1943

Diseases of some vegetable and fruit crops and their control

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DISEASES OF SOME VEGETABLE AND FRUIT CROPS AND THEIR CONTROL

By

A. G. Plakidas
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INTRODUCTION

The need for a convenient handbook of plant diseases and their control has been felt in the state for a long time. Bringing together, under the same cover, of the scattered information on the diseases of various crops and their control would obviously be of great help and convenience to both growers and county agents. Such a handbook has not been published earlier because it was felt that not enough experimental work on control measures of various crop diseases had been done in the State to have first-hand information. It is not always safe or practical to base recommendations for control on studies made elsewhere because environmental conditions vary so much that a certain control measure which has been found very effective in one part of the country may be worthless in another part. Information based on local studies, whenever available, is always more desirable.

During the past several years, considerable work has been done by different workers of the Louisiana Agricultural Experiment Station on the causes and control of diseases of various crops. Much valuable information has accumulated from these studies, and it is the purpose of this bulletin to place this information in the hands of farmers of the State.

Another reason for publishing this bulletin at this time is the hope that it may be helpful in the farm food production program. One way of increasing food production is by controlling the diseases which rob the farmer of a large part of the fruits of his labors. The acute scarcity of farm labor makes it difficult for the farmer to produce more by planting more acres, but he can produce more per acre by controlling the disease and insect pests of his crops.

No attempt has been made to include all crops grown in Louisiana or all diseases of each crop. The important diseases of only the vegetable and fruit crops are considered. Consequently, some of the most important crops of the State, namely, sugarcane, rice, cotton, and corn, are not included.

CAUSES OF PLANT DISEASES

It will probably be easier to understand the discussion of the individual diseases and their control if a brief, general account of the
causes of plant diseases and troubles is presented first. The different causes of plant diseases and troubles are given in the following outline:

I. Parasitic Diseases
   1. Fungi
   2. Bacteria
   3. Nematodes
   4. Insects

II. Non-parasitic Diseases
   1. Unfavorable climatic conditions
   2. Adverse soil conditions
   3. Noxious gases

III. Virus Diseases

Fungi are the most important plant-disease producing organisms. They are minute organisms composed mostly of a thread-like body (the "mycelium") and of microscopic fruits (the "spores"). The spores may, for convenience, be termed the "seed" of the fungi because it is by means of these organs that fungi are disseminated and infect the plants. Fungi cause many different kinds of diseases. They may attack the underground parts of the plant causing various root rots; they may attack the above-ground parts causing various cankers on the trunk and branches, rusts and mildews, leaf spots, blights of leaves and flowers, and various rots and molds of different fruits; or they may invade the vascular system of the roots and stems to produce wilting. The combating of fungus diseases is, therefore, a complicated process. It is necessary to know the life history of the particular fungus involved in order to know when to apply the fungicide to do the most good. Generally speaking, fungus diseases occurring on the above-ground parts of a plant are fairly easily controlled by sprays or dusts. The soil-inhabiting fungi which attack the roots and those that invade the vascular system of the stems are most difficult to control.

Bacteria are microscopic organisms much smaller than fungi. Like fungi, bacteria are capable of causing a great diversity of diseases. They too can invade the vascular system of plants and cause wilts. They can attack leaves, stems, shoots, blossoms, and fruit of different plants and cause serious blights (bean blight and fire blight of pears and apples, for example). In addition, bacteria can attack roots and crowns, which results in the formation of swellings and knots (crown gall). They can cause cankers on trunks and branches of trees, and various rots on fruits and vegetables. Bacterial diseases are much more difficult to control by sprays and dusts than are those caused by fungi.

Nematodes are microscopic animals (eelworms). The most common and most destructive species is the one that causes galls or knots on the

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1 The injuries caused by insects are not considered in this bulletin. A separate bulletin describing the insect pests of various crops and their control is in the process of preparation by the Department of Entomology and will be released soon.
roots of many plants (root-knot nematode). Others prefer to feed inside the crowns of certain plants (see "strawberry dwarf," page 82) and some can attack the leaves, stems, and flowers of different plants. The root-knot nematode is very difficult to control. It is very common in the South, especially in light sandy soils. It can attack a very large number of different plants (over 800 kinds of plants are known to be affected) and it can survive in the soil outside the plant for a long time.

Non-parasitic diseases are caused by adverse climatic or soil conditions, such as cold, heat, drought, poor drainage, unfavorable soil reaction (acidity or alkalinity), general infertiltiy of the soil, lack of one or more of the "minor elements" (zinc, manganese, copper, boron, etc.), excess of soluble salts, or the presence of a toxic substance in the soil, etc. In cities and in the vicinity of industrial plants, smoke and poisonous fumes may cause injury.

For convenience, virus diseases have been placed in a separate group instead of being included either among the parasitic or the non-parasitic causes, because it is not definitely known whether viruses are living or non-living. In some ways viruses behave like living organisms and in other ways like non-living chemical substances. What is known is that viruses are ultramicroscopic (they cannot be seen even with the strongest microscope) entities which, when introduced into the plant, increase and spread very rapidly, and produce specific diseases which are often very destructive. Virus diseases are spread chiefly by insects (aphids, leaf-hoppers, thrips, etc.) which feed on diseased plants and then on healthy ones, but some can also be spread mechanically during handling operations. Tomato mosaic, for example, is often spread during pruning and staking.

Viruses produce a great variety of symptoms depending on the kind of virus and often on the kind of plant. Some of these symptoms are green and yellow mottling of leaves ("mosaic"), general yellowing or chlorosis ("yellows"), dwarfing and stunting of the growth of the entire plant, distortion or rolling of leaves, dead spots on leaves or stems, etc. Often there is a combination of several of these symptoms.
Section I. Vegetable Diseases

**BEAN**

**Anthracnose**

*Symptoms:* This disease, which is caused by a fungus (*Colletotrichum lindemuthianum*), affects all part of the bean, seed, stem, leaves, and pods. The spots on the pods are the most conspicuous symptom (Fig. 1). Mature spots on the pods are sunken in the tissue, black with brownish margins. In the presence of moisture, the centers of the spots may become flesh-colored. On the stems the cankers are at first brown in color, later becoming black and sunken. The symptoms on the leaves are angular dead areas on the upper surface and blackening and killing of the veins on the under surface. The petioles also are affected.

*Control:* Control of anthracnose is based on the fact that the disease is seed-borne. The organism causing the disease does not survive the high temperatures of Louisiana summers. Therefore, if disease-free seed is planted in the spring, the beans will be free of anthracnose. In former years, when most of the bean seed planted in Louisiana was grown in the cool, humid, northern states (chiefly Michigan) bean anthracnose was very serious. In recent years, with the planting of Western-grown seed (seed grown in the arid, irrigated areas of the West where anthracnose is not prevalent) the disease has been practically eliminated and it has ceased to be of economic importance in Louisiana. This point should be kept well in mind in connection with the control of another seed-borne disease of beans, bacterial blight, which is discussed next.

**Bacterial Blight**

*Symptoms:* There are really two blights of beans, the common blight and the halo blight. These are caused by two distinct species of bacteria. Common blight is caused by *Phytomonas phaseoli* and halo blight by
Phytomonas medicaginis var. phaseolicola. They differ in symptoms somewhat, the chief difference being that the dead spots on the leaf caused by the halo blight organism are surrounded by distinct yellow halos (Fig. 2), while those of the common blight are not. For practical purposes, however, and especially from the point of view of control, the two diseases may be treated as one because both have many things in common. Both are seed-borne. Both may affect all parts of the plant—seed, seedlings, stems, leaves, and pods of the mature plant; and both may be very destructive under conditions favorable for infection and spread. The spots on the leaves have a water-soaked ("greasy") appearance at first, and in the case of halo blight are usually surrounded by a yellow halo. Later the spotted leaf tissue dies and turns brown. When the spots are numerous, there are no distinct halos, but the entire leaf turns yellow. When infection starts early, the entire plant is severally stunted and may be killed outright. The spots on the pods also start as water-soaked ("greasy") areas resembling sunscald, but may become reddish-brown on drying. The spots may be separate and more or less circular, or may run together forming irregular water-soaked areas on the pod (Fig. 2).

FIGURE 2.—BACTERIAL BLIGHT OF BEANS. SYMPTOMS ON FOLIAGE AND PODS.
Control: In discussing control for bean blight, the following facts should be emphasized: (1) The disease is seed-borne; (2) the bacteria occur under the seed coat where ordinary seed disinfectants cannot reach them; (3) sprays have not given satisfactory control; and (4) under Louisiana conditions the blight bacteria do not survive in the soil from one year to the next. With these facts in mind it is apparent that the logical way to control bean blight is to plant blight-free seed. Until recently, blight-free seed was not available. Seed grown in the cool, humid northern states almost invariably contains a large percentage of blight infection. For this reason, many seed companies in recent years have been growing their seed in the semi-arid sections of the West. This practice, unfortunately, has not resulted in the production of completely blight-free seed. It must be emphasized at this point that if the seed contains even a very small amount of blight, the disease may spread in the field very rapidly if conditions (chiefly wind and splashing rains) are favorable for infection and spread. It is, therefore, not enough to have seed that is almost blight-free. To get complete protection against blight it is necessary to plant seed which is entirely blight-free.

Through the efforts of the Plant Pathology Department of the Louisiana Agricultural Experiment Station and the cooperation of the University of California, blight-free seed has been produced in one of the dry areas of the Sacramento Valley in California where there is no summer rainfall, and beans are grown under irrigation. Carefully conducted field tests in Louisiana during the past three years have shown that the California-grown seed was completely blight-free. For the protection of the buyer, bags containing this seed are sealed with a specially devised metal seal which automatically breaks when the bag is opened. Thus, if the seal is not broken the buyer is assured that the seed has not been tampered with. In addition to the metal seal, the bags bear a tag with the inscription “CALAPPROVED.” This is the stamp of approval of the University of California and means that the seed so labeled has been grown under its supervision.

Caution: It is very important to remember that this California-grown seed is blight-free, not blight-proof. None of the commercial varieties of snap beans is blight-proof—not even blight-resistant. Plants from California-grown seed will blight if they come in close contact with plants grown from blight-infected seed. Therefore, never mix California-grown seed with seed from other sources. If enough seed is available, make all plantings with California-grown seed. If enough California-grown seed is not available and you have to use seed from other sources, plant the California-grown seed separately, at least removed by a quarter of a mile.

Web Blight

(Rhizoctonia microsclerotia)

Description: This is a new disease which has been in the State for only about four years, but which has proved that it can be very destruc-
tive in seasons in which weather conditions are favorable for its development. In 1941 it destroyed over 75 per cent of the fall crop of beans in the State. The first symptoms of the disease include a scalding of some of the leaves, and the appearance of spots or cankers on the pods. Affected leaves cling to other leaves or to stems and when pulled apart it is seen that they are held together by means of a cobweb-like material. Later the whole plant may become blighted, and leaves and stems become peppered with minute, dark-brown bodies (the sclerotia of the web-bligh fungus) which look somewhat like grains of sand.

**Control:** No method of control is known for web-bligh. The fungus causing the disease lives in the soil and it is scattered by winds and rain. It attacks not only beans, but a very large number of other plants including trees, such as the fig. Rotation probably would not help. In the fall of 1941 the disease destroyed the crop in many fields in which beans had never been planted before. Fortunately, the disease is not bad every year. It thrives in hot, humid weather. It hardly ever occurs on the spring crop of beans because the weather then is relatively cool and dry. For the same reason early plantings of fall beans suffer more than late plantings. In the fall of 1941, for example, most early plantings were completely destroyed, while later plantings escaped. The fall of 1941 was very warm, unseasonably hot weather prevailing throughout September and October.

**Mosaic**

*(Virus)*

**Symptoms:** Leaves become mottled (irregular light yellow areas on the green leaf), puckered, and deformed (Fig. 3). The whole plant is somewhat stunted and of a sickly yellow appearance. If infection starts...
when the plant is young, very few pods are formed, and those that form are of inferior grade. On some varieties, at least, (Black Valentine and Tendergreen in particular) mosaic causes water-soaked irregular spots on the pods. This type of injury has been termed "water wave" by inspectors, and beans so affected fail to make the U. S. No. 1 grade.

Control: The bean mosaic is seed-borne. There is no cure for mosaic once the plant becomes infected. With the use of certified seed, the amount of initial infection is small. Bean mosaic is relatively of minor economic importance in the State.

Rust

(Uromyces phaseoli typica)

Rust rarely occurs on the spring crop of bush beans in this State and is not a factor to be reckoned with in the commercial production of snap beans. The disease is, however, often found on pole beans in gardens later in the season, often becoming very destructive. Sulphur dusts or wettable sulphur sprays have proved very successful for the control of bean rust in Florida. We have had no experience with the use of sulphur on beans in this State, but there is every reason to believe that it should control rust on pole beans. It should be used cautiously, however, for it may cause some burning of the foliage during hot and dry weather usually prevailing in June.

Root Knot

(Heterodera marioni)

In spite of the fact that beans are very susceptible to the root-knot nematodes, the injury caused to the spring crop is insignificant. This is because soil temperatures are still relatively cool in the spring and the nematodes are not very active. On the fall crop of beans considerable injury may sometimes be caused by the root-knot nematode, especially on sandy soils. It is advisable to avoid, as far as possible, the planting of fall beans on very sandy soil in a field which is known to be heavily infested with nematodes.

BEET

Seed treatment: Better germination and better stands are obtained if the seed is treated. Use either Cuprocide or Vasco 4 (see pages 87 and 88).

Leaf spot: Spots with brown to grayish center and purplish borders appear on the leaves. These are caused by a fungus parasite (Cercospora beticola) which is seed-borne. The fungus causing leaf spot is a warm weather organism, so spots usually do not develop until relatively late in the season and injury caused from this disease is too small to justify control measures. Spraying with 4-4-50 Bordeaux will check the disease, but in general spraying is not practical.
CABBAGE, COLLARD, CAULIFLOWER, BROcoli, BRUSSELS SPROUTS

These plants of the crucifer family are all affected more or less by the same diseases and insect pests, so they are all treated here as a group.

Black Rot

*(Bacterium campestre)*

*Description:* This is one of the most destructive diseases of crucifers. The organism causing the disease is seed-borne and may affect the plant at any stage of its growth, from seedling to maturity, in the seed bed or in the field. Symptoms vary with the age of the plant. However, one symptom is nearly always present, and that is the blackening of the leaf veins and vascular bundles of the affected leaves and stems (Fig. 4). Affected leaves usually turn yellow and drop off. Secondary organisms (soft rot bacteria) often invade affected tissues causing a soft rot with a very offensive odor.

![Figure 4](image)

**FIGURE 4.—BLACK ROT OF CABBAGE. SECTION OF STEM SHOWING CONSPICUOUS RING OF BLACK VASCULAR BUNDLES.**

*Control:* The germ causing black rot is carried on the seed, so the control of black rot is accomplished by treating the seed with corrosive sublimate (bichloride of mercury). Make a 1-1000 solution of corrosive sublimate. This is most conveniently made by using the blue tablets which can be purchased at the drug store. One tablet in one pint of water makes a 1-1000 solution. Place the seed in a cloth bag and soak in the solution for 20 minutes. Then wash it in running water for 15 minutes, or if there is no running water, change the water several times. Spread the washed seed out to dry.

*Caution:* Corrosive sublimate is a deadly poison if taken internally and should be kept away from children and livestock. It is not, however, dangerous to the hands. Corrosive sublimate should not be dissolved in a metal container. Use either a glass, porcelain, or wooden vessel.

The hot water treatment (see "black leg") is also effective against
black rot. Therefore, it is not necessary to treat seed which has been
hot-water treated with corrosive sublimate.

Black Leg
(Phoma lingam)

Description: This disease is mentioned not so much for its present im-
portance—for in recent years black-leg has rarely been seen in the State—
but because it is potentially one of the most destructive diseases of cab-
bage and allied plants. The disease may affect any part of the plant in the
seed bed, in the field, or in storage, but primarily it rots the roots and
stems, causing the collapse and death of the plants. In the seed bed, af-
forded seedlings show whitish sunken dead areas on the stems. Very
numerous, minute specks dot the surface of the killed tissue. These are
the fruiting bodies of the organism causing the disease. These bodies
produce millions of spores which in turn infect other plants in the seed
bed or in the field, if conditions are favorable. Infected seedlings usually
die soon after transplanting. Older plants in the field may collapse and
die at any time.

Control: Black-leg is another of the many diseases that are seed-borne.
To control black-leg, then, it is necessary either to plant disease-free seed
or to treat the seed. Seed produced in the Puget Sound district, where
black-leg does not normally occur, is free of infection and requires no
treatment for the control of black-leg. If the seed has been grown in a
region in which black-leg is known to occur it is necessary to treat it. The
black-leg fungus occurs both on the surface and inside the seed. The cor-
rosive sublimate treatment (see “black rot”) will kill the fungus on the
outside but not on the inside of the seed. Treating the seed with hot
water (see page 88) will kill the fungus inside the seed. The hot water
treatment is a delicate and drastic method of control and should not be
used except when absolutely necessary. It reduces the germination of the
seed considerable.

Damping-Off
(Caused by several soil fungi)

Description: The term “damping off” has been used to designate a
disease of seedlings of many different plants, in the plant bed or in the
field, which causes the seedlings to rot at the soil line and collapse sud-
denly.

The soil contains various fungi which are capable of causing damp-
ing-off of seedlings of many different plants. Damping-off damage is of
two kinds. Germination may be considerably reduced by the rotting of
the seed or of the young seedlings while still under ground (pre-emerg-
ence damping-off); or the seedlings may be killed after germination
(post-emergence damping-off).

Control: In recent years various seed treatments have been devised
which are giving very satisfactory control of damping-off of many dif-
different crops. For cabbage, cauliflower, broccoli, brussels sprouts, collard, radish, turnip, mustard, kohlrabi, rutabaga, and spinach, Vasco 4 has given the best results for the control of damping-off. Add one level tablespoonful of Vasco 4 per pound of seed in a closed container, shake until the seed is well covered, then screen off any excess dust. If the seed are to be planted with a drill, add one-half as much graphite dust as the Vasco 4 when treating. This reduces friction in the drill. In the seed bed, it is well to cover the surface of the soil with a thin layer of Vasco 4, or of zinc oxide, as soon as the seedlings begin to come up.

**Blind Plant**

*Description:* During the past few years a peculiar trouble of cabbage, collard, cauliflower, and brussels sprouts has been noted. The trouble has been variously designated by different growers, the name “blind plant” being the one most commonly used. The symptoms of this trouble are briefly as follows: Some of the older leaves (especially those of cauliflower) are narrow and malformed (whiptail); there is considerable cupping of the margins of some of the leaves; the young leaves near the growing points may show bronzing, brittleness, and tip-burning; the growing point is often killed, the plant becoming “blind”; cauliflower may not head at all, or may form only small imperfect heads.

The cause of this trouble is not definitely known, but it seems to be associated with acid soils. The trouble has been especially common and severe in the southeastern part of the State (Florida Parishes) where the soils are definitely acid. It is not known whether soil acidity as such is the cause of the trouble, or whether under conditions of high soil acidity some element, such as manganese, becomes soluble in sufficient quantities to be toxic. In some respects, the trouble appears similar to that which effects cotton in some fields in the same general area which has been shown to be due to manganese toxicity.

*Control:* Liming appears to correct this condition. Before planting cauliflower or other crucifers on soil which is suspected of being acid, have your soil tested. Consult your county agricultural agent on how to get a sample of your soil and where to send it to be tested. In this way you can find out if liming is necessary and how much lime it is advisable to apply.

**CARROT**

*Seed treatment:* Better germination and better stand are obtained if the seed is treated. Use either Cuprocide or Vasco 4 (see pages 87 and 88).

*Leaf spot:* The disease is caused by a fungus (*Macrosporium caroiae*). It causes grayish spots on leaves and leaf stalks, finally killing the outer leaves.

*Control:* In small garden plots the disease is hardly ever severe enough to require control, but in larger plantings it may become very destructive.

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2 Write to the Louisiana Agricultural Experiment Station for Bulletin No. 349.
3 Vasco 4, a product of the Virginia Smelting Company, West Norfolk, Va., is a combination of zinc oxide and zinc hydroxide. It is on the market and can be bought at any seed store. If Vasco 4 is not available, zinc oxide may be used in its place.
The disease can be controlled by about 3 applications of 4-4-50 Bordeaux spray.

**CUCUMBER, CANTALOUPE, WATERMELON, SQUASH**

Plants of the cucurbit family are subject to a very large number of diseases. Some of these are of universal occurrence and importance; others are of great economic importance in some regions and relatively unimportant in others. While practically all the diseases that affect cucurbits occur in Louisiana, only the ones that are of economic importance are included in this bulletin.

**Downy Mildew (Blight)**

*(Peronoplasmopara cubensis)*

Although downy mildew affects practically all cucurbits, in Louisiana it is primarily a disease of the fall crop of cucumbers. Spring crops of cucumbers, cantaloupes, and watermelons either escape infection or become infected late in the season when the crop is nearly over and the resulting damage is small, although in some years severe defoliation of cantaloupes and watermelons may occur. Fall cucumbers, on the other hand, become infected almost as soon as the plants come up. The reason for the difference between spring and fall crops is this: The mildew fungus is a hot weather organism and does not survive the winter in Louisiana. It passes the winter in southern Florida and as the weather warms up in the

![Downy Mildew (Blight) of Cucumber. Early Stage Showing the Numerous, Angular, Yellow Spots on the Leaf.](image)
spring it spreads north gradually, reaching Louisiana usually the last part of June or early July.

**Symptoms:** Yellowish spots, usually angular in shape (Fig. 5), appear on the leaves. Later the whole leaf shrivels. The older leaves are killed first so there is a progressive defoliation from the base of the vine toward its tip. Diseased vines produce very little fruit of marketable grade.

**Control:** The standard method of control of downy mildew on cucumbers in Louisiana is to spray often (about twice a week) with 4-4-50 Bordeaux. Insecticides such as calcium arsenate or lead arsenate and Black Leaf 40 are added to the Bordeaux to take care of the insect pests (beetles, worms, aphids). This method has been in practice for many years and has proved fairly satisfactory. However, this method has these disadvantages: (1) In spite of frequent applications it is not entirely effective against mildew and it gives relatively poor control of the insect pests; and (2) under certain conditions Bordeaux causes injury to the plant (stunting of growth and burning of leaves and flowers) which results in reduced yields (Fig. 6).

It has been felt for years that a better method of control than that afforded by Bordeaux spray is needed. Since it is known that the lime component of Bordeaux causes the injury, it was decided to test some of the fixed copper compounds (which contain no free lime) in the form of dusts and sprays as substitutes for Bordeaux. Results obtained so far indicate that copper dusts with 5-6 per cent copper content plus a suitable insecticide give better control of mildew and insects than the Bordeaux spray. In some cases as high as 50 per cent increased yields were obtained from dusted cucumbers over those sprayed with Bordeaux. The increased yields were due to two reasons: (1) The dust caused no injury to the plant; and (2) the dust gave better control of insects, especially the cucumber worms, and as good control of the mildew as the Bordeaux.

Dusting experiments were started in 1938. In 1938 and 1939 the dust used was supplied by the General Chemical Company of New York. This dust contained 6 per cent copper in the form of basic copper sulphate, 20 per cent arsenicals (zinc arsenate and calcium arsenate), and 0.08 per cent rotenone. In 1942, two different dusts were tried:

![Image of Bordeaux Injury to Cucumber Leaves](image_url)
“Blue Cucumber Dust” containing 6 per cent copper in the form of tribasic sulphate (supplied by the Tennessee Copper Company) and 34 per cent Cryolite; and “Red Cucumber Dust” containing 5% Cuprocide (yellow copper oxide) and 34 per cent Cryolite. Nicotine in the form of “Black Leaf 10” was mixed with these dusts at the rate of 1 per cent when aphids appeared on the plants.

All the dusts used gave good control of mildew and excellent control of the insects. Several growers who have used dusts said that they are so well pleased with the results that they will never go back to spraying. So it looks as if dusting will eventually supplant spraying for cucumbers.

It should be emphasized, however, that our experiments with dusting versus spraying are not completed. In order to produce dusts that will be as cheap as possible, further tests will be carried out to determine the minimum amounts of copper and insecticides that can be put into dusts and still have satisfactory control. Work is also in progress to devise some sort of inexpensive power duster that will be suitable for cucumber dusting. When this experimental work is completed, recommendations on the best method of control of mildew and insects of cucumbers will be made. For the present, either of the following control measures are recommended:

1. **Spray.** Spray twice a week with 4-4-50 Bordeaux plus 2 lbs. of lead arsenate or calcium arsenate per 50 gallons of spray. If aphids (lice) are present, add 3/4 of a pint of Black Leaf 40 to 50 gallons of spray. This method, while it has many disadvantages, has stood the test for years and is known to be reliable.

2. **Dusts.** Dust twice a week with a dust containing 5 to 6 per cent copper and 34 per cent Cryolite. If aphids (lice) are present, mix with the dust one per cent Black Leaf 10. This material is very volatile and should be kept in an air-tight container. It should be mixed with the dust immediately before dusting. Apply the dust either early in the morning when the plants are wet with dew or as late as possible in the afternoon.

Two dusts which are on the market as “Blue Cucumber Dust” and “Red Cucumber Dust” are suitable and easily obtainable. Dusts can also be obtained from the Farmers and Merchants Grain Company in Ponchatoula, La., where a dust-mixing plant has been recently installed.

**Root Knot**

*(Heterodera marioni)*

Cucurbitis are among the plants most susceptible to the root knot nematode (see page 4). Plants affected with root knot are stunted in growth, pale green and unthrifty in appearance. When dug and examined, their roots are found to be covered with swellings or knots.

**Control:** See under TOMATO, page 47.
Bacterial Wilt
(\textit{Erwinia tracheiphila})

\textbf{Symptoms}: The first noticeable symptoms is the wilting of a few leaves or of a single branch of the vine. This is soon followed by the sudden wilting of the entire plant. When the stem is cut and squeezed, a sticky whitish ooze exudes from the cut surfaces. This is a reliable means of telling bacterial wilt from \textit{Fusarium} wilt, which is discussed next.

\textbf{Control}: Bacterial wilt is caused by a species of bacteria (\textit{Erwinia tracheiphila}). These bacteria, as far as known, are not seed-borne and do not survive in the soil or in plant refuse. They pass the winter within the bodies of the cucumber beetles and the plants become infected when the beetles feed on them. Therefore, the only effective control for bacterial wilt is to control the beetles. The beetles are easily controlled by dusting the plants with calcium arsenate or with cryolite. In the case of cucumbers which are sprayed or dusted for the control of downy mildew, the arsenical or cryolite is mixed with the spray or dust.

Cucumber and cantaloupe are very susceptible to bacterial wilt; watermelon is very resistant, and squash is intermediate.

\textbf{Fusarium Wilt}

This wilt, which is caused by a fungus (\textit{Fusarium niveum}), is primarily a disease of watermelon. Cucumber, cantaloupe, squash, and pumpkin are not affected.\textsuperscript{4}

\textbf{Symptoms}: The wilt fungus may affect the plant in all stages of its development. It can cause rot of the seedlings underground before they emerge, wilt and damping-off of the seedlings after emergence, and wilt and death of older plants. Wilt shows first at the tips of the runners during the hot part of the day. Wilted vines at first recover during the night, only to wilt again the next day. Wilting becomes progressively more severe, and the vine finally dies.

\textbf{Control}: Control of watermelon wilt is a difficult problem. The wilt fungus can live in the soil outside the plant, and once a field becomes infected it remains so for a long time. Furthermore, the wilt fungus is seed-borne, and in this way it may be spread to new ground if infected seed is planted. Seed-borne infection is not important the first year watermelons are planted on wilt-free soil, because only relatively few seeds will harbor the fungus, but it is important from the point of view of dissemination of the disease to new fields.

A five-year rotation, that is, not planting watermelons in the same field any oftener than once in 5 years, offers a practical relief against wilt. The wilt fungus is not eliminated from the soil in 5 years (it is known that it persists in soils 16 years or longer), but it is reduced to the point where watermelons can be grown for one season without much loss from wilt.

\textsuperscript{4}Other species of \textit{Fusarium} have been reported as causing wilts of muskmelon, squash, and pumpkin elsewhere, but as far as known these diseases do not occur in Louisiana.
Varieties of watermelon resistant to wilt have been developed. Unfortunately these have proved unsatisfactory in many respects. In general, the wilt-resistant varieties are of inferior quality compared to the susceptible ones. Also, some of these varieties which have shown considerable resistance further north are not resistant when planted in the deep South. Two varieties, the Leesburg and the Hawkesbury, show marked resistance to wilt in the South, and while these may not be of highest quality, they can be grown where the soil is so wilt-sick that no other varieties can be grown on it.

Anthracnose

Anthracnose, caused by the fungus Colletotrichum legenarium, affects watermelon, cucumber, cantaloupe, and other related plants, but in Louisiana, it is primarily a disease of watermelon and, to a lesser degree, of cantaloupe. Anthracnose is only rarely seen on cucumbers in Louisiana. This is due to two reasons: First, most cucumbers in the State are grown in late summer (August to October) and the high temperature prevailing at this time of the year is unfavorable for the anthracnose fungus. Secondly, even if conditions were favorable for the development of anthracnose, the spray for the control of downy mildew would also control the anthracnose.

Symptoms: Dead spots on leaves. These spots which are reddish brown on cucumber and cantaloupe and black on watermelon, enlarge until the whole leaf shrivels and scorches. The plant thus becomes de-foliated to a large extent, and the fruit becomes sunscalded. Spots develop also on stems and fruits.

Control: Anthracnose is usually not serious enough in Louisiana to justify control measures. In Florida, where the watermelon crop is very important and where Anthracnose is the most serious disease of this crop, the following measures have been found effective: (1) Seed is disinfected by soaking for 10 minutes in 1-1000 solution of mercury bichloride, then rinsing well in several changes of water. This eliminates the seed-borne infection. (2) Plants are either sprayed with 4-4-50 Bordeaux or dusted with 20-80 copper lime dust. One spray or dust application is made when the first 2 or 3 leaves have formed, the second when the vines have begun to run, the third about one week after the fruit has set, and the fourth about two weeks later.

Southern Wilt

(See under PEPPER, page 30.)

Mosaic

(Virus)

Mosaic, which is caused by a virus (see page 5) is one of the most serious diseases of cucumbers in the North, but in Louisiana it is rarely seen on cucumbers. This is probably due to the fact that the insects which spread the virus from diseased to healthy plants are kept well under
control in the process of spraying for downy mildew. Mosaic often occurs on squash in Louisiana, probably because this crop is not sprayed so assiduously as cucumbers. Watermelon is resistant to most strains of the mosaic virus and the disease is seldom seen on watermelon in the field.

**Symptoms:** Symptoms vary with different strains of the virus, but in general the leaves and fruit becomes mottled and distorted and the entire plant is stunted.

**Control:** Since mosaic is spread by insects, especially by plant lice, control is obtained by controlling the insects by spraying or dusting.

**Powdery Mildew**

*(Erysiphe cichoracearum)*

In Louisiana powdery mildew is of some importance only on squash. It is hardly ever seen on cucumber, cantaloupe, or watermelon.

**Control:** Powdery mildew on squash can be controlled by dusting with sulphur. Sulphur should not be used on cucumber or cantaloupe because these plants are sulphur sensitive and severe burning may result.

**EGGPLANT**

**Damping-Off**

*(Caused by several soil fungi)*

Eggplant seedlings are very susceptible to damping-off, and to control this trouble it is necessary to treat both the seed and the soil. Treat the seed with Cuprocide (see page 87). As soon as the seedlings begin to emerge from the ground, water the seed bed with a suspension made of 1½ oz. of Cuprocide (red or yellow) in one gallon of water. Repeat this once a week. Instead of watering with the Cuprocide suspension, the surface of the ground can be covered with a thin layer of Vasco 4 (see page 88) as soon as the seedlings begin to emerge. Leave the layer of Vasco 4 undisturbed.

**Blight**

*(Phomopsis vexans)*

Blight is by far the most serious disease of eggplants and it is really the limiting factor to the successful growing of eggplants in the State. It affects the plant and its fruit in all stages of development, from seedlings to mature fruit.

**Symptoms:** Brown dead spots form on the leaves. When the spots are numerous the entire leaf is killed. Elongated cankers develop on the main stem and its branches, usually occurring close to the ground. When the cankers girdle the main stem the plant wilts and dies. On the fruit, the disease shows sunken brown spots of various sizes (Fig 7). Sometimes these spots grow very large. Infected fruit usually sheds. The fruit tissue rots underneath the spots. Very numerous dark-colored pimples dot the surface of the cankers on the stem and of the spots on the leaves.
and fruit. These are the fruiting bodies of the blight fungus. They give rise to millions of spores which are scattered by winds and rains and spread the disease in other plants.

FIGURE 7.—BLIGHT ON EGGPLANT FRUIT.

Control: Eggplant blight is one of the most difficult diseases to control under the weather conditions prevailing in the State in the summer. The disease is seed-borne, the causal organism occurring both on the inside and outside of the seed. The seed treatment recommended above for damping-off will kill the fungus on the surface of the seed and thus reduce the infection considerably. Seed treatment is strongly recommended but will probably not get the fungus inside the seed. Spraying with Bordeaux has given a fair control of the disease on stems and leaves but rather poor control on the fruit. Some varieties are more resistant than others. The Black Beauty, which is considered the best variety from the point of quality, is very susceptible. The Florida High Bush (New Orleans Market) is somewhat resistant.

To summarize, the following control measures are suggested: (1) Treat the seed; (2) grow the resistant variety; and (3) spray the young plants several times with Bordeaux to prevent early infection on the leaves and stems.

Yellows
(Virus)

Yellows is a new disease of the eggplant and is probably caused by a virus (see page 5). The upper leaves turn bright yellow, or sometimes
bleach nearly white. Later the entire plant may become yellow and may finally die.

Control: In Texas, where the yellows disease is sometimes very prevalent in some sections, good control has been obtained by the use of sulphur dust. The plants in the seed bed are kept dusted with sulphur, then one or two additional dustings are given the plants after they are set out in the field. This apparently is a preventive measure. Sulphur evidently kills or repels the insect which transmits the yellows virus from diseased to healthy plants.

Although yellows has been found on eggplants in Louisiana, so far it has not become prevalent enough to be of economic importance.

**OKRA**

Okra is grown in practically every garden in Louisiana and is usually considered a “fool-proof” crop. However, this plant also is subject to several diseases, some of which may be destructive at times.

**Wilt**

Okra wilt is caused by the same fungus which causes the destructive wilt of cotton (*Fusarium vasinfectum*). First symptom is yellowing of the lower leaves, followed by wilting and finally by the death of the plant.

**Leaf Spots**

Several fungi can cause spots on okra leaves and pods. The most common one in Louisiana is a species of *Cercospora*.

Control: The leaf-spotting diseases of okra are not serious enough to justify control measures.

**Root Knot**

(See page 4.)

**ONION** AND **GARLIC**

Some onion diseases (smut, for example) which are destructive in other parts of the country either do not occur or are of minor economic importance in our State. On the other hand, some diseases that are of no importance in the North are very destructive in Louisiana and in the South in general. The diseases which attack onions and garlic in Louisiana are extremely difficult to control. In fact, diseases constitute the chief factor limiting the development of an extensive onion-growing industry in the State.

**Downy Mildew (Blight)**

(*Peronospora destructor*)

Symptoms: Leaves first become pale green, then turn yellow, and finally collapse and shrivel. Seed stalks are also affected. The plant is

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8For information on the culture of onions and shallots, see “Horticultural Hints,” Vol. 1, No. 7, and Extension Circular No. 242. These publications may be obtained free by writing to the Louisiana Agricultural Extension Department.
not completely killed, but the destruction of the top growth causes the bulbs to be small. Mildew is especially destructive to onions used for production of seed, as mildewed stalks usually fall over before the seed is mature.

**Cause:** The disease is caused by a fungus (*Peronospora destructor*). The fungus carries over from season to season in many ways—in the seed, in the bulbs, and in the soil. Development and spread of the fungus are favored by cool, humid weather.

**Control:** Control of mildew is extremely difficult. Since the fungus can survive from one season to the next in so many different ways (in the seed, bulbs, and soil) control or eradication by sanitary measures is practically impossible. Spraying has been tried in the past, both in Louisiana and in other onion-growing states, but it has not proved very satisfactory. To obtain good control it is necessary to keep the new growth covered with spray material as soon as it develops. This means spraying at least once a week for several months. Obviously such a procedure is economically impractical.

**Pink Root**

Pink root is another serious disease of shallots, onions, and garlic. The disease is caused by a fungus (*Phoma terrestris*) which lives in the soil.

**Symptoms:** The most characteristic symptom is the pink color of the roots. In addition to the pink color, the affected roots become soft, limp, and finally rot. The plants have an unhealthy, unthrifty appearance, pale green color, more or less stunted growth, and a die-back of the leaf tips. As these above-ground symptoms may be brought about by other conditions, the only sure way of knowing whether or not plants have the pink root disease is to examine the roots.

**Control:** Control of pink root is a very difficult problem. Once a field becomes infested, the pink root fungus can survive in the soil for many years, even if no onions or garlic are planted, and so rotation is of a doubtful value as a control measure. Furthermore, the fungus is carried over on infected bulbs and sets, and its presence on the dried bulbs and sets is not easy to detect. By the use of diseased sets, the disease is unwittingly spread to new fields. It is possible that varieties resistant to pink root will be developed eventually. Until this has been accomplished the only control measure that may be suggested is prevention. Do not plant onions, shallots, or garlic in fields that are known to be infested. Whenever possible, make sure that the sets you plant have come from disease-free fields. Plant onion seed on new soil or in soil which is not infested with the pink root fungus. This precaution is very important. If the seed is sown on infested soil, the seedlings will become infested and the disease will be spread to areas in which these seedlings are transplanted.
Black Stalk Rot

This is primarily a disease of the seed stalks and is of importance only when onions are grown for seed. It is caused by a fungus (*Macrosporium parasiticum*) which grows on the stalks (and also on the leaves), causing them to rot and fall over before the seed is mature. Affected parts of the stalks become covered with black masses which are made up of the spores of the fungus. The black stalk-rot fungus is not an aggressive parasite, and usually attacks plants which have been weakened by mildew or in some other way.

No satisfactory control measure has been found for this disease.

White Rot

This disease, which was found in Louisiana for the first time in 1942, is included here not because it is of economic importance at present, but because it is potentially a very serious disease of onions, shallots, and garlic, and should be brought to the attention of growers so as to have them on the lookout for it in case it appears in their fields. In this way it can be caught before it spreads. White rot (caused by the fungus *Sclerotium cepivorum*) is a serious disease of onion and garlic in Europe. In the United States the disease has been found previously in localized areas in Kentucky, Virginia, Oregon, California and New Jersey.

Symptoms: The roots and the bases of the scales rot. A white fluffy growth (the "mycelium" of the fungus) and small, spherical, black bodies ("sclerotia") occur on the surface of the bulbs (Fig. 8). Affected plants may wilt and die rather suddenly, or may persist in a sickly, unthrifty condition.

Control: Prevention is the only effective control measure for this disease. Once the soil becomes infested, it remains so for many years because the fungus can survive in the soil even when onions or garlic are not planted. Care, therefore, should be taken to use only healthy sets or transplants. The white rot fungus thrives in cool weather and since onions in Louisiana are grown during the cool months of the year this disease is a potential menace and care should be taken to prevent its spread.

FIGURE 8.—White Rot on Shallots.
Yellows\textsuperscript{6}

This disease is mentioned here not because it is important but because it is so striking in its appearance that it is easily noticed in the field and may arouse curiosity or concern. The disease has been seen on shallots and the Creole onion. The leaves of affected plants are so strikingly bright yellow that such plants can be easily noticed from a distance. The plants are stunted in growth and the bulbs are small, soft, and flaccid. If harvested, affected bulbs or sets usually shrivel and dry up in storage. This is fortunate, for the disease is thus self-eliminating.

The cause of yellows is not known. Its symptoms suggest that it is a virus disease but attempts to transmit it by means of juice inoculation have failed. It is possible that it is transmitted by means of an insect vector.

Storage Rots

Decay of onions and garlic in storage or in transit is caused by a large number of fungi and bacteria, such as species of Botrytis (neck rot), Fusarium (dry rot), Aspergillus (black mold), Macrosporium, Colletotrichum (smudge), bacteria (soft rot), and many others. White onions are more susceptible to storage rots than those with colored skins. Our Creole onion is a good keeper, and shows considerable resistance to many of the storage rots.

Control of storage rots: All organisms causing storage rots require moisture for their development. Control of storage rots, therefore, is based on proper curing and storage. Many of the storage rots start in the field about harvest time and continue their development in storage. If dry weather prevails during the period of harvesting so as to allow drying and curing, losses from subsequent storage rots will be small. On the other hand, if rains prevail during the period of harvesting and curing, losses from storage rots are to be expected. Curing by the use of artificial heat is very helpful, but facilities for artificial curing are not always available.

To summarize, storage rots are kept in check by proper curing and storing in a cool, well-ventilated storage house.

PEA (GARDEN AND SWEET)

Damping-Off and Root Rots

Peas, both the edible (English) and those used for their flowers (flowering sweet peas), are attacked by a large number of soil-inhabiting fungi which cause the roots to rot. In this popular bulletin it is considered unnecessary to name and describe the various root-decaying fungi. It is enough to state that at least seven different soil-inhabiting fungi are known to cause root rots in peas.

\textsuperscript{6}This disease should not be confused with Yellow Dwarf, a virus disease of onions which occurs in some of the northern states. As far as known, yellow dwarf does not occur in Louisiana.
Root troubles may manifest themselves in different ways: (1) The seed may rot without germinating, or the little seedlings may rot before coming out of the ground (pre-emergence damping-off). (2) The emerged seedlings may be killed gradually. (3) The older plants may show an unthrifty, unhealthy kind of growth, pale green color, stunting, wilting, and gradual dying. If such plants are examined it will be found that their underground parts will show various degrees of decay.

Control: Root rots are difficult to control. Most root rotting fungi live in the soil. Others are seed-borne. Soil and moisture conditions also influence the severity of root rots. No single control measure for root rot can be offered. However, the following measures are suggested as of value for keeping injury from root rots to a minimum:

1. Seed treatment: Treat the seed with Cuprocide (see page 87). This treatment controls pre-emergence damping-off and insures a good stand.

2. Source of seed: Use western-grown seed when available. Western-grown seed is not only free of some of the root and foot-rotting organisms, but also of those of bacterial blight and Ascochyta blight.

3. Rotation: Rotation is very helpful. If enough land is available it is advisable not to plant peas on the same ground any often than once in 4 years.

4. Resistant varieties: The “Creole” pea, which in recent years has been grown extensively in home gardens throughout the State, is relatively resistant to root rots. It is also fairly tolerant to mildew. Unfortunately, the Creole is a rather poor quality pea.

5. Soil moisture: Plant peas only on well-drained ground. Root rots are decidedly more destructive in poorly drained soils.

Ascochyta Blight

Three species of the fungus known as Ascochyta are involved in this blight. These cause purplish to tan-brown, irregular to round, often sunken spots on the leaves and pods (Fig. 9, A) and elongate lesions on the stems. When stem lesions occur near the ground a foot rot is produced which kills the plants.

Control: Since the fungi causing this disease are seed-borne, good control has been obtained by planting blight-free seed on land on which peas were not growing the previous year. That is, control of blight is based on a combination of disease-free seed and rotation. Western-grown seed is usually free of blight. If local seed is used, it should be saved only from healthy plants.

Bacterial Blight

A second blight which very commonly becomes destructive on peas in Louisiana is that caused by bacteria (Pseudomonas pisi).

Symptoms: Numerous watersoaked spots on leaves, stems, and pods (Fig. 9, B). Later the spots turn brown in color. Heavily diseased plants may wilt.
Control: Use blight-free seed. Seed grown in the semi-arid western states is usually blight-free.

**FIGURE 9.—Pod Blights of Peas. A. Ascochyta Blight. B. Bacterial Blight.**

**Powdery Mildew**

_Erysiphe polygoni_

Powdery mildew is easily recognized by the whitish, powdery growth on the upper surface of leaves and stems. After some time affected leaves shrivel and fall off.

Control: Powdery mildew usually occurs late in the season after the crop is nearly over, and it is doubtful that control measures are justifiable. However, powdery mildew can be easily controlled by dusting with sulphur. It is advisable to dust as soon as mildew appears before any damage is done. A second application of sulphur may be necessary if mildew persists.

**Anthracnose**

Anthracnose, caused by a fungus _Colletotrichum pisi_, is of no importance on English peas in Louisiana but it is often very destructive on flowering sweet peas. It causes irregular, brown dead spots on leaves and flowers and elongated dead areas on stems and flower stalks.
The disease is favored by cool, moist weather. It often becomes very destructive on sweet peas during April if cool, rainy weather prevails. No satisfactory control is known for this disease.

**PEANUT**

In the past the peanut acreage in Louisiana has been limited. Only in two relatively small areas in Caddo and Rapides parishes have peanuts been grown on a commercial scale. The rest of the plantings have been small patches for home use. Under these conditions peanut diseases have been of minor importance. However, under the stimulus of the farm food production program the peanut acreage in the State was markedly increased in 1942 and a still larger increase is expected in later years. With the increase in acreage, disease control becomes important.

**Leaf Spot**

*(Mycosphaerella arachidicola and M. Berkeleyii)*

*Description:* The most important disease of peanuts is the leaf spot which is caused by two species of the fungus *Mycosphaerella*. The spots on the leaves are brownish to black with light-colored margins and circular to irregular in outline. On the stems and leaf stalks, the spots are elongated. The disease causes the leaves to shed before the crop is ready to harvest and this premature defoliation results in low yields of both nuts and hay.

*Control:* Leaf spots can be effectively controlled by dusting about 3 times with 325 mesh sulphur. The first dusting should be made about the first week of July (60-65 days after planting). The other two applications should be made at intervals of about two weeks. If it rains heavily within 24 hours after dusting, a fourth application is advisable. A dust mixture made up of 9 parts of 325 mesh sulphur and 1 part basic copper sulphate has given slightly better control than sulphur alone.

In tests made in Caddo Parish in 1941 the sulphur dusted plots yielded about 40 per cent more nuts and about 32 per cent more hay than those that were not dusted. Similar results have been obtained in other states. So it is evident that it pays to control this disease.

**Southern Blight**

*(Sclerotium rolfsii)*

This fungus which attacks many different kinds of plants (see PEP-PER, page 30) sometimes causes stem and pod rot.

*Control:* Rotate. Do not plant peanuts on the same land on which the disease occurred the previous year.
**PEPPER**

**Damping-Off**
(Caused by several soil fungi)

Description: See page 84.

Control: By treating the seed with copper oxide (Cuprocide) better germination and better stand of seedlings are obtained. Add 2 level teaspoonfuls of Cuprocide to each pound of seed in a closed container, shake until the seed is well covered, then screen to remove any surplus dust that has not adhered to the seed.

This treatment is usually sufficient to insure good germination and to prevent damping-off of the seedlings after germination. If the seed has not been treated, or if plants continue to damp off in spite of seed treatment, water the plants with a suspension made with 1½ oz. of Cuprocide per gallon of water. One watering usually is enough, though a second will not be harmful.

**Bacterial Spot**
(Bacterium vesicatorium)

Description: This disease occurs both in the seed bed and in the field. It forms spots on leaves and fruit. On the leaves, the spots are at first raised and wart-like but soon the tissues dry out, leaving small, dark-brown, more or less angular spots (Fig. 10). Spotted leaves soon turn yellow and shed, resulting in defoliation and stunting of the plant. Severely defoliated plants set very little fruit, which is usually of unmarketable quality. On the fruit, the spots are raised, wart-like.

Control: The disease is seed-borne. The bacteria causing the disease are carried on the surface of the seed and they are known to remain viable for at least a year. It is suspected that the bacteria may live over in the old plants in the field, but this has not been proved experimental-

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**FIGURE 10.**—**Bacterial Leaf Spot of Pepper.**
ly. Under cultural practices prevailing in the sweet pepper growing districts of Louisiana, where the plants are plowed under as soon as the crop is harvested in early summer, it is very doubtful that the bacteria survive in the soil from one year to the next. So far as sweet peppers are concerned the control of bacterial spot is best accomplished by disinfecting the seed. Cuprocide, which is recommended for the control of damping off, unfortunately does not control bacterial spot. A more drastic method is necessary. Of several treatments recommended by different pathologists, the three most promising ones are given here:

A. *The corrosive sublimate treatment*: Soak the seed in a 1-1000 solution of corrosive sublimate (see "black rot of cabbage" for directions for making the solution) for 5 to 6 minutes, wash thoroughly in running water (or in several changes of water), and either plant directly while still wet or spread out to dry. It is better to dry the seed after this treatment, for then it can be dusted with red pepper oxide (Cuprocide) for the control of damping-off. While the corrosive sublimate treatment is very effective, it is also risky and should be used with care. Pepper seed is sensitive to corrosive sublimate and may be injured somewhat under certain conditions.

B. *The Semesan treatment*: Dissolve 1 oz. of Semesan in 3 gallons of water. Soak the seed in this solution for 1 to 1½ hours, drain, and spread out to dry. This treatment will also control the pre-emergence phase of damping-off (see page 84).

C. *The copper sulphate treatment*: Soak the seed in water 6 to 12 hours (or overnight), drain off the water, then place the seed in a copper sulphate (bluestone) solution made by dissolving 1 oz. of copper sulphate in 2 quarts of water. Soak the seed in the copper sulphate solution for 5 minutes, drain, then roll the seed in hydrated lime and plant immediately after treatment. This treatment will also control the pre-emergence phase of damping-off.

In recent years seed dealers have been treating their seed, and pepper seed sold to growers is usually labeled "treated for diseases." This is a step in the right direction, for the seedsman is better equipped to do the job than the average grower. However, since one particular treatment is not effective against all diseases, it is well for the grower to ascertain for what particular disease the seed he buys has been treated.

Some growers follow the practice of planting a few tomato seeds in the pepper plant bed for transplanting later in the home garden. This should not be done because the same bacteria which cause pepper blight infect tomatoes also, and tomato seed is often infected. A single infected tomato plant is enough to spread the blight over the entire plant bed.

**Cercospora Leaf Spot (Leaf Drop)**

*(Cercospora capsici)*

*Description*: This disease is distinguished from the bacterial leaf spot by the large, circular to oblong spots with grayish centers and dark brown
margins (Fig. 11). Spotted leaves turn yellow and drop off, hence the common name "leaf drop." The damage is caused by the defoliation of the plant. Spots develop also on the stems of the plant and on the fruit.

The disease appears in the field usually about the middle of May, and if conditions are favorable (hot, wet weather), the plants may become badly defoliated in 2 or 3 weeks. The disease apparently is not seedborne. We have been unable to obtain the fungus from the seed and we have never found the disease in the seed-bed, although a careful search for it has been made. On the other hand, we have found the fungus fruiting profusely in the spring on infected pepper stems outdoors. So it appears that, under Louisiana conditions, the leaf drop fungus is carried over from one season to the next on infected pepper refuse.

Control: The disease can be controlled by spraying with 4-4-50 Bordeaux mixture (or with some other copper spray). We have obtained good control by spraying with 4-4-50 Bordeaux and also with "Spray-cop," at the rate of 3 lbs. in 50 gallons of water.

Even though spraying is effective in controlling this disease, it is still a question whether or not it pays to spray. The disease becomes progressively worse as summer advances. If the harvesting season is long, it will undoubtedly pay to spray, and the length of the harvesting season is conditioned by the market price for peppers. During the past few years the price of peppers dropped by the end of June to the point where it did not pay to pick. Under these conditions it is questionable whether spraying for the control of this disease would be economically practicable.

Southern Wilt (Southern Blight)

This disease is caused by a soil-inhabiting fungus known by the technical name of Sclerotium rolfsii. The fungus is a warm climate organism and is common in the Southern States. It attacks a very large number of different plants during the hot summer months. The fungus attacks the plant at the ground line, girdling and causing it to wilt and die rather suddenly. The disease is easily recognized by the white web-like growth of the fungus and the numerous creamy-white to brown seed-like bodies (sclerotia) which are found on the girdled part of the stem and on the ground. The sclerotia are about the size, shape, and color of
mustard seed. These bodies remain viable in the soil and carry the fungus over from one season to the next.

No control is known for this disease. Fortunately it is a minor disease. Occasionally it may cause the death of a considerable number of pepper plants in some fields, but in general it is a disease of small importance.

Mosaic
(Virus)

Description: The symptoms of mosaic vary considerably (there are different strains of mosaic) but in general they consist of mottling (green and yellow color) and distortion (puckering, twisting malformation) of the leaves and general stunting of the entire plant. If the plant becomes infected when young it is entirely worthless; it remains stunted and either sheds its blossoms or, if it sets any fruit, it is small and misshapen. If infection occurs after the plant has reached maturity the damage is decidedly less.

Control: Mosaic is very infectious. It is spread principally by plant lice, but also by other insects and by handling, such as transplanting and picking. Once the plant becomes infected, there is no cure. Control, therefore, is based on preventing infection. The plants in the seed bed should be sprayed often with nicotine to kill the aphids. In the field, diseased plants should be destroyed as soon as they appear to keep the disease from spreading.

IRISH POTATO

The Irish potato is affected by a very large number of diseases. Fortunately, control measures have been worked out for most of these diseases. Furthermore, climatic conditions play an important role in the distribution and severity of some diseases, and so it happens that one of the most serious diseases of the potato—late blight—seldom occurs in Louisiana. Most potato diseases are "seed-borne," that is, they are carried over on or in the tubers. For this reason, the planting of certified seed is the best preventive measure against disease of the potato. Certified seed, however, is not a "cure-all." Some disease producing organisms are soil-borne, and others are carried over on other plants which are related to the potato, such as tomato, eggplant, pepper and many weeds. In this bulletin, the potato diseases which commonly occur in the State, or are likely to occur, are briefly described and recommendations for their control or prevention are given.  

Common Scab
(Actinomyces scabies)

Description: Scab affects only the tubers (Fig. 12). It forms round to irregular, hard, corky areas on the tubers. Scabby spots may be small and

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*For a more detailed description of potato diseases and their control see U. S. Department of Agriculture Farmers' Bulletin Nos. 1881 and 1904.*
solitary or large and fusing together to cover most of the surface of the tuber. The scab organism is both seed and soil-borne. It likes neutral to alkaline soils. Scab is not a problem in acid soils.

FIGURE 12.—SCAB OF POTATO.

Control: Treat the seed with either of the following disinfectants: (1) Hot formaldehyde (page 88). This method has been in use in Louisiana for several years and has proven its usefulness. (2) Acidified mercuric chloride (page 85).

Black Scurf
(Rhizoctonia solani)

Scurf affects both tubers and stems. On the tubers it forms hard, black bodies (sclerotia) which adhere tightly to the skin. When the tubers with scurf sclerotia on them are planted, the scurf fungus (Rhizoctonia) grows and attacks the new shoots, forming cankers on the stems and stolons and finally on the new tubers.

Control: Same as for "scab" (pages 88 and 85).

Since both scab and the scurf organisms can live over in the soil, seed disinfection does not give 100 per cent control. However, seed disinfection is a great help in reducing infection with both these diseases and its practice is strongly recommended. Crop rotation is recommended for reducing soil infection.
Brown Rot (Bacterial Wilt)
(Phytoponas solanacearum)

**Symptoms:** The first manifestation of the disease is a slight wilting of the plant during the hottest period of the day. The plant recovers at night but wilts again the next day and the wilting becomes progressively worse until the plant dies. At first there is a brown discoloration in the inside of stems and roots (in the vascular bundles), but later the brown color appears externally. The same is true of the tuber. In the early stages the brown discoloration is internal—around the vascular bundles—but later the brown color appears on the outside of the tuber, especially about the eyes. Finally the tubers rot.

**Control:** Brown rot does not occur in the northern states where potato seed is grown, so the disease cannot be avoided by the use of certified seed; the disease is limited to the southern states. The bacteria causing brown rot can survive in the soil (particularly in sandy soils) for long periods, and they also attack many other cultivated plants and weeds. This makes it very difficult to try to eliminate the disease from potato-growing land. In Florida where brown rot has been very severe in certain areas, good control has been obtained by applying sulphur to the land in the summer (800 lbs. per acre), followed by liming in the fall (3000 lbs. per acre). In Louisiana brown rot has not been of sufficient economic importance to justify such a drastic and costly method of control.

Ring Rot
(Phytoponas sepedonica)

Ring rot also is caused by bacteria (a different species from that causing brown rot). The field symptoms of ring rot and brown rot are similar to the extent that both diseases cause wilting of the plants. They vary, however, in many other respects. Ring rot does not cause a brown discoloration of the stem; brown rot does. Ring rot causes cracking of the tubers and a reddish-brown discoloration of the skin of the tubers; brown rot produces a dark-brown to black discoloration of the tissue of the tuber, with no trace of red color and no cracking.

**Control:** Unlike brown rot, the ring rot disease is not limited to the South, but occurs in practically all the potato-growing regions of the country. Fortunately, the ring rot bacteria apparently do not survive in the soil from one season to the next. The disease is carried over in slightly infected tubers which do not show external symptoms and may therefore be overlooked by the seed inspector. The bacteria are very infectious and the disease can easily be spread from the few infected tubers by the knife during the process of cutting seed potatoes for planting. In spite of this difficulty, the use of certified seed helps to keep losses from ring rot to a minimum. Seed-producing states are very strict regarding this disease. They will not certify any field that shows even a trace of ring rot, and the only way that the disease can get by is in slightly infected tubers which show no external symptoms and thereby escape de-
tection. Furthermore, Louisiana allows no tolerance for ring rot in certified seed that enters the State. If any trace of ring rot is found in a lot of seed shipped into the State, certification tags are removed, and the lot cannot be sold as certified seed. In this way the grower is protected, to a great extent, against this serious potato disease.

Early Blight
(Alternaria solani)

Description: This disease is caused by the same (or closely related) fungus which causes leaf blight of tomatoes (see page 43). It forms brown, dead spots on the leaves. When the spots are numerous they run together and kill large portions of the leaves, thereby causing a reduction in the yield of potatoes. Early blight makes its appearance usually toward the latter part of April. The disease is influenced by weather conditions; wet, warm weather favors its development.

Control: Early blight can be controlled by spraying with Bordeaux 4-4-50 or some of the other copper sprays. Copper dusts are also effective. It is a question, however, whether or not it is economically profitable to spray for this disease. The severity of the disease and the price of potatoes in any particular year are the chief factors to be considered. In tests made by this department, markedly increased yields were obtained by spraying in 2 out of 3 years. In one year, when the disease was very light, the sprayed plants actually yielded less than the unsprayed. In general, it is not profitable to spray for this disease.

The blight fungus passes the winter on infected plant parts left in the field. For this reason it is not a wise practice to have a spring crop of potatoes in the same field in which a fall crop of potatoes or tomatoes was grown the previous year.

Late Blight
(Phytophthora infestans)

Late blight is another fungus disease. It is the most destructive potato disease in the northeastern States. It is called "late blight" because in the North the disease occurs in late summer. In Louisiana, however, when the disease occurs it appears early in the season—earlier than the "early blight." Fortunately, the disease occurs very rarely in Louisiana. It is a cool, wet weather disease, and so it appears in Louisiana only when unseasonable, cool, wet weather prevails during April.

The late blight fungus is carried in diseased tubers. Certified seed produced in the relatively dry northwestern States is usually (but not always) free of infection. On the other hand, seed grown in the more humid States bordering the Great Lakes and eastward usually contains some infected tubers in spite of rigid inspections.
Description: The blight usually appears first as water-soaked spots on the margins of the lower leaves. These spots enlarge rapidly and soon the entire leaf is killed (Fig 13). A whitish, downy, fungus growth can usually be seen on the under surface of the affected areas of the leaves. If weather conditions are favorable (high humidity and cool temperature), the blight spreads very rapidly and all the plants in a field may be killed in a few days. The blight fungus can also attack the tubers. Affected tubers show reddish-brown areas when cut. Blight-infected tubers may rot in the soil or in storage.

Control: Although late blight rarely occurs in Louisiana, it is potentially such a serious and destructive disease that it is well for the grower to be on the alert for it, especially if the seed he has planted has come from a region where the blight is known to occur. It takes only a few infected tubers in a field to start an outbreak of blight if weather conditions are favorable. The blight can be effectively controlled by spraying with 4-4-50 Bordeaux mixture or with some other copper sprays (see page 89).

Leaf Roll

(Virus)

Description: Leaf roll is one of the many virus diseases (see page 5) of the potato. The virus is carried over in tubers of diseased plants and the disease is spread very rapidly by aphids. The most prominent symptom of leaf roll is the pronounced upward rolling of the leaflets. Other symptoms are stunting of the plant, stiff, leathery texture of the leaves, chlorosis, purplish discoloration of some leaves, and reduction in yield.

Control: Since leaf roll is carried over in infected tubers, the obvious way to control the disease is to prevent it by planting disease-free seed. Plant only certified seed. Seed-producing states have strict rules in respect to seed certification in order to keep virus and other seed-borne
diseases to a minimum. The tolerance for leaf roll permitted by Louisiana is only 2.0 per cent.

**Mosaic**
*(Virus)*

Mosaic is another virus disease. There are several strains of mosaic, differentiated by the symptoms they produce on the plant. Two of the common strains are treated here, namely, "mild mosaic" and "rugose mosaic."

*Mild mosaic* is characterized by mottling—scattered yellowish areas on the green leaf—and by slight crinkling of the leaves. This is a relatively mild disease.

*Rugose mosaic* is a much more serious disease than mild mosaic. There is mottling of the leaves as in mild mosaic and the crinkling of the leaves is very pronounced (Fig. 14). Affected plants are decidedly stunted and die earlier than the healthy ones. Losses from rugose mosaic may run as high as 60 to 75 per cent.

![FIGURE 14.—RUGOSE MOSAIC OF POTATO. A. HEALTHY PLANT. B. PLANT AFFECTED WITH RUGOSE MOSAIC.](image)

*Control:* Same as for leaf roll. Plant certified seed. The tolerance permitted by Louisiana in certified seed are 2 per cent for rugose and 5 per cent for mild mosaic. Of the two principal varieties grown in Louisiana, the Kathahdin is resistant to mild mosaic.

**Haywire**

This disease is of very minor importance but because of the very striking appearance of affected plants in the field it is mentioned here.
Symptoms: There is a delayed emergence of plants from diseased tubers. The plants are severely stunted; the foliage is stiff, brittle, rolled, pointed, and yellowish with purplish discoloration at the tips and margins. Aerial tubers sometimes are formed at the leaf axils. Very few tubers are produced.

The cause of haywire is not definitely known. It is believed that it is a virus disease. Infected plants are worthless and should be removed.

Root Knot

(Heterodera marioni)

The potato is one of many crop plants that are affected by the root knot (gall) nematodes. Swellings or galls form on the roots and tubers. Infected tubers have a knotty, bumpy surface.

The root knot disease is of relatively minor importance. Losses from it are slight, especially on the spring crop which is grown during the cool season. However, care should be taken not to use infected tubers for seed, for that is a very effective way of spreading the nematodes to new fields.

SPINACH

In the past, spinach has been grown in Louisiana only in isolated patches in home gardens, and under these conditions diseases on the crop have not been a problem. In recent years, however, commercial growing of spinach for canning, quick-freezing and dehydrating has come into use, and the acreage devoted to this crop has been on the increase. Judging by what happens in other spinach-growing regions, and also by past experiences when attempts were made to grow spinach on a large scale in this State, diseases in commercial spinach fields are to be expected. It is for this reason that some of the diseases of this crop are included here.

Damping-Off

(Caused by several soil fungi)

Spinach seed responds very favorably to treatment. Better germination, better stand, and less post-emergence damping-off of seedlings are obtained if the seed is treated. The seed may be treated either with Cupro-cide (see page 87), or with Vasco 4 (see page 88).

Downy Mildew

(Peronospora effusa)

Symptoms: Yellowish spots on the upper surface of the leaves and a bluish moldy growth on the under surface of the spots. Later the entire leaf may be killed.

Control: This disease is difficult to control. It can be controlled by copper sprays and dusts, but these leave objectionable residues on the leaves which detract from the market value of the crop. If sprays or dusts are used, applications should stop at least 10 days before harvesting.
White Rust
(*Albugo occidentalis*)

White blister-like spots mostly on the undersides of the leaves. The leaf areas surrounding the spots turn yellow. This is a new disease which appeared in the Winter Garden area of Texas a few years ago, and in some years it has been very destructive. No satisfactory control is known. Thus far, white rust has not been found on spinach in Louisiana.

**SWEET POTATO**

**Black Rot**
(*Ceratostomella fimбриata*)

*Description:* Black rot is a field, storage, and seed-bed disease, the greatest losses occurring in storage. The disease attacks all under-ground parts of the plant. The most conspicuous spots are found on the mature potato, appearing as dark circular to irregular areas varying in size from very small to those which may cover a large part of the potato (Fig. 15). The spots are somewhat depressed and greenish-black in color. The diseased portion of the potato is bitter in taste, and in cooking this bitter taste spreads throughout the entire potato.

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**FIGURE 15.—BLACK ROT OF SWEET POTATO.**

In the bedded potatoes, black spots may occur on the young sprouts. If the sprouts are infected early the stems may be girdled and the plants become dwarfed and yellow.

In the storage house the disease is spread by spores of the disease organism that are produced in small black bodies (perithecia) found near the center of the black rot spots.

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*The section on sweet potato diseases was written by Dr. L. H. Person.*
Control: The best method of control is by the use of clean seed potatoes. Clean seed can be obtained by grading out at digging time all potatoes that show any type of rot. This operation should be repeated again in the spring before the potatoes are bedded. If a large number of black rot potatoes are found, it is advisable to discard the old seed and obtain the best possible certified seed. Seed treatment should be practiced if black rot is present on potatoes that are to be used for seed. For treating seed potatoes, the mercuric chloride method (see page 85) should be used. The seed certification service of the State Department of Agriculture requires that the mercuric chloride method be used if the potatoes are intended for the production of certified seed or plants.

The organism causing the disease lives over in the soil, so at least a 3-year rotation should be practiced.

Stem Rot (Wilt)
(Fusarium batatatis and Fusarium hyperoxysporum)

Description: Stem rot is primarily a field disease, although sometimes it occurs in the seed bed. Diseased plant in the seed bed show a slight yellowing of the leaves, which are also somewhat puckered. Quite often a cluster of plants in the bed shows these symptoms, indicating that they have been produced from a diseased potato. The disease is recognized in the field by a slight yellowing of the leaves. If the plants become diseased soon after being set in the field, or if they are slightly diseased when removed from the seed bed, they are usually somewhat stunted and smaller than the healthy plants. If the cortex (outer covering of the stem) is peeled away the underneath portion of the stem is dark brown in color. This dark brown discoloration may extend several feet into the stem and is the most characteristic symptom of the wilt disease. Sometimes the stems swell and burst near the soil surface, exposing the brown discolored portion of the diseased stem.

Control: This disease is caused by an organism that is capable of living over in the soil for a number of years; therefore, as long a rotation of crops as is practical should be followed—if possible a 4 to 5-year rotation plan.

The disease organism is also carried in the potatoes and this is probably the main way in which the disease is spread from farm to farm. If wilted plants have been seen in the field, seed potatoes should be selected in the fall at digging time. Each hill should be examined by splitting the stems, and potatoes should only be saved for seed from hills which show no discoloration in the stems. The seed potatoes should be stored in clean crates and kept separate from the remainder of the crop. The seed potatoes should be bedded in land which is free from the wilt organism.

At the present time wilt or stem rot is not a serious disease in most of the commercial sweet potato growing area in Louisiana. In northern Louisiana the disease is more serious, due to the fact that the land is more sandy. In the lighter soil types this disease may cause greatly re-
duced yields when introduced into a field, and every precaution should be taken to keep the disease off the farm. If a new farmer goes into sweet potato growing, he should obtain the best possible certified seed potatoes.

**Soil Rot (Pox)**

*Actinomyces ipomoeae*

*Description:* Soil rot has been reported from most of the sweet potato growing states, and has become a serious disease in some areas in Louisiana. The disease is recognized in the field by plants failing to grow or vine in definite localized spots. The spots may be small if the disease organism has been present only a short time, or the entire field may be diseased if the disease organism has been present for several years. The plants in the diseased spots remain small and stunted as though conditions were unfavorable for growth. The leaves are pale green to yellow in color, and many of the plants die before the end of the season. The diseased plants are easily lifted from the ground and the root systems are very poorly developed, most of the roots being entirely rotten. The disease is also found on the mature potatoes as pits or scab spots with irregular jagged or roughened margins, varying from small spots to spots more than one inch in diameter (Fig. 16). Sometimes the spots are so numerous that most of the potato is covered. The roughened appearance of the spots is due to the black granular remnants of the old dead tissue. Sometimes the potatoes are rough and badly misshapen. Late in the season the diseased spots in the field can be located by grassy areas which come in where the plants fail to vine and cover the ground.

The disease is much more severe in dry seasons, especially when a 2 or 3-week dry period follows immediately after the plants are set in the

![FIGURE 16.—Soil Rot (Pox) of Sweet Potato.](image)
field, than in seasons when a large amount of rain falls in May, June, and July. In wet or rainy seasons fairly normal yields of potatoes have been obtained in heavily diseased fields. The same diseased fields in dry seasons have been a total loss, the crop not even being harvested as no vine growth developed and the entire fields were overrun by grass and weeds.

Control: The organism causing this disease lives for a number of years in the soil and every precaution should be taken to keep the disease off the farm. Do not bed potatoes that show any roughened or scabby spots. Do everything possible to keep from spreading soil from a diseased spot into other fields where the disease is not present. In dry seasons sulphur added to the soil at the rate of 500 to 700 pounds per acre, 2 to 3 months before the plants are set in the field, has given fairly satisfactory control. In wet seasons sulphur added to diseased fields has not given enough increase in yield to warrant the use of sulphur as a control measure. Experiments now being carried on indicate that the one application of sulphur will be effective for at least 3 years and possibly longer.

Scurf

*(Monilochaetes infuscans)*

Description: Scurf is found on the underground parts of the plant, primarily on the mature potatoes. It is observed as a brownish to brown-black discoloration of the outer skin of the potato. The discolored areas may be in spots or may cover a greater portion of the potato. The spots are only superficial and do not injure the quality of the potato, although they affect the appearance and grade. The disease is most serious in heavy, poorly-drained soils that have an abundance of organic matter.

Control: (1) Use clean seed potatoes, (2) practice rotation, and (3) in heavy soils do not plant potatoes following a heavy cover crop that has been turned under the previous year.

**TOMATO**

**Damping-Off**

*(Caused by several soil fungi)*

Description: See page 84.

Control: Treat the seed with Cuprocide (see page 87 for method of seed treatment).

**Fusarium Wilt**

*(Fusarium lycopersici)*

Description: This is by far the most serious tomato disease in the southern states. The disease is caused by a soil-inhabiting fungus which penetrates the roots of the plant and grows upward into the vascular bundles of the stem and leaves, causing the plant to wilt and eventually
to die (Fig. 17). The lower leaves are the first to show the symptoms. They wilt, turn yellow, and die. The disease progresses upward gradually until the entire plant is killed. Dark brown discoloration of the inside tissue of the stems and leaf stalks is a characteristic symptom.

FIGURE 17.—Tomato Field Severely Infected with Fusarium Wilt.

Control of wilt: The only effective way to control tomato wilt is to grow wilt-resistant varieties. There are several varieties which are resistant to wilt and which are well adapted to Louisiana growing conditions. At present, the following tomato varieties are most commonly grown in Louisiana: Gulf State Market, Louisiana Gulf State, Dixie, Rutgers, Prichard, Marglobe, and Louisiana Pink. Of these the Marglobe and the Louisiana Pink are resistant to Fusarium wilt, the Louisiana Pink being very highly resistant and the Marglobe only moderately so. The other varieties should not be planted in soil known to be wilt-sick.

Unfortunately, it is a well-known fact that quality and wilt-resistance apparently do not go together. None of the wilt-resistant varieties possesses the quality excellence found in the susceptible varieties. On new soil on which tomatoes have never been grown before, one may succeed in growing a particularly desirable wilt-susceptible variety. For the normal run of the field and garden, however, only resistant varieties should be planted to avoid losses from wilt.
Mention should be made here of the new wilt-resistant variety, the "Pan America." This variety, which has been developed recently by workers of the United States Department of Agriculture, is so highly resistant as to be practically immune. It has good quality fruit. The variety has not been completely pure-lined, and so in a planting a few of the plants may be off-type. The Pan America has not been tested sufficiently for yield and other characters in Louisiana, but because of its very high degree of resistance to wilt its planting is recommended.

**Bacterial Wilt**

*(Phytoponas solanacearum)*

*Description:* This disease differs in symptoms from the common tomato wilt. The leaves wilt rapidly and the plant dies rather suddenly, instead of slowly from the bottom leaves upward as in the case of the Fusarium (common) wilt. The inside of the stem and leaf stalks may be somewhat discolored, but it is not dark brown to black as with the common wilt. The pith of the stem is usually dark-colored.

*Control:* No satisfactory control is known for this disease. The wilt bacteria carry over in the soil from one season to the next and there is strong evidence that they are spread over the field by surface water during heavy rains. Furthermore, the bacteria are not limited to the tomato. They attack potato, eggplant, and several weed plants. They are probably carried on or in the seed. Spread from plant to plant by insects is also likely. All these factors make the control of this disease very difficult. There are no resistant varieties known. The only control measure that can be suggested for the disease is sanitation. Tomatoes should not be planted on the same ground on which the disease was present the previous year. Plant on well-drained soil to prevent the spread of the disease by surface water during heavy rains.

Fortunately, bacterial wilt is usually not severe in an average year. There are local outbreaks every year, sometimes very severe. In the spring of 1942, for example, bacterial wilt was very prevalent and very destructive in the vicinity of Baton Rouge. In general, however, the losses from this disease are minor.

**Early Blight and Nailhead Spot**

*(Alternaria solani)*

There is some disagreement among pathologists as to whether early blight of the tomato leaves and nailhead spots of the tomato fruit are two distinct diseases caused by two closely related fungi, or whether the foliage and fruit symptoms are expressions of one and the same disease. For practical purposes this question is not important, and in this bulletin early blight and nailhead spot will be treated as one disease.

*Description:* The disease may attack plants at almost any stage of their development, in the cold frame or in the field. However, in what we may term a normal growing season the disease makes its appearance after
the plants have been set out in the field, usually about blossom and fruit-setting time. The first sign of the disease is the appearance of small brown spots on the lower leaves. These spots enlarge (Fig. 18), and the leaf gradually turns brown, dries up, and dies. The disease progresses upward, the lower leaves being killed first and later the upper ones. In a badly blighted plant all lower leaves are dead and the upper ones are covered with brown spots of different sizes. Spots also often develop on the stems.

In a normal season spots do not develop on the fruit. If seasonal conditions are favorable for the development of the disease, however, the fruit may become severely spotted. This phase of the disease is called the nailhead spot (also termed "nailhead rust" by some growers). The spots on the fruit appear first as small, shallow, gray or tan specks anywhere on the fruit surface. Later the spots enlarge, becoming grayish-black and sunken. The color of the spots varies somewhat with the age of the fruit, but in general they are sunken, grayish-white in the center, with dark-brown to black borders.

It is the nailhead spot (fruit-spotting) phase of the disease that is most destructive and of the greatest economic importance. Under favorable

FIGURE 18.—Tomato Leaves Spotted by the Alternaria Blight.
conditions the fruit will spot not only in the field but also in storage or in transit. Fortunately, the fruit is not affected every year in Louisiana. In fact, the fruit-spotting phase of the disease occurs very seldom in this State.

Control: This disease can be effectively controlled by spraying with copper fungicides, especially with Bordeaux mixture. The question still remains, however, whether or not it pays to spray for this disease. Tests over a period of years, both in Louisiana and in other states, have shown that in a normal year (when the disease was not particularly severe) tomato plants sprayed with Bordeaux actually yielded less than those left unsprayed, even though the spray gave a good control of the disease. The reason for this is that Bordeaux causes a certain amount of injury to tomatoes. Bordeaux causes stunting of the plant, shedding of some of the blossoms, and delayed ripening of the fruit. The delayed ripening of the fruit is especially important in the case of commercial plantings, for the early fruit sells at a higher price. In "bad" disease years (when there is a rapid spread of the blight to the upper leaves and to the fruit) it would certainly pay to spray. The difficulty is that it is not always possible to predict a "bad" disease year. To get around the Bordeaux spray injury, several of the so-called insoluble copper compounds have come into use in recent years. Several of these have proved fairly satisfactory without solving the problem entirely, for those that are not harmful to the tomato plant are also not very effective in controlling the disease.

Another point to consider in discussing control measures for tomato blight is the kind of planting. In a commercial field the object is to get as high a yield as possible as early as possible. In a home garden, high yields and earliness are not important. The object for the home garden should be to maintain the plants in a healthy condition for as long as possible so as to prolong the picking season and have fresh fruit for the home over a long period. It is therefore advisable that the tomatoes in the home garden should be sprayed.

Spray Recommendations for Tomatoes

1. For the home garden: Spray with 2-2-50 Bordeaux mixture (2 lbs. bluestone, 2 lbs. hydrated lime, 50 gallons of water). Begin spraying about the time the plants have begun to set fruit, and spray about every 10 days. Cover both surfaces of the leaves thoroughly.

II. For the commercial planting: Watch your plants. As long as the spots are limited to the lower leaves, do not spray. If the spots begin to spread to the upper, younger leaves early in the season (late May or early June), then begin to spray and spray about every 10 days. Use either 2-2-50 Bordeaux or some of the Bordeaux substitutes that are on the market, such as Sprycop, Cuprocide, Tri-basic copper sulphate, etc. These commercial copper compounds differ widely in the percentage of copper they contain so it is well to follow the directions of the manufacturer as to what amount to use.
A copper dust may be used instead of a spray. There are several such prepared dusts on the market (such as Copox, Tri-basic, Cuprocide, etc.) which can be easily obtained from any seed store or farmers’ supply house. These should be used according to the recommendations of the manufacturer. The dust has some advantages over the spray. It is less harmful to the plant than the spray and it is easier to apply. The main disadvantage of the dust is that it does not stick as well as the spray and it may be washed away by rains.

**Mosaic**

**(Virus)**

**Symptoms:** There is considerable variation in the appearance of mosaic symptoms depending on growth conditions, strain of mosaic, stage of growth at which the plant became infected, etc. In general the leaves of mosaic-infected plants are mottled with light green or yellowish areas interspersed among the normal green color of the leaves. The leaflets are stunted and considerably distorted and malformed. Sometimes the leaflets become narrow, ribbon-like. When infection starts early the entire plant becomes much stunted and is practically worthless. If the plant becomes infected when full grown, the damage from mosaic is very small.

**Control:** Mosaic is a systemic disease. By this is meant that the causal agent of the disease is in the sap of the plant. Sprays and dusts, therefore, are ineffective against mosaic. Prevention is the only practical control measure against this disease. Mosaic is very infectious. It is spread by insects and by the handling of the plants by the workers, especially during the transplanting and pruning operations. The following preventive measures are recommended:

1. Prevent infection in the seed bed and cold frame by spraying periodically with nicotine (Black Leaf 40) to kill the plant lice. This is important, for plants which become infected when very young are worthless.

2. Since mosaic can be spread very easily from diseased to healthy plants by means of the pruning knife, reduce the pruning operation to a minimum. Remove the side shoots up to the first flower cluster then prune no more. Most of the suckers and side shoots can be jerked off by hand without using a pruning knife and without touching the rest of the plant.

3. Do not plant the fall crop of tomatoes near any surviving plants of the spring crop. By the end of the summer any surviving tomato plants from an early planting are almost invariably infected with mosaic which may easily spread to the new plants by insects. Also the fall crop should, as far as possible, be planted away from peppers and from garden flowers such as petunias and zinnias, for the mosaic virus can infect all these, as well as many other plants.

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Root Knot

(*Heterodera marioni*)

Root knot is a disease familiar enough not to need description. It is caused by a soil-inhabiting microscopic worm (nematode) which invades the root tissues causing them to form the familiar galls or knots (Fig. 19). Nematodes occur universally in the soils of regions with mild winters such as those prevailing in the South. They attack a very large number of plants. Among the vegetable crops, tomatoes and cucumbers are very susceptible. Nematodes are especially troublesome in light sandy soils.

No practical control is known for nematodes under normal field conditions. As far as possible tomatoes should not be planted on light sandy soil which is infested with nematodes. This is especially true in the case of the fall crop of tomatoes. The spring crop is planted while the temper-
ature of the soil is still relatively cool and the nematodes are not very active; thus the plants escape heavy nematode infestation in the early stages of their growth. For this reason the damage to the spring crop of tomatoes from root knot is usually not so severe as on the fall crop. If a piece of ground becomes heavily infested with nematodes, partial relief may be obtained by keeping the land clean-cultivated during the warm season of the year, or by planting a root-knot resistant crop such as corn, sorghum, velvet bean, peanuts, or the Iron Clay variety of cowpea for two or three successive years. When such root-knot resistant crop is planted it is essential to cultivate between the rows to destroy the weeds because many of the weed plants are susceptible to the root-knot nematodes.

**Southern Wilt (Southern Blight)**
*(Sclerotium rolfsii)*

This disease causes the death of an occasional tomato plant in the field, but it is of minor importance. (See under pepper, page 30).

**Blossom-End Rot**
*(Non-parasitic)*

This is a disease of the fruit. For the most part it affects fruit that is about half grown, but it may be found on very young fruit (buttons) or on fruit that is nearly mature. It always affects the blossom-end part of the fruit. The rot starts as a water-soaked spot which enlarges, turns brown in color, and becomes dry, flat, or sunken. Later the killed tissue may be invaded by secondary organisms and become black and hard or soft and watery.

The cause of the blossom-end rot is not definitely known. It has been definitely established that the disease is not caused by any parasitic organism. Therefore, spraying or dusting will not control it. The disease is physiological in nature, that is, it is brought about by some disturbance of the normal growth of the plant. It has been found that the disease is worse where the nitrogen part of the fertilizer is supplied from manure or from other organic nitrogenous materials such as dried blood or cottonseed meal than where nitrate of soda has been used. Also, abrupt changes in weather conditions, especially drought following a wet spell, brings about an increase in blossom-end rot. No practical control measure is known for this disease. Some varieties are less subject to this disease than others. Of the varieties currently grown in Louisiana, Marglobe and Prichard are the least susceptible.

**Other Rots of the Tomato Fruit**

There are several other rots of the tomato fruit caused by different parasitic organisms, such as the Anthracnose rot (caused by the fungus *Colletotrichum phomoides*) and the Phoma rot (caused by *Phoma destructiva*). While these and other rots are usually initiated in the field, they are primarily diseases of storage and will not be discussed here.
TURNIP

The turnip, like many other members of the crucifer family of plants, is a cool weather plant. During the cool seasons of the year it grows well and is free from any serious diseases. In recent years, some attempts have been made to grow turnips in the summer (late July or early August), and these attempts almost always have resulted in failure. Diseases are the chief factor for this failure. Two diseases—web blight and white spot—are especially destructive.

Web Blight
(Rhizoctonia microsclerotia)

For description, see page 8.

White Spot
(Cercosporella albomaculans)

Description: The white spot disease is caused by a fungus parasite. The disease is characterized by white or ashen-colored dead spots on the leaves. These spots vary in size from about one-eighth to one-fourth inch in diameter and are circular to angular in outline. When the spots are numerous the plant turns yellow, shrivels, and dries up ("scorches").

Control: White spot can probably be controlled by spraying with 4-4-50 Bordeaux mixture, but we have no information on this subject based on experiment. Even if it be assumed that this particular disease can be kept in check by spraying, it would still be impractical to try to grow turnips in the summer because of other diseases. No control is known, for example, for web blight (see page 8). The only practical way of avoiding diseases of turnip is to refrain from attempting to grow this cool-weather crop during the hot summer months.
Section II. Fruit Diseases

APPLE

Fire Blight
(\textit{Erwinia amylovora})

See pear, page 70. Apples are more resistant to fire blight than pears.

Rust
(\textit{Gymnosporangium spp.})

\textit{Description:} The rust fungus passes part of its life on the apple and part on the cedar (Fig. 20). On the cedar it forms the well-known swellings or galls ("cedar apples"). On the apple it causes spots on leaves, fruit, and sometimes on young twigs. The spots on the leaves and fruit are orange-yellow in color and a blister or cushion forms in the center of each spot. Later, minute cup-like structures form on the blistered area of the spot.

\textit{Control:} Since the rust requires both the apple and the cedar to complete its life cycle, the most effective way to control it is to eliminate the
cedar trees. In many of the commercial apple-growing regions, the general practice is to destroy all cedars for a distance of about one mile around the apple orchard. In Louisiana, where apples are not grown commercially, this method cannot be recommended, for the cedars are usually more valuable than the apples.

Spraying with Bordeaux or lime sulphur, or dusting with sulphur can control the rust, but this is not practical for the average grower, because about 7 applications of spray or dust are necessary and these have to be made at the critical period during which the rust is discharging its spores from the galls of the cedars. If spraying or dusting is not done at the right time, no control is obtained.

**Fruit Rots**

Several fungus diseases affect the apple fruit at various stages of its development, causing various spots and rots. The most important of these are:

1. **Blotch:** Dark-brown to black blotches with irregular margins on the fruit. Small, angular spots on the leaves, and cankers on the twigs.
2. **Black rot:** (See pear, page 74).
3. **Bitter Rot:** Sunken, more or less watery, pinkish to brown rot spots on the fruit.

**Spray Schedule for Apples**

<table>
<thead>
<tr>
<th>TIME</th>
<th>Spray Mixture</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dormant</strong></td>
<td>Oil emulsion 2 gal. Water 50 gal.</td>
<td>San Jose Scale</td>
</tr>
<tr>
<td><strong>Pink clusters, buds separated</strong></td>
<td>Liquid lime sulfur 1 gal. Water 50 gal.</td>
<td>Scab</td>
</tr>
<tr>
<td><strong>Calyx</strong> (1/4 petals fallen)</td>
<td>Liquid lime sulfur 1 gal. Hydrated lime 3 lbs. Lead arsenate 1 1/2 lbs. Water 50 gal.</td>
<td>Scab, Codling moth worms</td>
</tr>
<tr>
<td><strong>Two weeks after petals fall...</strong></td>
<td>Same as calyx spray</td>
<td></td>
</tr>
<tr>
<td><strong>When apples are well grown, but not ripening...</strong></td>
<td>Hydrated lime 3 lbs. Copper sulfate 3 lbs. Lead arsenate 1 1/2 lbs. Water 50 gal.</td>
<td>Codling moth, Bitter rot, Blotch</td>
</tr>
<tr>
<td></td>
<td>Four pounds of dry lime sulfur may be substiuted for one gallon of liquid lime sulfur</td>
<td></td>
</tr>
</tbody>
</table>

**Control:** In commercial apple orchards the various fruit rots are effectively controlled by following rigid spraying schedules. In small home

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9This spray schedule was prepared by C. O. Eddy and A. G. Plakidas of The Louisiana Agricultural Experiment Station, with the advice of Horticulturists, Extension Specialists, Agricultural leaders and growers.

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orchards where facilities for adequate spraying are usually lacking, control of these diseases is difficult. Sanitary measures are helpful in keeping them in check. All dead wood and all rotted and mummied fruit should be removed and burned. The spray schedule, if followed, will insure reasonably clean fruit, although it is not calculated to give complete control.

**BLACKBERRY AND DEWBERRY**

**Leaf Spots**

There are several fungi which cause spotting of the foliage of blackberries and dewberries (Fig. 21). Two of these, *Cercospora rubi* and *Septoria rubi*, are the most common ones in Louisiana. Sometimes these leaf-spotting diseases cause considerable defoliation of the plants by late summer, and this naturally affects the vitality of the plants and their fruitfulness the following spring.

![Fig. 21: Septoria Leaf Spot of Blackberry](image)

**FIGURE 21.—Septoria Leaf Spot of Blackberry.**

*Control:* No tests have been made in Louisiana aimed directly toward the control of blackberry and dewberry leaf spots. However, in the course of some spraying experiments for the control of the rosette disease
(See below), it was noted the 4-4-50 Bordeaux mixture controlled the leaf spots very well. The sprayed plants reached late summer with green foliage while the non-sprayed ones were badly spotted and defoliated. Whether or not it would be economically profitable to spray blackberries and dewberries for the control of the leaf spots is a matter for the grower to determine, but it would seem that one application of 4-4-50 Bordeaux before blooming and about two more applications later on, during June and July should keep the leaf spotting diseases in check.

**Cane Blight**

In the spring, some of the fruit canes appear weak and have dead patches or cankers on the bark. As the weather warms, some of these die back. There are several fungi that can cause cane blight. *Leptosphaeria coniothyrium* is the most common one in Louisiana. Winter injury is a contributing cause. This is especially true in South Louisiana where the plants do not become dormant in the fall but continue active growth until there is a killing frost.

**Control:** Cut out and burn all the old canes as soon as the fruit is harvested. This will not completely control cane blight, but will help by eliminating the main source of infection.

**Rosette**  
(*Cercosporella rubi*)

**Description:** The rosette disease is very striking and very easy to recognize (Fig. 22). In the spring diseased canes give rise to multiple shoots which produce a bunchy type of growth (witches' brooms). The diseased flower buds are loose, puffy, and elongated, instead of being round and compact like the healthy ones. Diseased flowers do not set fruit and sometimes the flower parts become leaf-like in growth. After the flowers begin to wither they become covered on the inside with a white powder which is made up of the spores of the fungus.

**Control:** Control measures recommended for rosette will be better appreciated if a brief description is given of the cycle of development of the disease. The fungus (*Cercosporella rubi*) which causes the rosette disease produces spores only on the withered blossoms in the spring. When the spores fall on the new canes they germinate and grow inside the buds. Infected canes do not show any disease symptoms until the next spring. The period during which the new canes are susceptible to infection is limited. No infection takes place after about the first of June.

**Summary of Control Measures**

1. Do not allow any wild blackberries or dewberries to grow close to your berry plantings, as the rosette disease will spread from the wild to the cultivated vines.

2. Inspect the plantings in the spring and remove any rosette growth that may be present. This will eliminate the source of infection from the...
immediate vicinity of the plants. This cutting off of the rosette growth should be done early in the spring (preferably in February) before the opening of the blossoms, that is, before the spores of the fungus have been formed.

3. Prune all the new canes to the ground about the first week in May. This will eliminate all the canes that may become infected up to this period.

4. Spray the new canes that develop from the time of pruning until the first week in June with 4-4-50 Bordeaux. The spraying should be done about every 10 days. Two to three sprayings should be sufficient.

5. Do not plant dewberry plants that come from tip layering of rosette canes.
Rust

Description: Two kinds of rust occur on blackberries and dewberries, the orange rust (*Kunkelia nitens*) and the yellow rust (*Kuhneola uredinis*).

The orange rust forms orange-colored masses of spores on the undersides of the leaves. It occurs just as soon as growth starts in the spring and usually covers all the new growth of the plant.

The yellow rust appears later and occurs as scattered yellow pustules mostly on stems, but also on leaves, throughout the summer and fall.

*FIGURE 23.* Scab on Sour Orange.

Control: The yellow rust is not important and there is no need to attempt to control it. The orange rust, on the other hand, is very destructive. It is systemic within the roots and crown of the plant and therefore
it cannot be controlled by sprays or dusts. The affected plants should be dug up, roots and all, and burned.

Crown Gall

See peach, page 68.

CITRUS

Citrus trees and their fruits are subject to a very large number of diseases. No attempt is made to describe or discuss all the citrus diseases in this popular bulletin. Only the most common ones are considered.

Scab

(Sphaceloma fawcettii)

Scab is primarily a disease of satsuma orange, tangerine, grapefruit, lemon, sour orange, and Citrus trifoliata. It does not affect the sweet orange. Scab affects fruit, leaves, and young shoots, causing irregular, raised, corky, scabby, wart-like outgrowths (Fig. 23). Severely scabbed leaves and fruits become misshapen and distorted. The rind of scabbed fruit is thick and puffy.

Control: Scab control is based on the fact that infection occurs only on young, immature growth, provided there is sufficient moisture in the atmosphere and that the temperature is neither too high nor too low (about 59° to 74° F. is the optimum). This combination of conditions usually prevails during the flush period of growth in the spring and it is during this period that the trees should be sprayed. (See Spray Schedule, page 59).

Melanose

(Diaporthe citri)

Description: Like scab, melanose is caused by a fungus (Diaporthe citri), and it also affects leaves, shoots, and fruit. It forms very numerous, dark brown dots or spots on the leaves, young shoots, and fruit (Fig. 24). These spots are at first sunken, but later become raised so that the rusted area has a rough, sand-paper feel. The spots may be irregularly scattered on the surface of the fruit, or they may run in streaks (“tear-stains”). Like scab, melanose infection occurs only on young, tender growth. The fruit becomes progressively resistant with age. However, the same fungus that causes melanose can infect the ripe fruit after harvest. It is one of the two most common causes of the very destructive fruit decay known as stem-end rot. Control of melanose, therefore, helps to reduce the losses from stem-end rot.

Control: Two methods are used for the control of melanose, sanitation and spraying.

1. Sanitation: The melanose fungus does not produce spores on the living parts of the plant (leaves, shoots, and fruit), but only on dead
twigs and branches. Therefore, pruning and burning the dead wood is a great help in controlling this disease because the practice eliminates much of the source of infection.


**FIGURE 24.—MELANOSE ON SWEET ORANGE.**

**Sooty Mold**

*Description:* The sooty mold fungus (*Capnodium citri*) is not a parasitic organism. It does not penetrate the tissue of the plant but grows superficially on the honeydew excretions of white flies, aphids, and scale insects. Sooty mold causes a certain degree of injury when its growth is very thick by preventing the sunlight from reaching the leaf, and by making the fruit black and unattractive. Fruit that is covered with sooty mold is smaller in size and does not color well.
Control: Sooty mold is controlled indirectly by controlling insects (white flies and scale) which excrete the honeydew on which the sooty mold fungus grows. When these insects are killed the sooty mold disappears. See Spray Schedule, page 59.

Lichens

Description: Growth of different kinds of lichens (commonly called "moss," locally) often occurs on trunks, branches, and sometimes on leaves of citrus trees. Lichen growth is less abundant on healthy, vigorous trees than on neglected, weakened trees which are growing poorly. For this reason the presence of lichens is often blamed for the unthrifty condition of the trees, when in fact the reverse is true; the lichen growth is abundant because the tree is unthrifty from some other cause. Lichens are generally considered harmless. They are not parasitic, do not invade the tissue of the bark, and cause no damage to the tree. An exception to this general statement may be made in the case of one kind of lichen (Melanotheca sp.). This species, which makes a grayish, compact, pimply type of growth on trunks and branches, probably causes a slight damage. The bark underneath the lichen growth, although not killed, appears damaged. It is somewhat sunken and brownish in color.

Control: Lichens are easily controlled by spraying with Bordeaux. The regular spray schedule (page 59) for the control of other diseases is usually sufficient to control the lichens also. If desired, stronger concentrations of Bordeaux mixture, 4-4-50 or 5-5-50, may be applied to the trunk and branches for the control of lichens.

Fruit Rots

Because the bulk of the fruit is sold locally, mostly on the New Orleans market, almost as soon as it is picked, the Louisiana citrus grower is not confronted with the serious problems of storage and transit rots that the citrus shipping states have to face. This does not mean that fruit rots are not important. Even though the grower may dispose of his fruit before it rots, some one along the line, whether it be the commission merchant, the grocery man, or the housewife, will suffer a loss if the fruit rots before it is consumed, and this loss will ultimately be passed back to the grower in the form of lower prices. Therefore, every effort should be made to prevent fruit decay.

In considering means of keeping losses from fruit rots to a minimum, the following facts should be kept in mind: (1) fruit rots are caused by parasitic fungi (molds) which invade the tissue of the fruit and cause it to rot; (2) these molds infect the fruit for the most part through cuts, wounds, bruises, thorn pricks; (3) the spores of these molds are produced in vast numbers on dead twigs and branches and on rotten fruit; (4) moisture is necessary for the germination of the spores.

With these facts in mind, the precautions to be taken for preventing fruit rots are obvious. Fruit should not be picked when wet, or, if picked when wet, provisions should be made for drying it as soon as possible
after it is picked. Dead wood of all kinds should be removed from the trees. This practice will help to keep down the losses from stem-end rot. Also, since one of the fungi which causes stem-rot is the same fungus which causes melanose, spraying for melanose helps to prevent stem-end rot. Every effort should be made to prevent injury to the fruit during the operations of picking and packing. The pickers and packers should be provided with gloves to prevent nail scratches. The boxes should be kept clean and in good condition with no splinters or protruding nails.

### Spray Schedule for Citrus

This program was arranged and was revised on January 30, 1942, by a committee of growers and technical men at a meeting in Plaquemines Parish. It is based on information supplied by the Louisiana Agricultural Experiment Station, Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, Louisiana State Department of Agriculture, the Louisiana Agricultural Extension Department, the Citrus Experiment Station of the University of Florida, and Plaquemines Parish County Agent.

<table>
<thead>
<tr>
<th>Time</th>
<th>Sprays or Dusts</th>
<th>For Control of</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*  Pregrowth sprays.</td>
<td>A. For all fruits except satsumas: Liquid lime sulphur 11/2 gals. per 100 gals. water plus 6 lbs. of wettable sulphur. Or dust with sulphur if sprayer is not available.</td>
<td>Rust Mite</td>
</tr>
<tr>
<td></td>
<td>B. For Satsumas: Bordeaux mixture 3-3-100 or its fungicidal equivalent in other recommended forms of copper. Six pounds of wettable sulphur should be added.</td>
<td>Scab Rust Mite</td>
</tr>
<tr>
<td>2*  One to four weeks after blooms.</td>
<td>Bordeaux mixture 3-3-100 with 6 lbs. wettable sulphur</td>
<td>Melanose Rust Mites Scale Crawlers Lichen (Moss)</td>
</tr>
<tr>
<td>(Stop approximately four weeks after blooms)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3*  June and early July</td>
<td>Oil emulsion 11/4 to 1 1/4% actual oil. Spray leaves, twigs, and all wood thoroughly. (See footnote on oil).</td>
<td>Purple Scale Red Scale Other Scale White Fly Red Spider</td>
</tr>
<tr>
<td>4. September and October. For all varieties except Satsumas use A or B or both at proper interval. See note on oil.</td>
<td>A. Oil emulsion 11/4 to 1 1/4% actual oil. (See note on oil)</td>
<td>Red Spider Purple Scale White Fly Red Scale</td>
</tr>
<tr>
<td></td>
<td>B. Sulphur spray: 1 gal. liquid lime sulphur with 6 lbs. wettable sulphur or sulphur dust.</td>
<td>Rust Mite</td>
</tr>
</tbody>
</table>

*The sprays marked with an asterisk are most important ones for the home orchard.

**Caution:** Oil and sulphur are not compatible and will cause severe injury if mixed. Never mix oil and sulphur in the same spray, and always allow at least three weeks interval between oil and sulphur applications.
No decaying fruit should be allowed to stay in or in the vicinity of the packing house. If the fruit is washed, it should be dried as rapidly as possible. Borax, at the rate of 5 to 8 per cent, either in the wash water or in a separate dipping tank, helps to keep down fruit rot.

**Nutritional Troubles**

It is known that some nutritional troubles, brought about by deficiencies in one or more of the so-called "minor" elements (zinc, manganese, copper, etc.), do occur in some of the groves in Plaquemines Parish. These deficiency troubles are characterized by various chlorotic patterns on the leaves, by die-back of the twigs, by growth abnormalities, etc. These troubles have not been studied sufficiently in this State to be well understood or to make recommendations for their correction.

**FIG**

*(Caused by several species of Corticium)*

The Corticium leaf blight is the most serious disease affecting fig trees in Louisiana. There are three different fungi (Corticiums) that cause blighting of fig leaves. They are very much alike in general symptoms and the control measures are the same for all three types; for this reason they are grouped together.

Leaf blight usually appears late in May or early in June. The worst damage usually occurs during the prolonged rainy spells. Leaves and fruit are attacked by the leaf blighting fungi. The injury is confined to the loss of leaves and fruit.

*Description:* The blight first shows up as irregular-shaped brown spots on the leaves. Infection usually starts at the base of the leaf and spreads in a fan-like manner, forming a large semi-circular brown discolored dead spot. Infected leaf tissues may shrivel up and fall out, producing a shot-hole effect, or the edges of the leaves may slough off, leaving them quite ragged in appearance. Some leaves may have the white or light brown colored, powdery-looking fruiting layer of the *Corticium* on the lower surfaces. When conditions are favorable, large numbers of leaves may be completely killed within a few days, leaving some limbs completely bare. Most of the damage occurs before the fruit ripens. On the limbs where the leaves are killed the fruit usually shrivels up or does not ripen properly.

The three fungi that cause leaf blight of fig are: (1) *Corticium stevensii* (the threat blight fungus) which produces small, brown, shiny hyphal threads on the small twigs, petioles, and leaves, and irregular-shaped, brown sclerotia on the twigs (Fig. 25). Leaves killed by this fungus usually hang on to the twigs by the small hyphal threads in a characteristic way. (2) *Corticium microsclerotia* is characterized by the production of large numbers of small, brown sclerotia about half the size

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10The section on Fig diseases has been prepared by Dr. E. C. Tims.
of mustard seed on the twigs, fruit, and leaves. (3) An undetermined species of *Corticium* which differs from the other two forms in the absence of any definite sclerotia or hyphal threads.

**FIGURE 25.—THREAD BLIGHT ON FIG.**

*Control:* Two types of sprays have been used successfully for the control of fig leaf blight. A dormant spray mixture applied during the winter when the trees are free of leaves has been effective in the control of thread blight. The dormant spray mixture consists of copper sulphate 1½%, lime 1%, zinc arsenite 1%, monocalcium arsenite ¼%, and fish oil 1% (the percentages being by weight except the fish oil, which is measured by volume). One application of this spray mixture in December or January
is usually sufficient for the control of thread blight. It should never be applied when the leaves are on the trees.

The arsenite (dormant) spray has been effective in the control of leaf blight caused by *Corticium microsclerotia*, or *Corticium sp.*, except in certain seasons when there was excessive rainfall in June and early July. Under such conditions one application of Bordeaux mixture (4-4-50) made between May 10 and June 1 has controlled the leaf blight caused by the two above mentioned fungi.

If fig trees are slightly diseased (that is, if only a few dead leaves appear during June or early July) one application of Bordeaux mixture is sufficient to control the disease. If trees are known to be severely diseased (large areas of dead leaves before the fruit ripens) a combination of the dormant (arsenite) spray and Bordeaux mixture may be necessary.

**Rust**

(*Physopella fici*)

*Description:* Rust is caused by *Physopella fici*, a fungus which is widespread over the State. It first appears as small yellowish to reddish pustules on the lower surface of the leaves, which enlarge and become more numerous until almost the entire surface may be involved. Many fig trees are completely defoliated by rust before the end of the summer, although the disease seldom develops early enough to damage the leaves seriously before the fruit ripens. The only serious aspect of the disease is premature defoliation of the trees.

*Control:* Measures used in the control of fig leaf blights have reduced the amount of rust to some extent.

**Cercospora Leaf Spot**

*Description:* This leaf spot, caused by *Cercospora fici*, is widespread in the State but causes only slight damage. The spots are brown in color, roughly circular in shape, and vary in size up to about ½ inch in diameter. The spots may coalesce to form larger areas of dead tissue.

*Control:* Control measures are usually unnecessary. Bordeaux mixture applied in May or early June will greatly reduce Cercospora leaf spot.

**Limb Blight**

*Description:* This disease is caused by the fungus *Corticium salmonicolor*. It is characterized by the sudden dying of twigs or branches up to 2 inches or more in diameter, with the production of bright pink color on the bark of the diseased twig. The leaves on the dead twigs usually turn a dark brown color and hang on for weeks after they are killed. This type of limb blight often recurs in the same trees year after year, sometimes causing considerable damage.

*Control:* No effective control measures are known. Pruning out diseased branches should be of some help.
Fig Canker

The fig canker is caused by the fungus *Tubercularia fici*. It is widely scattered over the State and causes some damage to many trees. The cankers appear as irregular-shaped swellings with sunken areas in the center. They partially girdle the twigs and small branches, killing some and weakening others so they break easily.

*Control:* The cankers should be cut out.

Stilbum Disease

*Description:* This disease is caused by a fungus called *Stilbum cinnabarum*. It causes a dying of twigs and even limbs on fig trees. Diseased areas are characterized by the presence of small pink fungus heads borne on short stalks growing on the bark. Infection takes place through wounds of various types, and may occur through the leaf scars on small twigs.

*Control:* Control measures are rarely necessary for the Stilbum disease, but where it occurs, the infected branches can be pruned out.

GRAPE

In discussing diseases of grapes, the varieties of grapes grown should be considered. Grapes are not grown commercially to any extent in Louisiana. In home gardens, two types of grapes are grown, the muscadines and the American bunch grapes.

From the practical standpoint, the muscadines are relatively free from diseases. The black rot fungus causes considerable spotting of the foliage, especially of the Scuppernong variety, but it does not affect the fruit to any appreciable extent. Two other fungi, *Cercospora sp.* and *Isariopsis clavispora*, also cause spotting of the leaves late in the season but they are not serious. In general, it may be safely stated that none of the diseases affecting the muscadine grapes causes sufficient damage to justify control measures.

The bunch grapes, on the other hand, are subject to many serious diseases, and unless one is prepared to practice control measures, one should not attempt to grow bunch grapes in Louisiana. The following are among the most important diseases of bunch grapes.

Black Rot

(*Guignardia bidwellii*)

*Description:* The black rot fungus affects the leaves, berries, fruit stems, and sometimes the young canes. It causes numerous definite brown dead spots on the leaves. The berries are affected in all stages of their development but most severely when they are one-half to two-thirds grown. The rot on the berries starts as a purplish or brown spot which spreads fast, and soon rots the entire berry which turns black in color and later...
dries and shrivels. The dried, mummified berries remain attached to the stem.

*Control: See Spray Schedule.*

**Anthracnose**  
(*Elsinoe ampelina*)

*Description:* Like the black rot, the anthracnose fungus attacks the leaves, shoots, fruit stems, and berries. On the leaves the spots are small, angular, with pale-brown centers and reddish-brown margins. On the berries, the spots are circular, sunken, and each is surrounded by a purplish to dark-colored border. The appearance of the rotted spots on the berries has given this disease the common name of “bird’s eye rot.” Spots, somewhat similar to those on the berries, develop also on the young shoots. Sometimes the spots are so numerous that the young shoots are girdled and killed.

*Control: See Spray Schedule.*

**Crown Gall**  
(See Peach, page 68.)

**Root Rot**  
(Oak root fungus. See Pear, page 73.)

**Spray Schedule for Grapes**

<table>
<thead>
<tr>
<th>Application</th>
<th>Time</th>
<th>Spray Mixture</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dormant season</td>
<td>Concentrated lime-sulfur</td>
<td>Anthracnose, scale, and black rot spores</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>1 gallon 8 gallons</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>New growth about 1” long</td>
<td>4-4-50 Bordeaux</td>
<td>Anthracnose and black rot</td>
</tr>
<tr>
<td>3</td>
<td>Pre-blossom when first blossoms are opening</td>
<td>Same as preceding spray. Add to each 50 gallons of spray 1 lb. calcium arsenate, ½ lb. soap chips, or 1 pint of liquid soap as a spreader to make the spray adhere.</td>
<td>Anthracnose, black rot, leaf-chewing insects.</td>
</tr>
<tr>
<td>4</td>
<td>Post-blossom when bloom is nearly complete</td>
<td>Same as above</td>
<td>Anthracnose, black rot, leaf-chewing insects.</td>
</tr>
<tr>
<td>5</td>
<td>2 weeks after 4 application</td>
<td>4-4-50 Bordeaux</td>
<td>Anthracnose, black rot</td>
</tr>
<tr>
<td>6</td>
<td>When fruit is about half-grown</td>
<td>4-4-50 Bordeaux</td>
<td>Black rot and other fungus diseases</td>
</tr>
</tbody>
</table>

**PEACH AND PLUM**

Peach and plum are grouped together here for the reason that these two crops have many diseases and insect pests in common, and for the most part the same control measures are applicable to both.
Scab

Description: Scab is caused by a fungus, *Cladosporium carpophilum*. It is characterized by greenish to black spots on the peach fruit (Fig. 26, A). The spots are usually localized on one side of the fruit near the stem end. When the infection is severe, the scabby part of the fruit cracks. The disease also forms irregular blotches on leaves and small cankers on tender twigs.

Control: See spray schedule, page 69.

Bacterial Leaf Spot and Cankers

This bacterial disease (caused by *Phytomonas pruni*) affects both peach and plum. It causes "shot-hole" spots on the leaves and roughening and spotting of fruit. Affected areas or spots on the fruit are usually sunken. It also causes small, thick-edged cankers on twigs and large cankers on branches and trunks.

Control: (1) As a preventive measure, nursery stock should be carefully inspected and any trees showing swollen cankers on the twigs should be discarded. (2) The more vigorous the growth of the tree, the more resistant it is to this disease. Therefore, good growing conditions by fertilization and cultivation should be maintained. Nitrogenous fertilizers are especially helpful. The application of nitrate of soda during the winter is recommended. (3) Spraying with zinc sulphate and lime (4 lbs. of zinc sulphate, 3 lbs. of hydrated lime, 50 gallons of water) gives a certain degree of control.
Leaf Curl

Description: This disease, which is one of the most serious diseases of the peach in most parts of the world, occurs only very rarely in Louisiana and it is of decidedly minor importance. It is due to a fungus (*Taphrina deformans*) which causes the young leaves to become thickened, twisted, curled and distorted (Fig. 27). The thickened portions of the leaf are pinkish with a whitish surface. Affected leaves fall off, resulting in defoliation of the tree. The fruit and tender twigs may also be affected.

Control: Since leaf curl occurs only rarely in Louisiana, and when it does occur the infection is usually not severe enough to cause much damage, control measures are probably not justified. However, this disease can be controlled very easily by one application of lime sulphur (1 gallon in 8 gallons of water) during the dormant season (December-January). In the spray schedule (page 69) no provision is made for the control of leaf curl. If it becomes necessary to control leaf curl, substitute lime sulphur in place of the oil emulsion which is recommended in the spray schedule for the dormant spray. Lime sulphur will control the leaf curl and it will also control the scale, although not so well as the oil emulsion.

A Bordeaux-oil emulsion spray mixture may be used instead of the lime sulphur for the dormant application. To make this mixture, add 5 gallons of oil emulsion to 75 gallons of a 3-5-50 Bordeaux.

Plum Pockets

Description: Two other species of the same genus of fungus which causes leaf curl on peach cause the well-known plum “pockets” or “blad-
ders" on plum. One of these (*Taphrina pruni*) affects the young plum fruits causing them to enlarge and become spongy and hollow, bladder-like. The other species (*Taphrina mirabilis*) affects primarily the young leaf buds and the tips of the young twigs, distorting them and producing fleshy, spongy, hollow overgrowths. This is especially bad on the Chickasaw plum and its relatives.

*Control:* No satisfactory control is known for this disease.

**Black Knot**

*Description:* This disease is striking in appearance and easily recognized by the large, black, warty swellings or knots on branches of the plum tree. It is caused by a fungus (*Plowrightia morbosa*) which invades the woody parts of the tree.

*Control:* Prune out during the fall and winter all diseased branches and burn. The cut should be made several inches below the knot so as to remove part of the fungus which is growing inside the tissue beyond the limits of the knot. Spraying (see spray schedule, page 69) also helps to prevent new infections from getting started.

**Brown Rot**

(*Sclerotinia fructicola*)

*Description:* Brown rot is by far the most important disease of peaches and plums in Louisiana. It affects the blossoms in the spring causing blossom blight. It causes cankers on twigs and branches, and causes rot of the fruit on the tree and in storage. The phase on the fruit is the most serious and most destructive. It may affect the fruit in various stages of its development but it is most prevalent as the fruit approaches maturity. On the fruit the rot starts as small, circular, soft, brown spots which enlarge very rapidly so that in a very short time the entire fruit is rotted. The spots usually start at points where the fruit skin has been broken in some way, such as by worms, rubbing, hail, bruising, etc. The surface of the rotted part of the fruit becomes covered with a brown to gray mass of fungus spores (Fig. 26, B). After the fruit has rotted, it dries up, shrinks, and forms a dry, hard, shriveled "mummy."

*Control:* The brown rot fungus is carried over from one season to the next (1) in cankers on twigs and branches, (2) on fruit "mummies" which may remain hanging on the trees, and (3) in fruit "mummies" which fall to the ground. With these facts in mind, it is easy to understand the control measures recommended for this disease.

1. **Sanitation:** Sanitary measures are very important because they eliminate much of the primary source of infection. All dead wood should be pruned out during the winter. All fruit that falls to the ground should be collected and either buried deep, burned, or fed to hogs. Hogs make a very clean job of picking up fallen fruit, and where the trees are con-
veniently located so that hogs can be turned loose under them, this is the most efficient and cheapest method of cleaning up.

2. Spraying and dusting: See spray schedule, page 69.

**Rust**

(*Tranzschelia pruni-spinosae*)

*Description:* This disease forms reddish pustules on the underside of the leaves and on the fruit. The upper side of rusted leaves show yellowish spots and affected foliage sheds prematurely. Rust is of minor importance in Louisiana. It is more common on plum than on peach.

*Control:* The spray schedule (page 69) recommended for the other diseases will control the rust until harvest time. Occasionally rust infection may become severe enough on the leaves after the fruit is harvested to cause defoliation. In that case, it may be necessary to dust with sulphur, or to spray with wettable sulphur once or twice.

**Root Knot**

(*Heterodera marioni*)

The peach is very susceptible to the root knot nematode and it is injured severely if planted on nematode-infested soil, especially if the soil is sandy.

*Control:* Do not plant on soils known to be infested with nematodes. Some nematode-resistant rootstocks are now available. These are seedlings of some Chinese and Indian peaches. The Shalil and Yunnan appear to be the most promising ones. These have proved very resistant to nematodes and are, apparently, well suited to Louisiana conditions.

**Crown Gall**

(*Phytomonas tumefaciens*)

Crown gall is another disease caused by bacteria (see page 4). It is characterized by the formation of large, spherical or irregular, rough galls usually on the crown and larger roots of the tree, although not infrequently the galls may form on the aerial parts, on the trunk, and on the branches. Crown gall affects a very large number of different plants, both woody and herbaceous. The rose and blackberry are among those most severely injured. The peach, although very susceptible, does not appear to be seriously injured by crown gall.

*Control:* Trees are injured by crown gall more if they become infected when young (in the nursery or soon after planting). Therefore, all nursery stock should be carefully examined before planting and any trees showing galls should be destroyed. Since crown gall bacteria can survive in the soil for many years, young trees should not be planted in soil from which old, diseased trees have been removed.
The peach is subject to several destructive diseases caused by viruses (see page 5). Fortunately, some of the most destructive ones like "yellows," "little peach," and "X-disease" do not as yet occur in Louisiana. However, one virus disease of the peach, "phony peach," occurs in the State, although it is not very common. The symptoms of this disease are such that it is very difficult for the inexperienced man to diagnose them with certainty, and for this reason no attempt is made in this popular publication to describe them. A cooperative eradication campaign between the Federal and State Departments of Agriculture is at present in progress. Any grower who suspects that any of his trees are

### Spray Schedule for Peaches and Plums

This program was assembled by entomologists and horticulturists with growers from the North Louisiana peach belt, using the best information available.

<table>
<thead>
<tr>
<th>TIME</th>
<th>Spray Mixture</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Dormant season before buds swell</td>
<td>Oil emulsion containing 2% oil for light to moderate infestation, 3% for heavy infestation. See notes about oil.</td>
<td>Scale</td>
</tr>
<tr>
<td>Petal fall spray when 3/4 petals have fallen</td>
<td>Lead arsenate 1 lb.</td>
<td>Curculio (If and where needed)</td>
</tr>
<tr>
<td></td>
<td>Hydrated lime 4 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc sulfate 2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
<tr>
<td>*Shuck Fall Spray. 75% Shucks off</td>
<td>Lead arsenate 1 1/2 lbs.</td>
<td>Curculio</td>
</tr>
<tr>
<td></td>
<td>Hydrated lime 4 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc sulfate 2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
<tr>
<td>See directions for mixing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*10 days after shucks fall</td>
<td>Lead arsenate 1 1/2 lbs.</td>
<td>Curculio, Scab</td>
</tr>
<tr>
<td></td>
<td>Hydrated lime 4 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc sulfate 2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wettable sulfur 3 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
<tr>
<td>Two weeks later</td>
<td>Lead arsenate 1 1/2 lbs.</td>
<td>Curculio, scab (omit lead arsenate if jarring shows no curculio)</td>
</tr>
<tr>
<td></td>
<td>Hydrated lime 4 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc sulfate 2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wettable sulfur 3 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
<tr>
<td>*Three weeks before harvest</td>
<td>Wettable sulfur 3 lbs.</td>
<td>Brown Rot</td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
<tr>
<td>*Just before harvest</td>
<td>Wettable sulfur 3 lbs.</td>
<td>Brown Rot</td>
</tr>
<tr>
<td></td>
<td>Water 50 gals.</td>
<td></td>
</tr>
</tbody>
</table>
affected with phony peach can obtain an expert opinion from the State Department of Agriculture in Baton Rouge. Diseased trees should, of course, be destroyed to prevent the spread of this disease to healthy trees.

Explanatory Notes for the Spray Schedule

1. The sprays which are marked with an * are the most important ones for the growers (home orchardists) who must use a limited spray schedule.

2. Dusting instead of spraying: For the small home orchard, where a spray machine is not available and where a duster (usually a small cotton duster) is available, it may be advisable to dust instead of spray for the control of curculio, scab and brown rot. Dusts are not as effective as sprays because they do not adhere to the foliage well and are washed off by rains. For this reason it is better to spray whenever possible. If facilities for spraying are not available, dusting is the second best thing to do. Use the following dusts: (1) When about \( \frac{3}{4} \) of the petals have fallen; 5 parts of arsenate of lead and 95 parts hydrated lime. (2) About 10 days later; same as in (1). (3) Two weeks after the second application; 80 parts of dusting sulphur, 5 parts of lead arsenate, and 15 parts of hydrated lime. (4) Three weeks after the third application; same as for (3). For best results, apply the dust either early in the morning when the air is still, or late in the evening.

3. Apply lead arsenate only when the foliage is dry and the temperature high.

4. Bordeaux mixture should never be used as a summer spray on peaches or plums.

5. Commercial oil emulsions vary in the percentage of oil they contain. For this reason, follow the recommendations of the manufacturer as to the amount to use, or consult the county agent.

(6) Mixing directions for sprays: Dissolve the zinc sulphate in water first; add lime and stir thoroughly, then add the other ingredients such as lead and wettable sulphur.

PEAR

Fire Blight

Fire blight, which is caused by Bacteria (Erwinia amylovora) is by far the most serious disease of pears and apples. It is because of the blight that the most desirable varieties of eating pears, such as the Bartlett, which is very susceptible, cannot be grown successfully in the State.

Symptoms: Blight is most conspicuous during blooming time. The blossoms and the leaves next to them turn black. The tips of twigs and branches die back, and the killed leaves which are dark brown to black
in color remain hanging (Fig. 28). Bark cankers of various sizes form on branches and stems, or even on the main trunk of tree.

Control: Under the warm, humid conditions of our State, control of fire blight is very difficult. In regions with drier climates the blight can be kept in check by removing and burning the blighted twigs and by scraping the cankers on the branches and painting the wounds. This practice has been tried in Louisiana and has not proved effective. Furthermore, blight affects other related plants such as apple, crab apple, loquat (Japanese plum), pyracantha, etc., and the bacteria are spread by insects, especially bees over long distances. For Louisiana conditions, the following recommendations will be found helpful.

1. Resistant varieties: The Pineapple variety is practically immune to blight. Unfortunately, this is of a very poor quality as an eating pear, although it is fairly satisfactory for cooking and for preserving. The Hood, the Garber, the LeConte, and the Kieffer, which are of better quality than the Pineapple, show a certain degree of re-

FIGURE 28.—Fire Blight on Pear. Note that the Blighted Leaves and Blossoms Turn Black and Remain Hanging on the Twig.
istance to blight, and, in general, can be grown successfully, although in some years these may blight badly.

2. Spraying: Spraying while the trees are in full bloom with 1-3-50 Bordeaux mixture has been found effective in the North, and it is reasonable to assume that it will prove helpful here for checking the blight on such varieties as the Hood, Garber, Kieffer, and LeConte, and also on apples. It is not necessary to spray the Pineapple, for this variety is practically immune.

3. Cultural practices: The blight bacteria prefer tender, succulent growth. For this reason the more vigorous the tree the worse it will blight. Therefore, it is advisable not to over-fertilize, not to prune heavily, and not to cultivate the trees. This applies to both pears and apples.

Leaf Spots
Two leaf-spotting diseases, caused by two different fungi, occur commonly on pear. For convenience, these are termed here the "Early Leaf Spot" and the "Late Leaf Spot" and are discussed separately.

Early Leaf Spot
(Fabraea maculata)

The early leaf spot disease makes its appearance early in the spring, usually in April. The spots on the leaves are mostly circular in outline, dark-brown to nearly black in color, with purplish margins (Fig 29, A). Spotted leaves turn yellow and shed. Defoliation usually starts on the lower branches and progresses upward. As new leaves are produced on the defoliated branches, they in turn become infected and fall off. Thus the defoliation continues throughout the summer. It is common for the defoliated trees to bloom profusely in late summer or early fall, and to bloom only sparingly and set very little fruit the following spring. In some varieties (as the Garber for example) the disease affects the fruit also, causing black cankers and cracks on it.

Control: The early leaf spot fungus has many ways of overwintering. It produces two kinds of spores on the dead leaves on the ground. It also forms minute cankers on the bark of twigs and shoots from which spores arise in the spring. In Louisiana the first method of overwintering of the fungus is the most common. Infection in the spring starts from spores produced on dead leaves on the ground. With these facts in mind, the following recommendations are made for the control of this disease:

1. Remove the dead leaves from under the trees in the winter either by plowing them under or, better still, by raking and burning. This will eliminate the main source of infection.

2. Spray the tree either with Bordeaux or with some other copper compound. Sometimes Bordeaux will cause injury to the leaves, and so it is better to use some Bordeaux substitute, such as "Spray Cop," "Tri-Basic Copper Sulphate," "Coposil," "Cuprocide," "Copper Hydro," etc.
These compounds are available on the market. Since the copper content of these different compounds varies, follow the recommendations of the manufacturer as to the amount to use. Two spray applications, one about the middle of April and the second about 3 weeks later should prove sufficient, but if the disease is not checked, a third application about 3 weeks after the second, may be necessary.

**Late Leaf Spot**

The late leaf spot disease is caused by another fungus (*Cercospora minima*). This disease makes its appearance late, usually in August. The spots are angular to indefinite in outline and brown to grayish in color (Fig. 29, B). When many spots develop on the leaves they turn yellow and shed, so this disease also causes defoliation.

*Control:* Since this disease appears late in the season, after the crop is over, it does not usually cause enough damage to justify control measures. However, if the infection is severe, or if it starts earlier than usual (under favorable conditions it may start in July), and it is found necessary to control it, the same kind of sprays recommended for the early leaf spot will be found effective.

**Foot Rot**

(*Clitocybe tabescens*)

During the summer (especially in late summer) pear trees are often seen with yellowish, unhealthy, wilting foliage. Such trees usually die before the end of the summer. Examination of trees thus affected will show

FIGURE 29.—LEAF SPOTS OF PEAR. A. EARLY LEAF SPOT (*Fahraea maculata*). B. LATE LEAF SPOT (*Cercospora minima*).
that the bark of the trunk near the ground line and that of the crown and main roots is dead. A creamy-white, matted fungus growth occurs between the bark and the wood and between layers of the bark. The disease is caused by the oak-root fungus (Clitocybe tabescens), which attacks a very large number of woody plants. In Louisiana the disease has been found on pear, tung, peach, apple, weeping willow, grape, and rose. The fungus occurs naturally on the roots of various kinds of oaks, and when the land is cleared it persists for several years on roots which are left in the ground. This is the reason why foot rot is almost invariably found on trees which have been planted on recently cleared land.

**Control:** If the disease is discovered in time, before the bark has been killed completely around the trunk, the tree may be saved by scraping the killed part and painting the wound with Bordeaux paste. Unfortunately, by the time the tree becomes sick enough to be noticed, the trunk is usually completely ringed and then it is too late to save it.

**Black Rot**

*(Botryosphaeria ribis)*

About the time pears are approaching maturity, spots which are at first brown but soon turn black, usually appear on some of the fruits. These rot spots usually start at worm holes or at places where the fruit has been injured by birds, hail, wind, etc. The rot increases rapidly so that in a short period large areas on the fruit, or even the entire fruit, rot and turn black.

Black rot is caused by a fungus *(Botryosphaeria ribis)* which is very common in the South and which grows on cankers of branches and other dead or injured plant parts. Besides causing black rot of fruit, the fungus

### Pear Spray Schedule

<table>
<thead>
<tr>
<th>Spray No.</th>
<th>Time</th>
<th>Spray Mixture</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dormant</td>
<td>Oil emulsion Water</td>
<td>2 gals. 50 gals.</td>
</tr>
<tr>
<td>2</td>
<td>Full bloom</td>
<td>Hydrated lime Copper sulfate Water</td>
<td>1 1/2 lbs. 1 1/2 lbs. 50 gals.</td>
</tr>
<tr>
<td>3</td>
<td>Calyx (1/4 petals fallen)</td>
<td>Hydrated lime Copper sulfate Lead arsenate</td>
<td>3 lbs. 3 lbs. 1 1/2 lbs.</td>
</tr>
<tr>
<td>4</td>
<td>About middle of April</td>
<td>3-4-50 Bordeaux or with substitute copper compound (see page... )</td>
<td>If early leaf spot is present</td>
</tr>
<tr>
<td>5</td>
<td>About middle of May</td>
<td>Same as for 4</td>
<td>If early leaf spot is present</td>
</tr>
<tr>
<td>6</td>
<td>Last part of July</td>
<td>Same as for 4</td>
<td>If late leaf spot is present</td>
</tr>
</tbody>
</table>
can cause cankers on branches and trunks of pear and other plants, especially following freeze injury. Another somewhat similar fungus (*Physalospora malorum*) which causes black rot of pear, apple and quince further north, also occurs in Louisiana but it is not common.

**Control:** Sanitary measures offer the cheapest method of control. Dead wood should be pruned and burned. Fruit that falls to the ground should be picked and removed from the orchard. Spraying for coddling moth (see spray schedule) will help to control black rot because much of the infection starts in holes of coddling moth worms. Spraying the fruit about 3 weeks before harvest with Bordeaux will probably prevent much of the black rot, but it is questionable if this is economically practicable.

**PECAN**

The pecan is affected by a very large number of diseases and insect pests. Only a few of the most common diseases are discussed here. For more complete information, write to the United States Department of Agriculture, Washington, D. C., for Farmers' Bulletin No. 1829 which contains a detailed account of all the diseases and insect pests of pecan and their control.

**Scab**

*Description:* Scab, caused by a fungus, *Cladosporium effusum*, is by far the most important pecan disease, especially in the more humid southern half of the State. In the drier, northern part of Louisiana, scab is less troublesome. Scab affects the leaves, shoots, and nuts. The spots are circular or elongated, olive-brown to black in color, raised at first, but becoming sunken with age. When numerous, the spots unite to form irregular black blotches on the nut husks (Fig. 30). Badly scabbed nuts fail to fill and usually drop.

**Control:** Scab can be effectively controlled by spraying with a low lime Bordeaux mixture as follows:

*First application:* Spray with a 4-1-100 mixture (4 lbs. of bluestone, 1 lb. of lime, and 100 gallons of water) early in the spring when the leaves are one-fourth to one-half grown before pollination.
Second application: Spray with a 6-2-100 mixture (6 lbs. of bluestone, 2 lbs. of lime, 100 gallons of water) as soon as pollination is complete (when the tips of the small nuts have turned brown).

Third and fourth applications: The third spray should be applied about 3 to 4 weeks after the second, and the fourth spray about 3 to 4 weeks after the third. Use a 6-2-100 mixture.

If black aphids are present, add one-half pint of Black Leaf 40 (nicotine sulphate) to each 100 gallons of the spray mixture in the third and fourth spray applications.

Caution: If the temperature is low (55°F. or lower) when the first spray application is made, injury may result.

Resistant varieties: Pecan varieties differ widely in their susceptibility to scab. For home planting, where means of spraying large trees are not available, the planting of resistant varieties is the only practical way of avoiding scab. Unfortunately, some of the most desirable varieties from the point of view of quality of nuts, like the Schley, are very susceptible to scab. The Stuart is the most resistant variety, followed by Teche, Curtis, Nelson, Moore, Moneymaker, Frotscher, and Success in order of decreasing resistance.

The problem of selecting resistant varieties is further complicated by the fact that there are strains of the scab fungus in different localities which vary in their pathogenicity, so a pecan variety may be highly resistant to scab in one locality and susceptible in another. The best rule to follow is to plant varieties which have proved successful in your particular locality.

Leaf Blights

Under the general heading of "leaf blights" are included several diseases which cause leaf spotting and premature defoliation. Some of these are:

1. Downy spot (Mycosphaerella caryigena): Greenish-yellow, downy spots on the underside of the leaves earlier in the season, becoming visible on the upper side of the leaves as brown dead spots during the latter part of the summer. Delmas, Moneymaker, Stuart, and Frotscher are among the more susceptible varieties to this disease.

2. Leaf blotch (Mycosphaerella dendroides): The first signs of this disease are a greenish-brown, velvety, tufted growth in spots on the underside of the leaves and faint yellow spots on the upper side. This disease makes its appearance usually in late June or early July. Later in the season the velvety growth on the underside of the spots disappears, and minute, black, pimple-like structures appear on the affected surface. The spots enlarge and many unite to form large, irregular blotches. Severe defoliation occurs in late summer. The oldest leaves are shed first.
3. **Vein spot (Gnomonia nerviseda):** The spots occur along the veins. Those along the midrib are long in shape; those originating near a smaller vein are circular. Spots also occur on the petioles (leaf stems) and on the stems of the leaflets. Severely affected leaves are shed prematurely. The Van Deman, Frotscher, and Stuart are among the most susceptible varieties.

4. **Brown leaf spot (Cercospora fusca):** Circular to irregular reddish-brown spots, varying in size from one-eighth to one-half inch across. The older spots become grayish in color. This disease usually appears in July and the older leaves are affected first. In late summer the spotting increases rapidly and the trees become badly defoliated by the first part of October. All pecan varieties are susceptible to this disease, but the Stuart and the Moneymaker are the worst affected.

5. **Liver spot (Gnomonia caryae, var. pecanae):** Dark brown circular spots on the lower surface of the leaves and located mainly along each side of the midrib. Later in the season the color of the spots changes to cinnamon-brown. This disease is more prevalent in the northern part of the State. Like the other leaf blights, liver spot causes premature shedding of leaves if the infection is severe.

**Control of leaf blight:** Organisms causing the leaf blights are relatively weak parasites, and for this reason the blights are more prevalent and more destructive on neglected or weakened trees which have not been adequately cultivated and fertilized. Strong, vigorously-growing trees are not damaged very appreciably. Proper care of the trees, adequate cultivation, and fertilization will in most cases be sufficient protection against the leaf blights. However, these diseases can also be easily controlled by spraying with Bordeaux mixture. If the trees have been sprayed for scab control (page 75) no additional spraying will be necessary. (See spray schedule for control of pecan diseases and insect pests, page 78).

**Rosette**

*(Non-parasitic)*

Rosette is a nutritional trouble caused by zinc deficiency. This disease is characterized by a variety of symptoms. In early stages the leaves, especially those of the top branches, show a slight yellow motling. In more advanced stages the leaflets become narrowed, crinkled with reddish brown spots or holes between the veins. The internodes of the new shoots become shortened so that the leaves are borne close together, forming a bunched, rosetted type of growth. In still more advanced stages, there is a die-back of the shoots. In the more advanced stages the foliage, as a whole, has a bronzed or rusty appearance. Trees that are severely rosetted usually do not bear fruit.
Rosette is more prevalent on alkaline or neutral soils, on soils poor in organic matter, and on badly eroded soils, but may occur on other types of soil.

Control: Rosette can be easily corrected by the use of zinc (usually in the form of zinc sulphate). Zinc sulphate may be applied in three different ways—in the soil, in holes bored in the trunk, or as a spray.

Applications of zinc sulphate to the soil at the rate of \( \frac{3}{4} \) to 1 lb. for each year of the tree's age should be made in late winter (February or March). The chemical should be broadcast evenly under the tree, and it is well to disc it in. The soil application method has long-lasting effect. The only drawback to this method is that with certain soil types (alkaline soils especially) it does not work. Some soils have the power of immobilizing the zinc so that the roots cannot take it up. The soil-application method works well with acid soils.

Spray Schedule for the Control of Pecan Diseases and Insects\(^\text{11}\)

<table>
<thead>
<tr>
<th>Name and Time of Spray</th>
<th>For Control of—</th>
<th>Materials</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cover or pre-pollination spray. When first leaves are half grown.</td>
<td>Scab, downy spot, vein spot.</td>
<td>4-1-100 bordeaux mixture.</td>
<td>A very important disease spray.</td>
</tr>
<tr>
<td>Second cover spray. About time tips of small nuts have turned brown.</td>
<td>Scab, pecan nut casebearer, aphids, blotch, brown leaf spot, liver spot, vein spot, downy spot, rosette.</td>
<td>6-2-100 bordeaux mixture, nicotine sulfate 13 oz., zinc sulfate 4 lbs.</td>
<td>Important spray to protect the nuts and foliage. Cover nuts and leaves thoroughly. Use the zinc sulfate only if rosette is present. Important spray for pecan nut casebearer and should be applied at the proper time to obtain good results.</td>
</tr>
<tr>
<td>Third cover spray. 3 weeks after second cover spray.</td>
<td>Scab, aphids, blotch, brown leaf spot, vein spot, liver spot, rosette.</td>
<td>6-2-100 bordeaux mixture, nicotine sulfate 6 oz., zinc sulfate 4 lbs.</td>
<td>As the black pecan aphid infests the foliage on all parts of pecan trees, thorough applications are necessary. Use zinc sulfate only if rosette is present. If the fall webworm or the walnut caterpillar is usually abundant and a serious pest, add 2 lbs. of calcium arsenate.</td>
</tr>
<tr>
<td>Fourth cover spray. 3 weeks after third cover spray.</td>
<td>Scab, pecan leaf casebearer, aphids.</td>
<td>6-2-100 bordeaux mixture, calcium arsenate 2 lbs., nicotine sulfate 6 oz., zinc sulfate 4 lbs.</td>
<td>On varieties that do not scab and where it is necessary to control the pecan leaf casebearer, use 2-1-100 bordeaux mixture and 2 lbs. of calcium arsenate. Bordeaux mixture is used in this case as a corrective for arsenical injury.</td>
</tr>
</tbody>
</table>

A second method is to bore holes in the trunk and insert zinc sulphate in them. Holes 7/16 of an inch in diameter and 2\( \frac{1}{2} \) to 3 inches deep are bored at intervals of about 4 to 6 inches spirally around the trunk. A heaping teaspoonful of dry zinc sulphate is inserted in each hole, and

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\(^{11}\)This schedule has been copied from United States Department of Agriculture Farmers' Bulletin No. 1829, with changes recommended by Dr. J. R. Cole.
the holes are then plugged with cork stoppers. This method should be used only where it is known that soil applications are not effective and where the trees cannot be sprayed, for boring the holes in the trunk injures the trees somewhat.

Where facilities are available for spraying, the easiest and cheapest way to control rosette is to spray with zinc sulphate at the rate of 2 to 4 lbs. per 100 gallons of water. Where spraying for the control of scab or other diseases or insect pests is practiced, zinc sulphate may be mixed with the other spray materials. See spray schedule.

**STRAWBERRY**

**Leaf Diseases**

*Leaf spot:* The leaf spot disease (which locally is called "rust") is caused by a fungus (*Mycosphaerella fragariae*) which enters the leaf and kills some of the leaf tissues. When the spots first appear they are small and purplish, but the typical mature spot has a grayish to white center with a reddish border and is about one-eighth of an inch in diameter. In the spring when infection occurs on rapidly-growing, tender foliage the spots are light-brown in color and have no reddish borders. In cases of severe infection the spots are so numerous that they cover the greater part of the leaf area and often kill the leaf (Fig. 31). Spots occur also on

![Strawberry Leaf Spot](image-url)

**FIGURE 31.—STRAWBERRY LEAF SPOT. CONTRAST BETWEEN SPRAYED AND NON-SPRAYED PLANTS FROM THE SAME FIELD AT THE END OF THE HARVESTING SEASON. A. NON-SPRAYED. B. SPRAYED.**
the petioles, on the fruit stalks, on the calyces, and occasionally on the green berries. The leaf spot is by far the most important disease of the strawberry in Louisiana.

Control: See page 81.

Leaf scorch: The scorch is caused by another fungous parasite, Diplocarpon earliana. Scorch makes its appearance first as minute purplish spots on the upper surface of the leaf. The spots enlarge rather rapidly, forming angular to irregular spots or blotches (Fig. 32). The centers of the scorch lesions never become gray or white. In this respect scorch differs from the leaf spot ("rust"). When infection becomes general the leaves "scorch," that is, they dry up as if scorched by fire. The disease also occurs on the petioles, fruit stalks, and calyces. The calyces dry up, making the fruit very unattractive. The scorch is much less common than the leaf spot in Louisiana.

Control: See page 81.

Purple leaf spot: The symptoms of this disease are almost identical with those of the leaf scorch, but the disease is caused by a different fungus, Mycosphaerella louisiana. This is of relatively small economic importance.

Control: See page 81.

Angular leaf spot (leaf blight): The spots are large, first purplish, then brown in color, and usually, but not always, triangular in shape, their margins being delimited by the larger leaf veins. This disease caused by the fungus Dendrophoma obscurans occurs for the most part during the hot summer months when the plants are in a weakened condition. It does very little damage.

Cercospora leaf spot (Cercospora sp.): The spots are small (smaller than those of any of the other leaf diseases) and round. They are purple
when young, becoming white with purplish borders when older. This disease also occurs only during the summer months and is of minor importance.

**Control of leaf diseases:** The following measures are recommended for the control of the strawberry leaf diseases.

1. **Spray:** All leaf blights can be controlled by spraying with 2-2-50 Bordeaux mixture. It is recommended to begin the spraying the latter part of January and spray about every 10 days until the fruit begins to ripen. It is also advisable to spray the plant beds in late summer and fall. If the plant beds have been sprayed so that the fall planting has been made with healthy plants, the winter spraying may be delayed until about the middle of February. “Spray Cop” at the rate of 3 lbs. in 50 gallons of water has been tried and has given as good control as Bordeaux. It is probable that others of the “fixed copper” compounds (see page 91) will be found effective.

2. **Sanitation:** Since the two main leaf blights, the leaf spot and the leaf scorch, do not spread very rapidly during the hot summer months, these can be almost completely eliminated from the plant bed by sanitary measures. In early June the plants that have been selected for plant production should be gone over carefully and all the old, spotted leaves should be removed and burned. This procedure should be repeated once or twice during the summer. This method of obtaining clean plants is especially effective with isolated small patches in home gardens.

3. **Resistant varieties:** The Klonmore (630) variety, which was developed by the Louisiana Agricultural Experiment Station, is highly resistant to both the leaf spot (“rust”) and the leaf scorch. It is not necessary to spray this variety.

### Crown Rot

**Description:** Crown rot, which is caused by a soil-inhabiting fungus (*Sclerotinia sclerotiorum*), some years causes serious damage to strawberry fields. The fungus attacks the plant at the crown. The bases of the leaves are killed and the leaves damp-off. The plant may be killed outright or it may recover. Recovering plants push out a number of secondary buds below the killed crown and produce small, spindly leaves.

Usually, but now invariably, numerous hard black bodies, the sclerotia, are found on the decaying parts of the plant. The sclerotia constitute the resting stage of the fungus, and they remain inactive in the soil during the summer months. The crown rot fungus is a cool weather organism and the disease is favored by prolonged cool, cloudy, rainy, or foggy spells in late winter and early spring. As soon as the weather warms, the disease disappears. The disease is worse during years in which the plants have been injured by freezes. The crown rot fungus attacks not only the strawberry but also a very large number of other plants.

**Control:** No practical method of control is known.
Dwarf

The dwarf disease, which also goes by such local names as “blind plant,” “wild plant,” etc., is caused by the bud nematode, *Aphelenchoides fragariae*. The nematodes occur in large numbers inside the buds and produce the injury by feeding on the young unfolded leaves.

The symptoms of dwarf are very striking. The leaves are narrow, brittle, twisted, varying in color from somewhat bronzed to even deeper green than the healthy ones. The petioles are very short, and the young leaves are greatly reduced in size. Usually, all the runner plants from a dwarf mother plant are diseased. Dwarf is a summer disease, the symptoms disappearing during late fall and winter. The reason for this is that the nematodes are inactive during the cold months.

*Control:* Even though dwarf is not a serious disease in Louisiana because the diseased plants recover during the winter and produce fruit in the spring, it causes injury to plants and a certain degree of reduction in yields. The disease can be easily kept in check by digging and destroying the diseased plants during the summer and early fall.

Root Knot

Root knot is caused by another nematode (*Heterodera marioni*) different from that causing the dwarf. Root knot occurs only very rarely on strawberries in Louisiana, and it is of no economic importance.

Berry Rots

There are several fungi which can cause rotting of the berries in the field if conditions for their development are favorable during the picking season. Warm wet weather, especially if prolonged for several days, is very favorable for the development of berry rots. When such weather prevails during harvest the losses from fruit rots are tremendous because the rots not only destroy the berries in the field but they affect the market price of the fruit, for the rots continue to develop in transit. On the other hand, if cool dry weather prevails during the picking season, losses from rots are negligible.

The following different kinds of berry rots are the most common ones in Louisiana.

*Gray mold* (*Botrytis sp.*) : This is one of the most common berry rots. It starts as a soft brown spot, usually on the side next to the ground or where a berry touches another rotten berry, which soon enlarges and covers the entire berry. After the berry is completely rotted, it dries up and its surface becomes covered with a gray powder, the spores of the fungus.

*Tan rot* (*Pezizella lythri*) : This is the most common and the most destructive berry rot in Louisiana during rainy weather. It starts as a tan-colored spot, often very inconspicuous. Later the rotted part of the berry becomes sunken, and it separates easily from the sound part of the berry.
Leather rot (*Phytophthora cactorum*): This rot is not generally common, but occasionally it assumes epidemic proportions in certain fields and causes severe losses locally. In the spring of 1940 this rot destroyed about 50 per cent of the fruit in some localized fields. It affects both green and ripe berries. The texture of the rotted berries is tough and leathery, and the taste is bitter. This characteristic makes it easy to distinguish this from other kinds of berry rots.

Hard rot (*Rhizoctonia sp.*): This is the least common and the least destructive of the berry rots. It affects berries that touch the ground, forming a hard, brown rot, usually with soil particles adhering to it, on one side of the berry.

Control: Berry rots are difficult to control. The fungi causing these rots live in the soil and on dead plant parts. Spraying has been tried and it has given a certain degree of control, but it is obviously impractical to spray when the fruit is ripe or nearly ripe, because of the objectionable spray residue. Heavy mulching, so that the fruit will be kept high above the ground and well ventilated is the most practical means of keeping the losses from fruit rots to a minimum.
Section III. Some Methods and Materials Used in Plant Disease Control

The plant pathologist has many different methods and many different chemicals at his disposal for the control of plant diseases. No attempt is made in this poplar bulletin to list or describe all the methods and chemicals employed in plant disease control. Only the ones most commonly used, and particularly the ones which are applicable to the diseases of the crops treated in this bulletin, are considered. It should be stated at this point that some of the chemicals used in the fight against diseases are either unobtainable, or are available in only limited quantities, during the present war emergency. It is hoped, however, that the usefulness of this handbook will extend beyond the period of war emergency and, for this reason, the most useful methods of chemical control of plant diseases are included even though some of the chemicals may be unobtainable at present.

SEED TREATMENTS

Various methods have been devised for treating seed. The purpose of seed treatment is twofold, first to kill the pathogenic organisms that are carried on or in the seed, and second to protect the plant against pathogenic organisms in the soil. Damping-off of the seedlings is one of the most common and most serious diseases caused by soil-borne parasites.

The term "damping-off" is used to designate a disease of plants in the seedling stage. Two distinct phases of damping-off are recognized, namely, pre-emergence damping-off and post-emergence damping-off. In the first phase, the seed and young seedlings rot in the soil and never reach the surface; in the second phase, the stems of the young plants rot at the soil line, and the plants collapse and die suddenly. With some plants, a seed treatment is sufficient to give protection against both pre-emergence and post-emergence damping-off; with others two treatments, a seed treatment and a soil treatment, are necessary for satisfactory control of the two phases.

It is also very important to make the distinction between seed treatments designed to control damping-off, which is caused primarily by soil-borne parasites, and treatments designed to control seed-borne diseases, because the same treatments will not always control both. For example, the mercuric chloride treatment of cabbage seed will control the black rot disease, which is seed-borne, but will not protect the seed against damping-off. It is necessary to re-treat the mercuric chloride-treated seed with zinc oxide or Vasco 4 for protection against damping-off.

12For more complete information on various seed treatments see U. S. Department of Agriculture Farmers' Bulletin No. 1862 and Louisiana Agricultural Experiment Station Bulletin No. 349.
With these preliminary remarks in mind, we can proceed to list and discuss some of the most common methods of treating vegetable seeds for the control of seed-borne and soil-borne diseases.

1. **Mercuric Chloride (Corrosive Sublimate):** This chemical is most commonly used in the concentration of 1 part in 1000 parts of water. Unless a large volume is required, it is most convenient to buy corrosive sublimate in the tablet form (it can be purchased at any drug store) for one tablet dissolved in 1 pint of water makes a 1-1000 solution. For larger volumes of solution, use 8 tablets to 1 gallon or 60 tablets (1 ounce) to 7\(\frac{1}{2}\) gallons.

Caution: Mercuric chloride is a deadly poison and great care should be used in handling it and in disposing of it after it is used. It should be kept away from children and farm animals. Also, the chemical is corrosive to metals and it should never be dissolved in, or placed in, a metal container. Use wooden, glass, enamel, or earthenware containers.

**Crops That Can Be Treated with Mercuric Chloride**

*Cabbage, cauliflower, collard, broccoli, brussels sprouts, and other crucifers:* Soak seed in 1-1000 solution for 20 to 30 minutes, wash thoroughly in running water, or in several changes of water, and spread out to dry. This treatment will control black rot, but will not control damping-off. Therefore, before planting, coat the dry seed with zinc oxide or Vasco 4 (see treatment No. 4).

*Pepper:* Use 1-1000 solution. Soak seed for 5 to 6 minutes, wash thoroughly in several changes of water, and spread out to dry. Pepper seed is sensitive to mercury, and some injury to germination may result. This treatment is for the control of bacterial blight. To control damping-off, treat the dried seed with Cuprocide (treatment No. 3).

*Irish potato:* For Louisiana conditions the hot formaldehyde method (page 88) is recommended for treating seed potato tubers. In some areas of the country, mercuric chloride is used for treating seed potatoes. The following two methods are used:

(a) **Cold mercuric chloride, 1-1000.** Soak tubers (uncut) for 1\(\frac{1}{2}\) hours. Plant immediately, or dry and store.\(^{13}\)

(b) **Acid-mercuric chloride** (6 ounces to 25 gallons of water plus 1 quart of commercial hydrochloric acid). Dip seed for 5 minutes, plant immediately, or dry and store.\(^{13}\) Do not store while wet. Twenty-five gallons of the solution will treat effectively about 40 bushels of potatoes, after which a new solution should be prepared.

*Sweet potato:* Use 1-1000 solution. Soak the potatoes for 8-10 minutes, then bed without washing. This treatment kills the spores of the black rot fungus (and of other pathogens) on the surface of the potatoes, and

\(^{13}\)Mercuric chloride is a deadly poison. Treated tubers should not be used for food or feed.
thus it helps to keep the disease in check. It does not kill the infection inside the potato, and so it does not provide complete protection against the black rot.

The seed certification service of the State Department of Agriculture requires that, for the production of certified sweet potato seed or plants, the potatoes be treated with mercuric chloride before bedding.

2. Organic Mercury Compounds: There is a long list of organic mercury compounds, sold under different trade names, which are used for disinfecting various kinds of seed. Two of these, "Semesan" and "New Improved Semesan Bel" are the ones most commonly used for treating vegetable seeds.

Semesan: This chemical may be used either as a dust to coat the seed, or in the liquid form in which the seed are soaked.

(1) Dust: Use Semesan dust at the rate of $\frac{1}{2}$ level teaspoonful per pound of seed for the following: beet, broccoli, brussels sprouts, cabbage, cauliflower, collard, carrot, cucumber, cantaloupe, eggplant, mustard, pea, radish, spinach, squash, Swiss chard, turnip, and watermelon.

For onion, parsley, and tomato, use the dust at the rate of $\frac{1}{4}$ level teaspoonful per pound of seed.

Place the seed and the dust in a tight container and shake well until the seeds are thoroughly coated. Screen off the excess dust. Plant immediately, or store in a dry place.

Notes: (a) The Semesan treatment cannot be used as a substitute for mercuric chloride (corrosive sublimate) treatment of seed of cabbage, cauliflower, broccoli, collard, brussels sprouts, and other crucifers for the control of black rot. However, for controlling damping-off in the seed bed (or in the field, if the seed is planted directly in the field) the seed which has already been treated with mercuric chloride can be re-treated by dusting either with Semesan or with zinc oxide (treatment No. 4, page 88). (b) Under certain conditions (planting in dry soil, for example) Semesan may cause injury to the treated seed. Therefore, for such seeds as tomato, pepper, eggplant, beet, carrot, pea, spinach, etc., which are copper-tolerant, the copper oxide treatment (page 87) should be used in preference to Semesan.

(2) Liquid form: Soak the seed in a solution made by stirring 1 ounce of Semesan in 3 gallons of water (1 level tablespoon in 1 gallon of water). The time of soaking varies from 15 minutes to 1 1/2 hours, depending on the kind of seed to be treated. Follow the directions on the container.

The liquid Semesan treatment is recommended especially for pepper seed for the control of the bacterial blight (see page 28). Soak the pepper seed for 1 1/2 hours, drain, and spread out to dry before planting.

New Improved Semesan Bel: In some parts of the country this chemical is used instead of the hot formaldehyde for treating seed potatoes, even though it is not so effective as the hot formaldehyde. For Louisiana, the hot formaldehyde method (page 88) is recommended for treating seed
potatoes. However, if one buys seed that has not been treated with hot formaldehyde, one can treat it with New Improved Semesan Bel. The method is easy and cheap.

Directions: Mix 1 pound of the powder with 7½ gallons of water. Dip (do not soak) the uncut potatoes in this solution, drain, cut, and plant immediately.

Caution: The organic mercury compounds are very poisonous and should be handled with care. In treating seed with the dust it is preferable to work outdoors and to avoid breathing the dust. Treated seed should be kept away from farm animals. Treated potatoes should not be used for food or feed.

3. Copper Oxide: This is one of the most useful and most widely used chemicals for the control of damping-off the seedlings of many different vegetables and flowers. The material is made by different chemical companies, and is sold under different trade names (Cuprocide, Curedamp, Metrox, etc.). It varies in color from red through yellow and brown to black. For vegetable seed treatment, only the red and the yellow should be used.

Directions for use: Place the seed to be treated in a tight container, add the copper oxide powder at the rate of 1½ level teaspoonsful per pound of small seed (such as tomato, pepper, eggplant) and ½ teaspoonsful per pound of large seed (such as pea), shake well until all seeds are thoroughly coated, then screen off the excess powder. Treated seed may be planted immediately, or it may be stored if kept dry.

Caution: Seed treated with copper oxide should not be planted in pure sand or in soil too dry for good germination, for under these conditions injury may result.

If the seed is to be planted by a drill, add a small amount of graphite powder (½ as much by weight as the copper oxide) at the time the seed is treated. Graphite acts as a lubricant and prevents clogging of the drill.

Seeds that are benefited by the copper oxide treatment: beet, carrot, celery, cucumber, eggplant, muskmelon, pea, pepper, pumpkin, romaine, spinach, squash, Swiss chard, tomato, calendula, cosmos, pansy, salvia, zinnia.

For all the above-named seeds, except eggplant, seed treatment alone is usually sufficient to prevent both pre-emergence and post-emergence damping-off. However, if the seedlings begin to damp-off after emergence, the disease can be stopped either by watering the plants once or twice with a suspension made with 1¾ oz. (6 level teaspoonfuls) of copper oxide to one gallon of water, or by coating the surface of the soil with a layer of zinc oxide or Vasco 4 (see treatment No. 4). The two last named materials can be applied to the soil surface by means of a large salt shaker or by means of a perforated tin can. Use at the rate of about 2 ounces per 3 square feet of soil. Care should be taken not to break this layer on the soil surface.
In the case of eggplant, the copper oxide treatment of the seed will control the pre-emergence phase of damping-off but will not protect the young seedlings against the post-emergence phase of the disease. For this reason, eggplant seedlings should either be watered with a copper oxide suspension in water, or the soil surface should be covered with a layer of zinc oxide or Vasco 4.

*Seeds that are likely to be injured by copper oxide:* Seeds of crucifers (cabbage, cauliflower, collard, brussels sprouts, broccoli, turnip, radish, etc.) are sensitive to copper injury, and should not be treated with copper oxide. These seeds should be treated with Vasco 4 or zinc oxide (see treatment No. 4) if they are to be planted in the seed bed, or with Semesan (see page 86) if they are to be planted in the field.

Lettuce seed is sometimes injured by copper oxide. Onion and corn usually are neither injured nor benefited by the copper oxide treatment.

4. **Zinc Oxide and Vasco 4:** Zinc oxide and Vasco 4 (a mixture of zinc oxide and zinc hydroxide) are very useful substances for combating damping-off. These chemicals are used in two ways, (1) to treat the seeds directly for control of pre-emergence damping-off, and (2) to coat the soil surface after the seedlings emerge to control the post-emergence phase of damping-off. They are especially useful for treating such copper-sensitive seeds as those of the cabbage family and for treating the soil surface of eggplant seed beds.

*Directions for using zinc oxide or Vasco 4:* For seed treatment, place the seed and either zinc oxide or Vasco 4 at the rate of 2 level teaspoonfuls to the pound of seed in a tight container and shake well until all the seed are well coated with the dust. Screen the seed to remove the excess dust. Plant immediately, or store dry.

For soil treatment, either zinc oxide or Vasco 4 should be applied to the surface of the soil at the time the seedlings are emerging. Use at the rate of about two ounces every 3 square feet of soil surface. Leave the layer of chemical on the soil surface undisturbed.

5. **Formaldehyde:** This chemical is used in either liquid or dust form for treating seed and for disinfecting soil.

For treating seed potatoes the hot formaldehyde method is extensively used. A solution is made by mixing 1 quart of commercial formalin (40% formaldehyde) with 30 gallons of water which is kept at a temperature between 124° and 126° F. while the potatoes are being treated. The potatoes are dipped in this solution for 4 minutes, then are removed and spread out to dry. After treating every 50 bushels of potatoes, 0.9 of a pint of formaldehyde should be added to the tank of solution to compensate for loss of strength.

6. **The Hot Water Method:** The hot water treatment is a most effective method of disinfecting seed because it kills seed-borne pathogens both on and in the seed. At the same time, this method is very drastic, and unless due care is exercised in controlling the temperature of the water, in correct timing of the treatment, and in drying the treated seed,
the germination of the seed may be considerably impaired. This is especially true in the case of old or weak seed. For this reason, the hot water treatment is recommended only for those seed-borne diseases against which no other effective treatment is known. For Louisiana, the hot water method is recommended only for treating seed of cabbage, cauliflower, brussels sprouts, and other crucifers for controlling the black-leg disease. As has been explained in the text (page 12), seed grown in the Puget Sound district is usually free of infection and requires no treatment for the control of black-leg. If the seed has been grown in a region in which black-leg is known to occur, it would be advisable to treat it with hot water.

Directions: Place the seed in a loosely-woven cloth bag, which should be only about one-half full, and immerse it in hot water at a temperature of 122° F. Keep the water stirred during the operation and have extra hot water handy to add to it as it begins to cool, in order to maintain the temperature at 122° F. After the required exposure, remove the bag and plunge it in cold water to cool the seed quickly. Drain, and plant immediately, or spread the seed out to dry. Quick drying is essential.

Cabbage seed should be treated for 25 minutes; seeds of cauliflower, brussels sprouts, broccoli, collard, kale, kohlrabi, and turnip for 15 to 18 minutes.

**SPRAYS AND DUSTS**

Most of the sprays and dusts used for the control of plant diseases contain either copper or sulphur as the active fungicide ingredient. The number of different kinds of sprays and dusts is very large. Only the ones most commonly used, and especially those which are recommended for the control of the diseases of crops considered in this bulletin, will be described.

**Copper Compounds**

1. *Bordeaux Mixture*: Bordeaux mixture is made with copper sulphate (bluestone), lime, and water. In writing the formula for Bordeaux, the amount of bluestone (in pounds) is given first, the amount of lime (in pounds) second, and the amount of water (in gallons) third. Thus, a 4-2-50 formula means 4 lbs. of bluestone, 2 lbs. of lime, and 50 gallons of water. Bordeaux mixture is relatively easy to make, and yet certain care is necessary in its preparation. To make 50 gallons of the standard 4-4-50 Bordeaux, the following method will be found satisfactory.

(a) Fill a 50-gallon wooden barrel about 2/3 full of water. Put 4 lbs. of bluestone in a sack, or cloth bag, and suspend it in the water to dissolve. Bluestone dissolves very slowly if placed at the bottom of the barrel, but rather rapidly (20-30 minutes) if suspended near the top of the water. Never dissolve bluestone in a metal container because it cor-
rodes metals, and it will not only ruin the container, but will change the chemical composition of the spray mixture.

(b) Place about 10 gallons of water in another container, and stir into it 4 lbs. of fresh hydrated lime. Stir well to make a fine, milky suspension. Lime does not corrode metals and so a metal container such as galvanized iron wash tub may be used for the lime suspension.

(c) After the bluestone has dissolved, pour the lime suspension into it and stir. Add enough water to bring the volume of the mixture to the 50-gallon mark. The spray mixture is now ready to use.

Quicklime (rock lime) may be used instead of hydrated lime. In fact, quick lime is better than hydrated lime because Bordeaux mixture made with quicklime is more gelatinous and more adhesive than that made with hydrated lime. However, quicklime is not only difficult to obtain (unless bought by the barrel) but also difficult to keep, for unless it is kept in an air-tight container, it will air-slake and become unfit for use. For this reason, the use of hydrated lime is recommended. Most of the brands of hydrated lime sold in Louisiana are suitable for making Bordeaux if used while fresh.

Bordeaux mixture deteriorates rapidly, and for this reason it should be used the same day it is made.

If large amounts of Bordeaux are to be made it is convenient and time-saving to prepare stock solutions of bluestone and lime. The most convenient concentration of each is 1 pound in 1 gallon of water. The two solutions should never be combined in the concentrated form. The spray tank or barrel should be filled about one-half full with water, the desired amounts of the stock solutions should be added and stirred, then more water should be added to fill the tank or barrel. For example, to make a 4-4-50 Bordeaux in a 200-gallon tank from stock solutions made with 1 pound of the materials per gallon of water, proceed as follows: (1) Fill the tank about one-half full and start the agitator. (2) Pour in 16 gallons of the bluestone stock solution and 16 gallons of the lime stock suspension. (3) Add more water to fill the tank.

The stock solutions, if kept separate, will keep indefinitely.

2. "Instant" Bordeaux: The so-called "instant" Bordeaux mixture is made from finely powdered copper sulphate, called "snow" or "flour," and hydrated lime. To make a 4-4-50 mixture, fill the 50-gallon barrel nearly full with water and add 4 lbs. of the powdered copper sulphate while stirring. The powder will dissolve in a few seconds. Make a suspension of the hydrated lime in 2-3 gallons of water in a bucket, pour it into the barrel, and stir for a few seconds. Add enough water to fill the barrel. The mixture is now ready to use.

The only advantage that "instant" Bordeaux has over the regular Bordeaux is the rapidity of its preparation, for the finely powdered bluestone dissolves almost instantly. The powdered bluestone, however, usually sells at a higher price than does the crystal form. Furthermore, it is necessary to keep the powdered bluestone in an air-tight container, otherwise it will "cake" and will not be easily soluble.
3. *Bordeaux Paste:* If Bordeaux mixture is prepared in the form of a thick paste, it makes an effective, safe, and cheap dressing for painting pruning wounds and other cuts on trees. It is made as follows: Dissolve 4 lbs. of bluestone in 3 gallons of water, slake 6 lbs. of quicklime with 3 gallons of water, and mix the two together. This makes a thick paste which can be applied by means of a brush. If quicklime is not available, use 8 lbs. of hydrated lime instead.

4. *Various “fixed” copper compounds:* In recent years several of the so-called “fixed” or “insoluble” copper compounds have come into use as substitutes for Bordeaux mixture for spraying, and also in the form of dusts. These compounds contain copper in some form, such as copper oxide, copper hydroxide, basic copper sulphate, copper oxychloride, copper silicate, copper phosphate, etc., and are sold under various trade names such as “Cuproicide,” “Tri-basic,” “Sprayed,” “Basicop,” “Coposil,” “Cupro-K,” “Copper Hydro-40,” etc. A few of the compounds have been tested in Louisiana on certain crops, and have been found satisfactory. Many of these have not as yet been tested, so no general recommendations regarding their use can be made. Satisfactory results, however, have been reported for most of these compounds in other States.

Compared with homemade Bordeaux, the following advantages and disadvantages may be stated in general for the fixed compounds.

**Advantages:** (1) They come in powder form, usually in weighed packages, and they are easy to mix. All one has to do is put the required amount of the dust in the required amount of water, stir, and the mixture is ready to use. (2) Since these compounds contain, in general, less soluble copper than Bordeaux and no free lime, they cause less injury to the plant than Bordeaux.

**Disadvantages:** (1) In general, these compounds are less effective fungicides than Bordeaux. (2) They are less adhesive to foliage than Bordeaux. (3) They tend to settle in the spray tank. If the spray tank is equipped with an agitator, this point is not important, but if the sprayer does not have an agitator (as is the case with most of the small knapsack type of sprayers in use in Louisiana) the settling of the spray material is a serious drawback.

Several of these copper compounds are diluted with some inert filler, with or without the addition of insecticides, and used as dusts (see cucumber, pages 15 and 16).

Since the percentage of copper in these different compounds varies, follow the recommendations of the manufacturer as to the amount to use in preparing a spray or a dust.

**Sulphur**

1. *Dusting sulphur:* Sulphur possesses both fungicidal and insecticidal properties and is used effectively against such diseases as the powdery mildews, some rusts, brown rot of stone fruits, etc., and against red spider, rust mite, some leafhoppers, etc. The effectiveness of sulphur depends
on the fineness of its particles. Dusting sulphur should be 300 mesh or finer. Most brands of dusting sulphur meet this specification. Sulphur may cause injury on some plants, especially under hot and dry conditions.

2. Wettable sulphur: Sulphur by itself does not mix with water. However, if some wetting agent, such as glue, casein, or lime, is mixed with it, the sulphur becomes wettable and it can be used with water as a spray. Wettable sulphur is easily available on the market. If it is found desirable to prepare wettable sulphur at home, the following formula will be found satisfactory:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dusting sulphur</td>
<td>2 1/2 pounds</td>
</tr>
<tr>
<td>Casein</td>
<td>4 ounces</td>
</tr>
<tr>
<td>Water</td>
<td>1 quart</td>
</tr>
<tr>
<td>Water to make</td>
<td>50 gallons</td>
</tr>
</tbody>
</table>

Mix the casein in 1 quart of water to make a smooth paste, mix this with the sulphur, then add the rest of the water.

Instead of the casein, 3/8 ounce of glue dissolved in 3 quarts of water may be used as the wetting agent.

3. Lime sulphur: Lime sulphur is one of the most important sprays, for it is both a fungicide and an insecticide. It is made by boiling together quicklime and sulphur (50 lbs. quicklime, 100 lbs. sulphur, 50 gallons of water). Commercial brands of lime sulphur, both the concentrated solution and the dry form, are easily available and relatively cheap, so no directions are given here for home made lime sulphur.

Most commercial preparations of concentrated solutions of lime sulphur vary in density from 28° Beaumé to 33° Beaumé. For winter (dormant) spraying, this is diluted at the rate of 1 gallon of the concentrated solution in 8 gallons of water. For summer spraying, much more dilute mixtures are used, 1 gallon in 50 to 100 gallons of water, depending on the time of spraying and the kind of plant being sprayed. (Follow directions given in spray schedules for various crops).

Dry lime sulphur is made by the dehydration of the concentrated lime sulphur solution. Dry lime sulphur is less active than the liquid form, and so it is necessary to use more of it to make a spray that will be equivalent to that prepared with liquid lime sulphur. (Follow directions given in spray schedules for various crops).

ACKNOWLEDGMENTS

The writer is indebted to Dr. C. W. Edgerton, Head of the Department of Plant Pathology, for contributing much valuable information and for help and encouragement in the preparation of this bulletin. He also acknowledges his thanks and appreciation to the other members of the Plant Pathology Department who contributed information, read the manuscript, and offered valuable suggestions and corrections, and to Dr. C. O. Eddy, of the Entomology Department, for the valuable help in the preparation of several of the spray schedules. Much valuable information was taken from publications of the United States Department of Agriculture and of the various State Experiment Stations.

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