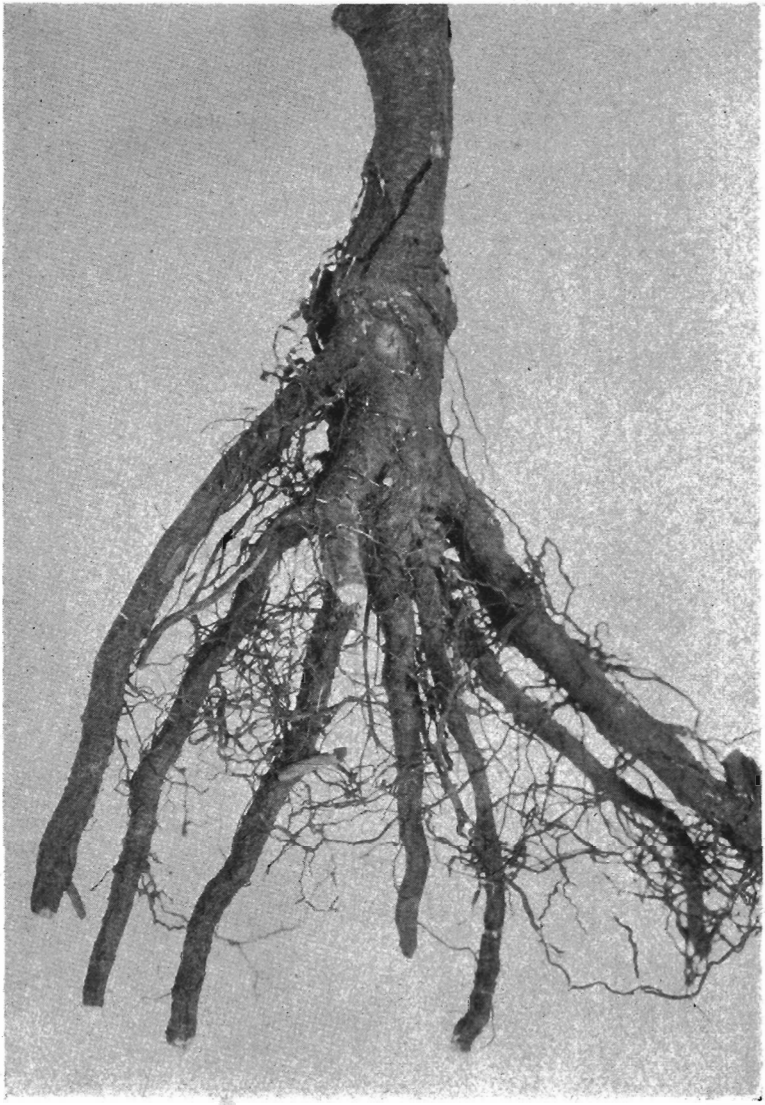

Figure 10. A young filbert tree killed by mushroom root rot.

MUSHROOM ROOT ROT

Cause and nature of the disease

The filbert is occasionally attacked by a crown and root rot caused by a fungus* producing a disease known as mushroom root rot. The first indication of the presence of this disease is usually a poor growth of the shoots together with a premature dropping of the leaves. Only one part or sector of a tree may be affected at first, corresponding to the side of the tree first attacked by the pathogen. The tree may live for a number of years after it is attacked before it finally dies (Figure 10). On examination of the crown or main roots of such trees, dark brown or black, branching, rootlike structures about 1/32 inch in diameter will generally be found clinging to the bark. These rootlike structures, known as "rhizomorphs," are characteristic of this fungus. They are the chief means by which the pathogen spreads from one area or tree to another.

The fungus gains access to the tissues through wounds or by direct penetration of the epidermis, parasitizing and killing the invaded areas. There is frequently a concentration of the whitish fungus mycelium in the cambial region where it grows in a fan-shaped manner.

Control

Mushroom root rot is a very difficult disease to control since it is not generally detected until after a considerable amount of the crown or the root system is involved. After the disease becomes well established there is little, if anything, that can be done to stop its further progress. If the disease is discovered while it is still localized it is sometimes possible to prolong the life of the tree by removing the soil from the crown and main roots, cutting out the diseased areas, and disinfecting the wounds left with bichloride of mercury 1-1000. The crown and main roots should then be left exposed to the air and sunshine to stop further progress of the disease. After the wound has dried out and started to heal up, a permanent wound dressing containing a fungicide should be applied to the surface to prevent the entrance of wood-rotting fungi. Bordeaux-linseed oil paint made by adding raw linseed oil to one of the commercially prepared, dry bordeaux powders is an excellent, inexpensive permanent wound dressing.

WOOD ROTS

The filbert is very susceptible to wood rots or heart rots caused by a variety of wood-rotting fungi. Most of these organisms are

* *Armillaria mellea* Vahl.

wound-parasites gaining access to the tissues through injuries made in pruning, wounds caused by careless cultivation, cold injury, sunscald, wind- and ice-storm injury, and others. Stubs of branches left in pruning are among the most common avenues of entry. Pruning cuts, therefore, should be made close to the main branch or body of the tree to expedite healing. In removing limbs, care also should be taken not to tear the bark. This danger will be avoided if the branch is cut nearly half through from the under side first and then finished off from above.

All wounds ½ inch or more in diameter, particularly if made in the fall or winter, should be immediately painted with bordeaux paste made by mixing equal parts by measure of a commercial bordeaux mixture powder and water. Later, after the wound has dried out and started to heal, a permanent wound dressing containing a fungicide such as bordeaux-linseed oil paint should be applied to the surface to prevent the entrance of blight bacteria and wood-rotting fungi.

DISORDERS DUE TO MALNUTRITION OR ADVERSE ENVIRONMENTAL FACTORS

SUNSCALD

On trunk and branches

As the bark of the trunk of a young filbert tree is relatively thin, it is very susceptible to injury from the hot rays of the sun whenever the temperature rises above 95° F. Sunscald generally occurs on the south or southwest side of the trunk (Figure 5, B). The first three years after planting is the most critical period for serious damage from sunscald.

Shading the south or southwest side of the trunk with a board 6 to 8 inches wide or covering the trunk with some sort of protective cover as soon as the tree is planted will prevent damage from sunscald (Figure 11). Among the materials that make good trunk protectors are newspaper mats, extra heavy wrapping paper, and Yucca boards. As an alternative, the trunks may be painted with a good adhesive exterior whitewash* which, while not quite so effective as trunk protectors, will aid in reducing the severity of damage.

Heading the trees low—about 18 inches from the ground line—and leaving small branches arising from below the head to grow,

* A very satisfactory whitewash formula is as follows:

Quicklime (do not substitute)	4 pounds
Skim milk	2½ quarts
Water	2½ quarts

Water-slake the quicklime; combine the skim milk and water and then add to the slaked lime while still warm; apply to trees with a brush.

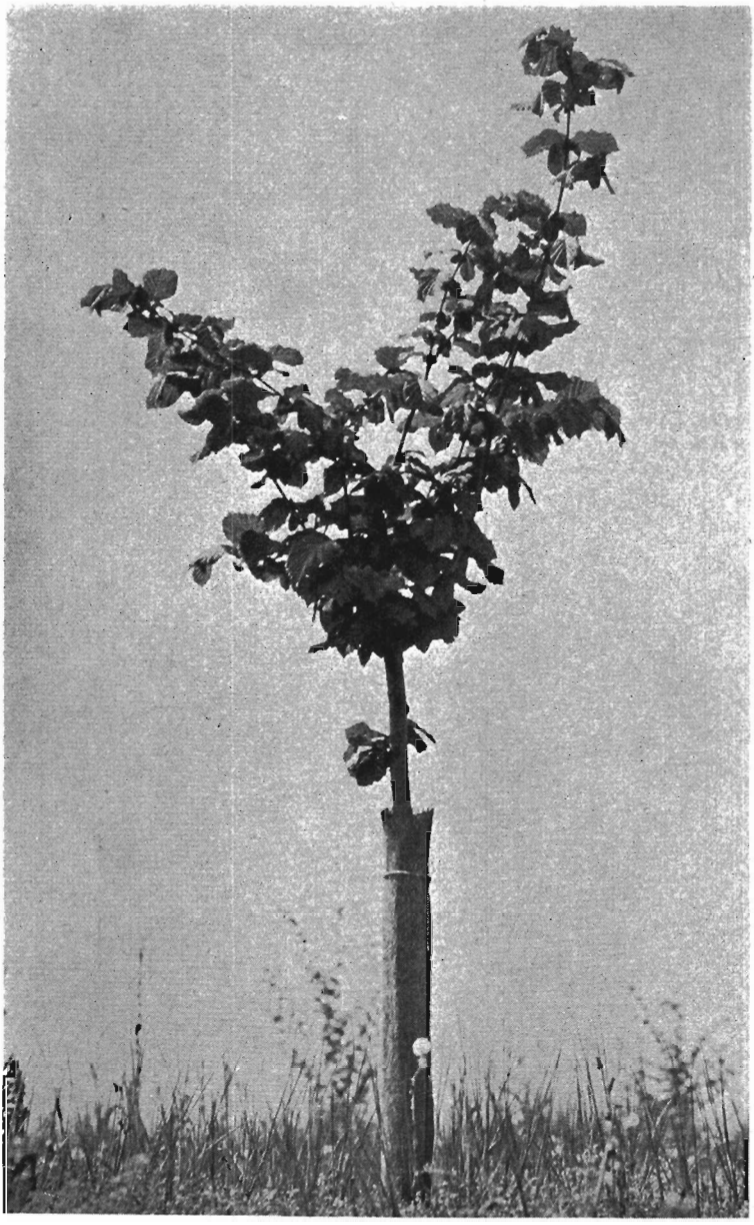

Figure 11. A Yucca board protector about the trunk of a filbert tree. Such a covering will prevent sunscald of the trunk. *Photograph by F. P. McWhorter.*

thus furnishing shade until danger of injury is past, will also aid in the prevention of sunscald.

Under some conditions, the top sides of the branches, particularly on the south or southwest side of the tree, are injured by the hot rays of the summer sun. Trees with sparse foliage and those suffering from drought are more susceptible to injury than trees with dense foliage and an abundant supply of moisture.

On leaves

The leaves of the filbert also are subject to injury by the hot rays of the sun. A necrosis of the tissues is produced that in severe cases may involve up to three-fourths of the leaf area (Figure 12). Badly injured leaves generally drop permanently. Orchards located on shallow soils with low reserves of available soil moisture and fertility are more susceptible to injury than are those on deep, fertile soils with an ample supply of moisture.

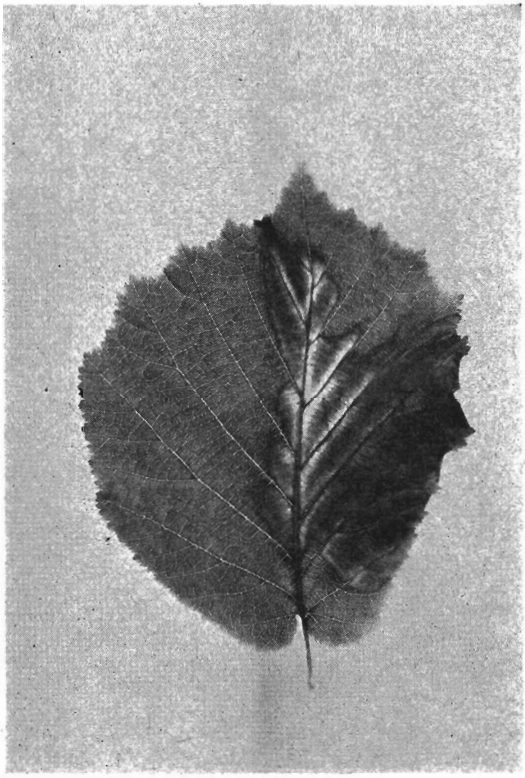

Figure 12. Leaf scorch of filbert due to sunscald.

BROWN-STAIN

In its initial stages, brown-stain is characterized by the occurrence of a brownish liquid on the sides or apical end of the nut (Figure 13, A.) It generally first appears when the nuts are from ½ to ¾ grown. Only localized areas in the shell are at first affected, the involved areas becoming water-soaked and considerably softer than normal (Figure 13, C). The internal areas are affected later, producing a water-soaking of the "pellicle" about the developing kernel

(Figure 13, B). The affected parts become brown or chocolate-colored. In the more advanced stages of the disorder the whole internal structure turns a watery brown and the development of the embryo is arrested. Such nuts are "blanks" at maturity. If the nut is affected relatively late in its development, only localized areas in the shell and in the pellicle are involved. The kernel continues to develop in these cases although it is often not perfectly formed at maturity. The conditions responsible for the development of this disorder are not definitely known. It is doubtless of nonparasitic origin as no parasitic organism has ever been found associated with its occurrence. The fact that it has been serious in only 2 out of the past 14 years leads to the belief that it is associated with the occurrence of certain unusual combinations of weather at certain critical stages in the development of the nut.

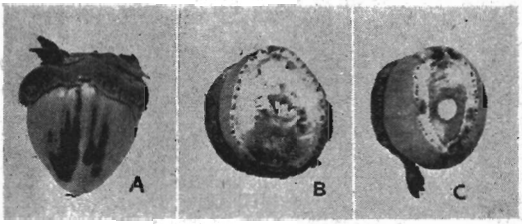

Figure 13. Brown-stain of filbert: A, appearance of the disorder from outside; B, C, cross-section views of two affected nuts. Only the shell is affected in C, while in B the lesion extends into the pellicle.

FILBERT SHRIVEL

Filbert shrivel is characterized by the failure of the embryo of the nut to develop. The shell may cease growing and turn brown while it is still very small or it may continue to grow until maturity. In all cases, however, the embryo never develops. The condition or conditions responsible for the occurrence of this disorder are not definitely known. The fact that it is much worse in orchards having fewer than the recommended number and kinds of pollenizer trees would indicate that it may be associated with a lack of pollination. Its occurrence in limited amounts in orchards with a sufficiency of pollenizers, however, suggests certain other causal factors also.

KERNEL-SPOT

Kernel-spot is characterized by the presence of dark brown, sunken spots in the kernel, generally at the apical end (Figure 14, A). Internally the spots are whitish, pithy, and porous, and decidedly bitter in taste (Figure 14, B). The disorder cannot be detected until the shells have been removed. The cause of kernel-spot is not definitely known. It is apparently of nonparasitic origin, however,

as no parasitic organism has been found associated with its development. A very similar injury of pecans in the South is said to be caused by the southern green stinkbug*, the leaf-footed bug†, and closely related species of insects. A limited number of attempts to reproduce kernel-spot of filberts by caging with some Say stinkbugs‡ was unsuccessful, however, thus indicating that some other factor is probably associated with its occurrence in the Pacific Northwest. The fact that the disorder is generally worse in orchards located on "poor" or "heavy" marginal soils would suggest that malnutrition may be concerned in its development.

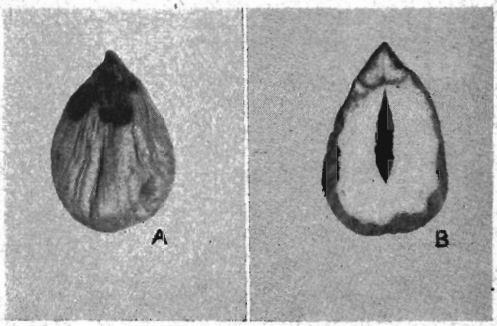

Figure 14. Kernel-spot of filberts. A, Appearance of the disorder from the outside; B, longitudinal median section through an affected kernel showing lesion at apex.

BUNCHY TOP

Bunchy top is characterized by the presence of bushy or broomy growths in the tree, resulting from an abnormal forcing of the lateral buds into growth (Figure 15). In the cases observed thus far, only portions of a few scattered branches in the trees have been involved. This is a rare disorder, having been found only in a few orchards in the northern part of the Willamette Valley. The cause of the disorder is not definitely known. No parasitic micro-organism has been found associated with its development. The symptoms suggest that it may be a virus disease, though definite proof is lacking.

COLD INJURY

Although filberts are hardier than some fruit trees, they are injured by exceptionally or unseasonably low temperatures. The old as well as the current growth is subject to injury (Figure 17).

Injury to the foliage from late frosts is manifested by dwarfing of the leaves and death of the tissues between the lateral veins. These dead areas later drop out of the tissues leaving holes in the leaf lamina (Figure 16).

* *Nezara viridula* (L.)
† *Letoglossus phyllopus* (L.)
‡ *Chlorochroa sayi* Stal.

The older branches and trunk are also subject to injury, particularly if freezing temperatures should occur before the trees go dormant. Damage to the trunk is often more severe if snow is on the ground than when it is bare. This is because the sunlight striking

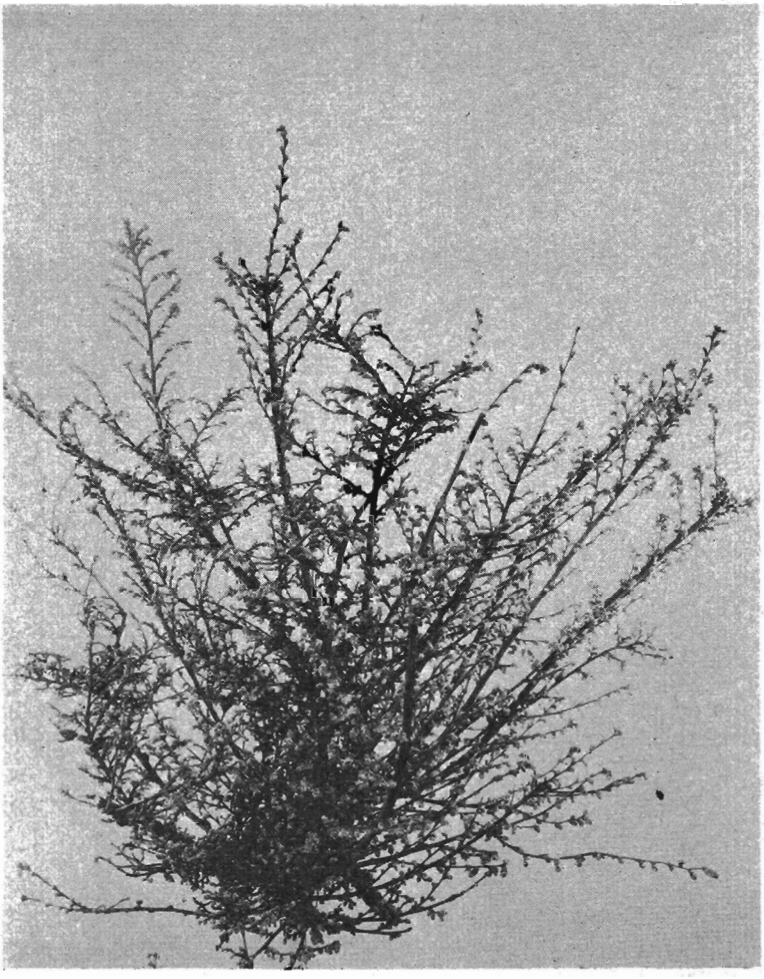

Figure 15. The bunchy-top disorder of filberts.

the snow is reflected to the trunks, thawing out the tissues on the south or southwest side of the tree. During the night freezing occurs again, and this alternate freezing and thawing results in the death of the tissues in strips on the south or southwest side of the trunk (Figure 5, C). Besides interfering with the flow of sap, the cold-injured areas may also serve as infection courts for blight bacteria and wood-rotting fungi. Some varieties appear more susceptible to cold injury than others. The Brixnut and DuChilly varieties in past years have been injured more than the Barcelona and Daviana.

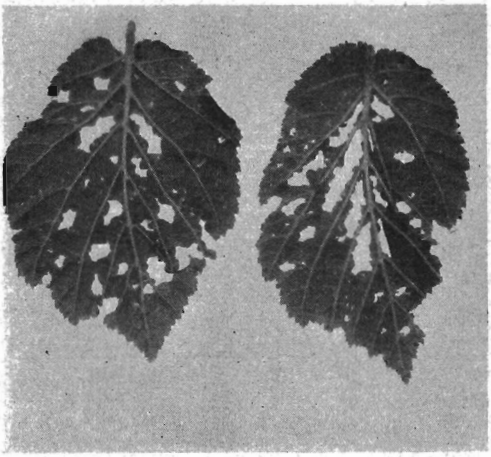

Figure 16. Filbert leaves injured by an early, spring "killing" frost. The injured tissues have dropped out, producing a shot-hole effect.

While there is little, if anything, that can be done to prevent cold injury if the temperatures drop too low, partial protection to the trunk from the injurious effects of alternate freezing and thawing can be obtained by covering with a trunk protector of one sort or another, or by painting the trunk with an adhesive whitewash that will withstand weathering (page 15). The whitewash reflects the heat rays of the sun, thereby diminishing the wide fluctuations in temperature that are the cause of much of the damage.

Relation of poor drainage to the decline of filberts. Filberts will not thrive in low, wet, poorly drained ground. This is because the high water table excludes air (oxygen) from the root zone, causing the roots to die. Under such conditions there are insufficient roots to take care of the needs of the plant during the growing season with the result that the twigs and branches die back, and as a rule the tree eventually dies. If poor drainage does not, of itself, kill the trees, it weakens them to such an extent that they are predisposed to infection by bacterial blight or rendered liable to attack by borers and other pests.

MOSSES AND LICHENS IN FILBERT ORCHARDS

A number of kinds of mosses and lichens grow on filbert trees in the Pacific Northwest. Although none of these are parasitic, they may harbor injurious insects of various kinds and may perhaps interfere with the normal functioning of the bark. Mosses and lichens, therefore, should not be allowed to become too abundant on the trees.

Figure 17. A "cold-injured" DuChilly filbert tree.

Where orchards are regularly sprayed for the control of bacterial blight, special sprays for moss control are not required, as the spray material regularly employed for the control of this disease is also effective for the control of moss, especially if the limbs and trunks are thoroughly wet in spraying. Where the orchard is not regularly sprayed, however, it is desirable to apply special sprays at 4- or 5-year intervals to keep mosses and lichens under control. Sometimes an abundance of mosses and lichens indicates lack of vigor or retarded growth from other causes, in which case other measures will be required to bring the trees back to a normal condition.

Filberts may be sprayed for the control of moss at any time during the dormant period or right after the period of pistillate (female) bloom. The trees should not be sprayed when the pistillate flowers are receptive to pollen as there is a possibility that the spray will interfere with pollination.

There are a number of spray materials that will kill mosses and lichens. Liquid lime-sulphur and bordeaux mixture are two of the most effective sprays for this purpose. Lime-sulphur acts more quickly than bordeaux mixture, but bordeaux mixture is preferable because it has a more lasting effect in keeping the trees free from mosses and lichens. Then too, lime-sulphur cannot be used on filberts except in the dormant period because sulphur is extremely toxic to filbert foliage. A relatively strong concentration of bordeaux mixture, as the 6-6-100 or 8-8-100 formula, is more efficient than weaker strengths, although weak concentrations will kill mosses and lichens on trees sprayed at regular intervals. If lime-sulphur is employed instead of bordeaux mixture, a 12-100 solution (12 gallons of 32° Baumé concentrated liquid lime-sulphur added to water to make 100 gallons of spray) should be used while the trees are dormant.

IMPORTANCE OF PROPER ORCHARD MANAGEMENT

There is an association between the incidence of certain diseases and lessened tree vigor; hence it is important to keep the trees in a vigorous, thrifty condition. Proper cultivation and cover cropping, supplemented if need be by fertilization with commercial fertilizers, will aid in maintaining proper vigor. The orchard should be disked or plowed in the spring as soon as the ground is workable. Subsequent cultivations in late spring may be found necessary to keep down weed growth and conserve moisture. The orchard should not be irrigated too late in the season, as late irrigations force a late fall growth of the trees which are susceptible to injury by cold.

SPRAY MATERIALS AND METHODS

Bordeaux mixture

Bordeaux mixture consists of a mixture of copper sulphate, quicklime (caustic) or hydrated lime, and water in varying quantities. The proportion of each ingredient used is indicated in the formula. The amount (pounds) of copper sulphate is always given first in the formula, that of lime next, and the quantity (gallons) of water last. For example, the concentration of bordeaux mixture recommended for the control of filbert blight is 6-3-100, which would contain 6 pounds of copper sulphate, 3 pounds of caustic (quick) lime (or 4 pounds of hydrated lime), and 100 gallons of water. If the spray tank holds 400 gallons, four times these quantities will be required.

A number of methods of preparing bordeaux mixture are in vogue. Regardless of the method used, it is important that at least one of the ingredients be highly diluted before the other is added. The "two-package" or so-called "instantaneous" method of making bordeaux mixture has a number of advantages not possessed by the stock-solution and other methods. These are: (1) no extra equipment necessary, (2) very economical in the use of labor, and (3) time is saved. In preparing bordeaux mixture by this method, the spray tank is filled about half full of water and the requisite amount of hydrated lime added with the agitator in motion. Then slowly add the powdered bluestone, pouring it into a stream of water flowing from the source of supply into the spray tank via a trough. The agitator should be kept running while completing the filling of the tank with water.

Spreaders and adhesives

Filbert leaves have a waxy, hairy surface that is wetted with difficulty. The addition of an efficient spreading and sticking agent to bordeaux mixture will improve the wetting, spreading, and adhering properties of the spray mixture and thereby increase its effectiveness.

A number of materials, both home-made and commercial, are efficient wetting and sticking agents.

One of the most efficient home-made spreader-stickers is rosin-potash soap* which should be used at the rate of 1 pint of spreader to 100 gallons of spray material.

* The basic formula for this spreader is as follows:
25 pounds lump rosin
6 pounds caustic potash (potassium hydroxide)
25 gallons of water
This is sufficient to make about 30 gallons of the spreader; if more or less is needed, the quantities of the ingredients used should be adjusted accordingly.
The procedure used to make the spreader is as follows: Place water in a metal container over fire; add the caustic potash (CAUTION: do not handle the potash with bare hands as it is very caustic); break up rosin into small pieces and add to the solution; bring to a boil and cook the mixture until all the rosin is dissolved; store in a tight container.

There are also a number of excellent commercial wetting and sticking agents available on the market. One of the best is a glycerol phthalic resin. Another efficient material is composed of sodium oleyl sulphate and a synthetic resinous sticker. These proprietary wetting agents should be used at not to exceed 1 ounce per 100 gallons of material since they cause excess run-off of the spray material if used in greater quantities.

Applying spray materials

If satisfactory control is to be obtained, the spray materials must be *thoroughly* applied and properly timed. A film of the spray material must uniformly coat the host parts, particularly the buds in the leaf axils, for good control.

To accomplish this objective, the trees must be sprayed from two sides. The spray machine should be drawn along one side of the tree row and back along the opposite side. It is impossible to do a good job of spraying from only one side of the tree. The best job of spraying can be done when there is little or no wind.

Table 1. SUMMARY OF CONTROL MEASURES FOR DISEASES OF FILBERTS

(For more complete information see discussion of individual diseases)

Name of disease	Control measures recommended or suggested	Time of application
Bacterial blight.....	(1) Disinfect pruning tools with corrosive sublimate 1-1000	.....
	(2) Spray with bordeaux mixture 6-3-100	In late summer before first fall rain
Mushroom root-rot	(1) Cut out diseased areas	
	(2) Uncover collar and basal roots during summer months	
	(3) Dig out infected plants and destroy	
Wood rots	Protect wounds made with a wound dressing (bordeaux-linseed oil paint)	