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Small Fruit Diseases and Their Control

by
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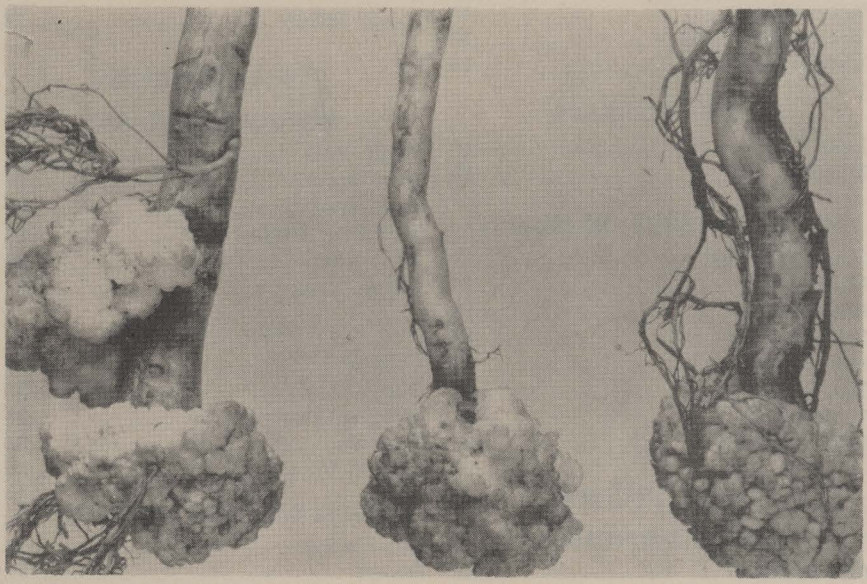

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Small Fruit Diseases and Their Control

A. W. HELTON[1]

BECAUSE of Idaho's extremely varied growing conditions, many types of disorders occur in small fruit culture. Most of these are due to infection by parasitic agents; others are considered to be of non-parasitic nature. Many times the pest is a minor one that common spray materials will easily control, but the trouble is often more serious.

In such cases environmental and seasonal factors play an important role and one set of control measures will not necessarily yield the same results in all areas. This is particularly true in Idaho where conditions may vary so widely from one community to another. Small fruits are grown in the lowest valleys and in high mountain areas; they are also common in desert communities as well as those having damp conditions during much of the year. It is advisable therefore that growers in a given area try variations in the recommended program until satisfactory results are obtained. Preliminary consultation with local county extension agents with this in mind is suggested.

Until recommendations are made available for new materials, the grower must conduct his own tests if he wishes to use them. The alternative is to accept the manufacturers' suggestions, but it must be borne in mind that manufacturers cannot be expected to make a single recommendation that is correct for every area and every set of conditions. However, it is unquestionable that proper use of the proper control program for any particular disorder will result in proportionately higher returns from the grower.

BRAMBLES

BACTERIAL DISEASES

CANE GALL

Importance: Practically all cane fruits are susceptible to cane gall. Extensive damage has been noted especially in Boysenberry and Himalaya blackberry. Infection[2] ordinarily begins in wounds such as those caused by winter injury and pruning. The bacteria causing the disease may be in the soil or they may be brought in on

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[2] If the pathogen has entered the plant and is causing damage, the plant is **infected**; if the pathogen is merely on the surface the plant is **infested**; soil is **infested** when it contains the pathogen.

new stock that shows no symptoms of infection. Cane gall is not nearly as common as is **crown gall.**

Distribution: Although not commonly found in Idaho, cane gall may occur in any bramble growing area. Aerial symptoms of **crown gall** frequently are confused with cane gall.

Cause: Cane gall is caused by the bacterium **Agrobacterium rubi,** which is closely related to the **crown gall** and **hairy root** organisms.

Symptoms: Large, bark splitting galls are formed along the stems in long masses, though they may be smaller and more localized in some cases. It is often extremely difficult to distinguish between cane gall and certain types of **crown gall** on the basis of visual examination alone. Fruiting canes are affected and plants are greatly reduced in vigor.

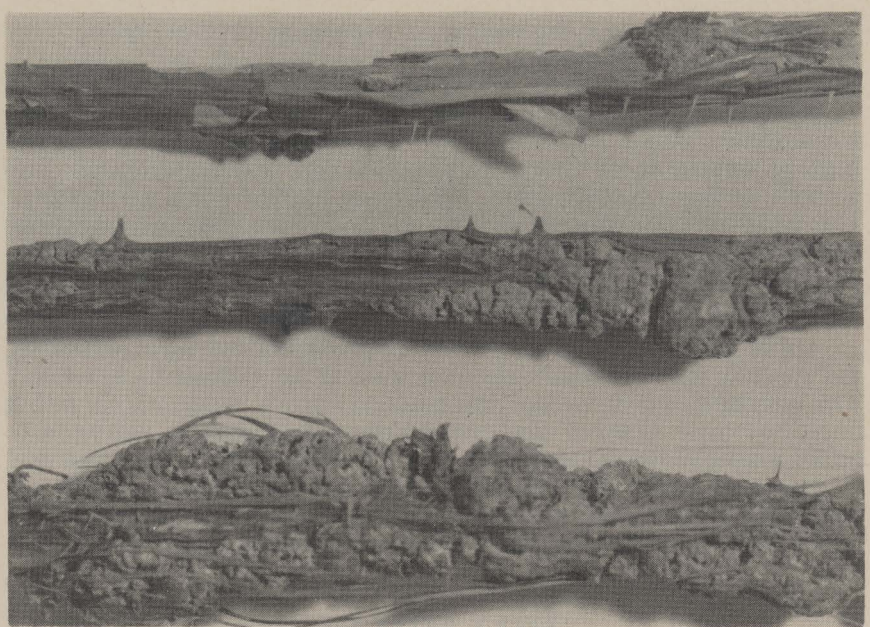

Figure 1. Cane gall of brambles.

Control: There is no known treatment that is satisfactory for the control of cane gall. As a simple safety precaution, infected plants should be removed and destroyed when found. Where diseased plants are removed, disinfestation of the hole with one of the new soil fumigants may help, but no recommendations are available (See Page 39). Where the disease is present, reasonable yields can still be had for a time with heavy nitrogen fertilization and the best cultural practices, but this is not a disease that can be tolerated for any length of time.

For nurserymen, sanitary propagation practices are necessary. The dipping of pruning or other cutting tools at frequent intervals in a solution of 1 ounce of potassium permanganate in 2 gallons of water is helpful. A protective practice that has been effective in rose propagation is soaking cuttings in 1-400 Semesan and water for 10 minutes. This has not been tested on brambles.

CROWN GALL

Importance: This disease causes serious loss in all types of fruit plantings. The bacteria survive for long periods in the soil and enter through wounds. Infected plants are more susceptible to winter injury and whole plantings are sometimes rendered worthless. Once a nursery has an infection of crown gall or **cane gall,** overcoming the disease is extremely difficult. This is due both to the fact that the bacteria attack several species in some 40 families of plants and to the fact that they are spread by almost any activity in the nursery.

Distribution: Crown gall can be found wherever brambles are grown.

Cause: The disease is caused by the bacterium **Agrobacterium tumefaciens.** Like the symptoms caused by **cane gall** infections, crown gall bacteria stimulate host tissues to overgrowth which results in small to very large and rough galls.

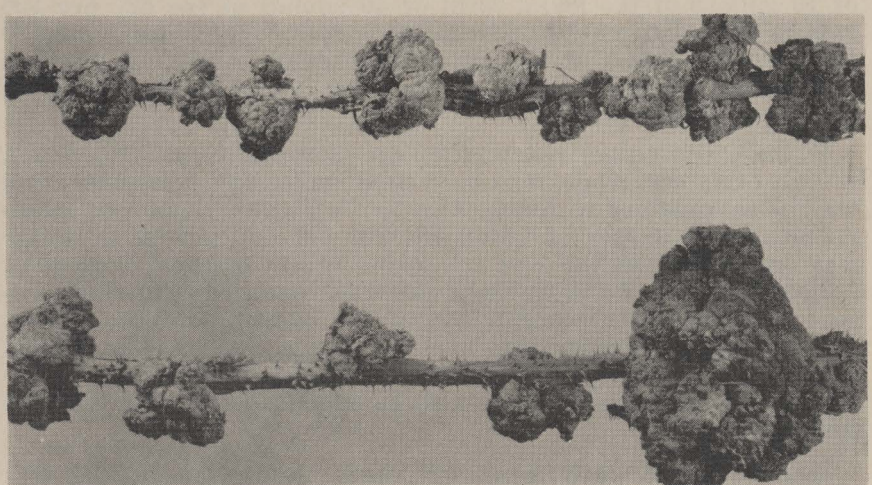

Figure 2. Crown gall in an advanced stage of development on Boysenberry canes.

Symptoms: In most cases large warty galls are formed below the soil line where they are not easily detected. However, they may be suspected when a generally declining condition of the plant becomes evident. When discovered in early stages the galls tend to be whitish in color, but they darken with age till they are a very

dense, crumbly brown mass. They may also occur on aerial portions of the canes.

Control: Control problems are much the same as for **cane gall.** Badly infected plants should be destroyed. When setting new plantings, clean plants should be used and if possible set on land that has been in grain for a number of years. (See discussion of fumigants and antibiotics on Page 39).

FUNGOUS DISEASES

ANTHRACNOSE

Importance: Bramble anthracnose is most serious with late spring rains and is usually most evident near the crown on the inside surfaces of canes growing in clumps.

Distribution: It is most prevalent on raspberries and most often occurs in the more humid sections of the state.

Cause: Anthracnose is caused by the fungus **Elsinoe veneta.**

Symptoms: Small, sunken spots about one-eighth inch in diameter appear on new growth, becoming larger with gray centers and raised purple margins as the canes grow older. In blackcaps, uneven ripening with white spots may result.

Control: Application of lime-sulfur should be made, at the rate of 10 gallons of the liquid form or 40 pounds of the dry per 100 gallons of water, as the buds begin to open. If necessary 6-6-100 Bordeaux mixture can be used when the new canes are about a foot high and again a week before bloom. Keep the Bordeaux off the tips of young canes.

If the grower does not wish to use lime-sulfur and Bordeaux, several other materials have been used successfully elsewhere and may be satisfactory in Idaho. One-half gallon of Elgetol or Krenite plus three ounces of triton BL 956 per 100 gallons of water may be applied as the bud tips show green (delayed dormant). Follow this with 2-100 Ferbam one week before blossoming. Repeat the Ferbam two weeks later if the disease has been severe. One pound of Ferbam plus one-half pound Phygon-XL instead of the 2-100 Ferbam also is reputed to be good. Two pounds Orthocide 406 per 100 gallons may also be substituted for the Ferbam sprays.

Removing and burning all old canes soon after harvest will help. The fungus affects different varieties with different degrees of severity.

The Cuthbert raspberry seems to be practically immune.

CANE BLIGHT

Importance: Cane blight can be serious when outbreaks occur. Raspberries are the most often affected of the brambles. The disease frequently enters through **yellow rust** lesions.

Distribution: The disease is not generally widespread but tends to develop in a spotty manner.

Cause: The blighting of canes usually referred to as cane blight is caused by the fungus **Lepthosphaeria coniothyrium,** but a "blighted" condition is frequently caused by several other diseases and injuries. When black raspberries and blackberries are affected by the cane blight fungus, entry usually is through wounds made by pruning or by freezing.

Symptoms: Purple to gray streaks up to several inches long appear on the canes. In advanced stages these streaks tend to flatten and crack longitudinally on raspberries. Symptoms can be found varying in severity from the large flattened and cracked lesions to smaller spots that are easily confused with **anthracnose** infection.

Control: Liquid lime-sulfur in dormancy (before buds swell) at the rate of 10-100 and removal of infected canes aids in the control of all parasitic blights of bramble canes, but good cultural practices and use of clean planting stock are most effective. Dry lime-sulfur at the rate of four pounds for each recommended gallon of liquid may be substituted.

FRUIT ROTS

Importance: Damage in the field is extensive during wet seasons. Severe losses also occur during transportation to markets, at shipping points, and in storage. Complete destruction of fruits can occur in a short time.

Distribution: Fruit rots are common everywhere, particularly in the more humid sections of the state.

Cause: Many soil inhabiting fungi cause rotting of bramble and other fruits, but species of **Botrytis, Rhizopus,** and **Penicillium** are responsible for most of the damage. These thrive on almost any kind of organic matter.

Symptoms: Rhizopus rots are watery and "whiskered." The fungus causes rapid disintegration of the fruit and spreads rapidly throughout the container. The mass is covered with a whiskery mold growth which is covered with small black specks. **Botrytis** rots are grayish but may develop brownish shades as they advance. **Penicillium** produces a bluish-white mold and fruit decay.

Control: Soft or overripe berries should not be boxed. Only disinfested (sterilized) or new boxes should be used. The fruits should be handled carefully from the plant to the market so that bruising is reduced to a minimum. Rotted fruits should not be left on the plants or in the fields since the fungi reproduce and spread rapidly from such fruits. Here, as in no

other case of diseases of fruits, sanitation is all important as a precautionary measure. Picked fruits should be promptly placed in a cool, well ventilated place until consumed. Cold storage is desirable, but **Botrytis** rots should be especially well culled from the pick before it is stored. Low temperature does not greatly hinder its development. Refrigeration at about 40 degrees usually keeps down loss of this kind except that caused by **Botrytis.**

Losses have been greatly reduced on strawberries in the East by spraying beds with approximately 3 pounds of Ferbam in 100 gallons of water just before blossoms open and again when the first berries are half size. Applications of 1½-100[3] Ziram before harvest reduces the storage rots of apples; and, since many of the same fungi attack small fruits, some benefit may be gained from the same treatment. Captan has shown good results in some parts of the West on strawberries. These have not been tested in Idaho.

If boxes must be reused, spraying them with Bordeaux mixture (or copper sulphate) will help. Any strong concentration (12-12-100) will be satisfactory. Hyamine compounds and lime-sulfur also are effective. Sulfur dioxide fumigation has been useful in preservation of grape shipments, but has not been tested sufficiently for other fruits.

GLOEOSPORIUM BLIGHT

Importance: In general Gloeosporium blight is not serious in Idaho; but, where it does occur, the resulting damage can be severe. Infected plants are very susceptible to drought and winter injury.

Distribution: Serious infestations have been found in the northern and southern parts of the state, and the disease very likely exists elsewhere. Infections occur on many types and varieties of blackberry, but evidence of the disease on raspberries has not yet been recorded in Idaho.

Cause: Glomerella (Gloeosporium) cingulata is the fungus responsible for the so-called **Gloeosporium** blight of brambles.

Symptoms: Overwintered canes are cankered and weakened. On some varieties the spots that develop are small and result in a speckled appearance. On other varieties the spots may be large and elongate, with some tendency to develop mostly around the buds. This symptom is sometimes confused with **spur blight.** Most spots have a grayish center and reddish margin by late summer. Small dark specks develop in the spots. These are the fruiting bodies of the fungus.

Control: Old canes should be removed and destroyed after harvest. Reasonable control results from delayed dormant applica-

[3] 1½ pounds of Ziram in 100 gallons of water.

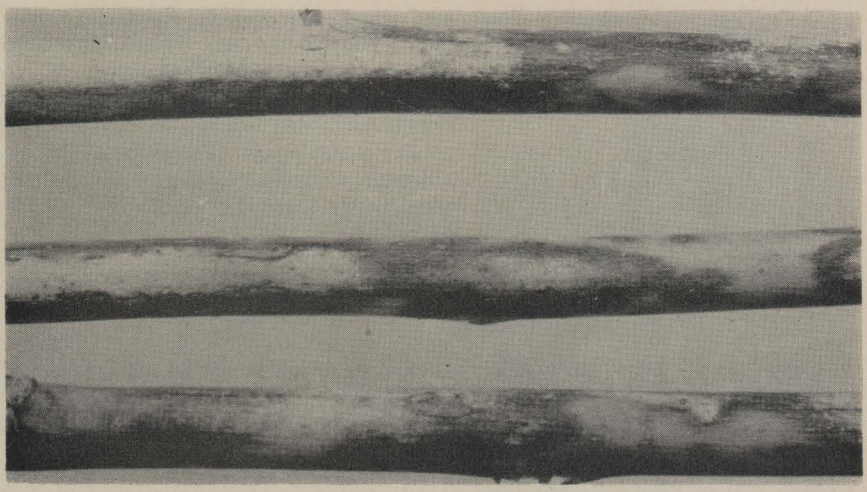

Fig. 3. Gloeosporium blight on Acme Thornless Youngberry (See also Fig. 5).

tion of 12-12-100 Bordeaux mixture, 8-8-100 just before blossom time, and 12-12-100 again in the fall about the time leaves are dropping. Liquid lime-sulfur at 10-100 or dry lime-sulfur at 40-100 may be used in place of 12-12-100 Bordeaux sprays.

LEAF SPOT

Importance: Wet fall and spring seasons frequently result in severe losses in brambles by one or more of the types of injury which occur during the development of the leaf spot disease. Most brambles are susceptible, with blackberry types such as Youngberry, Loganberry, Boysenberry and Dewberry being most affected.

Distribution: Since 1938, leaf spot has been known to be common throughout most of Idaho.

Cause: The disease is caused by the fungus **Mycosphaerella (Septoria) rubi** in most cases, though other species of the fungus may play a minor role.

Symptoms: Spots of approximately one-eigth inch in diameter are formed on the leaves (Figure 4). In early stages these are purplish in color, but they become reddish-brown as they develop and a whitish center appears. Two or three small black specks, which are the fungus fruiting bodies, form in the white centers. The leaf symptom usually is present but not always.

Spots on the canes (Figure 5) are much like those on the leaves. The symptoms may be confined to the canes in some cases and frequently look like some forms of **Gloeosporium blight** (Figure 3). The black specks in the white areas on the canes are slightly larger

Figure 4. Leaf spot symptoms on a Youngberry leaf.

and more circular in **Septoria** infections than they are where the spots are caused by **Gloeosporium.** The black fruiting bodies of **Septoria** exude whitish spore tendrils under moist conditions. There also is considerably more damage from the cankering and dieback of **Septoria** infection.

Control: Infected canes and leaf debris should be removed and destroyed. In severe cases a delayed dormant application of 10-100 liquid lime-sulfur may be necessary. This should be done after pruning and training. The Bordeaux mixture schedule suggested for the control of **Gloeosporium blight** also should yield satisfactory results.

ORANGE RUST

Importance: Orange rust is not a serious disease in Idaho, but it can

Figure 5. The cane spotting and cankering symptoms of Septoria leaf spot infection of Youngberry. Gloeosporium blight symptoms are very similar in some cases to the spots shown here.

easily become serious when diseased plants are allowed to remain in the field. For this reason growers should be able to recognize orange rust infections.

This is one of the few systemic fungous diseases. The plants do not have simple spot infections but become completely infected by movement of the fungus throughout the interior of the plant. Such plants are a total loss in 1 to 2 years.

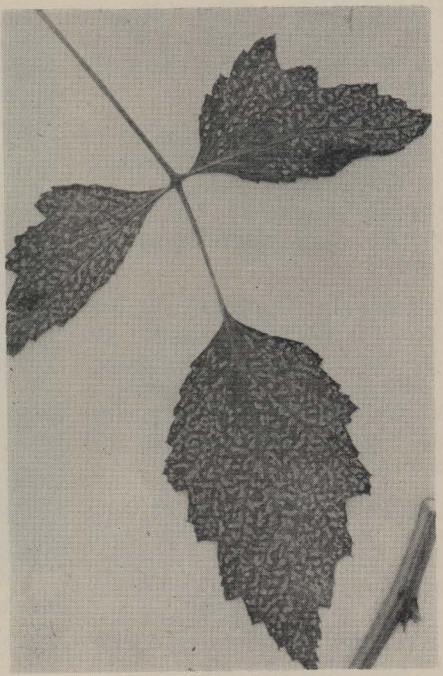

Figure 6. Orange rust of raspberry.

Distribution: There is little evidence that orange rust spreads rapidly in Idaho, but it is found on incoming plants and consequently may be found in any part of the state.

Cause: The fungus causing orange rust is **Gymnoconia interstitialis.** It is entirely different from the **yellow rust** which is local in nature and produces yellow spore masses on the leaves instead of orange spots.

Symptoms: Orange rust usually appears first in young suckers or cane terminals and results in a witch's-brooming effect, severe stunting and small leaves. The witch's-broom comes from the fact that newly infected canes are spindly and clustered.

The smaller leaves are narrow and pale with small pimple-like spots on the upper surfaces, and blisters and heavy orange spore coatings on the lower surfaces. This is much different from **yellow rust,** in which the yellow spore postules are on the upper leaf surfaces and more likely to remain as individual spots. The stunting is not an early effect of the disease, but develops after the infection has been there for some time.

Control: Infected plants should be grubbed out and burned when discovered. In addition to this, the only satisfactory control presently obtainable is through use of clean stock in replanting. Once the disease is brought into an area it escapes rather easily to wild and other brambles. Because of this, fields should be kept under observation subsequent to the discovery of an infected plant.

POWDERY MILDEW

Importance: Powdery mildew has not been of great seriousness in the past, but it is increasing in occurrence and may become quite troublesome. All varieties of brambles are susceptible but in varying degrees.

Distribution: The disease has been observed at many scattered locations throughout the state.

Cause: Powdery mildew of brambles is due to infection by the fungus **Sphaerotheca humuli** primarily but other species are sometimes involved.

Sypmtoms: Plants are stunted and deformed to some extent, and canes are seriously weakened. Leaves develop a whitish-gray moldy covering and the margins tend to roll upward.

Figure 7. Powdery mildew on red raspberry. Note thin white fungus growth, especially in outer half of tip leaflet.

Control: Controlling **anthracnose** with lime-sulfur will take care of the powdery mildew. Dusting-sulfur is effective if used lightly at the time signs of infection occur. Do not load the plants with it; sulfur sometimes causes considerable injury to raspberries when heavily applied.

Powdery mildews seem to thrive better under dry conditions. In this case overwintering takes place on old canes. Removal and destruction of these weakened and stunted canes will not only help to reduce the amount of inoculum in the field but will help to keep down infection by opening up the rows so that air circulates better among the plants.

SPUR BLIGHT

Importance: Spur blight is not generally severe over the state, but it has caused considerable damage in individual locations. Such damage occurs most often where more humid conditions prevail. Ordinarily spur blight is not troublesome in dry climates unless there is considerable intermittent summer rainfall. Irrigation seems to contribute to spread and to cane blighting.

Distribution: Serious loss in raspberries has resulted in the west central part of the state. In this case Improved Alten suffered heavily.

Cause: Spur blight is caused by **Didymella applanata,** a fungus which over-winters in small black bodies on infected canes. The following year these black specks produce spores, which establish additional infections.

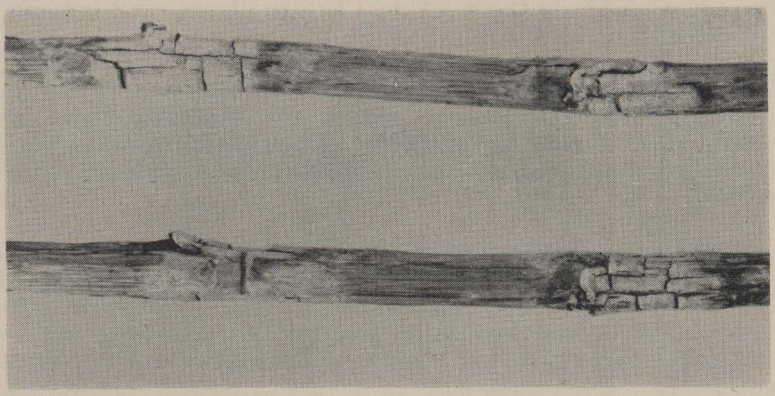

Figure 8. Spur blight of raspberry.

Symptoms: Reddish-brown discolored areas appear at bud and spur sites on the canes, particularly on young canes in late summer. By the following spring the bark at the sites of infection is grayish in color with small black specks scattered throughout. Affected buds and spurs die outright or grow very little. In severe cases, canes may be "blighted" from the soil line upward for a considerable distance as a result of coalescing of numerous lesions.

Control: Young canes may be treated with 6-8-100 Bordeaux when they are about 10 inches high and again when about 18 inches high. In severe cases liquid lime-sulfur at 10-100 or dry at 40 pounds per 100 gallons can be used during dormancy. Old canes should be removed and burned in the fall before the onset of the rainy period. Avoid dense leaf or weed growth and avoid crowding of the plants. Very susceptible varieties are Latham, Newburgh, Taylor, and Indian Summer.

VERTICILLIUM WILT

Importance: Wilt is more serious on raspberries than blackberries. Small roots appear to be infected first. The fungus remains in the soil on small root particles. It is able to live on a number of different hosts such as strawberry, maple trees, eggplant, tomato, pigweed, groundsel, fruit trees, and others.

Distribution: The disease has been encountered in several locations over the state.

Cause: The fungus responsible for **Verticillium** wilt is **Verticillium alboatrum.**

Symptoms: Infections result in dwarfing a nd wilting of new growth, with bluish stripes showing in the canes near the soil. It is sometimes confused with the bramble **streak** virus which also causes bluish streaks in the canes and occasional dieback of the terminals. However, **Verticillium** wilt is primarily a soil-borne disease which moves up through the crown of the plant. Thus it is more obvious

in the crown and near the soil line. Entire plants may become severely wilted.

Control: Three to four year rotations with non-susceptible crops are necessary to satisfactorily reduce soil contamination. Then only clean stock should be replanted. Where little infection exists, strict roguing and destruction of infected plant material will delay spread.

Some of the newer fumigants such as CBP-55 may be helpful in cleaning up the soil but no definite recommendations are yet available (See page 39). Experiments with Elgetol or carbon disulfide might be worthwhile in severe cases, but they could not be used safely around living plants. All varieties are not equally susceptible to **Verticillium** wilt. Cuthbert raspberry is resistant, as are Evergreen, Himalaya, and wild Northwest trailing blackberries.

YELLOW RUST

Importance: Yellow rust is serious only when prolonged spring rains occur. The lower leaves of infected plants drop off, which results in a reduced crop and low vigor the following year.

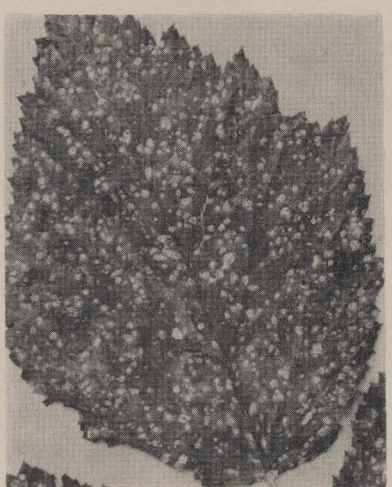

Figure 9. Yellow rust of raspberry.

Distribution: It is not a common disease in Idaho, but it has been observed in many scattered locations.

Cause: The fungus which causes this disease is **Phragmidium rubi-idaei.**

Symptoms: Small yellow spots appear first on the leaves, especially the upper surfaces. Canes frequently are infected during succulent growth. A blackish covering on the lower leaf surfaces in autumn. The leaves drop off during the fall and become the source of infection for other plants the next year. In severe cases, wilting, cane breaking, and dry berries may result.

Control: Making new plantings with clean stock is most desirable, but after infection has occurred the best control lies in destruction of diseased material. Late fall or early spring plowing toward the row helps because the leaf debris on the ground and in the crowns is thereby covered. This must be done before new leaves appear. Fruiting canes should be removed and destroyed soon after harvest. No stubs should be left when pruning because infected leaves lodge there and spread the disease easily the following season.

In some cases a 4-100 liquid lime-sulfur spray as the buds expand to about one inch of growth has been helpful. If this is used it should be directed toward the ground and lower parts of the canes.

VIRUS DISEASES

LEAF CURL

Importance. Although leaf curl has not become of generally serious consequence in Idaho, production is very much reduced where infection occurs. A planting near Moscow was worthless the next year after the grower observed a few "old looking" plants.

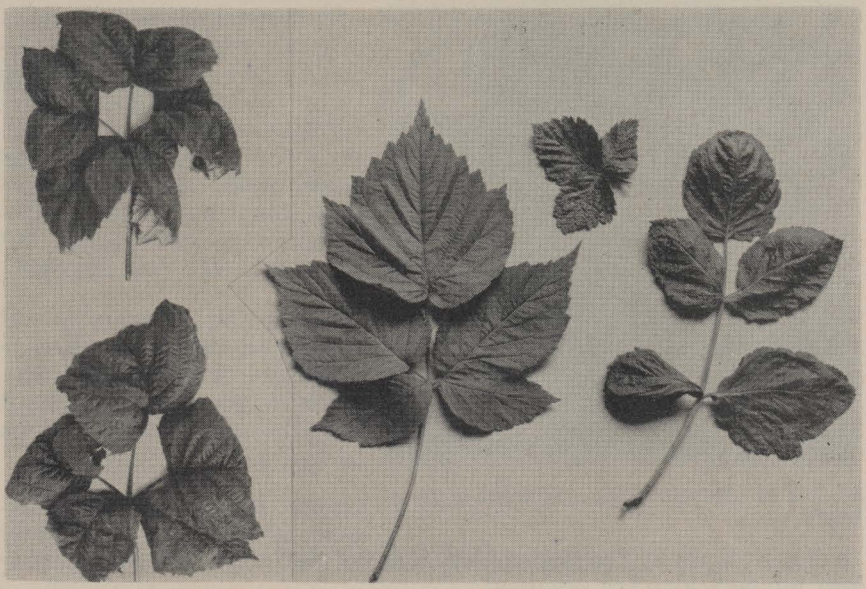

Figure 10. Leaf curl in raspberry. The leaves to the left are infected with the leaf curl virus; those to the right are injured by frost; the center leaf is unaffected.

Distribution: The disease has been observed throughout the state.

Cause: Leaf curl is caused by a virus and is spread by the feeding of aphids. It is frequently associated with other viruses. Whether other insects such as leaf hoppers are involved is uncertain.

Symptoms: Infection with leaf curl results not in a mottling, unless **mosaic** virus also is present, but in a normal to darker than normal green and a wrinkling and downward curling of the leaves. Affected plants are smaller, weaker and less productive.

Control: Remove and destroy infected plants as soon as they are

found. Use only clean stock in replanting or setting a new field. Research is resulting in the finding of some apparently virus-free varieties.

Keep black and purple raspberries as far removed from other brambles as possible, because black and purple varieties are more seriously affected.

MOSIAC

Importance: The various types of mosaic, with the frequently associated **leaf curl,** constitute the worst problem in bramble growing in Idaho. Very few fields are free of serious infection and many are 100 per cent affected. Losses are substantial. Many people do not realize what is happening until the whole planting is infested. This is particularly so of home gardens and small plots. All varieties of both raspberries and blackberries are susceptible but in widely varying degrees.

Figure 11. Mosaic virus symptoms in raspberry.

Distribution: Mosaic is encountered almost as often as brambles themselves. Infestation is general throughout the state but is most serious in the southern part.

Cause: Mosaic is a virus disease and is spread rapidly to other plants by feeding aphids. It is not definitely known whether leaf hoppers also are involved.

Symptoms. Leaves show a pale mottling at first and canes are somewhat shorter each year.

The injury caused by heavy aphid feeding sometimes resembles virus symptoms.

Fruit is usually crumbly and insipid. Leaflets become smaller and narrow and arch downward at the margins in many cases. Mottling becomes less well defined as the summer advances and a general bronzing follows.

Plants are late in beginning spring growth. On the very susceptible blackcaps the young growth frequently dies completely and the berries dry up. Brambles in general lose vigor, become unproductive, and die when infected with mosaic. Many strains of

the virus probably exist and strain differences as well as varietal differences are to be expected.

Control: Rigid inspection should be made in the spring and all infections grubbed out and burned. After this has been done, no suckers must be allowed to rise from roots remaining in the soil or all the work of grubbing will be undone.

Some resistance is exhibited by the reds Newburgh, Marcy, Lloyd George, and Washington, and by the blacks Logan and New Logan. However, the only good control now known is the planting of clean stock as far removed from other brambles as possible. Recent research has resulted in the finding of several apparently

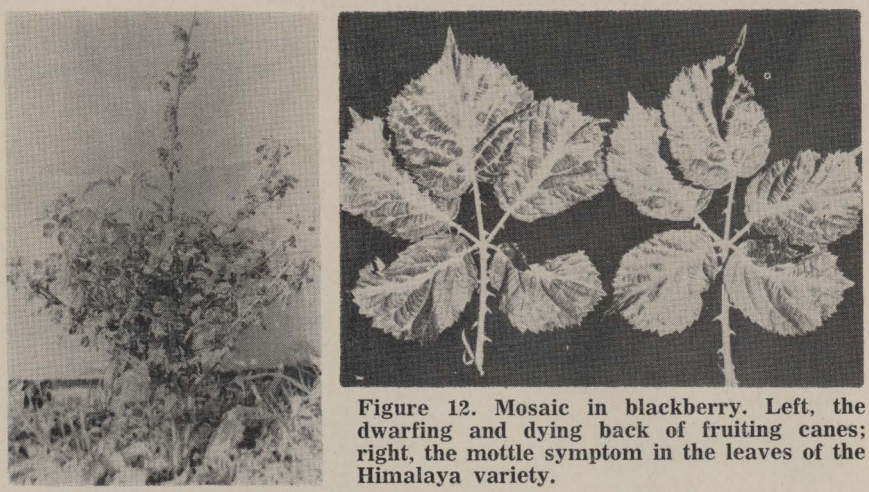

Figure 12. Mosaic in blackberry. Left, the dwarfing and dying back of fruiting canes; right, the mottle symptom in the leaves of the Himalaya variety.

virus free source plants. Black varieties of raspberries particularly should be isolated from other varieties because of their great susceptiblity to mosaic.

The mosaics are spread by feeding aphids, but control of the aphid population has not proved practical as a means of controlling mosaic. The survival of very few aphids and the emergence of one infected sucker after the roguing has been done can result in infection of the remaining healthy plants. In short, forget about aphid control, and rogue effectively or don't waste the time and effort. Resistant varieties are helpful, but this resistance is often no more than latency. The disease can be present without showing until insects carry it to more susceptible plants nearby.

MISCELLANEOUS DISORDERS

CRUMBLY FRUIT

Importance: Crumbly fruit symptoms are easily found in Idaho although the condition has not reached serious proportions.

Distribution: Throughout the state.

Cause: No definite cause is known but the symptom occurs either in the presence of virus infection or in plants showing no evidence of virus. It is possible that unknown viruses are involved, but index methods that reveal the presence of such viruses have not been worked out. Evidence indicates in some cases that crumbly fruit accompanies certain types of seedlings and may be partly due therefore to genetic weaknesses. Freeze injury and nutrition probably also are factors. In some cases early thrip injury might be a factor.

Symptoms: Excepting the virus infections, there is nothing apparently wrong with the plants in most cases of crumbly fruit other than that the fruit crumbles and falls apart.

Control: Little can be recommended for the control of crumbly fruit except the development of disease-free and genetically stable stock through certification.

NUBBINS

Importance: Nubbins, or **dry berry,** has not caused serious losses in Idaho, but in a few instances it has become of problematic proportions.

Figure 13. Nubbins symptoms on blackberry.

Distribution: Like **crumbly fruit,** nubbins may occur anywhere in the state.

Cause: Nubbins appears to be similar in nature to the **crumbly fruit** condition, but it is also possible that such other factors as poor fertilization of the flowers, frost injury, and fungi interact. Sometimes red spider or other mite injury may be responsible.

Symptoms: Nubbins fruits are malformed and only partially developed.

Control: Nubbins will not likely be eliminated in the absence of good, reliable planting stock.

ROUGH BARK

Importance: The overall damage from this so-called rough bark condition of brambles does not appear to be great.

Distribution: Symptoms may be observed in most sections of the state, particularly those having the most rigorous winters.

Cause: The real causes of rough bark are not known. The symptom has been observed most frequently after severe winters but a direct relationship has not been established. A deficiency of boron may be involved; soil organisms may also play a part.

Symptoms: Discolored areas become evident on lower canes in late summer. These areas worsen until the bark becomes cankerous, splits, and eventually develops a shredded appearance.

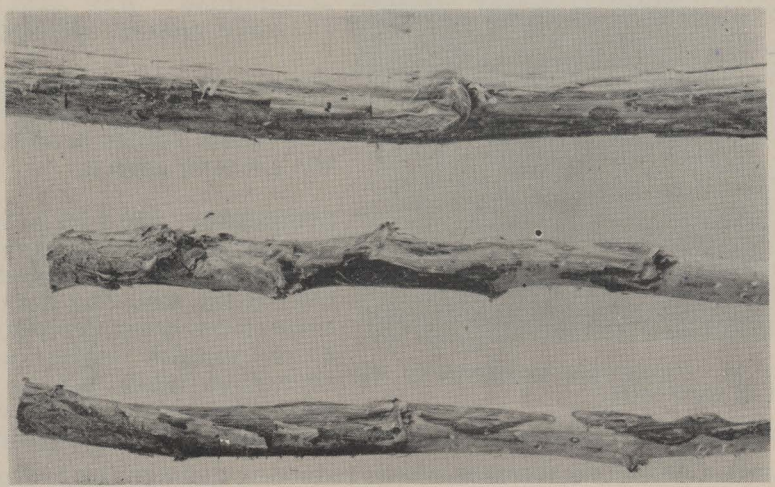

Figure 14. Red raspberry canes showing the cankering and bark splitting which precedes the shredded condition of rough bark. Shredding is beginning.

Control: No definite measures have been tested, but the Newburgh variety of raspberry seems to have been most affected. Planting to leeward of wind breaks may offer some protection if the trouble actually is due to winter conditions.

SNOW INJURY

Importance: Snow injury to brambles is sometimes severe in certain parts of the state, depending on elevation and season.

Distribution: Northern parts of the state and other high elevations.

Cause: The damage done by excessive snow load on the plants is mechanical breakage for the most part.

Symptoms: Side shoots and buds may be torn off, canes may be broken at or above the soil line, and in severe cases there may be extensive lodging or breaking over of the entire plants.

Control: Snow injury may be considerably reduced by withholding pruning of old canes till spring and by growing the plants in wide hedge rows instead of singly.

Figure 15. Variegation symptoms in the leaves of blackberry.

SUN SCALD

Importance: Depending on weather conditions, sun scald may cause extensive damage to bramble plantings in Idaho.

Distribution: Any area in the state may be affected.

Cause: The heat of the sun may result in damage either during the winter or during the growing season.

Symptoms: During hot weather exposed berries often become scalded on the side toward the sun. The normal color of the berry is replaced by a grayish white, and shriveling takes place. In unprotected places the leaves of some varieties tend to be susceptible to browning and blighting.

Control: Controlling diseases which reduce or damage the foliage, and proper pruning and training, will do much to prevent extensive damage. Maintaining vigorous growth also is important.

TIP BLIGHT

Importance: Tip blight is the name given a condition of sudden wilting and death of the tips of the young canes. Although the disorder is not common it has been known to be serious.

Distribution: Tip blight has been found throughout Idaho.

Cause: Such symptoms are most frequently caused by wind injury in which the canes are split off at the crown. Tip wilting due to **Verticillium wilt** can be distinguished from tip blight by the fact that in wilt infection blue streaks appear in the canes near the base. The **Botrytis fruit rot** fungus also causes tip blighting occasionally after frosts, especially if cool, moist conditions prevail.

Symptoms: Young cane tips in vigorous growth suddenly wilt and die back.

Control: Proper pruning and training are important, but in some cases staking may be necessary. Black raspberries are more susceptible than other varieties.

VARIEGATION

Importance: Leaf variegation is not a serious disorder in Idaho, and the symptoms are characteristic enough that it should not be confused with virus infection or nutritional deficiency.

Distribution: The condition has been observed at widely scattered points in the state.

Cause: Variegation is a non-contagious disorder that in some stages might be confused with certain types of virus infection but this is unusual. It is a genetic abnormality which occurs in certain types of planting stock.

Symptoms: In the leaves, yellowish areas develop which are ordinarily rather sharply defined and tend to be limited by veins. The symptom rarely is a general leaf yellowing such as occurs in cases of chlorosis due to iron deficiency. Virus chloroses are in general less well defined and less confined by veins.

Control: Affected plants need not be destroyed unless they lose their productiveness. Progeny from such plants should not be maintained and certainly not used for replants.

WINTER INJURY

Importance: It is impossible to estimate the importance of winter injury to brambles because freezing temperatures are rarely entirely to blame. More often plants are weak because of some other factor and are less able to withstand the rigors of winter. This does not mean that serious damage from winter injury itself does not occur in Idaho. Late frosts alone cause extensive damage occasionally.

Distribution: Losses from winter injury occur generally over the state.

Cause: The direct cause of winter injury is low temperature, but the time of year during which this occurs is an important factor. Plants are much better able to withstand low temperatures during the winter than in fall or spring. Early fall freezes that occur before canes are fully dormant and late spring frosts after growth has started do much damage. Cold winds can cause extensive dieback when coming from one direction for a prolonged period of time.

Symptoms: Late spring freeze damage frequently is manifested

as water soaked spots in the young tissue which may persist for some time or collapse immediately. Other common symptoms of winter injury are splitting and roughening of the bark, fruit deformities similar to **nubbins,** dieback, generally low vitality and weakened canes.

If the symptoms are questionable and winter injury actually is the trouble, splitting the canes lengthwise through the pith should reveal a brownish color and crosswise cracks in the pith.

Plants frequently die outright if they have been weakened previously by other factors such as disease.

Control: The possibility of winter injury is materially reduced by cultural practices that permit early fall maturity of the current season's growth. Immature tissues entering the winter period are quite susceptible. Proper control of diseases helps prevent weakening of the tissues. Avoid planting in low, cold areas where air drainage is poor. Follow cultural practices that produce vigorous plants and mature them early. In irrigated sections where there have not been adequate fall rains, irrigate in late November so that the plants will not enter the winter in a dry condition. Grow hardy varieties such as Taylor, Chief, Latham, and Washington.

BUSH FRUITS

FUNGOUS DISEASES

ANTHRACNOSE

Importance: Anthracnose is common on wild currants and gooseberries **(Ribes)** but is not often serious on cultivated varieties. In some cases, however, losses have been severe in a secondary way. Under favorable conditions, anthracnose may cause defoliation which results in **sun scald.** Sometimes considerable reduction in vigor results and the plants become more suceptible to damage by other factors such as **winter injury.**

Distribution: The disease has been severe on currants in the northern part of the state. It has been found farther south on wild gooseberries.

Cause: The fungus **Pseudopeziza (Gloeosporium) ribis** causes anthracnose of bush fruits **(Ribes).** It thrives best under moist conditions. Overwintering is on old leaf debris.

Symptoms: Small brown specks develop on the leaves. These may be few or very numerous, depending on the severity of the infection. Under proper conditions considerably larger spots with clearly defined margins may develop instead of the tiny specks. Under

moist conditions, white, glistening masses of spores usually develop on the spots.

Seriously infected leaves ordinarily turn yellow, die, and drop off in mid season. Such defoliation weakens the plants, hinders productivity, and predisposes the fruits to sunburn.

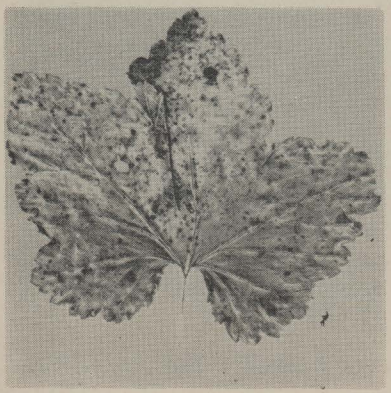

Figure 16. A red currant leaf showing the small brown spots of anthracnose which are most common.

Control: Spraying for the control of **powdery mildew** will keep down the anthracnose in most cases. Plowing under or otherwise destroying leaf debris is helpful. If other measures are needed, good control can be obtained with 8-8-100 Bordeaux mixture. This should be applied just after bloom and again 2 weeks later. Repeat just after harvest if necessary. The treatment has in most cases given better control than the new organic fungicides.

BLISTER RUST

Importance: Blister rust is seldom serious on cultivated red currants and some other varieties, but where the disease occurs in the state **Ribes** plants should be destroyed because of the danger to white pine timber. Black currants are particularly susceptible.

Distribution: The disease is most common in northern Idaho and on wild **Ribes** plants.

Cause: Blister rust of both white pine and bush fruits is caused by the fungus **Cronartium ribicola.** Infection cannot spread without both pines and bush fruits in the same vicinity. This is because part of the life cycle of the fungus is spent on the pine and part on the gooseberry or currant plant. These parts are not interchangeable, and when either the bush fruits or the pines are removed the blister rust ceases to spread and is no longer a problem.

Symptoms: In the spring small, yellowish spots appear on the lower surfaces of the leaves of currants and gooseberries. These spots may appear only faintly in the case of wild **Ribes;** they are slowly replaced by brownish spots as the season progresses. Affected plants are increasingly weakened.

Control: Infected currants and gooseberries should be removed and burned because of the danger to pine stands.

POWDERY MILDEW

Importance: This is the most serious disease of cultivated goose-

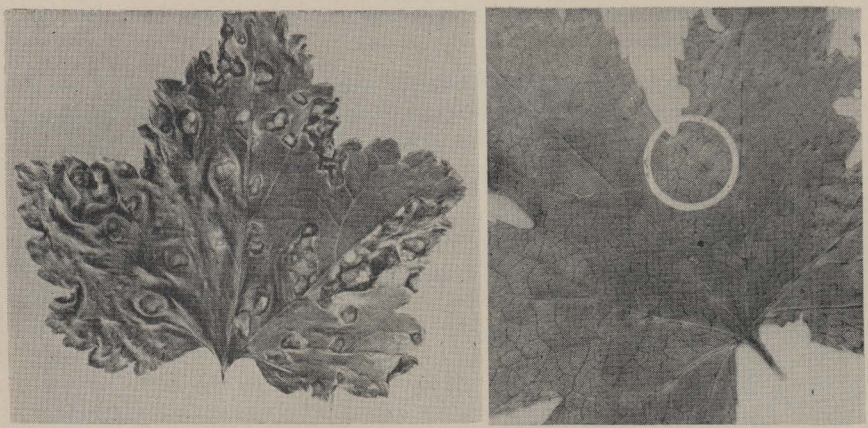

Figure 17.—White pine blister rust on wild currant (right) and on red currant (left). Symptoms on the wild currant are the very faint fuzzy spots of irregular shape scattered thickly over the leaf. (See circle).

berries in Idaho and frequently causes considerable damage to the foliage of currants.

Distribution: Mildew occurs generally over the state.

Cause: Powdery mildew of bush fruits is caused by the fungus **Sphaerotheca mors-uvae.** It overwinters as mycelium (mold) and in small, black fruiting bodies on infected leaves and twigs.

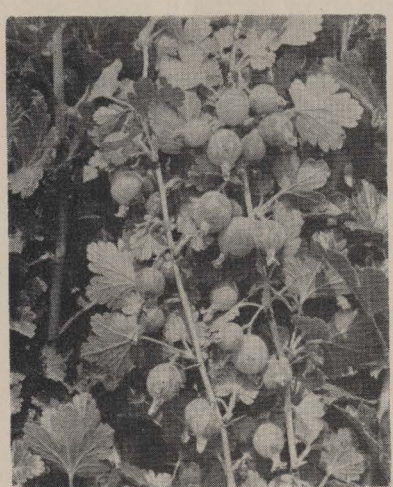

Figure 18. Powdery mildew on gooseberry fruits. Close examination reveals the fine mold and small dark spots due to mildew. See also Figure 19.

Symptoms: Powdery mildews are superficial parasites and do not cause rotting. A whitish, powdery growth first appears on the fruits and leaves. When twigs become infected, the plants begin to show a dwarfing effect and the fruits are small and misshapen. As the fruits mature, the white mildew takes on a brown color with small black specks embedded in it.

Control: Good coverage of bushes and crowns with 2-100 liquid lime-sulfur containing a spreader applied just as the flowers start to open, and again after 90 percent are open, gives good control. Bordeaux at 8-8-100 may be substituted for the second spray, especially if anthracnose is present. If the infection is severe spray again 2 weeks later using either the lime-sulfur or Bor-

deaux. Some injury may result from the lime-sulfur, particularly if hot weather follows spray applications, but the damage has not been serious. Dry lime-sulfur also has been effective at about 12 pounds per 100 gallons of water. Simply dusting occasionally with fine dusting sulfur should give some control.

MISCELLANEOUS DISORDERS

SUN SCALD

Importance: Extensive damage frequently occurs on currants and gooseberries from direct and prolonged exposure to the sun.

Figure 19. Powdery mildew on leaves and twigs of red currant.

Distribution: Sun scald is troublesome throughout the state but is especially destructive in the southern part.

Cause: High temperature and direct exposure to the sun result in sun scalded fruits.

Symptoms: Berries turn white, shrivel, sour, and may actually be cooked.

Control: Prune properly so that shading is provided; maintain good growing conditions, and control diseases which weaken or defoliate the plants.

GRAPES

BACTERIAL DISEASES

CROWN GALL

See crown gall of BRAMBLES

FUNGOUS DISEASES

FRUIT ROTS

See fruit rots of BRAMBLES

POWDERY MILDEW

Importance: Severe outbreaks of this disease have been encountered in Idaho. Affected fruits are worthless and production is greatly reduced.

Distribution: Powdery mildew is not a state-wide problem, but it has been observed in severe proportions in southern Idaho.

Cause: The fungus **Uncinula necator** causes powdery mildew of grapes. Like all powdery mildews, however, the fungus is superficial on the foliage, fruits, and young shoots. Overwintering is in small black specks on old shoots and leaves. Heavy sporulation occurs in late summer and the disease spreads rapidly.

Symptoms: First symptoms may be observed as light, powdery, fuzzy growth on the upper sides of leaves. This growth darkens to various shades of brown and small black specks develop throughout the fungus matt till the leaves fall. Symptoms are in general much like those of other powdery mildews.

Control: Dusting with sulfur is satisfactory if started when mildew first appears. This should be repeated frequently enough to keep new growth covered until the disease ceases to be a problem.

SLIME MOLD

Importance: Slime mold is not serious enough on fruits in Idaho to justify special control measures, but it is of considerable interest from the curiosity standpoint.

Distribution: Scattered in occurrence, particularly in low, damp places in the vineyard.

Cause: Slime molds are primitive fungus type organisms which appear in jelly-like masses until they start to sporulate.

Symptoms: Signs of infection may be the jelly-like masses, or at later stages, large grayish to black and fluffy powdery masses on the canes.

Figure 20. Slime mold on grape.

Control: Remove and destroy affected parts as discovered.

MISCELLANEOUS DISORDERS

2,4-D INJURY

Importance: Injury resulting from the use of weed killers has been of increasing seriousness throughout Idaho in recent years.

Distribution: State wide, but most damage has been sustained in locations adjacent to grain fields where 2,4-D has been used for weed control.

Cause: Injury of one kind or another usually occurs when 2,4-D comes in contact with broad leafed plants.

Symptoms: Leaves become more narrow and ribbed, various stages of which are illustrated in figure 21.

Control: Do not use 2,4-D sprays near grape vines. If it is necessary to do so, use low velocity sprays with nozzles near the ground and directed at the ground. Do this only on very still days. **Do not** under any conditions use the ester form because 2,4-D continues to rise from the ground over protracted periods of time.

STRAWBERRIES

FUNGOUS DISEASES

FRUIT ROTS

Fruit rotting results in tremendous losses to the strawberry industry every year. It may begin on green berries and increase in seriousness right up to the consumer.

Many fungi are responsible for such rotting but the most damaging in Idaho seem to be species of **Rhizopus, Penicillium, Botrytis** and **Rhizoctonia.** Each produces characteristic symptoms and signs. The most troublesome of these are discussed under BRAMBLES, but in strawberries extensive damage sometimes is caused by a fungus not mentioned under BRAMBLES, namely **Rhizoctonia. Rhizoctonia,** or **hard brown rot,** reduces the fruits to hard and shrunken mummies. Parts of all of the fruit may be affected. **Rhizoctonia** also causes a bud injury that can be confused with the nematode disease **spring dwarf,** or with insect damage.

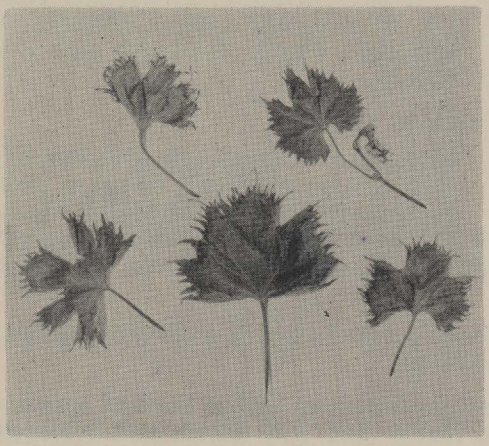

Figure 21. 2,4-D injury to grape—least affected leaf in the center.

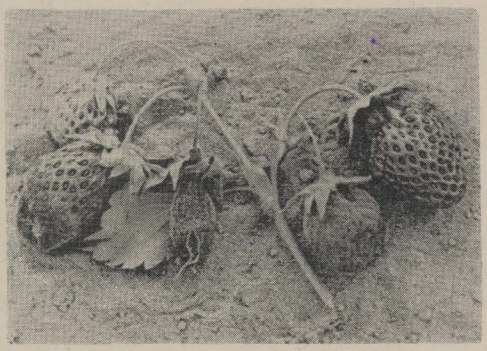

Figure 22. Botrytis rot of strawberries.

In addition to measures discussed under BRAMBLES two other precautions are beneficial with strawberries. Mulch the berries with hay or straw to keep them off the ground, and irrigate only lightly.

LEAF SCORCH

Importance: Leaf scorch is common throughout Idaho, but it has not developed in serious proportions except in a few cases.

Distribution: The disease occurs most often in more humid areas in the northern part of the state.

Cause: The fungus **Diplocarpon earliana** causes the leaf scorch disease.

Symptoms: Brownish spots with purple-red margins develop on the leaves. These spots tend to be irregular in shape, particularly where they have begun to run together. The spots caused by the leaf scorch fungus do not have the light-colored centers characteristic of spots caused by the **leaf spot** disease.

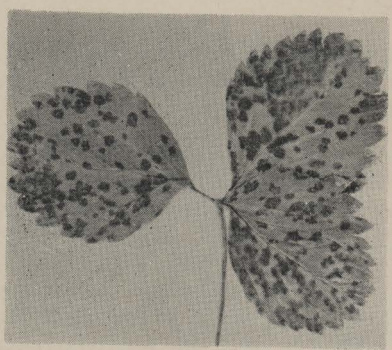

Figure 23. Leaf scorch of strawberry.

Control: Leaf scorch rarely is serious enough to warrant control measures; but, if sprays are necessary, use the same program recommended for the control of **leaf spot.** Varieties least affected by scorch are Blakemore, Catskill, Chesapeake, Dorsett, Fairfax, Fairmore, Fairpeake, Heflin, Howard 17, Lupton, Mastadon, Midland, Pearl, Rockhill and Suwanee.

LEAF SPOT

Importance: Although widespread, this disease ordinarily is not a seriously damaging one in Idaho. During some seasons, however, it has been known to limit production sharply and to reduce the vigor with which the plants begin the next year's growth.

Distribution: Leaf spot is general in Idaho but is especially prevalent in more humid northern regions.

Cause: The fungus **Mycosphaerella fragariae** causes the leaf spot disease. It overwinters on old leaves and leaf debris and releases spores which infect new foliage as it appears.

Symptoms: This is most often a leaf spotting disease, but the fungus may attack other parts of the plant also. The spots have purplish-red margins and may be small to fairly large. They always have whitish-gray centers. In severe cases the spots may fuse together so that the whole leaf is discolored, or spots on the stems may result in withering of leaves or fruits. Small black specks often are discernable in the gray areas in the centers of the spots. Fruit infections sometimes result in a condition known as **black seed,** in which individual seeds turn black.

Control: In most cases of intermittent damage the disease can be kept down by mowing and burning the leaves after harvest. To avoid plant injury do not fire the field if the leaves are damp or if the ground is very dry.

In severe cases a spray program may become necessary. Bordeaux

mixture is helpful at 8-8-100 if applied in the spring when leaves appear, again before blossoming, and again in early fall. Bordeaux can be used any time on strawberries without harmful effects. On the contrary, it even seems to be beneficial in a stimulatory way. Fixed coppers are helpful when used as directed by the manufacturer, but Bordeaux seems to be superior.

Figure 24. Leaf spot of strawberry.

Overhead irrigation should be avoided. Obtain clean plants; but, if new planting stock shows evidence of leaf spot, remove and destroy all leaves when the plants are set out. This will help prevent establishment of the fungus. After removing leaves of the new plants, even greater assurance that the disease will be kept out can be had by dipping the crowns in Bordeaux mixture before planting. Use a mild concentration, about 3-4-100.

Other helpful practices include keeping down weeds, avoiding wide matted rows, and making frequent new plantings. Less affected varieties are Dorsett, Fairfax, Fairmore, Premier (Howard 17), Aroma, Daybreak, Klonmore, Massey, Midland, Pearl, Progressive and Rockhill. Marshall, Glen Mary, and Klondike are very susceptible.

POWDERY MILDEW

Importance: Mildew has not been a wide spread problem in Idaho.

Distribution: Infestations have been scattered thus far but considerable damage has been done in some cases.

Cause: The disease is caused by the fungus **Sphaerotheca humuli,** a superficial parasite growing only on the surface of affected tissue.

Figure 25. Powdery mildew on strawberries in the greenhouse.

Symptoms: Where the disease occurs, a whitish mat appears on the leaves, stems and young fruits. Later this mat becomes brownish in color and the plants and fruits are variously dwarfed and distorted. The leaves may tend to roll upward at the margins.

Control: In areas where powdery wildew is troublesome, good sanitation measures and periodic application, as needed, of sulfur dusts should prevent serious damage.

ROOT ROTS

Importance: Root rotting of the plants is one of the most common limiting factors in profitable strawberry production. A large number of fungi can cause rotting of the roots under various conditions, and when these become established in a field, productivity drops sharply and plant death becomes common. Little is known about the complicating factors of soils and weather conditions.

Distribution: Many of the fungi responsible for root rotting thrive also on other plants and are already in the soil when strawberries are planted. Consequently root rot damage is generally found over the state.

Cause: A number of factors interact in producing root rot disease. The many species of fungi associated with it may be responsible either directly or indirectly. Species of **Rhizoctonia, Pythium, Fusarium** and **Ramularia** are especially troublesome. Several may act collectively, and it is often almost impossible to determine for a given case which caused the trouble primarily. Even if such determinations were simple, which they are not, the end result would in most cases be the same as far as control measures are concerned, excluding the factors of winter injury. Thus, meticulous isolation of organisms is not justified in most cases.

The alternate freezing and thawing common in many parts of Idaho during the winter months is likely responsible for much of the **black root** condition so commonly encountered.

Symptoms: Strawberry roots darken with age but retain their white, healthy interiors. Roots affected by the root rot, or **black root,** disease darken throughout and actually rot off.

First evidence of this may be nothing more than a failure to grow well. As the infection advances the plants may show several browning leaves or they may begin to wilt and die in the spring or early summer. It is this sudden wilting and death that most frequently calls the attention of the grower to the fact that something is wrong. This occurs because new roots are not formed until later in the growing season, and the sudden burst of growth in the spring, plus the heavy demand on the root system at fruiting, over tax the diseased root systems. Because of the entry of secondary fungi and weak parasites that thrive in wounds and weakened tissues, it is virtually impossible to determine this late in the development of the condition whether winter injury was primarily responsible.

Control: The best control that can be advised at present is the obtaining of clean plants and growing them in a soil of balanced fertility under good cultural practices. Short rotations are definitely to be encouraged.

Figure 26. An intermediate stage of strawberry root rot showing discoloration of both old and new roots.

Strawberries should not be planted after potatoes, tomatoes, brambles, sweet clover or alfalfa, because these crops tend to build up fungus populations in the soil.

Satisfactory rotation crops are grasses (including grains and sweet corn), beans, peas, cauliflower, broccoli, cabbage, squash, carrots and cucumbers. Grasses are best.

A new soil fumigant known as CBP—55 (See page 39) appears to be promising for root rot control, but insufficient information is available for recommendations to be made. The material also is unpleasant to handle.

If winter injury due to freezing and thawing is suspected as the initial cause of the trouble, mulching is recommended. Straw, wild hay, or pine needles will serve as long as care is taken to avoid using something that will result in heavy grass or weed seed deposit in the field. Sawdust probably will increase the damage if the **red stele** disease is present, but there are no reports of it in Idaho so far. Sawdust is a good mulch and is recommended, with this exception, after there have been a few frosts. Straw mulches probably should be applied at the rate of approximately 3-4 tons per acre.

Figure 27. Slime-mold growth on strawberry leaves.

SLIME MOLD

Slime mold damage is not generally a problem on strawberries in Idaho, but as much as 10 per cent loss has been sustained in some cases. Fluffy masses have been known to cover plants completely. This may take place any time during the period between harvest and fall. Infected plants should be removed and destroyed. (See also GRAPE slime mold.)

VIRUS DISEASES

CRINKLE

Importance: As evidenced by field symptom expression, crinkle appears in general to be of minor importance

in Idaho. However, it is capable of causing extensive losses. Fields have been known to become unprofitable within a year. Recent evidence indicates that there may be many strains of the virus which do not normally show symptoms in the field on most varieties but which may result in just as much loss over a prolonged period of time through reduced yield and shorter plant life.

Distribution: Field symptoms of crinkle have been found throughout the state, particularly as a result of the importing of plants from affected areas.

Cause: Many strains of crinkle, recognized and unrecognized, probably exist throughout Idaho. The virus is transmitted by aphids from plant to plant. Once a plant is infected, all the runner plants it produces are infected also. This is true of all vegetative propagations of materials carrying virus diseases as normally encountered.

Symptoms: As field symptoms develop, the plants become yellowed and dwarfed with smaller, crinkled, and roughened leaves. The yellowing is spotty and more pronounced around the leaf margins rather than generally over the leaf surface as it is in cases of chlorosis due to iron deficiency. Similar symptoms are sometimes caused by two-spotted mites. The dwarfing is particularly noticeable in the petioles or leaf stems. The fruit is of poor quality and often distorted.

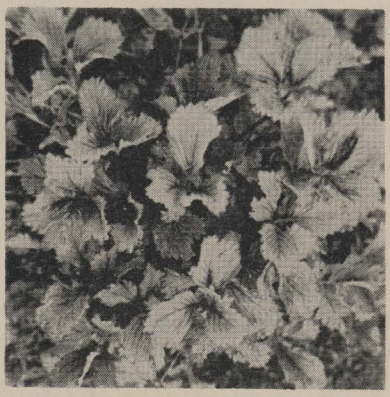

Figure 28. Crinkle virus infection of strawberry.

Control: The problems encountered in crinkle control are the same as those for the other virus diseases. These are discussed under the **yellows** disease on page 33.

STUNT

Importance: Stunt has not been known to cause severe damage in Idaho except in isolated cases.

Distribution: Although the disease ordinarily is a minor one, considerable loss has been known to occur in west-central Idaho.

Cause: Stunt is a virus disease and, like **crinkle,** is aphid-transmitted. Runner plants from diseased plants are always infected.

Symptoms: Leaf petioles (stems) stand upright, bearing small leaves which have a pronounced cupped appearance. Leaf color is about normal but fruits are small and seedy.

Control: Control methods for stunt are the same as those for **yellows.**

WITCHES'-BROOM

Importance: Witches' broom is of minor importance thus far, but it has ruined plantings in 1 to 2 years.

Distribution: The disease has been observed only in the northern part of the state but quite likely is present elsewhere. Witches'-broom was first discovered in Idaho in 1939.

Cause: An aphid-transmitted virus is responsible for the disease.

Symptoms: Leaves of infected plants are smaller and lighter than normal. Numerous slender petioles arise from the crowns in an upright manner. The lighter color and great numbers of petioles help to distinguish witches'-broom from **stunt.** Runners are short, when formed at all, and runner plants are infected.

Control: Same as for **yellows.**

Figure 29. Witches'-broom infected strawberry plant.

YELLOWS

Importance: Yellows of strawberry has been recognized in Idaho for many years. It has also been recognized on incoming stock, but until recently the disease was considered to be a minor one. However, newer information indicates that numbers of different virus strains make up the yellows group, some of which cause symptoms in the field and some of which do not. Certain combinations of strains also cause greater damage and more severe symptoms.

Thus, the yellows complex is now considered to be one of the greatest detriments to successful strawberry culture. Strains of this virus—perhaps never showing symptoms — likely are responsible for much of the decline in vigor and **running out** of plantings after a few years.

Distribution: The disease is general over the state, though obvious field symptoms are not common.

Cause: Yellows is a virus disease, many different strains of which are already known. It is transmitted by aphids and all runner plants formed by an infected plant also are infected.

Symptoms: Field symptoms ordinarily appear as a dwarfing of the

plants, yellowing and perhaps mottling of the leaves, and reduced yield. Such fruits are of poor quality. The leaves may be yellowed only near the margins—which are cupped or curled—and are considerably smaller than normal. The leaves in the center of the plant often are most affected. They do not become a uniform bright yellow as they do in cases of chlorosis due to iron deficiency. They do not have the roughening of the leaves which is characteristic of the **crinkle** disease. However, two-spotted mites may sometimes cause similar symptoms.

Figure 30. Yellows of strawberry:—Left, showing cupping of the leaves and yellowing of the margins, (Var. Lassen); right, a young leaf severely reduced in size, with pale margins. (Many varieties do not show symptoms at all in the field.)

Control: Virus diseases of strawberries vary widely among varieties. They cannot be controlled by any but the vigilant and careful grower. If he is engaged in the growing of plants for sale, these qualities are of supreme importance. Even for the berry producer, all infected plants must be dug out and destroyed immediately on discovery if he is to prevent future trouble.

Aphids carry infection rapidly from an infected plant to other plants, or from one field to another. Before symptoms appear on the new plants, the infection may have been picked up many times by other insects and carried to additional numbers of plants. In this way, even after the original diseased plant has been removed, infection can continue to spread. In prevention of this lies the value of earliest possible roguing. This is a difficult and time consuming procedure, and it is not always as effective as it should be.

Because of this, plants made available to the public through programs of certification are recommended as a prevention as well as a "control" measure. Use of certified plants does not preclude the necessity of a good roguing program however.

Certified plants of a few varieties can now be obtained in California, Washington, Oregon, or Idaho.

In the past, virus-free plants have been sought by an exhaustive testing procedure. Recent information indicates that heat treatments may soon be used to free plants of desired varieties of viruses they carry; this will greatly aid and expand certification.

Insect vector control programs to reduce spread of viruses are not yet advised for general use in Idaho, because we have not been able to show that this is justified by insect populations.

LATENT VIRUSES

Importance: Great but unrecognized until recently. The term "latent" is frequently used in connection with viruses and strains of viruses which do not commonly produce visible field symptoms. There are such strains of **crinkle** and **yellows** which are known to exist because of their effects on certain indicator plants (See figure 31). These are discussed under the **crinkle** and **yellows** diseases. Others likely exist which have as yet escaped detection.

Distribution: Latent strains are essentially universal in occurrence. Both yield and growth are reduced. Exhaustive tests with grafting to sensitive indicator plants repeatedly show that almost all strawberry plants carry one or more viruses, or strains of viruses already known, without showing symptoms.

Cause: Latent viruses are infectious and are transmitted by aphids and probably other insects as well. All runner plants from infected parent plants are infected.

Symptoms: Field symptoms are not produced by the latent viruses except in certain combinations and under certain conditions. These combinations arise from natural spread in the field through the feeding of the insect vectors. The Marshall and some other varieties show symptoms of such combinations rather well; others may not show symptoms at all.

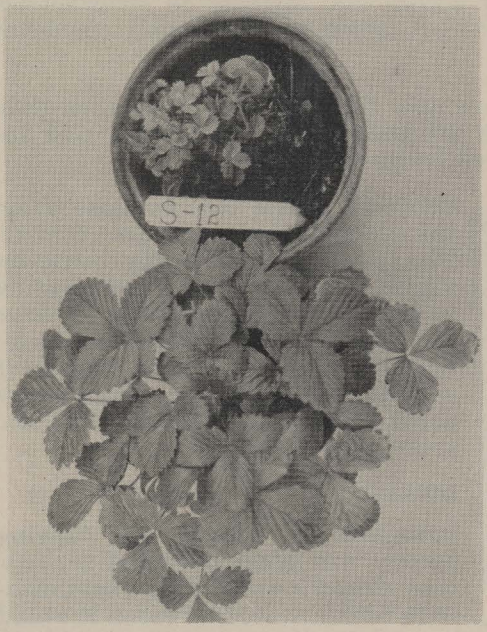

Figure 31. The indicator plant reaction to latent strawberry virus. Both plants are indicators but the plant above has been grafted to a garden variety strawberry plant which showed no evidence of virus infection.

Since diagnosis is made on the basis of symptom expression, the viruses have to be transferred to other host plants which more readily produce symptomatic reactions. A search for such hosts has led to the discovery that certain wild strawberry plants readily show symptoms when runner grafted to infected plants. This technique is now being used in the renovation of existing certification programs and in the establishment of new ones. Figure 31 illustrates a latent virus effect on the indicator plant.

Control: Since latent viruses cannot be seen in the field, roguing as a control measure is not effective. Effective chemical control measures are not known. The best measure now recommended is the use of Certified plants which have gone through the indexing process without revealing the presence of any virus. Such plants should not be set near other strawberries. At least 500 yards to windward of other strawberry fields is suggested.

All varieties are not equally affected, but good resistance is not yet available. The Northwest shows considerably more tolerance than the standard Marshall however.

MISCELLANEOUS DISORDERS

CAT-FACING

Importance: Losses from cat-facing do not occur uniformly but sometimes are serious. Everbearers seem to be most affected.

Distribution: The condition has been observed throughout Idaho.

Cause: Several factors are thought to result in cat-facing under certain conditions but present information is inadequate. Frost injury is frequently considered to be the chief cause. Insects such as species of **Lygus** and cyclamen mites are sometimes involved. Some such insects breed on alfalfa and migrate to strawberries later in the season to produce cat-facing that obviously could not be due to frost.

Symptoms: Berries may have only an occasional dimple, or they may be so affected that they are reduced to small, warty and unevenly distorted masses. Such fruits are worthless.

Figure 32. Cat-facing of strawberry fruits.

Control: Little can be done from the standpoint of practical control. The use of more hardy varieties where frost is a factor, and planting as far removed from alfalfa fields as possible may help. Standard insecticide sprays may reduce damage if used at the proper time where heavy populations have migrated into the strawberry field.

DWARF

Importance: Dwarf, or "spring dwarf" has great potential seriousness should it ever become established in Idaho. For this reason it would be well for the grower to be able to recognize suspicious symptoms.

Distribution: The disease occurs sporadically throughout the United States, but as yet it has not definitely been proved to occur in Idaho.

Cause: A nematode, of the **Aphelencoides** group, is responsible for the dwarf disease. Nematodes are extremely tiny, microscopic worms that live in the soil and on plant debris.

Symptoms: When infected, young leaves are small and severely deformed. The edges tend to be crinkled. If the infection is severe the entire plant may be dwarfed. Leaves become thickened and linearly distorted into various narrow shapes. This alone distinguishes the disease from other strawberry disorders. Glossiness may develop and flower buds be killed before they show, or the entire plant may die.

Dwarf may be distinguished from **stunt,** which is caused by a virus, by the upright position of the petioles and cupping of the leaves, in **stunt** infections. Leaves of **stunt** plants are not thickened, elongate, and glossy as in dwarf infections. Runner plants are often infected, with as many as several thousand of the nematodes in a single bud.

Control: Dig out and burn plants suspected of being infected with nematodes. The only sure control is prevention through an effective program of inspection and certification.

JUNE YELLOWS

Importance: June yellows, or leaf **variegation,** rarely reaches severe proportions in Idaho, but it is disturbing to the grower who is familiar with virus symptoms. In the early part of the growing season June yellows and virus **yellows** may occasionally look very similar to the inexperienced observer.

Distribution: June yellows has been observed at widely scattered locations in the state.

Cause: The disorder is not transmissible to other plants and hence is not considered to be of virus nature. It is most often associated with certain varieties and is in general considered to be a genetic weakness or abnormality. Runner plants from parents showing June yellows nearly always are affected.

Symptoms: Affected plants are approximately normal in size. The appearance is normal except for the characteristic type of yellowing or chlorosis of the foliage. In mild cases there may only be faint yellowish streaks running through the leaflet; in others there may be bright yellow areas, mostly between veins; in advanced cases the entire leaf may be yellow. Such yellow leaves are easily confused with chlorosis due to iron deficiency. The early and intermediate stages may be confused with virus **crinkle** and **yellows** in a few cases, but only in June yellows do the chlorotic spots tend to be streaked or angular and bordered by veins.

Control: Destroy affected plants. The disorder is not contagious, but runner plants from an affected plant ordinarily are affected also.

WINTER INJURY

Importance: The various factors involved in winter injury to straw-

berries result in mild to extremely severe losses in strawberry production in Idaho.

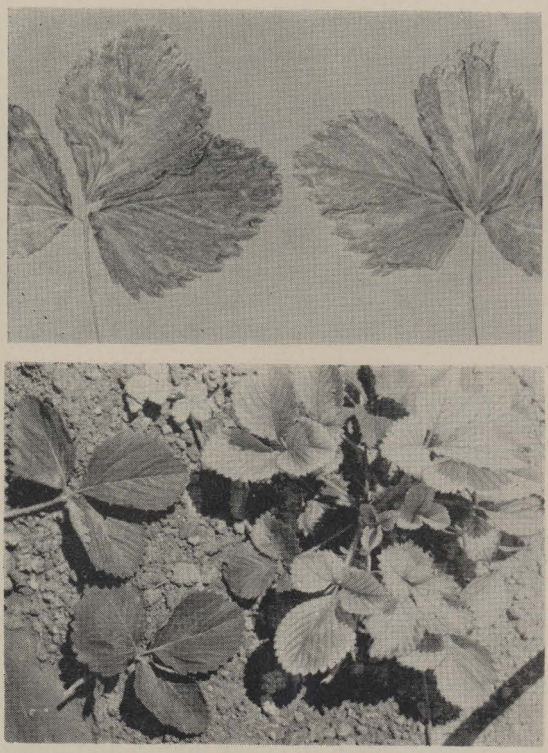

Figure 33. June yellows of strawberry (above) and chlorosis due to high lime soil, i.e., iron deficiency (below). Note that in iron chlorosis the veins remain green longest whereas June yellows leaves are streaked.

Distribution: Such injury is spotty in occurrence but is to be found throughout the state. Late frost damage most frequently occurs in low places having poor air drainage. Freezing and thawing may take place on any site.

Cause: Freezing or frosting are the two most direct causes of plant killing during the winter period as far as is known. Root breakage as a result of alternate freezing and thawing of the soil probably accounts indirectly for most of the plant losses over a period of time. Many factors other than these are to be considered however. Different varieties are affected differently. Environmental fluctuations peculiar to a given locality are of importance. Unusual seasonal variations play a part. The condition in which the plants go into the winter period is of considerable importance. Weakened plants — whatever the cause of the weakening — are more susceptible to winter damage.

Symptoms: Plants sometimes are killed by the low winter temperatures, particularly where temperatures drop suddenly in the absence of mulch or snow cover. Blossoms may fail to set fruit as a result of late frosts, or new terminal growth may be damaged. A water soaked discoloration ordinarily is associated with such freezing of tissues.

Control: Mulching is helpful where winter freezes are expected. If frost periods can be predicted, irrigation during the time the frost is expected will often reduce the damage that might otherwise occur. (See also the winter injury discussion accompanying the discussion of **root rot**).

NEW PESTICIDES

Soil Fumigants

Disease control materials of fumigant nature have been known and used for years, but many new ones have been marketed recently. Among these materials are extremely effective fungicides, bactericides, insecticides, and nematocides. Most of them require special equipment for proper application, and many are unpleasant to handle. Consequently such products are recommended in control programs only after their effectiveness for a given disease agent has been established and when equally effective but less unpleasant preparations are not available. In some cases considerable expense is involved besides that required for equipment.

Carbon bisulfide is one of the oldest materials and has long been used in various ways for reducing damage by the oak-root fungus or **Armillaria root rot.** In some cases entire fields have been treated. A fallow period of 60 days afterward is required before planting, however. CBP-55 is one of the newest of the soil fumigants. In California tests it has shown unusual promise for the control of several soil-borne parasites of fruits but has not yet proved itself sufficiently to be recommended. Preliminary tests with **crown gall** resulted in a high degree of control under the conditions of the test. Unfortunately it is one of the more unpleasant ones to use.

Results with fumigants vary considerably, depending on the soil type, organic matter content, moisture content, and temperature. This is one factor which creates considerable difficulty in formulation of general recommendations. However fumigation of dry soil should in general be avoided.

Antibiotics

Heretofore, use of antibiotics has largely been confined to the field of medicine, but recent information indicates that some of these materials—notably streptomycin and terramycin—may in the future prove to be among our most effective controls of bacterial diseases. Tests are being conducted throughout the country, and preliminary results show that they definitely are effective on such diseases as **fire blight** of pome fruits under the conditions of the tests. General recommendations are not yet formulated however.

CAUTIONS

New products are becoming so numerous that no single agency can investigate them all as soon as they appear. Many such materials that have been marketed in recent years have been rather ordinary spray materials, but many of them also have been dangerous when used indiscriminately. Control recommendations should be accepted only from reliable sources—depend upon county extension agents for clarification.

Many good spray materials can do tremendous damage when used at the wrong time or in the wrong concentration. Fumigants can be immediately and disastrously damaging to both plant and animal life. Equally undesirable results can be brought about by certain types of residue buildups. Antibiotics are just entering the plant disease field, and many products of varying composition likely will soon become available.

Improper mixing of various products can sometimes destroy all possibility of obtaining the control for which a program is recommended.

Many of the newer products are toxic to animal life, and this includes the operator. Before any material is used, all printed matter on the package should be read and thoroughly understood. In the first place be careful, but in case of accident be prepared with the antidote.

Any disease-control material can be damaging when used improperly. **ACCEPT NEW EVIDENCE WHEN IT HAS BEEN PROVED—USE OTHER INFORMATION WITH GOOD COMMON "HORSE SENSE."**

POINTS TO REMEMBER

Keep Equipment Clean

Do not allow spray materials to stand in tanks or pipes. Many are corrosive. Many settle out on standing, which results in plugging of screens and nozzles by the residue. Use the spray when it is prepared and keep the agitator running until the tank is drained and flushed out. Do not use equipment for disease or insect control sprays that has been used for application of weed killers. If it is necessary to do so, wash out the equipment with extreme thoroughness. Even then there may be damage to the fruit plants.

Mixing the Spray Materials

Do not mix pesticidal materials unless they are compatible. If the information is not on the package, ask your dealer or county extension agent. Mimeo-Leaflet 128 will be useful also and can be obtained from or through him.

Spraying Practices

Apply sprays with discretion. Narrow nozzle streams at excessive pressures can damage the foliage. Fine mists at distances of three feet or more should be safe enough.

Spray Methods vs. Quantity

The method of application has little bearing on the needed quantity of the effective part of the material, whether it be concentrate, semi-concentrate, or dilute.

Dusts Vs. Sprays

Dusts must be thoroughly applied at the proper time. They should contain at least equal quantities of active components as do sprays. More frequent applications of the dusts may be necessary because they do not adhere and retain their effectiveness as long as sprays.

Dusting With Sulfur

When dusting with sulfur becomes advisable, use the finest particle dusting product available. Effectiveness seems to increase as particle size decreases.

Liquid Vs. Dry Lime-Sulfur

In general, liquid lime-sulfur is indicated where recommendations are made, because it mixes more rapidly and easily. Where it is not available, dry lime-sulfur may be substituted at the rate of 4 pounds of the dry for each gallon of the liquid recommended.

Do not apply oil within 30 days after lime-sulfur applications.

Delayed Dormant Sprays

A delayed dormant spray is one which should be applied just as the buds expand enough to show green at the tips.

Pruning and Spacing

Pest control programs are more effective with proper spacing of trees, or other plants, and pruning practices. This helps in the control of most pests.

Viruses Can't Be Sprayed For

Viruses exist only inside the plant. They are spread by sucking insects much as mosquitos spread malaria among humans. Such insects are vectors of the viruses they transmit. Spraying to control virus spread by killing off the vectors generally is not effective.

Spray Concentration Numbers

The first figure means pounds or gallons of the pesticide. The last means gallons of water. For example, 1½-100 Ferbam means 1½ pounds of Ferbam in 100 gallons of water. (See table on Page 42).

THE MEANING OF BORDEAUX MIXTURE NUMBERS

(Example No. 1: 12-12-100)

First No.	Second No.	Third No.
12 Pounds of copper sulfate	12 Pounds of lime, freshly slaked (One-third more by weight if hydrated lime is used—never use air-slaked lime)	100 gallons of water

(Example No. 2: 16-100)

First No.	Second No.
16 pounds of pre-mixed Bordeaux. (This is the commercial type, in which the proportion of copper sulfate to lime is not given. The two ingredients are usually present in roughly equal quantities.)	100 gallons of water

THE MEANING OF LIME-SULFUR NUMBERS

(Example: 10-100)

First No.	Second No.
10 Gallons of liquid lime-sulfur concentrate unless dry lime-sulfur is specified. (Approx. 4 lbs. dry lime-sulfur are equal in value to 1 gal. of liquid)	100 Gallons of water

CONVERSION TABLE

1 fluid oz. = 2 tablespoons
8 fluid oz. = 1 cup
2 cups (16 oz.) = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon
1000 milliliters (ml.) = 1 liter
1 liter = 1.07 quarts
1 acre = 43,560 square feet

USEFUL IDAHO PUBLICATIONS FOR SMALL FRUIT GROWERS

Curative and Preventive Methods in Controlling Fruit Diseases, VII. (A preliminary survey of preparation, use and injury factors for pesticides.) Mimeo-Leaflet No. 128.

Growing Raspberries in Idaho. Mimeo-Leaflet No. 114.

Growing Strawberries in Idaho. Extension Bulletin No. 182.

Idaho Recommendations for Insect Control. Bulletin No. 216.

These may be obtained from the University of Idaho, College of Agriculture, Moscow; from the University Agricultural Extension Service, State House, Boise; or from your county agricultural agent.