B-132

Plant Diseases in Texas and Their Control

A. A. DUNLAP
J. F. ROSBOROUGH

Revision of Circular 91
Texas Agricultural Experiment Station

Issued by
The Extension Service
Agricultural and Mechanical College of Texas and
The United States Department of Agriculture
J. D. Prewit, Acting Director, College Station, Texas

CONTENTS

PLANT DISEASES IN TEXAS AND THEIR CONTROL

A. A. Dunlap*
J. F. Rosborough**

For many years the Agricultural and Mechanical College of Texas has carried on research on the causes and control of plant diseases. As a result of this work, much useful information has been accumulated. Many disease-resistant varieties of plants have been developed and treatments for a number of diseases have been perfected. The proper application of this knowledge of disease control should prevent much of the large loss that is suffered annually through plant diseases. Such losses now amount to millions of dollars in Texas alone each year. Some plant diseases may be found on every plantation, farm or ranch, and in every orchard, nursery, home garden, and storage house.

It is the purpose of this handbook to present briefly the results of research which may be useful in the practical control of the more common diseases of economic plants in the State of Texas. The first part of this circular lists the various crops in alphabetical order and treats of their common diseases and methods for control. The diseases are listed in the order of their importance under each crop, except where only reference is made to other pages. Short descriptions of the diseases are included, to aid in identifying the trouble at hand. Wherever possible, only those disease control measures are suggested that can be carried out conveniently by the average grower. Measures that have proven useful in regions outside of Texas have been included in those cases where results of experiments within the State are not yet available.

The second part of the handbook deals with general information about certain diseases which attack a large variety of plants. Here are given detailed descriptions of these diseases, and of control methods that are applicable to the large number of different plants that are attacked.

The third part of this hand book includes specific information about methods used in the control of plant diseases, with directions for the preparation and application of various fungicides.

Since plant diseases are usually prevented rather than cured, control of these troubles calls for foresight and preparedness on the part of the grower. Outstanding among practical disease-control measures is the growing of resistant varieties of plants if such strains are known to be satisfactory. Rotation with non-susceptible crops is another satisfactory and economical measure in many cases. Treatment of the seed often prevents loss of young plants and results in increased yields. Removal and destruction of infected plant refuse is an important factor in keeping down many types of diseases. Soil sterilization is effective against certain soil-borne diseases but it is usually too expensive for areas larger than small garden plots and greenhouses.

*Chief, Division of Plant Pathology and Physiology, Texas Agricultural Experiment Station.
**Horticulturist, Extension Service.

More active disease-control steps involve the spraying or dusting of the plants. Under most conditions, spraying is usually more effective than dusting for the control of plant diseases. In some cases, however, dusting may be more practical than spraying. For example, it may be difficult at times to haul a heavy sprayer through muddy or sandy soil. In spraying or dusting, as in other measures, the success of attempts at control depend largely upon the thoroughness of the application. Timeliness is also important. Growers should always be on the alert to notice a disease at its first appearance and to apply proper control measures as soon as possible. This is important because the presence of the fungi, bacteria, and nematodes causing plant diseases frequently is not noticed until considerable damage has been done.

Besides the possible use of the suggestions made here for the control of plant diseases, growers should also understand their insect problems and whenever possible combine necessary insect control measures with disease control. Furthermore, County Agents, the Extension Service, and the Experiment Station are always ready to render all possible assistance in aiding growers to diagnose their disease problems and to assist them in applying control measures successfully.

SYMPTOMS AND CONTROL MEASURES FOR COMMON PLANT DISEASES

Alfalfa

Disease	Symptoms	Control Measures
Crown wart	Galls of various sizes on stem at ground line. Plants have yellow foliage, are stunted, and frequently are killed.	Plow under affected field and plant to some other crop for 3 to 5 years.
Dodder	Plants overrun by small tangled yellow vines.	Use only high grade, pure seed. Burn infested spots in field after mowing and drying.
Cotton root rot	See page 48.	Plant badly infected land to non-susceptible crops. Dead spots may be reseeded for first 2 or 3 years after first appearance of root rot. See Root Rot.
Rust	Round, reddish - brown dusty spots on either side of the leaves and on the stem.	When rust becomes serious, the crop should be cut as soon as possible to prevent loss of leaves and to allow new growth to start possibly under rust-free conditions.
Leaf spots	Small dark spots on leaves.	See above measures for rust.

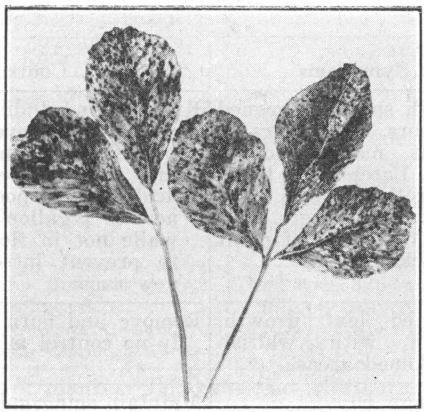


Fig. 1. Rust pustules on leaves of alfalfa.

Apple

Disease	Symptoms	Control Measures
Fire blight	Dead leaves on tips of twigs or on fruiting spurs. Cankers on twigs, limbs, or main trunk.	See Pear.
Fruit blotch Leaf spot Black rot Bitter rot Powdery mildew	These diseases cause various fruit rots, or spotting of the foliage and fruit.	Use the following spray schedule: 1. At petal fall, spray with liquid lime sulphur, 1 gal. to 50 gal. water (or with dry lime sulphur, 4 lbs. to 50 gal.) 2. Repeat No. 1 about 2 to 3 weeks later. 3. Spray with 2-3-50 Bordeaux mixture about 2 to 3 weeks after spray No. 2.
Crown gall	See page 54.	
Cotton root rot	See page 48.	Plant trees only in root-rot-free areas. Use cotton as indicator crop in suspected areas to select land that is free from disease.

Apricot (See Plum)

Arbor Vitae (See Cedar)

Aster (China)

Wilt	Drooping of lower leaves. Plant finally dies.	Plant wilt-resistant varieties or plant in new location next season.
Yellows	Stunting, yellowing, malformation, and clustering of foliage.	Remove and burn infected plants, as soon as discovered. Because leaf-hoppers carry the disease, plants should be protected from them by screen wire or cloth netting.

Azalea

Disease	Symptoms	Control Measures
Flower spot (Petal blight)	Whitish spots on opened flowers. All flowers on plant may suddenly wilt. Later small black sclerotia form on dried blighted flowers. Petals only part of plant attacked.	Kurume and Indian types are most susceptible. Remove infected flowers from plants and change mulch after flowering. Spray open flowers with acetic acid (1 tablespoonful of glacial-strength acid to 1 gallon of water). Move plants while not in flower and remove mulch to prevent introducing the disease to new areas.
Leaf gall	Distorted leaf growth, often with whitish thickened areas.	Remove and burn affected leaves. Usually no control measures are necessary.
Chlorosis	See page 59.	Maintain acid condition in soil, pH 4.5 to 6.

Barley

Mildew	Grayish white mold on the surface of leaves. Small round black bodies are sometimes embedded in the mold.	Keep down wild grasses and volunteer barley. Can be controlled by dusting with sulphur but application not practical. Texan and Tunis varieties are resistant. Further breeding for resistance is in progress.
Stem rust Leaf rust	Rusty to blackish pustules breaking out on leaves, stems and sheaths.	Resistant varieties will soon be available which are adapted to South Texas conditions.
Loose smut Covered smut	Immature kernels reduced to a black smutty mass at time of flowering.	Treat seed with New Improved Ceresan, ½ oz. per bu. For best control soak a small lot of seed in water 5 hrs., then in hot (126° to 129° F.) water 13 min.; dry and sow in isolated field. Use smut-free crop for seed next year.
Stripe Net blotch Spot blotch	Stunted plants with brown streaks or spots on leaves and stems.	Clean seed thoroughly. Treat seed with New Improved Ceresan, ½ oz. per bu. Rotate crop and eradicate wild grasses in and around fields.

Bean (Bush, Pole, Lima)

Bacterial blights	Irregular dead areas on leaves. Dark spots or blotches on pods. Girdling of the lower part of the stem.	Use 3 to 6 year rotations. Secure Idaho-grown seed. The Refugee varieties are somewhat resistant.
Mosaic	Leaves have a puckered, mottled appearance, with light and dark green areas. Plants are stunted.	Refugee U. S. No. 5, Idaho Refugee, and Wisconsin Refugee are resistant.

Bean (Bush, Pole, Lima) (Continued)

Disease	Symptoms	Control Measures
Rust	Small reddish-brown to black pustules mostly on lower surfaces of leaves.	Among the snap beans the wax-podded varieties are usually resistant. The Kentucky Wonder variety of pole bean is highly susceptible. Dust 3 to 5 times with 325-mesh sulphur, before blooms appear. Where rust frequently occurs, begin dusting a few days after the plants come up.
Powdery mildew	Whitish, powdery growth over surface of all above-ground parts of plant. Curled leaves.	Dust with 325-mesh sulphur as soon as the mildew appears. Make 2 or 3 applications of dust at 10-day intervals.
Curly top	Stunted plants; foliage distorted.	Great Northern, Univ. Idaho No. 15 and Red Mexican varieties are resistant.
Cotton root rot	See page 48.	
Stem rot	Se page 49.	
Root knot	See page 52.	

Beet

Leaf spot	Small grayish spots with reddish margins on leaves. In severe cases all larger leaves may be killed.	Plow under old leaves as soon as crop is harvested. In small gardens, destroy infected leaves by burning. Use a 3-year rotation with other crops. Treat seed for 7 minutes in formaldehyde (1 part to 70 parts water), rinse and plant or dry thoroughly.
Scab	Rough areas on surface of underground parts.	Plant on new land. Do not plant on land following Irish potatoes. Scab is less prevalent on acid soils.
Stem rot	See page 49.	
Root knot	See page 52.	
Cotton root rot	See page 48.	

Blackberry and Dewberry

Cane blight	Wilting of foliage. Grayish cankers on stems, often with small black dots.	Cut out and burn diseased canes as soon as possible after berries are picked. Obtain healthy plants for setting new fields.
Leaf spots and Anthracnose	Various types of spotting on leaves and larger spots or cankers on canes. Serious on Young and Boysen berries.	Remove old canes ("handles") when setting plants. Spray 2 times with liquid lime-sulphur (32° Baumé), using 1 gal. to 50 gal. of water. Apply first spray just before blossoming and the second just after harvesting. (Fig. No. 2.)
Rust	Lower surfaces of leaves covered with orange-colored mass of spores.	Rogue out and burn infected plants, including the roots. Destroy likewise infected wild berry plants nearby.

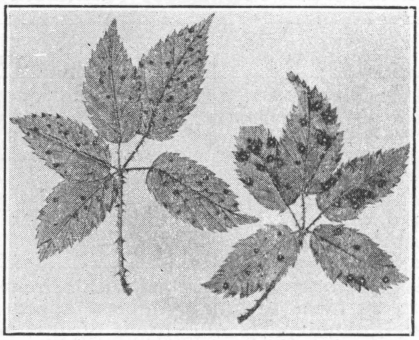


Fig. 2. Leaf spot of blackberry

Blackberry and Dewberry (Continued)

Disease	Symptoms	Control Measures
Crown gall	Large, rough, roundish galls on lower portion of stem or on the larger roots.	Inspect all new plants carefully before setting. Locate new planting in land that has not raised fruits, berries, or grapes. See page 54.
Rosette	Bunchy growth, many shoots arising from one point. Foliage light colored. Diseased flower buds leafy and malformed, sterile, often covered later with whitish powdery fungous growth.	Destroy wild berry plants growing nearby. Take new plants from healthy canes. Cut out all rosette growth in February. Cut off new canes at ground about May 1. Spray new canes, produced later, 2 or 3 times at 10-day intervals with 4-4-50 Bordeaux mixture.

Cabbage, Cauliflower, Brussels Sprouts, Mustard, Turnip

Leaf spot	Round, brownish to black spots on older leaves. Also discoloration of cauliflower heads. Usually not serious in the field but may cause heavy losses in storage.	Treat cabbage seed in hot water at 120°-122° F. for 25 minutes (all others 15 min.). Plant at once or dry carefully if planting is delayed. Remove all refuse and remains of previous crop from storage room. Disinfect walls, shelves, and floor in storage room with formaldehyde (1-50) or copper sulphate (blue vitriol) solution (1 oz. in 2 gal. water.)
Black rot	Blackening of veins near margin of leaf. Followed by soft rot of stem and other parts of plant.	Rotate crops. Discard all plants if disease appears in seed bed. Treat seed as for **leaf spot** above. Start plants in new soil free from crop refuse.
Downy mildew	Moldy appearance of entire leaf in case of seedlings, spots are formed on older leaves and seed stalks.	Locate seed bed in a new place each year. Plant seeds far enough apart so that seedlings will not be crowded. Transplant only the healthy seedlings.

Cabbage, Cauliflower, Brussels Sprouts, Mustard Turnip, (Continued)

Disease	Symptoms	Control Measures
Yellows	Stunted plants with yellowish color. Lower leaves die and drop off. Darkened water vessels in stem and leaf stalks.	Rotate crop. Cabbage is most susceptible and several resistant varieties are available, such as: All Head Select, Jersey Queen, Marion Market, and Resistant Detroit (early types). Wisconsin Ballhead, Globe, and Wisconsin All Seasons (late types).

Cantaloupe

(Also Cucumber and Squash)

Downy mildew	Yellowish spots on upper surface of leaf. Faint patches of grayish or purplish downy mold underneath. Under conditions favorable for the fungus the entire field may appear brown in a few days. Melons from blighted vines lack flavor and are worthless.	Spray with weak Bordeaux mixture (2-3-50). Make first application when any of these diseases first appear. Follow with other applications at about 2-week intervals until harvesting. Copper-lime dust (20-80) may be used instead of the Bordeaux spray. Certain new copper compounds now on the market offer considerable promise as fungicides for cantaloupes. They are less injurious to the foliage than Bordeaux mixture or copper-lime dust. These materials are now being tested under Texas conditions.
Powdery mildew	Dusty white appearance on upper surface of leaves. Entire plant later appears yellowish and sometimes the foliage may be killed.	Sulphur sprays or dusts cannot be used on cantaloupes (except Ferry-Morse V-I). M. R. No. 45, M. R. No. 4-50, and M. R. No. 5 cantaloupes are resistant to powdery mildew.
Anthracnose	Brownish spots on leaves and leaf petioles. Dark sunken spots on fruit often with a pinkish covering of fungous spores.	The Experiment Station is now developing a downy-mildew resistant cantaloupe.
Sooty mold	Black discoloration over surface of leaves and fruit. This is due to growth of a fungus on honeydew given off by aphids.	Control aphids (plant lice) by dusting with 3% nicotine dust—1 lb. nicotine sulphate thoroughly mixed with 13 lb. hydrated lime. Add 10% sodium carbonate for dust mixture, or as a spray equal parts of household ammonia and nicotine sulphate. Make close inspection for first infested plants and spot dust to prevent infestation from becoming general.
Bacterial wilt	Sudden wilting of entire plant which later dries up. A sticky ooze can be pressed from the freshly cut stem.	Keep plants well covered with a dust consisting of 1 part of calcium arsenate to 20 parts of gypsum (land plaster) to protect against the striped cucumber beetle. Plant an excess of seed and thin out after plants are started. Remove wilted plants as soon as they are seen.

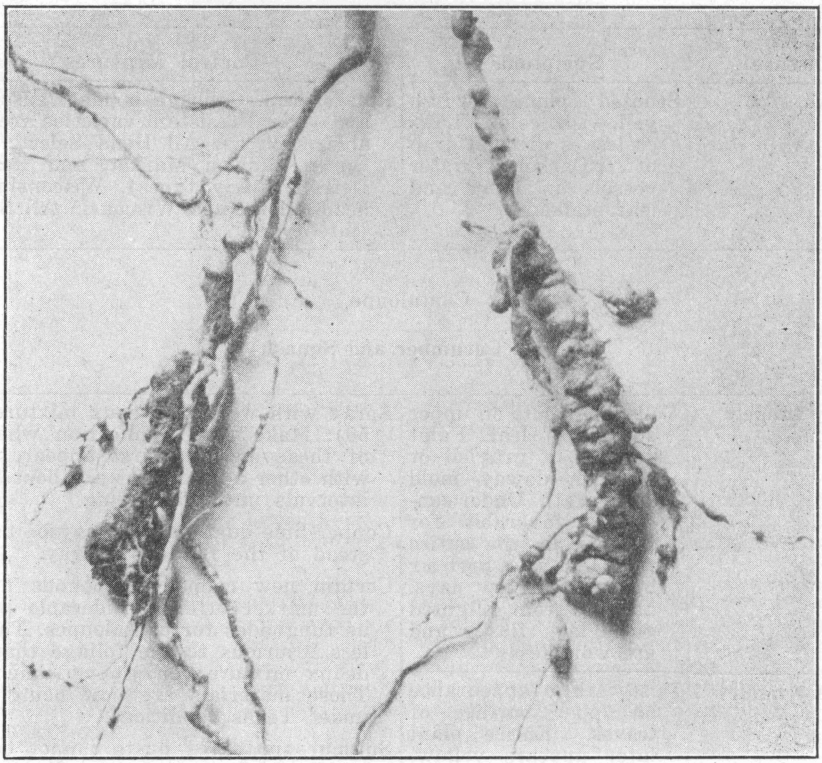


Fig. 3. Nematode root knots on cantaloupe. (Large galls such as these are typical of nematode infection on herbaceous plants.)

Cantaloupe (Continued)

Disease	Symptoms	Control Measures
Wilt (Fusarium)	Wilting of entire plant. A discolored streak often forms along one side of stem.	Use wilt-resistant Minnesota 10-38 variety.
Southern blight	See page 50.	
Stem rot	See page 49.	
Root knot	See page 52.	
Mosaic	See page 54.	

Carnation

Rust	Stunted plants with distorted leaves. Brown pustules of spores break out on leaves and stems.	Take cuttings from rust-free plants only. Dust once a week with 325-mesh sulphur until the flowers begin to open. In the greenhouse, maintain good ventilation and low humidity.
Root knot	See page 52.	

Carrot

Disease	Symptoms	Control Measures
Leaf spot	Grayish spots on leaf and leaf stalk. May result in death of outer leaves.	Make 3 applications of Bordeaux mixture (5-3-50) or dust with 20-80 copper-lime dust at 2-week intervals starting when spotting first appears on lower leaves.
Aster Yellows	Tops become yellow, stunted and bunchy. Many small rootlets on carrot. Infects many weeds and is spread by leafhoppers.	No control known.
Crown and root rots	See page 49.	
Cotton root rot	See page 48.	

Cauliflower (See Cabbage)

Cedar
(Juniper, also Arbor Vitae and Arizona Cypress)

Blight	Dying of tips of smaller branches. With seedlings and small trees the entire plant may become brown. Destructive in nurseries and frequent on older trees.	Prune off and burn dying branches. Spray with Bordeaux mixture (4-4-50) 3 times (or more if season is wet) at 3-week intervals during the winter and spring, or dust with 90:10 sulphur: copper dust.
Rust	Orange spore masses on small branches in spring, often on small galls.	Avoid planting near apple or hawthorn. Destroy wild hawthorn bushes nearby. Remove cedar-apple galls from cedars.

Chrysanthemum

Leaf spots	Three or four different fungi cause spotting of the leaves. Usually the spots are small, sunken, and grayish to brownish in color.	Spray with wettable sulphur (1 lb. to 10 gal. water) every 10 days, starting when spots first appear and continuing as long as the disease is present.
Powdery mildew	Grayish dusty appearance on upper surfaces of leaves.	Dust with 325-mesh sulphur once a week until mildew disappears, or use spray as suggested for leaf spots.
Rust	Dark brown pustules on lower surfaces of leaves. Badly rusted leaves are shed.	Take cuttings from healthy plants. Remove the first leaves which show infection. Avoid wetting the foliage when watering. Dust with sulphur (as for mildew) before the disease is widespread among the plants.
Root knot	See page 52.	
Stem and root rot	See page 49.	
Cotton root rot	See page 48.	

Citrus

(Grapefruit, lemon, orange, tangerine, etc.)

Disease	Symptoms	Control Measures
Scab	Raised lumps or warty outgrowths on surface of fruits. Upon ripening the fruit tends to remain green where scabby. Similar growths occur on the leaves chiefly on the under surface. Leaves are often deformed.	Spray twice as follows: 1. Just before growth starts in the spring, using either 3-3-50 Bordeaux mixture plus 1 per cent oil emulsion or 3 lb. wettable sulphur. 2. While trees are in full bloom, or up to petal fall, using 3-3-50 Bordeaux mixture plus 1 per cent oil emulsion. Thorough spraying each season prevents accumulation of foliage infection.
Stem-end rot	A dark discoloration starting at the "button" and finally covering the entire fruit. Affected fruits become pliable and finally shriveled. Two distinct different types of stem-end rot.	Prune trees thoroughly, taking care to remove all dead branches. Spray once with Bordeaux mixture (3-3-50) plus 1 per cent oil emulsion during early April. Dip fruit upon arrival at packing house in warm (117° F.) borax solution (8%), see U. S. D. A. Tech. Bull. No. 488. Store fruit between 40° and 45° F.
Psorosis or Scaly bark	Dead, scaly areas on bark. Trees decline in vigor. Spotting and mottling of leaves on new growth often evident.	In early stages of infection, scrape off scaly area and margin down to healthy bark. Select budwood only from healthy trees. No cure known for affected trees.
Chlorosis	See page 59.	

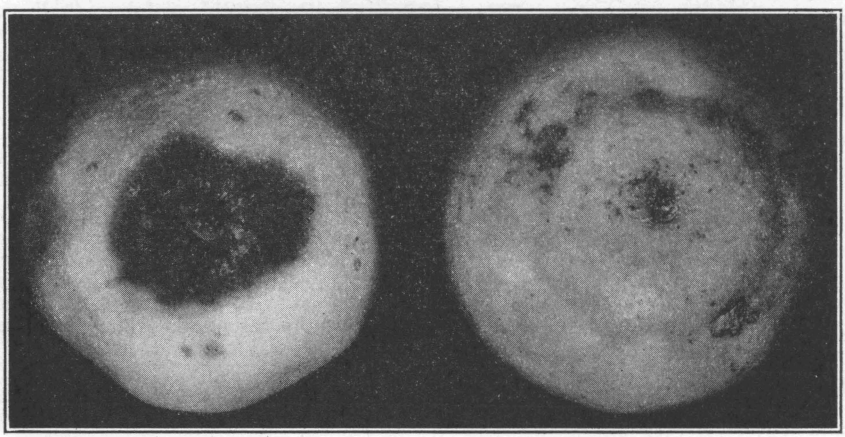


Fig. 4. Stem-end rot of grapefruit.

Disease	Symptoms	Control Measures
Gummosis	A clear gummy substance appears at different regions on the bark where it accumulates and drips downward. A mild form of brief duration is non-infectious and non-injurious. The serious form is infectious through wounds and produces discolored wood with pinkish margin.	Tree surgery, including removal of badly affected branches to protect the main trunk, and cutting out discolored wood where it is not too deeply established. All such excavations, and all pruning wounds over ¾ inch should be treated with a disinfecting and wound protecting paint. A 50-50 mixture (60-40 in summer) of solid asphalt and anthracene oil is good, "stepped up" with a strong disinfectant such as 3 oz. to the gallon of phenol (carbolic acid). ("Carbolineums" are mostly anthracene oil).
Melanose	Small brown spots on leaves, fruit and twigs, making rough surface. Infection through young tissues.	Prune off and burn all dead wood. Spray with copper fungicide some time within 3 weeks after blossoms fall. See Tex. Agr. Expt. Sta. Prog. Rept. 825.

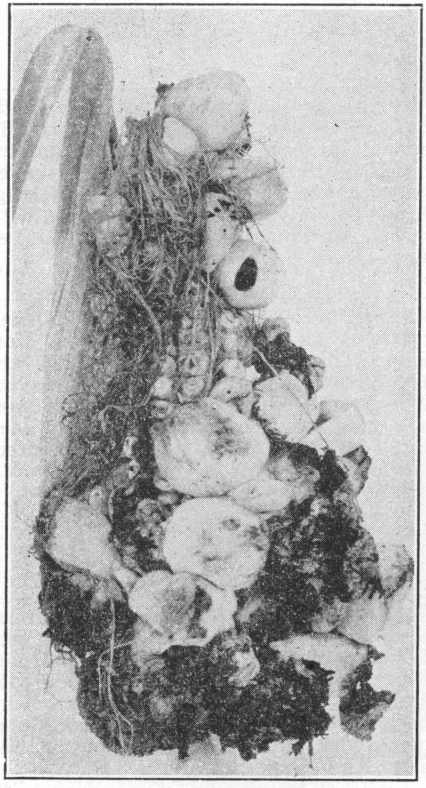


Fig. 5. Corn smut (occurs on all parts of the plant).

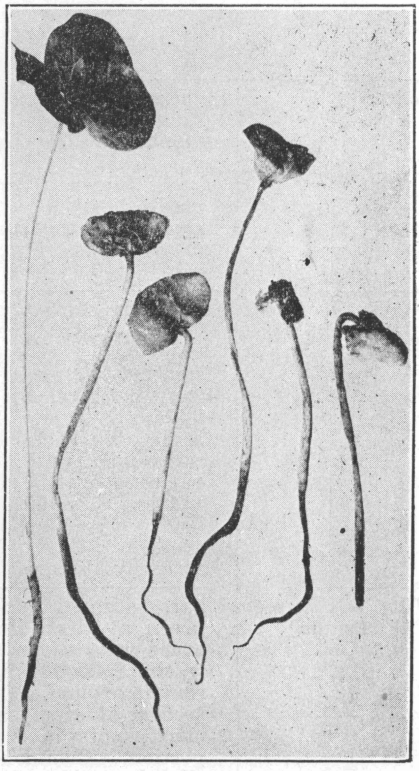


Fig. 6. Sore-shin on cotton seedlings.

Corn

Disease	Symptoms	Control Measures
Ear, stalk, and root rots	Certain fungi cause a cob and kernel decay of maturing ears. When carried over into the next crop on seed, losses through poor germination, death of seedlings, and later stalk and ear rots may result.	Select only healthy, well matured and properly cured ears for seed. If such seed is not available, treat seed with Semesan Jr., or Spergon, see page 66. In irrigated fields, avoid standing water around roots of plants.
Smut	Large black smutty masses on ears, stalk leaves, or tassel. Early stages appear as hard, greenish "boils." Corn smut can overwinter in the soil and the spores may be blown a considerable distance.	In small gardens diseased plants should be destroyed before the spores (black dust) are spread. If the disease appears to a damaging extent in a large field, plant to some other crop for 3 years. Since corn smut is not transmitted by the seed, treatment of the seed is not effective in control of this disease.

Cotton

Root rot	Plants wilt suddenly. Roots decay and dead plants can be pulled up easily. Foliage turns brown as entire plant dies. Brownish strands of the fungus may be seen on the tap root.	If possible avoid planting cotton in fields or local areas where root rot usually causes large losses. Use green manure crops, preferably legumes. Plow under cotton immediately after final picking. Use a 2 or 3-year rotation of cotton with corn, sorghums or small grains. See page 48.
Angular leaf spot (Boll rot)	Small dark, irregular spots on the leaves. Considerable defoliation may occur on cotton seedlings. On the bolls the spots are large, round, and have a greenish water soaked appearance, later turning brown or black. The lint from spotted bolls is damaged by discoloration.	Delinting of seed (Kemgas or Corneli methods) or seed treatment with New Improved Ceresan (see page 66) are recommended. Under conditions favorable for the disease, considerable damage may result even when treated seed has been used. To be most effective, all seed in a given community should be treated each season.
Wilt (Fusarium)	Plants stunted, darker green at first. Brown areas in leaves and wilting plants. Roots remain sound. Cross section of stem shows black spots in woody portion. Common in slightly acid soils of East Texas.	Rotate crops. Use a high-potash fertilizer such as 6-8-8. Resistant varieties are: Coker 4-in-1, Coker 100 W. R., Miller 610, Rowden 2088, Dixie Triumph 12, and Clevewilt 6. Wilt resistance may be lowered by the presence of root-knot nematodes in the soil (see below). See Tex. Agr. Exp. Sta. Bull. 627.

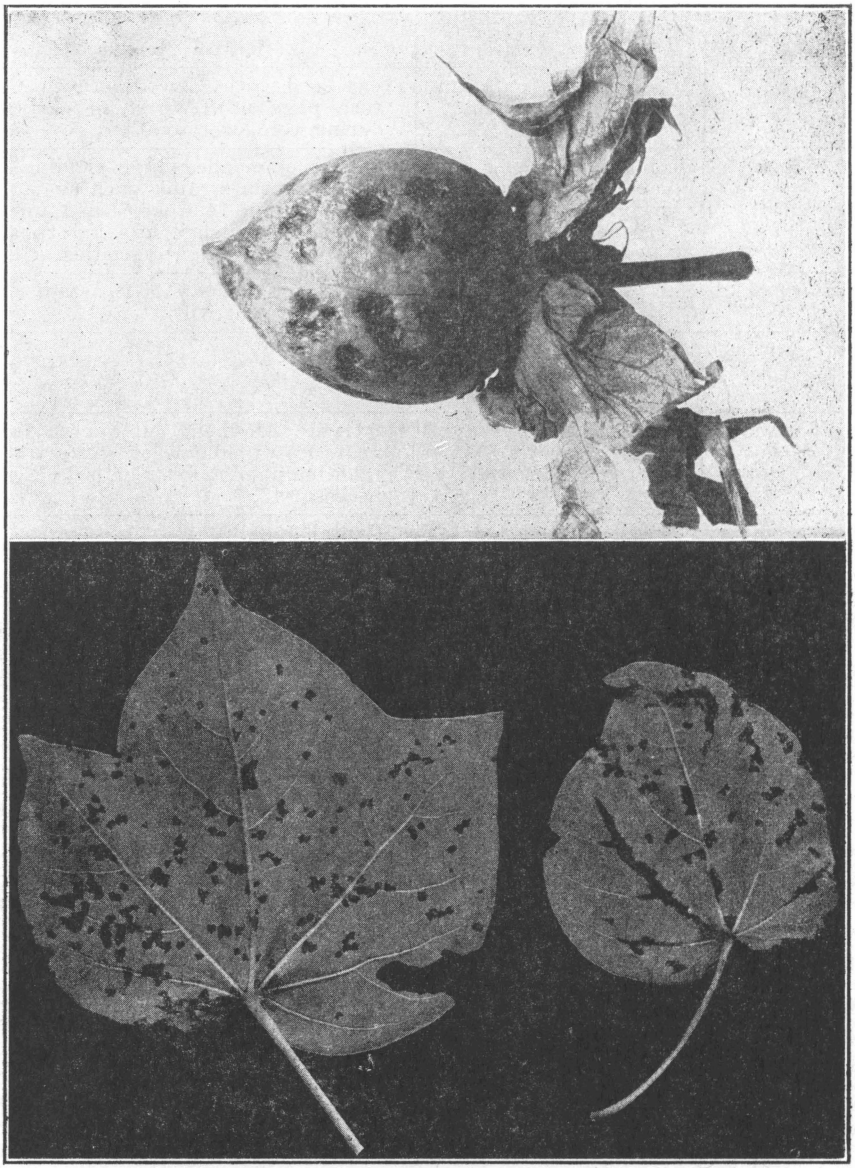


Fig. 7. Angular leaf spot of cotton. Above, a cotton boll showing lesions caused by the disease, later these boll infections often develop into a boll rot.

Cotton (Continued)

Disease	Symptoms	Control Measures
Wilt (Verticillium)	Similar to Fusarium wilt, but occurs mostly in West Texas.	See page 52.

Cotton (Continued)

Disease	Symptoms	Control Measures
Sore shin	Brown lesions on young stems near soil line.	Treat seed with New Improved Ceresan (see page 66). Worst in early fields during cold, wet weather.
Boll-shedding	Dropping of young bolls usually just after flowering. Caused by cloudy weather or drought.	Plant recommended high-yielding varieties. Certain strains, such as Stoneville 2B, Deltapine 14, Coker 4-in-1, and Roldo Rowden have shed less in experiments than certain other varieties.
Root knot	See page 52.	Coker 4-in-1 variety is resistant to both root knot and wilt.

Cowpea (see Pea)

Crapemyrtle

Powdery mildew	Whitish to grayish growth covering upper surface of leaves.	Dust with 325-mesh sulphur at first appearance of mildew or spray with wettable sulphur, 2 oz. per gal. Repeat as necessary.

Cucumber (See Cantaloupe)

Date Palm

Leaf spots	Small, grayish to dark colored areas on leaves that may unite and form large, dead blotches.	Spray with 4-4-50 Bordeaux mixture using a spreading agent for good coverage. Two sprays in the fall about a month apart and 2 more in the early spring.
False smut	Small, black, raised dots on either upper or lower leaf surfaces.	

Eggplant

Leaf spot Fruit rot	Spots on the fruits and leaves are circular and brownish in color. On the fruit, soft, sunken spots cause rotting or shriveling.	Spray with 4-4-50 Bordeaux mixture, commencing when the fruits are first set and repeating every two weeks until fruits are nearly mature.
Yellows	Yellowing and whitening of upper leaves, later entire plant becomes yellow, may finally die.	Keep plants in seed bed well dusted with sulphur; for complete control apply additional sulphur dust to plants in field once or twice after transplanting.
Cotton root rot	See page 48.	

Elm

Anthracnose	Black crusty spots with whitish margins on upper surface of leaves.	Spray with 4-4-50 Bordeaux mixture 2 or 3 times starting as soon as the leaves are fully grown and again at 3-week intervals. Collect and burn leaves in the fall.
Leaf spots	Small brownish or grayish spots, usually slightly sunken in leaf tissues.	

Elm (Continued)

Disease	Symptoms	Control Measures
Cotton root rot	See page 48.	Chinese elm is highly susceptible. Native cedar elm (**U. crassifolia**) is more resistant.

Euonymus

Mildew (Powdery)	White spots or blotches on both sides of leaves (more on upper surface).	Spray or dust with a copper, sulphur-copper or sulphur fungicide at first appearance of mildew. It is often best to replace a badly infested plant with a different species.

Fig

Rust	Numerous small reddish spots on under surface of leaves. May cause complete defoliation of tree.	Apply 5-5-50 Bordeaux mixture every 30 days from June 1 to October 1. Be careful to spray lower surfaces of leaves and new growth thoroughly. Copper-lime dust (20-80) may be used instead of Bordeaux mixture.
Leaf spots Limb cankers Leaf blight Die-back Etc.	Several different fungi attack the limbs and foliage tending to lower the vigor of the tree.	The above spray for fig rust will also help to control these other diseases. In addition, prune the trees carefully and remove all dead branches, cankers, and dried-up fruits.
Souring	Fruits become sour and decay.	Keep fruits picked as soon as ripe. Collect dropped fruit from ground.
Cotton root rot	See page 48.	Do not plant in areas where root rot occurs.

Flax

Rust	Reddish, dusty spots on leaves or stems. Later certain of these spots become hard and black. Black spots on the stem are often much longer than wide.	Varieties of flax such as Rio and Viking are highly resistant or immune.
Pasmo	Elongated brown spots on the stems; greenish yellow to brownish spots on the leaves. Affected plants have a brown appearance.	Burn or plow under affected stubble promptly after harvest. Rotate with other crops when Pasmo diseases is present. See seed treatment for wilt.
Wilt	Drying-up of young plants in the seedling stage. Wilting and dying of older plants in spots in the field. Not yet found in Texas but likely to occur with continued planting.	Where wilt occurs, do not plant flax in same field oftener than once in 4 or 5 years. Save seed from healthy fields. Disinfect seed with New Improved Ceresan (½ oz. per bu.) (See page 66.) This seed treatment also helps to prevent damping-off and to prevent introduction of rust and Pasmo into new land.

Flax (Continued)

Disease	Symptoms	Control Measures
Anthracnose	Cankers on stems of plants at soil line.	Injury has been noted in Texas. Treat seed. Rotate crops.

Gardenia (Cape Jasmine)

Canker	Swollen ridges girdling stem just above soil line. Leaves may wilt and die.	Destroy affected plants to prevent spread.
Chlorosis	Young leaves become yellow. Plants make poor growth.	Usually caused by alkaline soil conditions. See page 59.
Sooty mold	Black, thin laver over upper surface of leaves. Caused by a fungus that grows on sugary exudate from white fly insects.	Control insects on under sides of leaves by spraying with 1½ teaspoon nicotine sulphate and 3 tablespoons summer oil per gal. of water.
Root knot	See page 52.	

Garlic

Pink root	Stunted plants, premature ripening. Pinkish discoloration of roots followed by browning and decay which may extend into bulb.	Plant garlic only once in 4 years on the same land. Do not plant onions in rotation with garlic.
Curing and storage rots	Soft decay starting in neck and progressing downwards into the bulb. Sometimes the decay has a black smutty appearance. Cloves become soft, shrivelled, discolored or decayed.	Select the best bulbs for seed. As the crop becomes ripe, move soil away from necks of plants. Allow tops to mature before pulling. After pulling, top plants as soon as possible and place on chicken-wire shelves in a drying shed or under a tight roof to cure. See Tex. Agr. Exp. Sta. Bull. 651.

Geranium

Bacterial blight	Large, brownish spots and dead areas on older leaves. Leaves turn yellow and fall.	Pick off leaves as soon as they show infection. When plants are indoors, allow ample space between them and ventilate freely.
Leaf spot	Circular brown or reddish spots with a ridge-like darker border. Spots may unite to affect entire leaf.	Indoor plants usually outgrow this trouble when set out-of-doors. Remove diseased leaves. Spray with 2-2-50 Bordeaux mixture in extreme cases.

Gladiolus

Disease	Symptoms	Control Measures
Leaf spot Scab and Crown rots	Three or four different Diseases cause a spotting of the leaves and various types of injury such as spotting or decay of the corms ("bulbs").	Separate new corms at time of harvest. Cure thoroughly and store at 35° to 45° F. Remove outer husks at planting time and discard all corms showing signs of disease. If corms from badly affected stock must be planted—treat by soaking in corrosive sublimate solution (1 tablet in 1 pint of water) for 5 hours.
Mosaic	Stunted plants with mottled leaves and the flowers have whitish or greenish streaks.	Pull up and burn all plants showing mosaic symptoms.

Grape

Black rot	Small brown spots (often containing black dots) on the upper leaf surface. Shrivelling and drying-up of grapes in cluster.	The following spray schedule is suggested for the control of these diseases. 1. 4 lbs. copper sulphate in 50 gal. water, in January. **or** 8-8-50 Bordeaux applied just as the buds begin to swell. 2. 2-3-50 Bordeaux when 2 or 3 leaves have formed on the shoot. 3. 2-3-50 Bordeaux before flowers open. 4. 2-3-50 Bordeaux after blossoms fall. 5. 2-3-50 Bordeaux after small grapes have set. When there is frequent rainfall, repeat spray No. 5 at about 12-day intervals until one month before fruit is ripe. In drier areas, less spraying is necessary. All Vinifera grapes are susceptible to black rot and downy mildew. The American, Bell, Carmen, Champanel, Delaware, Manito, Marguerite, Salamander, and the Muscadine varieties are resistant to black rot.
Downy mildew	Small reddish areas on the upper surface showing the presence of the whitish mildew on the lower leaf surface. A brown decay of some of the grapes may also occur.	
Anthracnose	Small irregular spots with dark margins on leaves. Small brown spots on shoots and tendrils. Large pinkish spots on berries giving the name "Birds-eye rot."	
Leaf spots	Several different types of leaf-spot fungi occur on grape foliage. They are usually small brownish, sunken spots.	
Powdery mildew	Whitish, moldy growth on upper side of leaf, on small stems, and fruit.	
Crown gall	Large, rough galls, either spherical or elongated, on lower stem, branches, or on larger roots. Affected plants usually lack vigor and frequently die.	Inspect all young plants thoroughly before setting. Treat young plants for 10 minutes with 1-1000 mercuric chloride just before setting out. When galls are formed on roots, remove and burn entire plant. Do not replace infected plant with another in same place.

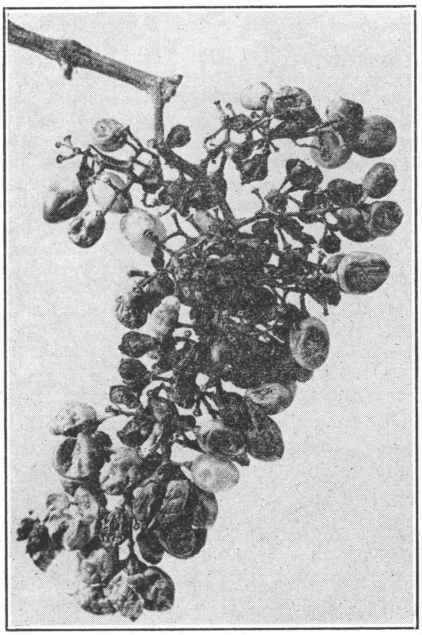


Fig. 8. Grape black rot.

Grape (Continued)

Disease	Symptoms	Control Measures
Cotton root rot	See page 48.	Select root-rot-free land for vineyard. Use resistant root stocks, such as Champanel, Dog Ridge, and La Pryor.
Root knot	See page 52.	

Grapefruit (see Citrus)

Grass (Lawn)

Brown patch	Dead brown, circular areas in turf, beginning as small spots and rapidly enlarging under favorable conditions. Most prevalent in wet weather on dense turf. In Texas, St. Augustine grass lawns are affected with brown patch quite frequently — especially along the Gulf coast. Reports of this disease on Bermuda grass in golf greens in northeast Texas have been received.	Avoid overwatering and over manuring of the lawn. Spread of the disease can be checked by spraying the affected spots with 4-4-50 Bordeaux mixture. In case the disease is prevalent over a considerable area, spray the lawn thoroughly with one of the following materials: Thiosan, Semesan, Special Semesan, or Wettable Spergon which are available on the market for brown patch treatment. In using these materials, follow the manufacturer's direction. Handle these poisonous materials carefully. A sprinkling can may be used if no sprayer is available.

Hollyhock

Disease	Symptoms	Control Measures
Leaf spot	Small, angular, grayish spots with dark margins on leaves. Dead tissue may fall out leaving a "shot-hole" appearance.	Rake up and burn all dead leaves and stems in the fall. If bad, spray plants every 2 or 3 weeks during the growing season with 4-4-50 Bordeaux mixture.
Rust	Brownish or purplish, circular rust spots on any above-ground part of plant.	Burn all old leaves and stalks of the plants in the fall. Remove first few leaves that show the rust in the spring. If the disease persists, dust with 325-mesh sulphur once a week.
Cotton root rot	See page 48.	

Iris

Crown and rhizome rots	Two or three different diseases cause rotting of the plant at the surface of the ground or below.	Plant shallow. Avoid overcrowding by frequent transplanting of rhizomes. Discard all plants showing decay. Dip rhizomes in corrosive sublimate solution (1:1000) just before replanting. Plant in light, well drained soil and avoid overwatering. See Southern Blight, page 50.
Leaf spots	Usually small, brownish spots appearing near the tip of the leaf. Entire leaf may be killed after flowering.	Cut off and burn all diseased leaves in the fall. Spray with a copper fungicide with a sticking agent added.

Juniper (see Cedar)

Lemon (see Citrus)

Milo (see Sorghum)

Mustard (see Cabbage)

Nectarine (see Peach)

Oak (Live and Deciduous)

Blister leaf	Leaves deformed, curled, or with blister-like depressions. Areas in leaf may often be yellowish or reddish and a dense whitish covering may appear beneath the infected spots.	These foliage diseases of oaks can be controlled by spraying with 4-4-50 Bordeaux mixture. Two or three applications should be made starting about the time the leaves are coming out in the spring and followed at 3-week intervals. **Or,** Dust with 90:10 sulphur-copper mixture, at 10-day intervals.
Leaf spots	Small, roundish or irregular spots showing chiefly on the upper surface.	
Tar spot	Hard, black, tar - like growth making a raised spot on the upper side of the leaf.	

Oak (Continued)

Disease	Symptoms	Control Measures
Cotton root rot	See page 49.	Most species of oaks will not survive in root-rot areas. The liveoak is resistant.

Oats

Loose smut	Black smutted heads appearing a few days before the healthy grain. Most of the smut masses in the oat hulls disintegrate and blow away by the time the crop matures.	Treat seed by either one of the following methods: (a) Treat seed with New Improved Ceresan dust (see page 66). Mix dust in thoroughly with the grain. **or** (b) Treat seed with formaldehyde at the rate of 1 pint plus 1 pint water to 50 bushels. Use a hand sprayer held close to spray grain as it is shoveled over and over on the floor. (Work in a well ventilated room.) Cover grain for 4 hours with a blanket or paper. Then spread grain out thinly. Varieties of oats resistant to smut have been developed by the Experiment Station. These are Fultex, Ranger, Rustler, and Rangler.
Covered smut	Diseased heads appear somewhat later than healthy ones. All kernels in head reduced to a black mass of spores. The kernels remain intact until threshing. Not common in Texas.	
Stem rust Leaf rust	Red or black dusty pustules on leaves and stems. These two diseases are caused by different fungi and may occur separately or together. Leaf rust appears earlier in the season than stem rust.	No effective method of control. Varieties of oats resistant to rust are being developed for certain regions of Texas. Consult your County Agent or Experiment Station for latest information and source of seed. Fultex, Ranger, Rustler, Rangler, and Verde varieties are resistant to leaf rust.
Mildew	Whitish to grayish mats of moldy growth on upper sides of leaves. Frequently with small round black or brownish bodies embedded in the fungous mat.	No practical control measure available. Losses usually slight.

Okra

Wilt	Plants first show yellowing and stunting followed by wilting and death. When stem is split lengthwise, dark streaks may be seen in the woody portions.	Plant in rotation with other vegetables. When soil has become badly infested, do not plant with okra for 10 years.
Cotton root rot	See page 48.	
Root knot	See page 52.	

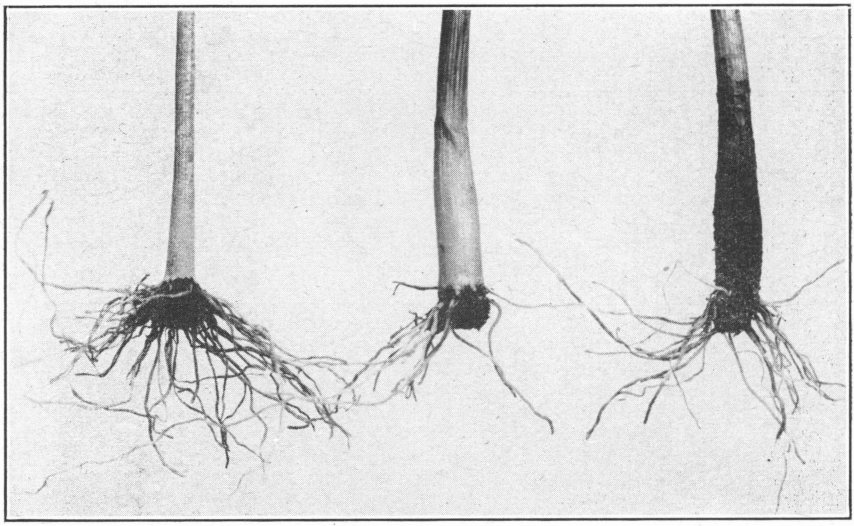


Fig. 9. Onion pink root.

Onion

Disease	Symptoms	Control Measures
Smudge	Dark green or black blotches of various size and shape on the bulb, usually at side or top.	Yellow or red varieties are resistant to this disease. There is no practical control for this disease on white onions. Provide good ventilation in storage.
Purple blotch	Large spots on leaves, becoming purplish. Pink fungous threads inside leaf. May cause dying of parts of leaf.	Spraying or dusting with a copper fungicide is suggested. Rotate crops.
Pink root	Roots turn pink and finally shrivel or decay. New roots eventually become diseased also. Plants are stunted.	Rotate crop. Provide good growing conditions so that rapid growth will be made. Select rich soil and apply a nitrogenous fertilizer. Plant so that growth will be made before hot weather. Yellow and White Bermuda onions are more resistant than Yellow Grano or Babosa.
Black mold	Black spots among outer scales near top of bulb. Under certain conditions the entire bulb may be covered with a black, smutty mass of spores. Appears during curing or storage.	Dry thoroughly before storing and place only the best of the crop in storage or shipment. Keep at a low temperature following curing.

Onion (Continued)

Disease	Symptoms	Control Measures
Neck rot	Grayish mold near top of onions in storage. Black crust-like formation may also appear in affected parts of bulb. Infection takes place in field at time of harvest and develops later in storage.	White onions are much more susceptible than colored types. Dry onions thoroughly before placing in storage. Grade carefully and discard all immature and thick-necked onions. Store in slatted crates at a temperature of 32° to 34° F. and provide ample ventilation.
"Blight"	Various types of leaf injury, such as spotting, streaks, and tip burn. Serious in Coastal Bend. Exact cause of trouble not yet known.	No control measures. In some cases purple blotch may be involved (see above).

Orange (see Citrus)

Pea (Cowpea)

Pod spot (Cladosporium)	Irregular purplish or black spots on pods. Infection on young pods may cause curling and shedding: The disease is seed-borne.	Do not plant on land where pod spot has occurred. Obtain seed from healthy plants. Spray with a copper fungicide at first appearance of the spots. Most field-type peas are resistant while the edible varieties are susceptible.
Canker (Bacterial)	Large, swollen cankers on lower stem that tend to crack open. Dead areas on leaves.	Rotate crop. Obtain seed from healthy plants. Certain varieties, such as Brabham, Crowder, and Iron may be resistant.
Leaf spot	Angular spots of varying sizes on leaves; reddish brown on upper surface and grayish to black on under side. Badly infected leaves may drop off.	Plant seed from healthy plants, on new land. Usually not destructive enough to require spray or dust treatment with a copper fungicide.
Wilt Root rot Foot rot	Yellowing or wilting followed by death of plant. Roots may be decayed. In some cases woody part of stem becomes discolored.	Rotate crops, planting peas not oftener than once in 4 years on same ground. Collect and burn plants from infected fields after harvest. California Black Eye No. 8081 and No. 8152 are resistant.
Ashy stem blight	Plants die quickly. Lower stem has gray color.	No control measures known.
Southern blight	See page 50.	
Root knot	See page 52.	
Cotton root rot	See page 48.	

Pea (English)

Disease	Symptoms	Control Measures
Powdery mildew	See Cowpea.	

Pea (Sweet)

Powdery mildew	Whitish, powdery growth on upper leaf surfaces. Leaves shrivel and drop off.	Dust with 325-mesh sulphur at first appearance of mildew. Further dusting may be necessary if mildew persists.
Root rot	Loss of seedlings. Older plants are stunted, yellowed and produce no blossoms. Brown lesions on roots and lower stem. Plants die in severe cases.	Plant in a different part of the garden each year. When only a few plants appear infected, remove these together with surrounding soil. Water as little as possible to obtain good growth.
Streak	Brown to black streaks on the stem, starting near base and extending upward. Leaves become spotted and turn brown. Entire plant finally dies.	Select seed for planting only from healthy pods. Discard all shriveled or discolored seed in purchased stocks. Treat seed in 5% formaldehyde solution 5 minutes, rinse and plant. Burn all plant refuse in the fall.
Mosaic	Leaves mottled, curled, and yellowish. Flower stalks short. Flowers streaked with white.	Remove and burn infected plants at once. Keep down aphids ("plant lice") which spread the disease.
Root knot	See page 52.	

Peach
(also Nectarine)

Scab	Small, dark green or black spots or blotches on the fruit, usually on one side near the stem. Reduces the value of the fruit without causing decay. Appears every season.	A thorough spraying schedule must be carefully followed if these major diseases are to be controlled. Systematic spraying each season insures against crop loss. SPRAY NO. 1. (Dormant or winter spray.) In the eastern part of the state where San Jose scale is prevalent, commercial oil emulsions, usually 3% strength, are recommended. Mix with water according to directions on the container. (Caution: if possible, avoid spraying just before freezing temperatures. Keep sprays well agitated at all times.) Where peach leaf curl and San Jose scale are prevalent, liquid lime sulphur mixed with water according to directions on the container is recommended. It is best to test the solution with a hydrometer before using it on a large scale. For winter spray the stock solution should test 32 degrees Baume. By adding more liquid lime sulphur or water to strengthen or weaken the spray solution, the proper strength is easily
Brown rot	Brown decay of fruit; decayed portions becoming covered with a dusty mass of spores. Especially bad during periods of wet weather. Also blights blossoms and attacks twigs.	
Leaf curl	Leaves curled, thickened and distored with	

Disease	Symptoms	Control Measures
	whitish or pinkish surface on curled portions. Affected fruits are misshapen with smooth areas. Entire tree may be defoliated early in season.	obtained. Lime sulphur (stock solution) is usually mixed at the rate of 1 part lime sulphur to eight or ten parts water. SPRAY NO. 2. (Blossom blight or brown rot control.) Wettable sulphur 10 lbs. to 100 gals. water; or liquid lime sulphur 2 gals. or dry lime sulphur 8 lbs. to 100 gals. water. Apply when buds have begun to swell and show slight pink color.
Powdery mildew	Whitish, powdery growth on leaves, stems, and fruit. Leaves also tend to curl and fold up. When affected early, leaves may fall.	SPRAY NO. 3. (When most of blossoms have shed.) To control curculio (worms) in peaches and plums, mix 2 lbs. zinc sulphate, 4 lbs. hydrated lime, 1 lb. of arsenate of lead to 50 gals. water. **Caution:** Where annual rainfall is less than 30 inches, **do not use zinc sulphate in the spray mixture. Important: Mix** this spray in the following order: dissolve the zinc in spray tank; add the lime as a thin creamy paste to a nearly full tank before adding the lead arsenate. SPRAY NO. 4. (Shuck spray.) About 10 days after the blossoms have shed, and the shucks of the blossoms are in evidence at the base of the tiny peaches or plums, repeat Spray No. 3. SPRAY NO. 5. (Two weeks after shuck spray.) Same as No. 3. This spray is directed against brown rot and curculio. Therefore to control brown rot, add 3 lbs. wettable sulphur to the spray tank just before the arsenate of lead. If either Spray No. 4 or Spray No. 5 is to be omitted, Spray No. 4 should be omitted. SPRAY NO. 6. (Two weeks after No. 5 spray.) Spray with 3 lbs. wettable sulphur to 50 gals. water. This spray is to protect early fruit against brown rot and scab. SPRAY NO. 7. (For mid season and late ripening varieties.) Spray with 3 lbs. wettable sulphur to 50 gals. water. This is approximately 30 days before fruit ripens. SPRAY NO. 8. (Just before or during harvest.) Spray with 5 lbs. wettable sulphur to 50 gals. water, or dust with dusting sulphur. This is to protect fruit that is to be held or shipped against rot.
Rust	Reddish pustules on lower surface of leaf, marked by a yellowish spot on upper surface. Also attacks the fruit. May cause leaves to drop prematurely.	When rust appears after harvest, apply wettable sulphur spray or 325-mesh sulphur dust to prevent early defoliation. The regular spray program (see preceeding page) will help to control rust.

Peach (Continued)

Disease	Symptoms	Control Measures
Bacterial spot or Canker	Small dead spots in leaves that may fall out leaving a "shot-hole" appearance. Fruit roughened with deeply sunken spots or areas. Small thick-edged cankers on twigs and larger lesions on branches or trunk.	Inspect all nursery stock carefully for swollen cankers on twigs. Discard infected plants. Prune off infected twigs or branches in orchard. Maintain good growing conditions by cultivation, fertilization, and cover crops. Fertilize trees with nitrate of soda (2 to 3 lbs. per tree) in the winter. Spray with zinc sulphate 4 lbs., hydrated lime 3 lbs., with milk spreader, in 50 gal. water.
Crown Gall	Large, spherical or irregular, rough galls on lower part of trunk or larger roots.	Dip all young plants 10 minutes in 1-1000 mercuric chloride before planting. Remove and burn all diseased trees. Do not replace with another tree in same place. Examine carefully all young trees for signs of galls before setting. Destroy all infected nursery stock.
Mosaic Yellows Little peach Phony peach	A number of different virus diseases, each with certain distinguishing characters but often difficult to diagnose. Characterized in some cases by poor growth of the tree; mottled, misshapen, or yellowish foliage; clusters of small twigs, mottled coloring in blossoms; and small, bumpy, spotted or misshapen fruits.	If possible obtain expert opinion as to actual presence of the virus diseases. Rogue out and burn all infected trees.
Root knot	See page 52.	Use resistant root stocks (Shalil, Yunnan, and others).
Oak root rot	See page 51.	
Cotton root rot	See page 48.	While the peach is susceptible to root rot it is not killed as quickly by the disease as are pears or apples.

Peanut

Wilt	Attacks young plants. Upper leaves become yellow followed, especially in dry weather, by wilting and death of the plant. Main root with brown lesions. Root readily breaks off.	Do not plant peanuts on the same land for more than two years in succession.

Peanut (Continued)

Disease	Symptoms	Control Measures
Stem and pod rot (Southern blight)	Rotting of stem and larger roots at or below soil line. Pods are also attacked and seed becomes infected. Whitish growth of fungus may be seen on infected plants.	Rotate crop. When disease appears, plant on new land. Use shelled seed for planting in a new field or on land previously planted with sorghum or corn. Harvest crop as early as possible. See page 51.
Leaf spot	Brownish or black spots with light colored margins on leaves. Also elongated spots on leaf stalks and stems. Causes early fall of leaves, also loss of hay and peanuts.	Dust 3 times with 325-mesh sulphur commencing about 60 days after planting and repeat after intervals of about 2 weeks. (If rain falls within 24 hours after dusting, repeat application within one week.)
Cotton root rot	See page 48.	

Pear

Fire blight	Blossoms turn black, followed by dying of nearby leaves. Tips of twigs of small branches die with brown or black leaves remaining attached. Circular or elongated cankers on branches and stems.	Remove infected twigs during winter by cutting off several inches below visible trace of disease. Cut out diseased areas (cankers) on main trunk or larger limbs, making cut in healthy wood. Prune out all small limbs when infectious cankers are present. Sterilize instruments between each cutting by dipping in formaldehyde (1 part in 25 parts water). Coat surface of pruning wounds with Bordeaux paint. (Alcoholic zinc chloride solutions have been used succesfully to treat cankers without removal from limbs or trunk). Spraying of trees in full bloom with 1-3-50 Bordeaux mixture is sometimes helpful. Avoid overfertilization of trees and do not prune heavily enough to cause excessive new growth. Kieffer, Douglas and Garber varieties are somewhat resistant. Highly susceptible varieties such as the Bartlett should not be planted in areas where the disease is serious.
Crown gall	See page 54.	
Cotton root rot	See page 48.	Since the pear is extremely susceptible to root rot, extensive plantings should not be made in areas where the disease is prevalent.

Pecan

Disease	Symptoms	Control Measures
Scab	Disease first appears in early spring as black spots on lower surface of veins. Typical spots on leaves are olive-black, velvety and slightly raised. Later dark sunken spots appear on the young nuts and twigs. These spots on the nuts cause the husk to crack open and become rough.	Remove all old hulls and leaf stems from trees and plow under all such material before new growth appears. A general spray program for pecans designed to control several of these foliage diseases (also leaf blotch, downy spot; vein spot, and liver spot) consists of applications of Bordeaux mixture (insecticides may be added as needed): 1. About the middle of April (when leaves are about one-third grown and before pollen is shed) spray with 2-½-50 Bordeaux mixture. 2. When brown tips of small nuts are visible, about 10 to 15 days after spray No. 1, spray with 3-1-50 Bordeaux. 3. About 3 to 4 weeks later, repeat spray No. 2. 4. About 3 to 4 weeks after No. 3, repeat spray No. 2 again. Bordeaux spray may cause infestation of aphids ("honey dew"). Examine trees frequently and spray first infested trees with 1 pint of nicotine sulphate, 3 lbs. soap, to 100 gal. water. Pressure of 400 to 500 lbs. should be maintained in all pecan spraying. The Frotscher, Moore, Moneymaker, Nelson, Mahan, Stuart, Teche, and Success varieties are more or less resistant to scab, although all have been known to be attacked by scab under some conditions.
Brown leaf spot	Large, circular or irregular, reddish brown spots on older leaves, appearing about midsummer or later. Trees may be entirely defoliated late in the season.	
Powdery mildew	White, moldy growth over surface of leaves and nuts. Sometimes becomes conspicuous during damp weather but does little damage.	
Rosette	Young leaves on tips of upper branches are small and yellow. Later leaves become crinkled, hardened, turn brown and drop off. Healthy growth takes place just below affected tips giving the end of the branch a clustered or "rosette" appearance. Sometimes only certain branches are affected, the others remaining healthy.	Spray 2 times with zinc sulphate solution (1 lb. to 50 gal. of water) beginning about 1 month after the buds open and repeating in 3 to 4 weeks. (If trees are sprayed for insects or disease, zinc sulphate may be added to the mixture.) **or** Add zinc sulphate (1 lb. for each inch in diameter of trunk) to soil over the region of the roots, in February. Work the zinc sulphate into the top soil. This soil treatment is most effective on acid soils.

Pecan (Continued)

Disease	Symptoms	Control Measures
Die-back	Tips of branches are killed and drop their leaves. This symptom is later followed by death of larger branches.	Prune out all affected branches in the spring just after leaves appear and again in the fall just before the leaves are dropped. Infection is likely to follow insect injury.
Crown gall	See page 54.	
Cotton root rot	See page 48.	Young pecan trees are much more susceptible than older ones.

Pepper

Leaf spot	Large, light-colored circular spots with dark borders on leaves and stems. Dead tissue in old spots may become cracked and fall out leaving large holes.	Spray with 4-4-50 Bordeaux mixture, with a sticking agent added, as soon as first spots are seen. Repeat as often as necessary to maintain coverage. Mature fruits may be slightly discolored by the spray.
Bacterial spot	Small, irregular, raised spots on leaves and fruits. Badly infected leaves become yellow and drop off. Infected fruits are rough and distorted.	Rotate crop. Do not plant peppers following tomatoes, especially in the same year. Soak seed in water over night, then soak in copper sulphate solution (one ounce in 2 quarts of water) for 5 minutes, shake off excess solution, roll in hydrated lime and plant at once. Start plants in a new seedbed each vear and spray seedlings with 2-3-50 Bordeaux mixture each week until transplanted.
Mosaic	Stunted plants with crinkled leaves that are mottled with yellow and green areas. Fruits small and malformed.	Destroy all plants showing mosaic symptoms. Also watch for and destroy all weeds growing in the vicinity that show mosaic. Keep down infestations of aphids (plant lice).
Southern blight	Decay of stem at or below ground line. Plant wilts and soon dies. Whitish fungus may be seen on stem and during wet weather small brownish seed-like fungous bodies may be present.	Remove all wilting plants as soon as they are noticed. Do not allow plant refuse to remain on soil. Rotate crops. Plant peppers following corn, sorghum, small grains, grasses or cotton.
Cotton root rot	See page 48.	
Root knot	See page 52.	

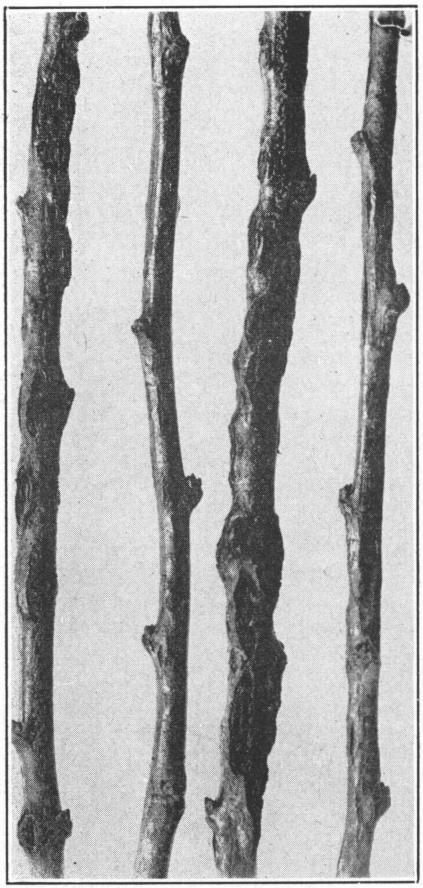


Fig. 10. Bacterial cankers on plum twigs.

Plum

(also Prune and Apricot)

Disease	Symptoms	Control Measures
Plum pockets	Fruits become hollow, wrinkled and irregular in shape. Disease appears soon after blossoming. Affected fruits drop early.	The following spray program may be followed to advantage in controlling a number of plum diseases: 1. Just before buds open in spring—liquid lime sulphur (1 gal. to 40 gal. water). 2. Shortly after petals fall—wettable sulphur (5 lbs. to 50 gal.) 3. About 2 weeks before fruit is ripe—repeat spray No. 2. During periods of wet weather additional
Brown rot	Nearly ripe or mature fruits become rotted on the tree and covered with brownish, dusty	

Plum (Continued)

Disease	Symptoms	Control Measures
	spore masses. Especially bad during periods of wet weather.	sprays of wettable sulphur may be necessary to prevent brown rot. Dead branches should be pruned out and all fallen fruits as well as dried "mummies" on trees should be gathered and destroyed. Thinning of fruit when about half-grown reduces loss from brown rot.
Leaf and fruit blotch	Small, irregular spots on upper surfaces of leaves and on fruits. Lesions on fruits are slightly sunken and made up of smaller spots, frequently accompanied by cracking of the skin.	
Black knot	Large, rough black swellings on branches, frequently several inches in length. Portion of branch beyond canker may be killed.	Prune out during the fall or winter all diseased branches making the cut several inches below the obvious infection. The above spray program also helps to keep black knot in check.
Bacterial shot-hole and canker	In addition to symptoms on peach, large, round black spots occur on young plums. Twig cankers are more frequent on this host.	See peach. Bruce, Opata, Red June, Sapa, and Six Weeks varieties are resistant. Gold, Methley, Shiro, and Wickson are susceptible.
Root knot	See page 52.	Use resistant Mariana rootstock.
Oak root rot	See page 51.	
Rust	See peach.	
Cotton root rot	See page 48.	

Potato (Irish)

Early blight	Small, brownish spots, often with faint concentric rings, on leaves. Several spots may run together to kill a portion of the leaf.	Spray with 3-2-50 Bordeaux mixture. Commence spraying when plants are 8 to 10 inches high and keep foliage covered as long as the leaves remain green. During rainy or foggy weather, sprays (or dust, 20-80 copper-lime) should be applied more frequently than in dry weather. In some regions where spray injury and decreased yields result from Bordeaux mixture applications, one of the new copper spray materials should be used in place of the Bordeaux.
Late blight	Large, water - soaked areas on leaves and stems. In damp weather a whitish moldy growth can be seen on the underside of infected leaves. Causes a rotting of tubers in field and storage—later becoming a soft rot.	

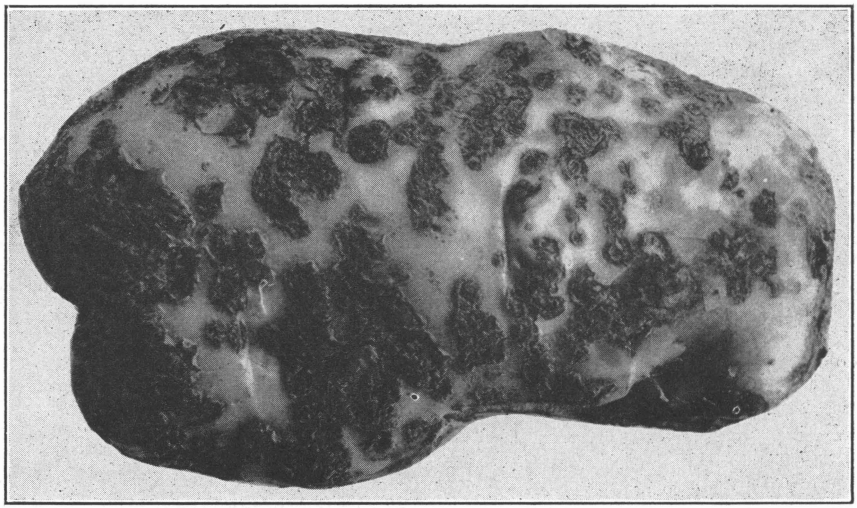


Fig. 11. Potato scab.

Potato Irish (Continued)

Disease	Symptoms	Control Measures
Scab	Roundish or irregular, rough, corky areas on surface of tubers. Injury does not extend far into the potato but scabby potatoes are objectionable in appearance.	Rotate crop. Use certified seed. Soak seed tubers before cutting in corrosive sublimate (1 oz. to 8 gals. water) for 90 minutes, in yellow oxide of mercury suspension for 1 minute, or in Semesan Bel suspension, see page 65. Scab is much less prevalent in acid soils than in alkaline soils. Plant on new land and use acid-forming, commercial fertilizers. Avoid barnyard manures.
Scurf and stem rot (Rhizoctonia)	Small, hard, black bodies adhering to surface of tuber. Browning of below-ground part of stem. Aerial tubers sometimes formed.	Rotate crop. Use certified seed. Treat seed as for scab.
Mosaic, Leaf roll, Curly dwarf, Spindle tuber	Plants usually stunted and off-color. Foliage mottled or leaflets tend to roll up. Tubers often small and in case of spindle tuber, elongated.	Use certified seed. Control insects.
Wilt (Fusarium)	Plants wilt suddenly and die. Brownish discolloration inside lower stem and stem end of tubers.	Rotate crop. Use certified seed.
Southern blight	See page 50.	
Root knot	See page 52.	

Potato Irish (Continued)

Disease	Symptoms	Control Measures
Brown rot (Bacterial wilt)	Plants wilt and die. Stems discolored (at first only on inside). Tuber with dark vascular ring may decay.	Avoid infested fields and plant seed from northern states. Discard all tubers with dark eyes or with sticky ooze on surface.
Ring rot	Resembles brown rot but stem is not discolored. Tubers with cracks on outside and circular decayed area beneath surface.	Use certified seed from states where zero tolerance for ring rot is required.
Charcoal rot	Shallow, dark areas on surface of tuber, often followed by bad-smelling soft rot.	Harvest potatoes as soon as tops mature. Avoid high temperature and humidity in storage.

Potato (Sweet)

Black rot	Roundish, almost black spots of varying size on the sweet potato. Bitter quinine taste in black areas. Small black lesions often completely girdle under-ground stems.	Select seed potatoes carefully at time of harvest and again at bedding. (It is better to use potatoes raised from vine cuttings for seed. Renew soil or sawdust in hot bed each season.) Treat seed potatoes in Semesan Bel (follow directions on container) or in corrosive sublimate (1 oz. to 8 gals.) for 10 minutes before bedding. Select only healthy plants for setting; discard all sprouts that appear sickly or those with discolored roots or stems.
Stem rot (Wilt)	Plants may die soon after setting (infected sprouts) or they may become stunted, yellowish or brownish, and finally dead. A dark inner portion of the stem may be seen when the stem is broken open lengthwise near the base.	Select seed potatoes only from hills in which the stems appear white and healthy when broken open at soil line. Also use seed potatoes grown from vine cuttings and follow other precautions given for black rot. For local use, slips that have been allowed to attain a good size and then cut off above the soil line instead of being pulled will carry less disease than pulled slips.
Storage rots (Mostly soft rot)	A number of different fungi cause sweet potatoes to decay in storage. Some of these result from disease infection in the field. Others gain entrance to the potato through wounds made at harvest time or subsequent handling.	Spray crates and all parts of storage room with formaldehyde (1 lb. to 30 gal. water). Harvest in dry weather and allow potatoes to dry in field before gathering. Cure potatoes for 5 days at 80° F. with a high relative humidity. During wet seasons, dry with artificial heat. Reduce temperature slowly to 55° F. and maintain at this point for long storage. Do not allow temperature to drop below 48° F. Handle potatoes carefully during harvest and storage.
Root knot	See page 52.	

Potato Sweet (Continued)

Disease	Symptoms	Control Measures
Pox or Soil rot	Potatoes often misshapen with rough scabby pits or shallow surface lesions that dry up and leave a scar.	Rotate crops. In some soils, the application broadcast of from 500 to 1000 pounds of sulphur per acre and worked into the soil one month before setting plants may be beneficial. (Maintain soil acidity around 5.0 pH.)
Cotton root rot	See page 48.	
Southern blight	See page 50.	

Also see Ext. Serv. M. S. 630 on Sweet Potato diseases.

Fig. 13. Black kernel of rice.

Rice

Disease	Symptoms	Control Measures
Blast	Killing of young plants, production of large leaf spots on the leaves, blasting of head and rotted neck.	Resistant varieties: Zenith, Nira, Fortuna, Blue Rose 41, C. I. 8327 (a Blue Rose type), Rexoro, Texas Patna.
Leaf spot (Helminthosporium)	Fairly large leaf spots from seedling stage to maturity. May kill some seedlings but does not blast heads as in above disease.	Resistant varieties; Nira, Rexoro, Texas Patna, Bluebonnet, C. I. 8326 (a Blue Rose type).
Leaf spot (Cercospora)	Narrow brown spots on leaves, usually after early July. In some varieties (Early Prolific) older leaves and leaf sheaths are killed.	Resistant varieties: Prelude, Nira, Fortuna, Caloro, Blue Rose 41, Kamrose. Bluebonnett, Texas Patna, Rexoro, Delrex, and C. I. 8326.
White-tip	A physiological disease. Leaf tips and other portions of the leaves are white instead of the normal green color.	Resistant varieties: Nira, Fortuna, Blue Rose 41, Bluebonnet, Texas Patna, and C. I. 8326.
Straight-head	A physiological disease. Heads remain erect because grains do not fill. Usually found on new ground or land that has been out of rice for a number of years.	Drain the fields and allow the soil to dry to the cracking stage at least once and preferably twice before rice is in boot. Avoid planting Early Prolific, Blue Rose, or Kamrose on land that tends to produce straight-head.
Black kernel	A small percentage of black kernels in the polished rice. There are no field symptoms.	No practical control. See Texas Agr. Exp. Station Bulletin 584.

Rose

Powdery mildew	White, powdery coating on leaves, buds, and young stems. Immature leaves may be curled, distorted, and light in color.	Dust with 90:10 sulphur-copper mixture once a week until mildew disappears. The Crimson Rambler and the Polyanthas are very susceptible to mildew. Certain other roses are rather resistant. (On account of possible leaf injury, use sulphur sparingly on roses during hot weather.)
Canker	Browning and drying out of canes starting from pruning or from injury in plants over 2 years of age.	Prune back all diseased canes to a strong stem and leave no stubs of branches.

Rose (Continued)

Disease	Symptoms	Control Measures
Black spot	Large, roundish, black spots with irregular or frayed margins on upper surface of leaves. When severe, leaves may turn yellow and drop off.	Dust with sulphur-copper mixture as for mildew. Keep plants well dusted during wet weather. Plants in home gardens may be sprayed once every 2 or 3 weeks with Bordeaux mixture or with 1 oz. wettable sulphur and ½ oz. of an insoluble copper fungicide in 1 gal. of water, with a spreading agent added. Gather and burn all old leaves on ground and dead leaves on plants.
Die-back	Blackening and death of the stem beginning at the old flower and progressing downwards.	Control black spot. Keep plants in healthy, actively-growing condition. Cut off old flowers.
Rust	Reddish, orange - brown or black dusty masses of spots on lower surfaces of leaves.	Gather and burn rose leaves as soon as they are dropped in the fall. Prune bushes back in the spring. Dust with sulphur-copper as for mildew.
Crown gall	Large rough galls on lower stem and larger roots. Sometimes galls may appear above ground.	Inspect all plants before setting out and discard all showing galls. Remove all infected plants and burn. See page 54.
Cotton root rot	See page 48.	
Root knot	See page 52.	

Rye (See Wheat)

Snapdragon

Leaf spot and Anthracnose	Large light - colored spots on leaves and stems. Spots frequently have black or brownish dots near centers. Entire leaves may be killed and often the whole plant dies from stem girdling.	Pull up and burn affected plants as soon as diseases appear. Spray with 4-4-50 Bordeaux mixture to prevent spread of disease. Water by irrigating surface of ground rather than wetting the plants.
Rust	Brown powdery pustules mostly on lower surfaces of leaves. Plants may be stunted and even killed.	Start plants from seed. Do not wet foliage when watering. Dust with 325-mesh sulphur once a week. Some varieties of snap-dragons are resistant to certain strains of the rust fungus and these varieties should be planted.
Root knot	See page 52.	
Stem and root rot	See page 49.	

Sorghum (Including Milo, Kafir, Sorgo, Sudan Grass, Etc.)

Disease	Symptoms	Control Measures
Kernel smut	Individual kernels in head become replaced by a black spore mass covered with a gray membrane. Later these kernels break open giving a black dusty appearance to entire head.	Treat seed with either: (a) Copper carbonate dust (50%), 2 oz. per bu. **or** (b) New Improved Ceresan dust, ½ oz. per bu. **or** (c) Dusting sulphur, 2 oz. per bu. Spur Feterita is resistant.
Leaf blight and Leaf stripe	These diseases vary in their severity in different parts of the State. Spotting or streaking of the leaves with red or brown discoloration are the general symptoms. Leaf blight is common near the Gulf Coast.	No practical control is as yet available. Certain varieties such as Shallu, Leoti, and Sourless are somewhat resistant. Tift Sudan and Sweet Sudan are more resistant than common Sudan grass.
Rust	Raised purplish, reddish or brown pustules on the older leaves. These later break open and release spores.	Although different varieties show varying susceptibility to this disease, no control measures are necessary as yet in Texas.

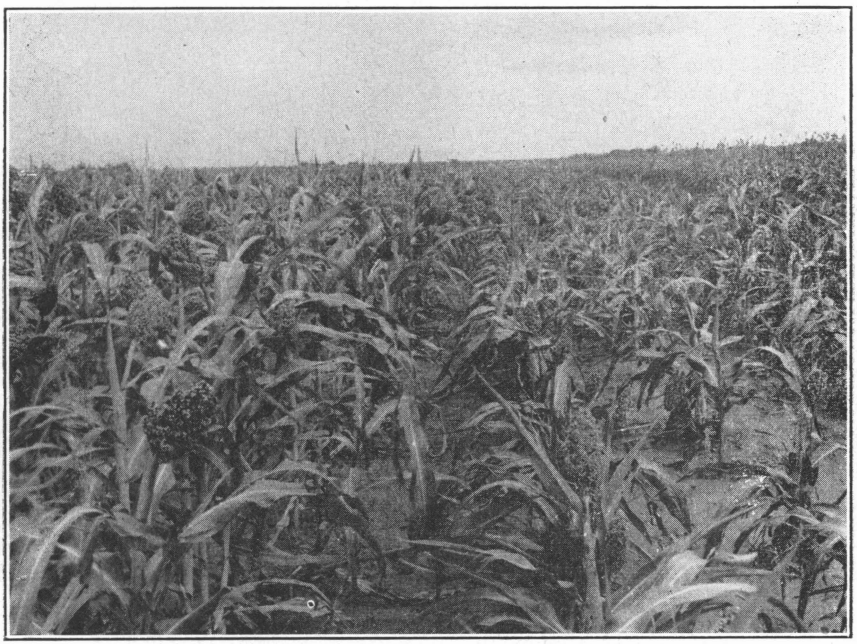


Fig. 14. Milo blight, diseased (stunted) plants on right; resistant strain on left.

Sorghum (Continued)

Disease	Symptoms	Control Measures
Milo root rot	Plants are stunted as if affected by drought. Little grain produced. Lower tip of stem (underground) appears reddish when cut lengthwise. Finally this stem tip and lower roots decay.	Kafir, Hegari, and most Sweet Sorghums are naturally resistant. Resistant varieties of Milo, Darso, and other susceptible sorghums have been selected by the Texas Station and are now available. They should be planted throughout the State. These are: Texas Dwarf Yellow Milo, Texas Double Dwarf Milo, Darso No. 28, and resistant forms of other varieties.
Lodging (Charcoal rot)	Plants break over about 6 to 12 inches above the ground. Localized circular areas occur in the field increasing in size as the crop comes to maturity. Interior of lower stalk appears shredded and contains many small black bodies.	This is apparently a new sorghum disease. Certain unfavorable soil-moisture conditions may be responsible since the trouble apparently is not serious under irrigated conditions. No control measures are known at this time. Practically all varieties are susceptible.
Seed decay Seedling blight	Seedlings killed before or after emergence.	Treat seed as for kernel smut.

Spinach

Blue mold	Yellowish spots on upper surface of leaves Spots covered underneath with a bluish moldy growth. Later the entire leaf may be killed and the whole plant often dies from severe infection.	No satisfactory control measures yet developed. Can be controlled by copper sprays or dusts but treatments are expensive and spray residues may be objectionable. In gardens, plant on ridges and avoid crowding of plants.
White rust	White, blister-like pustules mostly on the under surface of the leaves. Surrounding parts of leaf become yellow.	No control measures are as yet available. Flat-leaved varieties are less susceptible than savoy types. Crop rotation should prevent primary infections from the soil. Avoid flooding during irrigation.
Wilt	Infected plants are undersized, light in color and with the lower leaves wilted. Roots become entirely decayed and interior of stem discolored.	Rotate crop. Avoid early fall and spring plantings.
Leaf spot "Pin-head rust"	Small brown spots on leaves. Entire leaf may turn brown.	Rotate crop. Harvest as early as possible.
Curly top	Young leaves curled and yellow. Plants often die.	No control measures. See page 54.

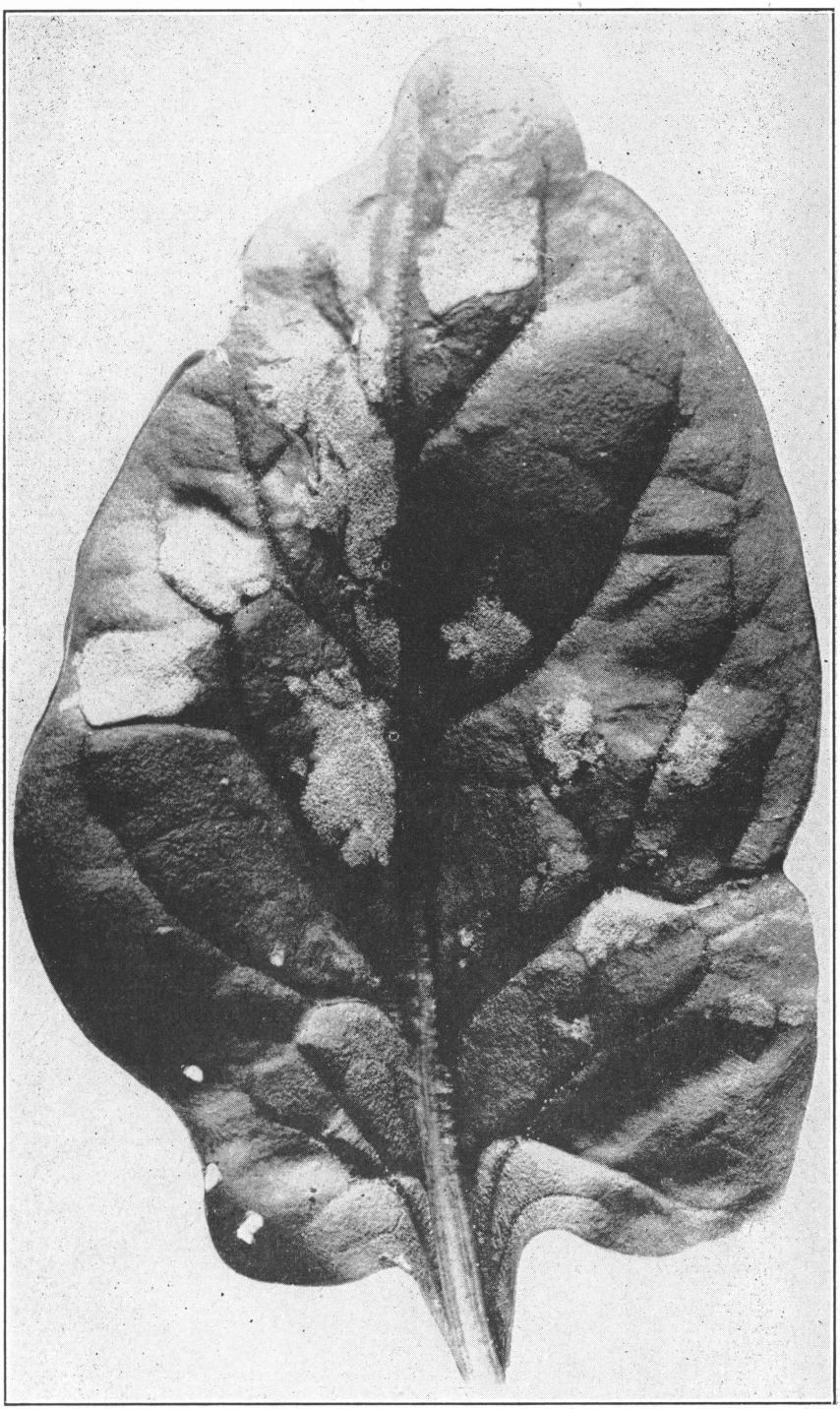


Fig. 15. Blue mold of spinach showing patches of downy fungous growth on the leaf.

Squash (see Cantaloupe)

Strawberry

Disease	Symptoms	Control Measures
Leaf spot	Large spots about ⅛ inch in diameter with a whitish center and reddish border.	Dip tops of plants in 4-4-50 Bordeaux mixture at time of setting. Spray with 4-4-50 Bordeaux once in the fall. Starting in December or January, spray regularly with above mixture until 2 weeks before first picking. This will increase the yield of later pickings. Bordeaux mixture also stimulates the growth of the plants. Certain new varieties such as Alamo, Ranger, and Rio Grande are resistant under Texas conditions.
Leaf scorch	Large, reddish to purplish blotches on upper surface of leaves. Entire leaf may become affected and start to dry up at the margin.	
Root rots	Strawberries frequently make poor growth and die from one trouble or another which causes the roots to become black and decayed. Fungi, weather, or soil conditions may be responsible.	Select well drained land for planting. When many plants have been lost from root rot and if the disease appears to be spreading, it is best to start with new plants in a different location.
Root knot	See page 52.	

Sudan Grass (see Sorghum)

Sweet Potato (see Potato—Sweet)

Tomato

Wilt	Plants in the field wilt, beginning with yellowing of lower leaves, and finally die. Roots and stem appear healthy outside. Inner tissues of stem turn brown.	Plant on new land or where tomatoes have not been grown for several years. Use Marglobe, Rutgers, Louisiana Red, Pritchard, Break O'Day or other wilt resistant varieties. The Pan America variety is practically immune.
Early blight	Young plants may have dark-colored cankers on stems (collar-rot). Later brownish spots (often with concentric rings) appear on the leaves. On the fruit, "nail-head" spots are formed.	Spray with 3-2-50 Bordeaux mixture at first appearance of leaf spots. One of the insoluble copper fungicides may be less harmful to the plants than Bordeaux mixture for spraying in hot weather. One or two applications of spray may be sufficient unless the weather is wet. Copper-lime dust (20-80; see page 68) may be used instead of Bordeaux mixture. Collect and burn all old plants as soon as the last fruits have been gathered.
Leaf spot (Septoria)	Small gray or brown spots on leaves. Older leaves are frequently shed.	
Bloom shedding	Usually caused by high temperature and low humidity.	Set plants early. Use Porter Bison and Denmark varieties. See page 61.
Mosaic	See page 54.	

Tomato (Continued)

Disease	Symptoms	Control Measures
Bacterial canker	Shriveling of scattered leaflets on plant. Interior of stem becomes brown, dries out and the stem cracks open. Small, white-bordered spots on young fruits.	Select seed from healthy plants or purchase from reliable seedsmen. Dust seed with Cuprocide or treat seed for 5 minutes in corrosive sublimate solution (1 tablet in 3 pints of water, using a glass or earthenware container), rinse in plain water, dry thoroughly or plant immediately. To control fruit-spot in field, spray with 3-2-50 Bordeaux or dust as for blight when disease appears.
Bacterial spot	Light - colored sunken spots on fruit, covered with broken epidermis. Spots at first are slightly raised and surrounded by dark water - soaked tissue. Small spots with thin dark centers also appear on the leaves.	Rotate crop and destroy old plants after harvesting. Treat seed as for bacterial canker above and spray plants in field with Bordeaux mixture or dust with 20-80 copper-lime mixture.
Late blight	See late blight of potato, page 32, for leaf symptoms. Large, sunken, brownish areas appear on green fruits which soon decay. Occurs in Texas chiefly in the Lower Rio Grande Valley.	Spray with 3-2-50 Bordeaux mixture at first appearance of the disease (earlier if blight occurs regularly.) Plants sprayed thoroughly only once when about half grown will frequently escape infection. Since Bordeaux mixture discolors the fruit, red copper oxide, copper oxychloride, or basic copper sulphate may be used for spraying plants after fruits are half grown.
Blossom-end rot	Black sunken dry areas on the blossom end of fruit. This trouble varies much in severity from year to year.	Both of these troubles are more prevalent under unfavorable growing conditions and water supply. Hot dry weather and sudden climatic changes usually result in increased losses. Select a soil for tomatoes which remains uniformly moist throughout the season and cultivate often to conserve soil moisture. The Marglobe and Pritchard varieties are less susceptible to these troubles than many other varieties.
Puffing "Pops"	Irregular - shaped fruits with large air - filled cavities inside. Angular "corners" on green tomatoes are the main external symptoms.	
Southern blight	See Pepper, page 30.	See page 50.
Root scald	Root decay with bad odor. Plants die.	Caused by too wet soil.
Root knot	See page 52.	

For more information on tomato diseases, see Tex. Agr. Exp. Sta. Circ. 82 and 86.

Turnip (see Cabbage)

Violet
(also Pansy)

Disease	Symptoms	Control Measures
Leaf spots	Two different fungi cause severe spotting of the leaves. Spots are usually irregular in shape and a light brown in color.	Spray with 4-4-50 Bordeaux mixture every 2 weeks during rainy weather or whenever the spots appear to be spreading. Burn old leaves in the fall.

Watermelon

Wilt	Entire plant wilts (at first only during hot part of day) and finally dies. Water vessels in wilted stems appear discolored.	Plant on new land whenever possible. At least, do not plant on the same land oftener than once in 4 or 5 years. Gather and burn old vines after harvest. Resistant varieties are available, such as Leesburg, Improved Stone Mountain No. 5, Hawkesbury, Iowa Belle, Iowa King, Pride of Muscatine, Wilt Resistant Klondike R 7, and Wilt Resistant Kleckly Sweet No. 6. In selecting a desirable wilt resistant melon, several varieties should be tested to obtain the one best adapted to local growing and market conditions. Treat seed as described below.
Anthracnose	Black spots on leaves and stems. Young fruits become dark colored and shrivel when the stem is attacked. Spots on fruits are numerous, large and often of a pinkish color.	A combination of crop rotation, destruction of plant refuse, seed treatment and spraying or dusting are necessary to keep in check these four diseases of watermelon. Seed should be treated by soaking in corrosive sublimate solution (1 tablet in 1 pint of water) for 5 minutes. Rinse thoroughly in plain water and dry quickly. Spraying with 4-4-50 Bordeaux mixture or dusting with 20-80 copper-lime dust should be started at first appearance of foliage diseases. (It is safer to start spray or dust applications as soon as the vines reach 2 or 3 feet in length.) Repeat treatment every 10 to 15 days. Remove infected or stunted melons from vines.
Leaf spot	Small, round, black spots on older leaves near base of stem. These leaves die and drop off.	
Downy mildew	Irregular black areas on leaves. Under moist weather conditions the entire foliage may be killed. Sometimes a faint, purplish, downy growth may be seen on the under side of the infected spots.	
Blossom-end rot	Discoloration and shriveling of the blossom end of melon. Decay progresses inwards.	
Southern blight	See page 50.	

Fig. 17. Watermelon anthracnose

Watermelon (Continued)

Disease	Symptoms	Control Measures
Stem-end rot	May appear in the field through wounds in the melon rind. Most frequent in shipments of watermelons. Infection takes place in the cut stem causing a dark, soft, water-soaked area near the stem. Decay progresses finally shriveling the entire melon.	Spray or dust crop in field as outlined above. When packed for shipment cut off end of stem and paint fresh cut with paste made as follows: Dissolve ½ lb. copper sulphate in 3½ qts. of boiling water (use enamelware vessel). Stir ½ lb. laundry starch into 1 pint of water and add to the above boiling copper sulphate solution, with rapid stirring. Boil until a thick paste is formed. Make up fresh paste for each treatment (a carload of melons requires 1 quart of paste.)
Root knot	See page 52.	

Wheat

(also Rye)

Stinking smut or Bunt	Infected plants are often dark green in color and stunted. Grains in head partly or entirely replaced by a hard black spore mass, shorter and thicker than the normal wheat kernel. Hulls over these smut balls tend to spread apart more than normally. This smut gives off a foul, fishy odor.	Remove smut from seed by cleaning in a fanning mill with strong air blast. Treat seed by dusting thoroughly with either: (a) copper carbonate dust (50%) at the rate of 2 oz. per bu.; (basic copper sulphate may be used in place of the carbonate), or (b) New Improved Ceresan, see page 66.

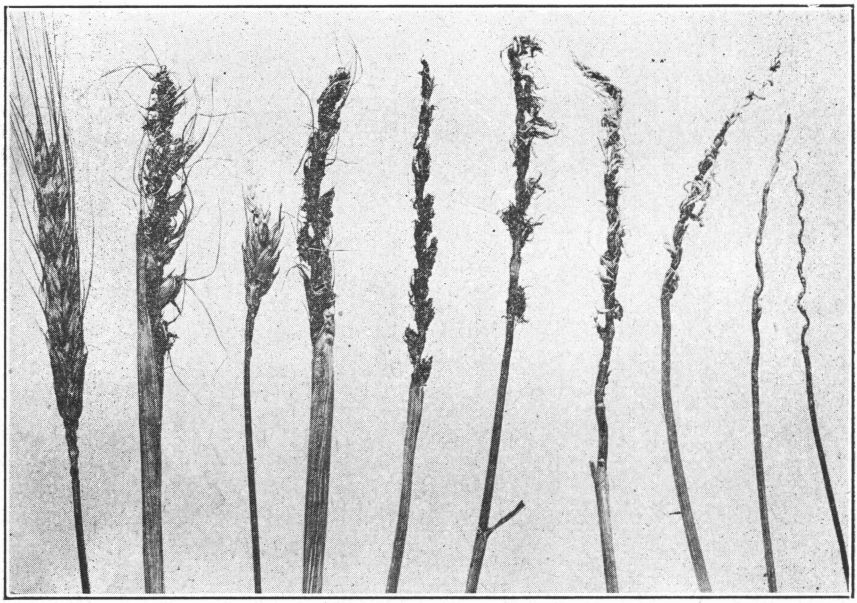
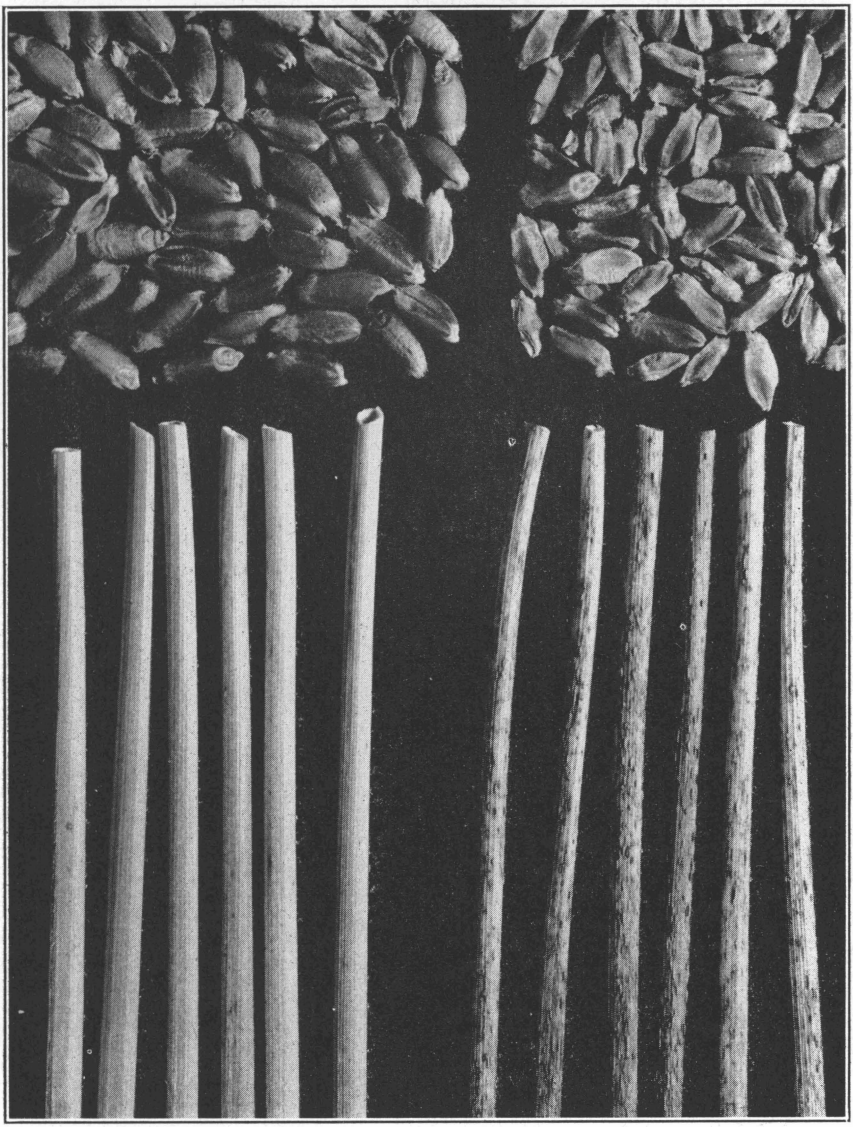


Fig. 18. Loose smut of wheat.

Wheat (Continued)

Disease	Symptoms	Control Measures
Loose smut	Appears as soon as the wheat begins to head out. The entire head is reduced to a black smutty mass, finally only the bare, scaly stalk remains. Seed becomes infected while in flower. Damp weather at blossoming time is apt to result in much infection which will show up in the next year's crop.	Since the fungus lives **inside** the seed, hot water treatment is necessary. Instead of treating the entire lot of seed grain each year, smaller lots are carefully treated and planted in isolated fields to supply seed for the next year. Soak seed in half-filled coarse bags for 4 to 5 hours in cold water, followed with hot water at 120° F. for 1 minute. Then heat for 10 minutes at 129° F. After treatment cool seed immediately and spread out thinly and allow seed to dry out completely. See U. S. D. A. Farmers' Bulletin No. 1711. The Austin variety is resistant.
Leaf rust	Orange to reddish, dusty pustules chiefly on leaves. Pustules are roundish or oblong in shape. Leaf rust infection decreases yield by reducing the number and weight of grains per head.	Resistant varieties for Texas are: Austin, Comanche, and Westar.



(Photograph by courtesy of Kansas State College)

Fig. 19. Stem rust of wheat showing effects of the disease (pustules on stems and shrunken kernels) on the susceptible strain (right) and control by resistant strain (left).

Wheat (Continued)

Disease	Symptoms	Control Measures
Stem rust	Elongated, reddish pustules on stems and leaves. Later in the season similar "black-rust" pustules appear. Stem rust comes on later than leaf rust and causes shriveling of the grain.	The Austin variety is resistant. Other resistant varieties will be available soon. Consult your County Agent or Experiment Station as to desirable varieties of rust-resistant wheat for your locality.
Foot rots	Several different fungi attack the roots, crown or lower stalk of the growing wheat plant, causing stunting or killing of the plant. Affected plants may occur singly in small groups or in large spots in the field.	Plant only clean seed. Treat seed with New Improved Ceresan dust (see page 66). Rotate crop with oats, sorghum, or legumes. Prevent infested straw from being spread on wheat field. Do not plant fall wheat too early because foot rots are worse in warm weather.

Yucca

Leaf spots	Several fungi cause large dead areas on the leaves. Frequently the leaf may be killed for more than half its length.	Spray with 4-4-50 Bordeaux mixture, using a spreading agent. Make regular applications about once every 3 or 4 weeks from November to May.

Zinnia

Leaf spot	Small grayish or brownish spots on foliage. Several spots may run together killing the entire leaf.	Spray with 4-4-50 Bordeaux mixture 2 or 3 times during the growth of the plant. In mild cases a single application may be sufficient.
Powdery mildew	Whitish, powdery growth on leaves and stems. Affected plants lose vigor and stop growth.	Dust with 325-mesh sulphur regularly at least once a week at first appearance of mildew. More frequent applications are necessary during wet weather.

DISEASES THAT ATTACK MANY KINDS OF PLANTS

Cotton Root Rot

This soil-inhabiting fungus, **Phymatotrichum omnivorum**, is widespread throughout most of Texas, with the exception of the northwest portion. It is most prevalent in heavy alkaline soils and less abundant in acid soils. While the greatest damage occurs to certain field crops such as cotton, alfalfa, pea and sweet potato, the root-rot fungus is also exceedingly destructive to orchard trees and ornamentals. All plants belonging to the grass family, such as corn, wheat, oats, and sorghum, as well as the lilies and a few plants of other groups, are immune. (See Texas Agr. Exp. Sta. Bull. 527.) The disease is most active during the summer and is favored by wet seasons. During the cooler months susceptible annual crops may be raised without serious loss even on infested land. The fungus may persist for many years in the soil either in its resting stage (sclerotia) or on the roots of perennial plants.

Plants affected with this root rot die suddenly after showing the first symptoms by wilting. When pulled from the soil, the bark of the roots is found to be decayed and frequently shows brownish, wooly strands of the fungus on the surface. Under field conditions, the disease frequently appears in spots which increase rapidly in size as the growing season progresses. (See Texas Agr. Exp. Sta. Bull. 423.)

In field crops, losses from root rot are lessened by planting some of the above-named immune crops in rotation with the susceptible crop. (See Texas Agr. Exp. Sta. Bull. 573.) For example, when cotton is planted in a four-year rotation with oats, sorghum, and corn, less root rot occurs. Plowing under of a green cover crop or of cotton soon after the final

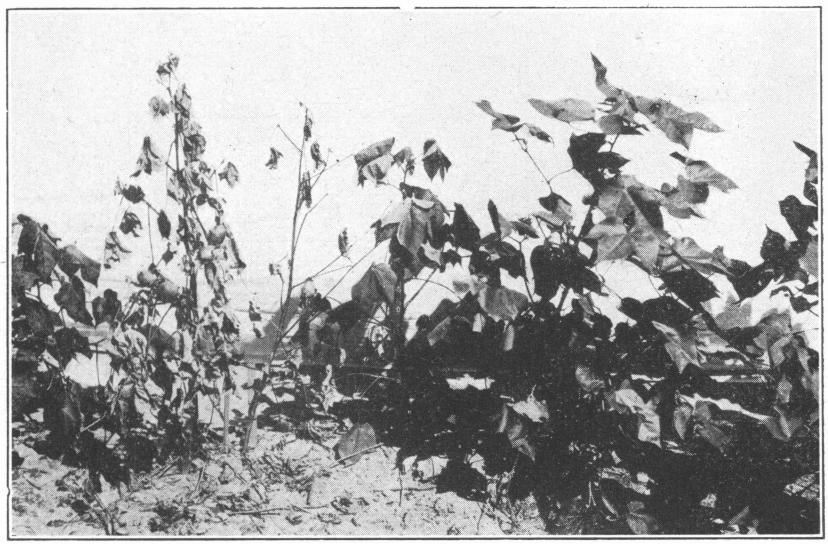


Fig. 20. Cotton root rot advancing along the row.

picking also tends to lessen the severity of the disease in succeeding crops. Preliminary experiments and observations in farmers' fields have indicated that losses in cotton from root rot may be greatly reduced following the spring turning-under of winter legumes or turn-under of a mature Hubam clover crop. Hubam may be cut for hay or seed previous to plowing.

When the disease occurs in ornamental planting, diseased plants should be replaced with such resistant species as live oak, hackberry, sycamore huisache, yaupon, coralberry, Texas mahonia, shrubby blue sage, pomegrante, mesquite, retama, red cedar, chaparral berry, and Yucca. (See Texas Agr. Exp. Sta. Progress Rpt. 656.) Among the common herbaceous plants the mints, gourds, strawflower, marigold, zinnia, violet, pansy, phlox, periwinkle, begonia, oxalis, geranium, mignonette, sweet alyssum, cockscomb, iris, canna, sweet william, hyacinth, narcissus, freesia, all lilies, and all grasses are highly resistant or immune. The fungus generally invades new areas by continued slow growth from plant to plant; it may occasionally be spread more rapidly by transplanting of infected plants. Ornamental plantings of root-rot-susceptible species should be made with isolated plants or groups of plants, rather than in continuous rows as in the case of hedges.

In locating new orchards (apple, pear, peach, or pecan), as well as vineyards, berry patches, and nurseries, care should be taken to select land that is not infested with the cotton root rot fungus, In order to make sure the disease is absent from such areas, an indicator crop of cotton should be planted and observed for root rot for one season before the above plants are introduced. In some cases valuable ornamental plants and orchard trees have been treated successfully even after root rot infection has taken place. The tree (or shrub) is first pruned back and a circular ridge (equal in diameter to the top of the plant) of soil is built up some distance away from the trunk. One pound of ammonium sulfate, for each 10 sq. ft. of surface within this ridge, is worked into the soil and the improvised dike is filled with water to a depth of about 4 inches. Repeat treatment and watering after 5 or 10 days. Not more than two treatments should be applied in the same season. Frequent watering should follow this treatment to prevent drought injury.

Stem and Root Rots

There are several different fungi (in addition to the cotton root rot fungus) which cause rotting of various plants either at the roots or on the stem at or below the soil line. These diseased plants usually show a softening or decay of at least the outer portion of the stem or root and sometimes the fungus itself is visible as a whitish growth on the surface of the affected parts of the plant. One form of this disease, caused by **Rhizoctonia solani**, is common in gardens and under certain conditions may cause considerable loss in larger plantings. Usually crop rotation is a sufficient control. In vegetable or flower gardens, however, one should water the plants only as often as necessary to maintain satisfactory growing conditions since the fungus is more active in wet soil. Crowding of plants in a bed also encourages this type of disease by retaining a moist condition near the soil line. In the field, cover crops should be plowed under early so as to allow complete decomposition before the susceptible crop is planted.

Southern blight is another form of this type of disease and is caused by the fungus, **Sclerotium rolfsii.** This disease is sometimes referred to as being caused by the "mustard seed fungus" since small seed-like struc-

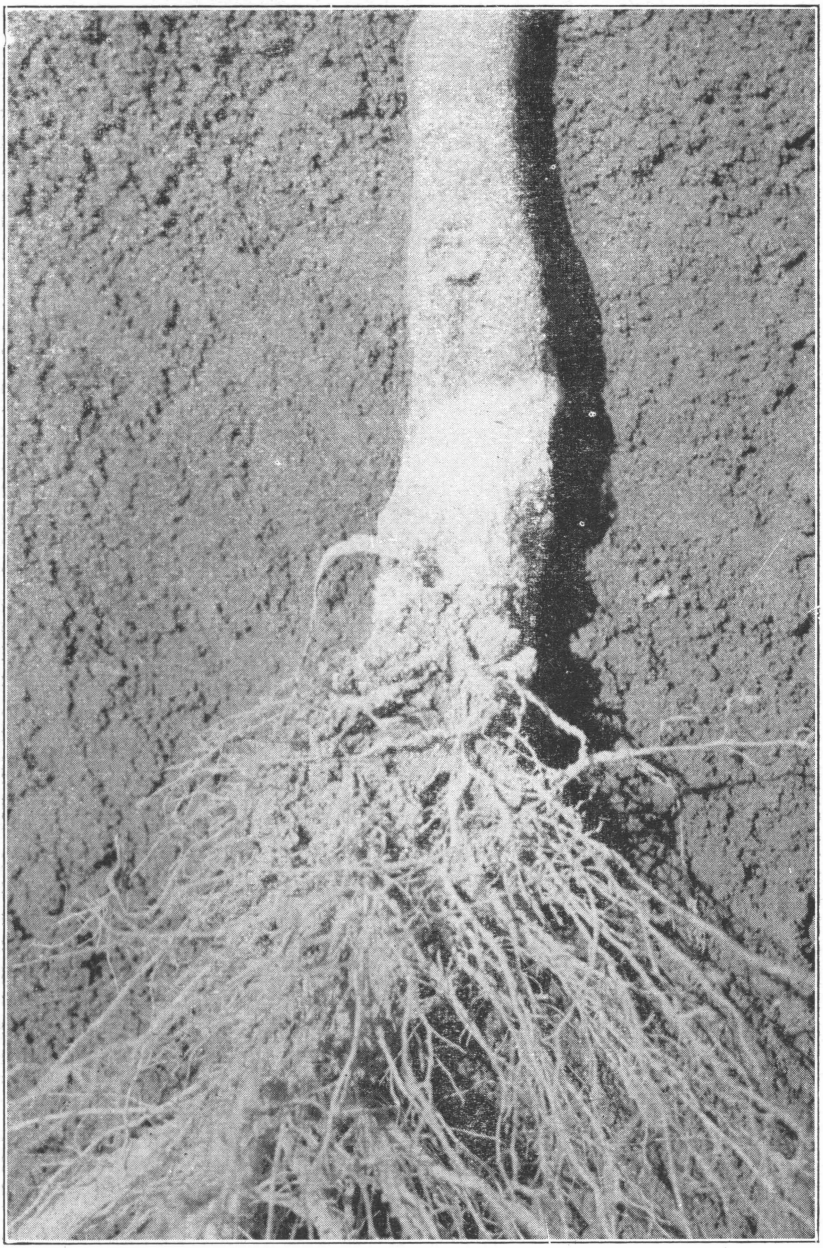


Fig. 21. Southern blight fungus on tomato stem.

tures (sclerotia) are frequently found along with the whitish fungus growth at the base of infected plants. This disease attacks all kinds of vegetables and even certain cereal crops are somewhat susceptible. Fleshy-rooted plants such as carrots and beets, also onions, tomatoes, peppers, Irish potatoes, peanuts, and many herbaceous ornamental plants, including iris, are frequently killed by southern blight. It also destroys watermelons and cantaloupes, the decay starting where the melons are in contact with the soil. Tomato and pepper fruits touching the ground are likewise apt to become infected. Fields may become infested with a few crops of peanuts to such an extent that other susceptible crops cannot be grown the following year. As in the case of the Rhizoctonia disease above, careful rotation of crops will help in avoiding losses from southern blight. Wheat, corn, oats, and sorghum are resistant to the disease and cotton is usually susceptible only in the seedling stages. In the small garden the problem of control may be more difficult but it is wise to remove affected plants together with a quantity of the soil around the roots as soon as this disease is detected. Good control of southern blight has been obtained in the home gardens by soil fumigation: See page 64 and Texas Agr. Exp. Station Bulletin 628. Even in infested soil, susceptible crops may be grown without loss from southern blight during the cooler months.

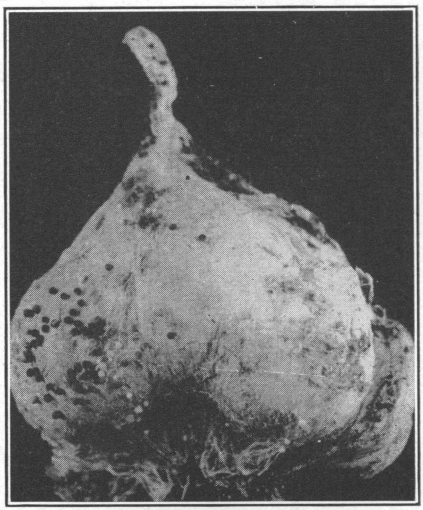


Fig.22. Southern blight fungus on a garlic bulb, showing the dark-colored sclerotia.

A common root disease of orchard trees and certain ornamentals is caused by the oak fungus (**Armillaria sp.** or **Clitocybe sp.**) Sometimes, even herbaceous plants are attacked. As in the case of cotton root rot, the plant is often killed soon after the effects of infection are noticeable in the above ground parts. Dead areas are produced on the main stem and larger roots just beneath the soil surface. When the dead bark is peeled back the white, fan-like growths of the fungus over the surface of the wood constitute a distinguishing character of this disease. In ad-

vanced cases of infection, hard, black strands of the fungus are formed, often just beneath the bark on decaying stumps, giving rise to the name "shoe-string fungus". This fungus also produces the "Honey Mushroom" on dead stumps. The oak fungus occurs most frequently in wooded areas or on recently cleared land. Therefore, all stumps and large roots should be removed as thoroughly as possible before orchard or other valuable trees are set in such locations. Planting of newly cleared land to an annual crop for several years helps to kill out this fungus.

Wilt Diseases

A group of diseases, commonly called wilts, affect a wide variety of crops in Texas. They are recognized by wilting of the plant in the field, frequently followed by complete killing and by dark streaks in the woody part of the stems or roots when split lengthwise. For the most part, wilts are caused by fungi belonging to the genus Fusarium. Crops commonly affected are: Cotton, watermelon, sweet potato, tomato, cowpea, squash, Irish potato, and okra. In practically all of these cases, however, the wilt fungus that attacks one of the crops does not attack any of the others (exception, cotton and okra). Therefore, it would be safe, for example, to plant tomatoes on land that was infested with the cotton wilt fungus or to plant watermelons where sweet potatoes had shown wilt symptoms. Fortunately, in most of these cases, plant breeders have found it possible to develop resistant strains of plants for use in combating these Fusarium wilt diseases.

Another wilt disease caused by the fungus **Verticillium albo-atrum**, occurs to a certain extent in Texas, especially on cotton in the El Paso Valley and certain other areas in West Texas. This fungus attacks a wide variety of plants such as tomato, apricot, eggplant, okra, blackberry, Irish potato, and maple. No satisfactory control measures for this wilt have as yet been developed. The Riverside variety of tomato developed in California for resistance to Verticillium wilt is apparently not well adapted to Texas conditions. There is some indication of resistance to Verticillium in certain strains of cotton and breeding work with these types is now in progress.

Root Knot

Elongated swellings or small, round galls on the roots of plants are common symptoms of the root-knot disease. The causal agent is a small worm, called a nematode, which is scarcely visible to the unaided eye. Plants affected with root knot are lacking in vigor, stunted, and pale in color. Root-knot galls are ordinarily much smaller and more numerous than the large, more spherical swellings of crown gall. One might confuse root knots with the nodules on leguminous plants which are produced by the beneficial nitrogen-fixing bacteria. These nodules are easily broken off from the side of the root, whereas nematode galls are swellings of the root itself and cannot be separated from the root. Another eel-worm, the meadow nematode, injures some plants by causing tufts of rootlets without causing galls. Still other kinds of nematodes cause injury to the leaves of such plants as chrysanthemum, wheat, and strawberry.

The eradication, or even satisfactory control, of root-knot nematodes is not easily obtained. Fields infested with root-knot nematodes should be planted with grasses, cereals, or **Crotalaria spectabilis** for several years. At the same time, all weeds should be controlled since many of them are hosts for the nematodes. Clean fallow of the soil with frequent cultivation during dry weather tends to reduce the nematode population through drying out of the soil and starvation. Smaller areas, such as a small garden patch, may be treated with chloropicrin or carbon bisulphide to

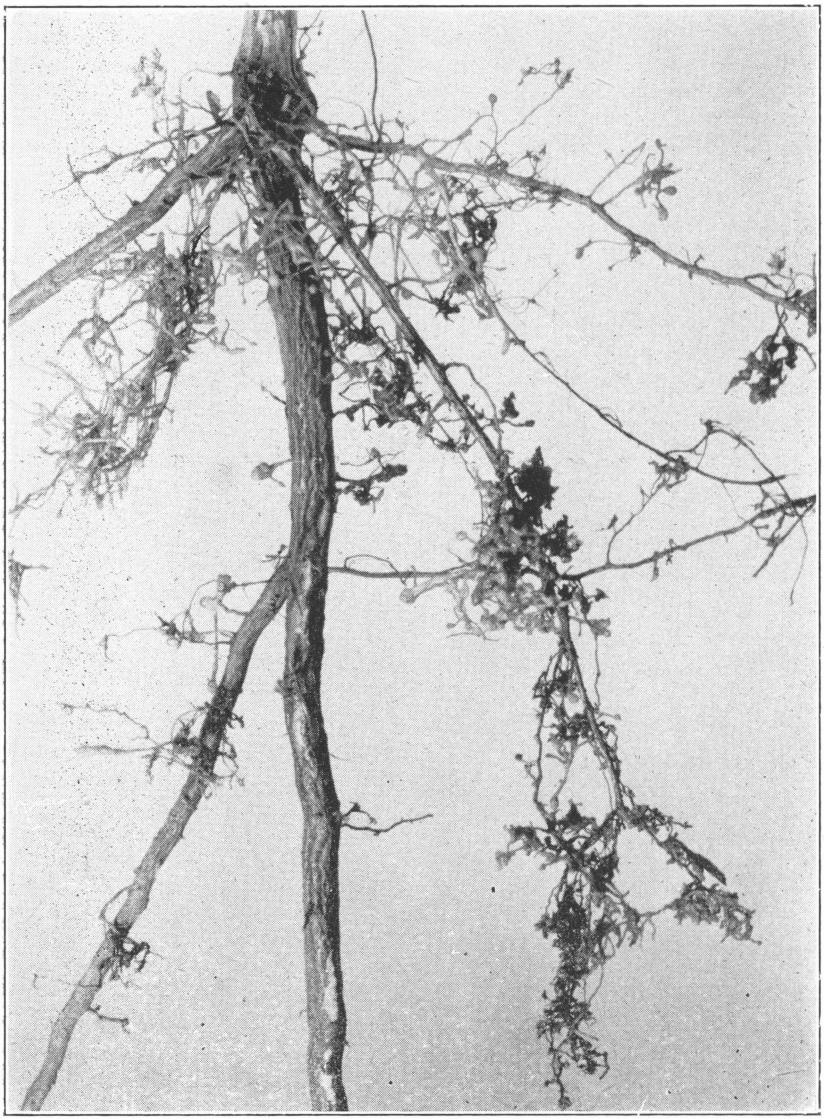


Fig.23.Nematode root knot on rose. (Typical of root knot on woody plants).

kill the nematodes. (This treatment will also kill any plants growing in treated soil). (See page 64.) Great care should be taken to prevent the introduction of nematodes into nematode-free soil, through contaminated nursery stock, manure, soil, or any plants from the outside. All plants showing signs of root knot should be burned. Spading or plowing of the soil a few times during hot dry weather may help to kill the nematodes. (See T.A.E.S. Prog. Rept. 837).

Although nearly all vegetables, many fruit trees, flax, most varieties of cotton and cowpea, and a large number of our common ornamentals are susceptible to root knot, there are many resistant plants or crops which may be planted on infested soil. Among these are all grains, peanuts, peach (on Shalil, P. I. No. 61302, Bakhara, and Yunnan roots); plum (on Marianna roots); velvet bean; California Blackeye Nos. 8081 and 8152, Iron Victor, and Brabham cowpea; Laredo soybean, Coker 4-in-1 cotton, **Crotalaria spectabilis**, marigold, zinnia, nasturtium, Japanese honeysuckle, cosmos, and geranium. Susceptible crops may be grown in cool weather and infested soil.

Crown Gall

Crown gall is a bacterial disease that attacks a large variety of herbaceous and woody plants. It occurs frequently on peach, plum, rose, apple, grape, blackberry, pecan, currant, alfalfa, and beet. Many other plants may become infected when planted in infested soil. It affects young plants more seriously than older ones and therefore causes serious losses when it occurs in nurseries. The disease is recognized by large, rough, roundish, woody swellings or galls on the lower part of the stem where the roots are attached (crown) or lower down on the larger roots. Sometimes galls (aerial) are formed on above-ground parts of the plant. Infected plants may be deformed, stunted, or even killed by crown gall. (A similar disease, called hairy root, is sometimes found on certain of the above named plants.)

Plants showing symptoms of crown gall should be removed and burned immediately. It is unwise to set another susceptible plant in the same place. All nursery stock should be carefully examined for galls of any sort, especially on the lower stem and roots, before planting. The roots of most nursery stock or rose cuttings may be treated for 10 minutes (1 minute for apple and peach) in a solution of corrosive sublimate (1-1000) as a disinfectant or in a solution of Semesan (1 oz. to 3 gal. water) before setting out. In the case of trees or shrubs, crown gall may become less harmful as the plant becomes older. Consequently certain trees may outgrow early infections.

Virus Diseases

Many important diseases of Texas plants are caused by plant viruses; the most common of which are the various mosaic diseases and the group known as yellows diseases. Among the mosaic diseases are those of bean, cowpea, tomato, pepper, Irish potato, cucumber, cantaloupe, squash, tobacco, wheat, sugarcane, blackberry, and peach. Common yellows diseases occur on eggplant, carrot, and aster. (A disease of cabbage called "yellows" is due to a wilt fungus (Fusarium) and "Psyllid yellows" on Irish potato is due to the presence of the psyllid insect). Other virus diseases are:

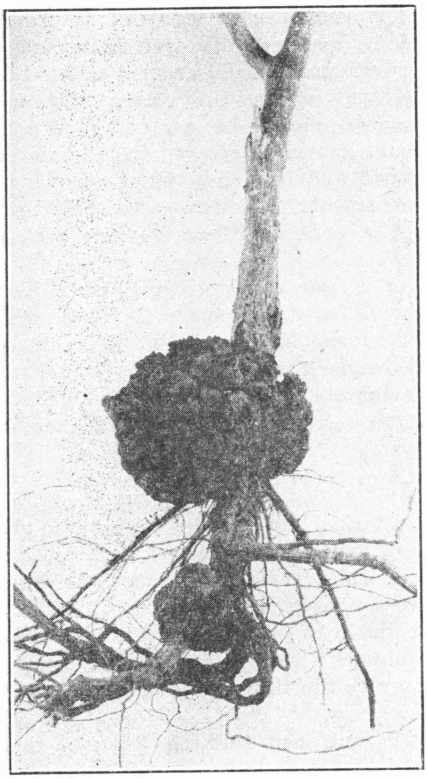


Fig.24. Crown gall on young peach tree.

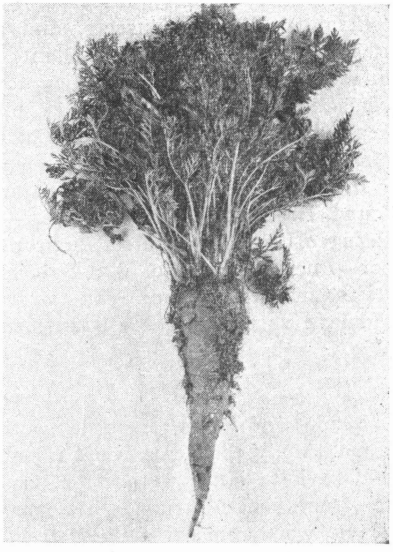


Fig. 24A. Carrot affected with aster yellows—a virus disease. Note the bunched top and clusters of small fibrous roots.

curly top of such plants as sugar beet, spinach, and tomato; leaf-roll, witches'-broom, and spindle tuber of Irish potato; leaf curl of blackberry; psorosis of citrus, rosette of peach; and others.

In general, virus diseases cause stunting, malformation of leaves and stems, and greatly reduced yields. The group of mosaic diseases are usually identified by a mottled appearance of the leaf due to the presence of light green areas scattered among the dark green tissues. Leaves from mosaic plants are also usually somewhat puckered or otherwise distorted. The yellows diseases usually cause a general yellowing of the foliage together with many types of abnormal shoot growth.

A few of the mosaic diseases, such as those of tomato and tobacco, can be transmitted readily by rubbing a leaf of a healthy plant with juice from a diseased plant. For this reason some of these diseases may be spread by workman or by cultivating tools. With the exception of bean and cowpea mosaic diseases, virus troubles in general are not seed borne (although tuber-borne in Irish potato). They are commonly transmitted by certain types of insects, such as leaf hoppers and aphids. Some of the virus diseases occur on a wide range of host plants and native weeds are a frequent source of infection.

Control of virus diseases consists in careful selection of seed or propagation stock from healthy plants. The use of certified seed of Irish potatoes is of prime importance in avoiding losses in this crop from many different virus troubles. Plants that are started in cold frames might be protected from early infection by spraying or dusting occasionally to control viruliferous insects, and all weeds should be destroyed within 100 feet of the cold frame. Plants are not known to recover from a virus infection and it is good policy to remove and burn any plants showing virus-disease-like symptoms, to prevent further infection of neighboring healthy plants. (Quarantine regulations have been set up against peach mosaic).

In many cases, varietal resistance to certain virus diseases has been found. Resistant to mosaic: bean—Idaho Refugee, Wisconsin Refugee, and Refugee U. S. No. 5, Red Mexican, Univ. Idaho No. 3 and No. 34; cucumber—Puerto Rico No. 39; Spinach—Virginia Savoy and Old Dominion. Resistant to curly top: bean—Great Northern Univ. Idaho No. 15 and Red Mexican varieties are resistant; sugar beet—resistant varieties are available.

Wood Rots

Shade and fruit trees are often attacked by wood-decaying fungi. Usually only the heart wood is damaged, leaving the more vital sap wood and bark to support the tree. Since the chief function of heart wood is to strengthen the trunk, a tree may live for years with only an outer shell of sap wood remaining. Such trees are liable to be broken over, however, by strong winds. Frequently, the fungous bodies (toadstools, conks, shelves, etc.) on the outside of a tree may be the first symptom of internal decay.

Since woodrotting fungi usually gain entrance through wounds, the prevention or treatment of such wounds is important in maintaining a healthy tree. In pruning limbs from valuable trees, care should be taken to make a cut on the under side first, to prevent stripping off of the bark or sapwood by the falling limb. The cut should be made smoothly and close to the trunk or main branch. As soon as cut is made, cover ½ to 1 inch band around edge of cut with orange shellac. Remove all dead limbs or limbs broken by wind or sleet. This will prevent their decay from extending into the tree. Pruning wounds larger than 2 inches in diameter or other bruised places on the trunks or larger limbs should be allowed to dry thoroughly for several days and then painted with some protective material. Asphalt or Bordeaux paints may be used for this purpose. In the Lower Rio Grande Valley, two coats of protective materials give good results on citrus trees: a primary coat of plant-safe carbolineum is followed after about a month with an asphalt-carbolineum mixture. Hot grafting wax makes a good wound dressing but since it does not last long, it should be renewed every few months. Asphalt paints are sold in cans under various trade names. A satisfactory Bordeaux paint may be made by adding sufficient raw linseed oil to dry powdered Bordeaux mixture (obtainable at seed and hardware stores) to make a thin paste. Fresh paste should be made up each time it is needed.

In the case of valuable shade or ornamental trees, a competent tree expert should be engaged to treat damaged wood or to fill decayed areas in the trunk.

Damping-off

Diseases that destroy numbers of young plants in the seedling stage are spoken of collectively as damping-off. Two or three different fungi are commonly recognized as the cause of this trouble. These fungi live in the soil and under favorable conditions attack the living seedlings. Damping-off may take place as soon as the seed germinates in the soil (pre-emergence damping-off) or after the seedlings have come up (post-emergence damping-off). The most common symptom consists of a softening or constriction of the stem near the soil line. Affected seedlings topple over and soon dry up. The disease may appear suddenly and spread rapidly throughout an entire lot of seedlings or it may be restricted to scattered spots among the plants. Because overwatering tends to encourage damping-off, only enough water should be added to seedlings to keep them from wilting. Frequently, this trouble can be entirely prevented by selection of new, fresh soil, careful watering and plenty of sunlight. When seedlings begin to damp-off, they should be given as much light as is practical and should be sprinkled thoroughly with a suspension of 1 oz. of Semesan in 3 gal. of water per 80 sq. ft. of hot bed soil. Semesan is best applied with a sprayer or a sprinkling can. The soil treatment may be repeated 2 or 3 times at 5-day intervals if necessary. As soon as the Semesan has been applied, water should be sprinkled on the soil to completely wet the surface.

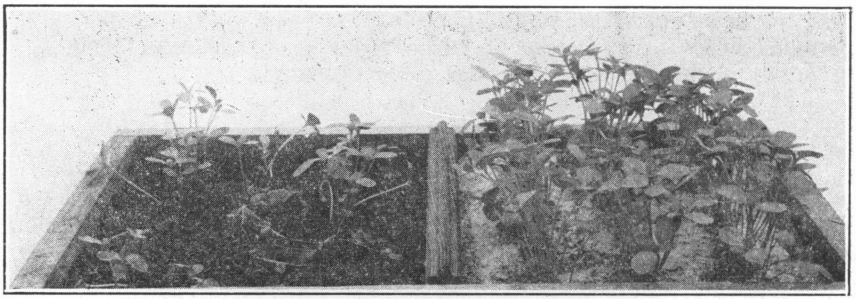


Fig. 25. Damping-off of zinnia seedlings in soil (left). Seedlings in washed sand (right) are all healthy. The same number of seeds were planted in each side of the flat.

For greenhouse conditions: Since damping-off is caused by soil-inhabiting fungi, sterilization of the soil before planting is one of the most satisfactory means of preventing loss of seedlings from this cause. Small lots of soil can be baked for a few hours in a hot oven to kill the destructive fungi. Larger volumes of soil such as would be found in a greenhouse or in small outdoor plots can be sterilized with live steam forced through the soil (See page 64). Fromaldehyde in the form of a drench (See page 64) or absorbed on fine charcoal, sawdust, or even light dry soil as a carrier is effective in treating soil against damping-off. Such a mixture, known as "formaldehyde dust" is made by mixing 1 pint

of liquid commercial formaldehyde thoroughly into 6 pounds of the carrier. To each bushel of soil to be treated, one-half pound of this dust is added and the soil and formaldehyde dust are carefully stirred together. The treated soil is then placed in flats or benches, the seeds are sown, covered, and the soil watered thoroughly. (A similar treatment for seedflat or potting soil consists in mixing 8 teaspoonfuls of commercial formaldehyde in ½ cup of water and sprinkling this through 1 bushel of soil as it is being stirred over. The treated soil is allowed to stand for 24 hours when it is again stirred thoroughly before using. It should be watered well after the seeds or plants are planted.) Formaldehyde treatment should not be used in cold frames where the formaldehyde gas can not escape rapidly.

Clean sand culture: Damping-off can be largely avoided by sowing the seeds in clean sand in clean containers. To furnish nutrients for the seedlings they should be watered every two or three days with a solution containing 1 teaspoonful each of saltpeter, superphosphate (phosphate of soda may be used instead), and Epsom salts in a gallon of water. If these materials are not available one can use 4 teaspoonfuls of a complete chemical fertilizer (such as 5-10-5) in a gallon of water as a nutrient solution. Plain water should be added between applications of the nutrient whenever necessary to keep the sand moist. The container should allow drainage. Seedlings raised in sand have excellent root systems and they can be transplanted into soil at an early age.

Damping-off is also controlled to a marked degree by certain of the seed treatments (See page 65). In many cases seed treatment alone will be found sufficient to protect the young plants against damping-off fungi, especially in the pre-emergence stages.

Crop Rotation

Continuous cropping of the same land with the same or closely related crops year after year results in increases in disease troubles each season. A disease that is only of slight importance during the first year on a given piece of land tends to carry-over in the soil and become more serious each succeeding year until finally the particular crop can be no longer grown with profit. For this reason, growers should plant a given crop on the same land no oftener than is necessary from a practical standpoint.

Many diseases, such as wheat rust or potato late blight, are wind borne while others are carried on the seed and all of these might occur even on the newest land. Most of the common soil diseases, however, such as damping-off, root-rots, wilts, and root knot, as well as many common foliage diseases such as early blight pass through unfavorable periods between crops in the soil, often on crop refuse. After introduction into a new field (frequently by the grower himself), a small amount of infection finally reaches serious proportions. Corn smut is a good example of a fungus that may be carried to a new field by windblown spores and the fungus may then survive in the soil for several seasons between crops of corn.

Newly cleared woodland or recently broken grassland with few exceptions would probably be as nearly free of soil-inhabiting plant diseases as could be found. Every effort should be taken to maintain such land in a disease-free condition, once it is brought into cultivation.

A disease already established in a given piece of land may often be avoided by planting a crop that is not susceptible to this particular trouble. Growers should ascertain through correct diagnosis the exact nature of any particular disease that is attacking their plants and use a different, immune or resistant crop for several succeeding seasons in the affected areas. Some disease organisms may live in the soil for many years even in the absence of a susceptible crop, while other diseases may become insignificant or may disappear after the land is planted for only a few seasons to non-susceptible crops.

Chlorosis

There are several causes of the yellowing of leaves of plants, known as chlorosis. Certain plants growing in highly calcareous or alkaline soils, such as occur in the Blacklands or in the Lower Rio Grande Valley, often show this yellowing of the foliage, usually caused by deficiency of iron. The iron in alkaline soils is not available to most plants except in the presence of decaying organic matter. Yellowing of the foliage due to deficiency chlorosis usually appears first in the young foliage near the tips of branches. Later, in the case of perennials, leaves on the older por-

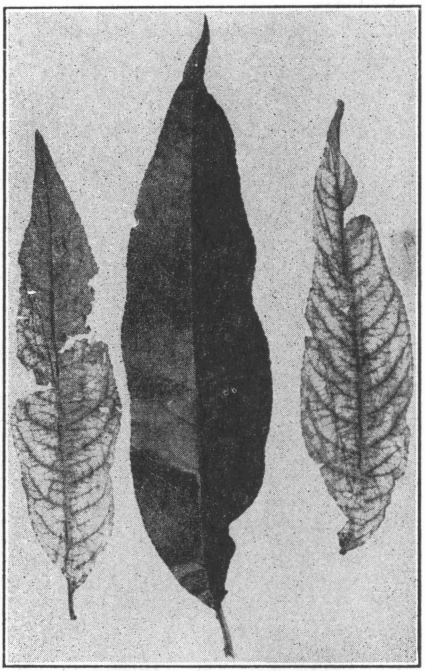


Fig. 26. Chlorosis (iron deficiency) in peach leaves (normal leaf in center).

tions of the plant may become yellowed. Severe chlorosis eventually causes lack of vigor, reduction in yield of flower or fruit, and even death of the plant. Trees, shrubs, and herbaceous annuals or perennials may be affected. Probably the greatest concern over this trouble occurs in the case of citrus trees, and in ornamentals of various sorts.

Several methods have been used in treating iron chlorosis. One way of treating chlorotic ornamentals involves spraying of the foliage with a soluble iron salt. The yellowed leaves should be thoroughly sprayed during the evening with a solution containing 1 teaspoonful of iron sulphate (copperas) in a gallon of water, to which one-fourth teaspoonful of glue may be added as a sticking agent. When new yellowed leaves appear they should be sprayed also.

The iron sulphate may also be applied to the soil, but the limestone in the soil after a time will act upon it to take the iron out of solution, so that it is not effective. This takes place quickly if it is mixed thoroughly with the soil. However, if properly applied, the application is frequently effective, and is much used. In case of trees or shrubs, the ferrous sulphate is put in holes punched with an iron bar about ½ inch in diameter, to a depth two feet. The hole is completely filled with the iron sulphate, alone, or mixed with commercial fertilizer in the proportion of 1 part of iron sulphate to 1 of fertilizer or even 1 part of

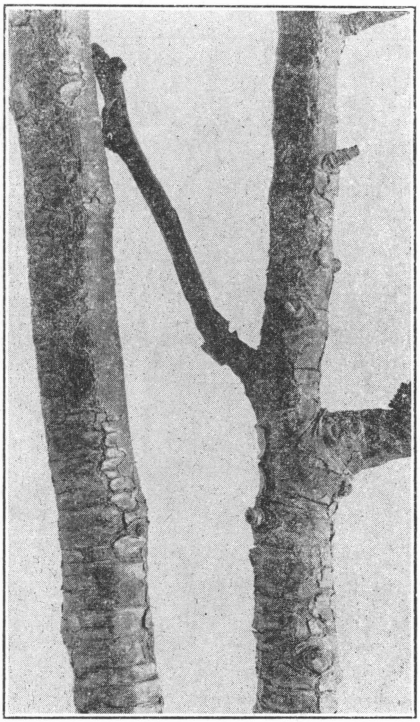


Fig. 27. Sun scald on apple tree.

iron sulphate to 4 of fertilizer. The holes should be placed about 1½ feet from a shrub and a little further from trees, and the application should not touch the main roots of the plant. The application may be made once or twice each year as necessary. In gardens or fields, iron sulphate may be applied in the row, about 3 inches deep and 2 inches from the plants or seed, alone or mixed with commercial fertilizer.

The use of sulphur, applied at the rate of about 4 or 5 pounds per 100 feet of row, may be effective on some soils, especially those not high in lime. The sulphur should be applied about two months before it is expected to be effective, because it is changed to acid, and this acts on the soil. For quick results, recent experiments (See Texas Agr. Expt. Station Progress Report 675) at the Weslaco Substation show that one might use a previously prepared mixture of sulphur and rotted manure placed in holes near the roots. Ammonium sulphate applied at the rate of 200 pounds per acre, at the time of planting, is also effective on some soils.

Chlorosis on soils that are not calcareous may be due to lack of nitrogen, excess of moisture, or other causes. Still another type of chlorosis may result from the yellowing effects of certain diseases (usually virus diseases, see page 54) which cause a loss of the green coloring matter in the leaves.

Winter, Heat, and Hail Injuries

Many plants, when growing in regions beyond their optimum climatic range, are likely to be damaged by unfavorable winter temperatures. Likewise, high summer temperatures, aside from the drought factor, may cause definite injury to certain plants. During periods of high temperature and dry atmospheric conditions, tomatoes and beans develop blossom sterility and shed off. Early planting for quick maturity under favorable weather conditions enables the plants to set fruit. The Porter, Denmark, and Bison (small fruit) tomatoes are recommended for hot weather production. Canker on young flax plants is known to be due to heat. Vegetables such as tomatoes and peppers and some fruits such as peaches and apples are frequently injured by sunburn, especially when they are not adequately protected by foliage. Trees and shrubs are affected also in this indirect fashion. Common symptoms of such troubles are seen as cankered areas along one side of a limb or trunk, roughened bark or outer wood (often accompanied by exudation of gum), browning of the foliage and dying-back of the smaller branches. Usually such damage occurs to a similar extent on a number of plants all at once, whereas a disease is likely to attack only a few plants at first. Careful examination is necessary for correct diagnosis of these injuries.

Hail storms frequently cause heavy damage to various crops. All succulent plants and their fruits such as cotton, corn, watermelons, tomatoes, small grains, are affected. Also, the young shoots and branches of ornamental plants, nut and fruit trees, as well as their fruits, are often damaged by hail. Sometimes, hail injury is difficult to distinguish from fungous or insect injuries.

In addition to the above factors, too much water in the soil, improper placement of fertilizer and high winds may cause severe and widespread damage to some crops.

Fig. 28. Hail injury to rind of watermelon.

Little is known definitely concerning the control or treatment of injuries due to unfavorable climatic conditions. Maintenance of favorable soil moisture through plowing under of cover crops or the use of a mulch may be helpful in certain cases. Affected plants should be pruned back after the injured parts have become distinct, to force normal growth. Small individual trees or valuable shrubs can be covered with burlap wrapping filled with straw to protect against winter injury. Careful selection of a favorable site for orchards or other plantings is also important in this connection.

Spray Injury

At times certain injuries to leaves and twigs of some plants may be caused by spray or dust treatments. Unfavorable weather or soil conditions may tend to increase the injury from certain fungicides. In general, browning or yellowing of the leaf-margins and brownish or discolored irregular areas on the leaf are common symptoms of spray burn. Stone fruits are so sensitive to copper that sprays containing this element cannot be used on the foliage. Bordeaux mixture frequently causes russeting of apples and this same spray is likely to stunt the growth of muskmelon leaves, causing the margins to become yellow. In the absence of a disease, Bordeaux mixture may cause a reduction in yields, especially in dry weather, of such crops as tomatoes, lima beans, and potatoes under certain conditions or in certain regions. In such cases the insoluble copper compounds are desirable. Dormant oil sprays frequently injure the twigs of trees unless proper emulsions with strong agitation are used in the spray tank. One of the most frequent types of spray injury results from the improper use of arsenical insecticides in spray mixtures; such materials should never be mixed with soap. Lime and zinc sulphate are used in

sprays (especially on peaches) containing lead arsenate to prevent arsenical injury. Zinc sulphate, however, should not be used in fruit sprays in areas having less than 30 inches of rainfall. During periods of continued high temperature, too frequent sulphur dusting may cause slight burning occasionally on the leaves of such plants as the rose. Owing to the injury produced, sulphur sprays or dusts cannot be used on cantaloupes. In many cases, however, unless some serious mistake has been made, spray or dust injury is not an important consideration.

Mistletoe, Spanish Moss, and Dodder

Mistletoe is a parasitic flowering plant with small flowers and white berries frequently seen growing on the limbs of such trees as hackberry, osage orange, oak, elm, and mesquite. It obtains water from the tree upon which it grows and may weaken or even kill its host. A few mistletoe plants growing on a large, healthy tree probably will do little damage. When these plants become too numerous, however, they should be removed, especially from valuable ornamental trees. Mistletoe can be readily pruned out with a saw or knife or it can be broken off with a hook fastened to the end of a pole. New mistletoe sprouts which arise later from the places where the original plant was growing should likewise be removed.

Spanish moss, like the mistletoe, is a seed-bearing plant which grows attached to trees but it does not obtain sufficient nutrients to injure the tree. When a tree becomes too densely covered with "moss", however, the foliage may be shaded to such an extent that the tree may be injured.

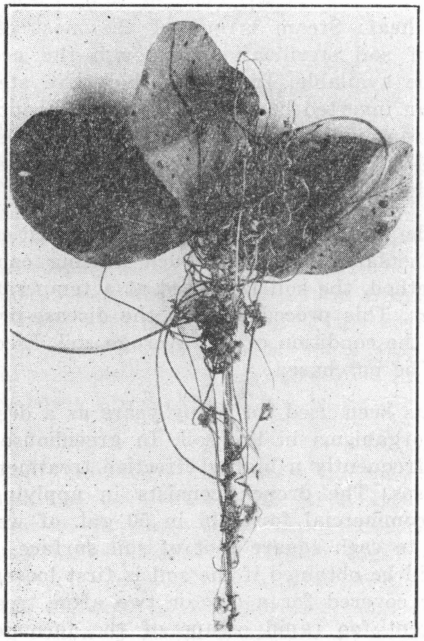


Fig. 29. Dodder on clover.

In such cases, the removal of Spanish moss from the tree would be desirable. This can be done by removing the moss by hand with a hook or rake. Spraying a moss-laden tree with lead arsenate (2 lb. to 50 gal. of water) will destroy the moss without injury to the tree. Calcium arsenate may be used when the trees are dormant. See Tex. Agr. Exp. Sta. Progress Report No. 747.

Dodder is a yellowish climbing vine. It is a parasitic seed plant which is often seen growing in dense masses over low herbaceous plants. It sometimes becomes serious in gardens or on certain field crops. The dodder vines should be removed and burned before the seed are ripe to prevent the infestation from becoming a nuisance later, in cultivated areas. In the case of certain field crops, it is desirable to clean the seed mechanically to remove the dodder seed and certain other contaminants.

METHODS AND MATERIALS USED IN THE CONTROL OF PLANT DISEASES

Soil Sterilization

In many cases, sterilization of the soil is a necessary step in the control of certain soil-borne and root diseases. Unfortunately, there is no simple, inexpensive method of sterilizing large areas of soil. Limited volumes of soil, such as are used in the greenhouse or hot bed, and small outdoor areas such as flower gardens, seed beds, or small nursery plots, however, can be effectively sterilized at reasonable costs.

Sterilization by heat: Steam is one of the most effective and satisfactory methods of soil sterilization, although the necessary equipment may not always be available. In this method, live steam from a boiler is conducted into an inverted box which is moved about over the loosened soil. Drain tile or iron pipe buried in the soil may also be used to distribute the steam. The soil is heated by steam until a medium-sized potato buried several inches in the soil is thoroughly cooked.

Electricity may be used for sterilizing small quantities (about one cubic yard) of soil in insulated boxes in which heating cables have been installed. By this method, the soil is heated at a temperature of about 160° F. for 3 or 4 hours. This procedure kills the disease-producing organisms without impairing the condition of the average soil. Electrical soil sterilizing units can now be purchased.

Formaldehyde has been used for many years as a drench to kill certain disease-producing organisms in the soil. In greenhouse beds and in outdoor plots this is frequently a highly effective treatment against fungous or bacterial diseases. The drench consists in applying a solution containing 1 gal. of commercial formalin in 50 gal. of water to the soil at the rate of 1 gal. to each square foot of soil surface. Better penetration of the fungicide will be obtained if the soil is first loosened up by spading. The soil should be covered for a day or two after treatment with paper or boards to prevent too rapid escape of the formaldehyde gas. After removal of the cover the soil should be spaded over occasionally and al-

lowed to dry out for 2 weeks before being used for sowing seeds or setting plants. For sterilizing small lots of soil for starting plants indoors or for potting purposes, another method for using formaldehyde is described under Damping-off (See page 57).

Chloropicrin is a liquid form of a tear gas which has come into wide use recently for sterilizing soil, especially against nematodes and certain fungi. It is used at a rate of about 1 lb. to 140 square feet of soil surface and is placed at a depth of 6 or 8 inches in the soil in holes about 15 inches apart. Another highly volatile chemical which is similarly used is **carbon bisulphide** ("High Life"). This material is especially effective against root knot nematodes. Since both of these treatments have to be rather carefully carried out, it is suggested that one read Texas Agricultural Experiment Station Bulletin 628 before attempting to use either of these methods.

D-D Mixture is a new material (not yet available commercially) that promises to be an effective and desirable soil fumigant.

Precautions. It should be remembered that any of the above treatments will kill any green plants growing in the treated soil. There is no widely effective soil treatment that will kill disease organisms in the soil without also destroying all living plants growing in the soil or nearby. Owing to the difficulties involved in such methods of sterilization, it is always best whenever possible to obtain fresh, disease-free soil from uncultivated areas to use for growing plants indoors or for replacing infested garden soil. Likewise when soil-borne diseases are discovered in the field, it is best to change the location of the affected crop if possible and plant some other non-susceptible crop in the infested areas.

Seed Treatment

Certain materials when dusted onto the outer surface of the seed frequently result in marked increases in yields by protecting the young seedling from fungous attack. Such treatments are helpful even in badly infested soil that has had no fungicidal treatment. In the field, this same protection is afforded oftentimes to treated seed, especially when planting is followed by unfavorable weather conditions, such as cold or too much rain, as well as indoors or in the seed bed or cold frame. Besides protection from damping-off, these seed treatments are often useful in killing certain disease-producing organisms that may be borne externally on the seed. Only a few special treatments, such as hot water, however, are effective in destroying seed-borne diseases that are lodged in the inner parts of the seed.

The following Seed Treatment Chart lists the materials commonly recommended for treating various kinds of seeds against both seed-borne and soil-borne diseases. In many cases the approximate amount of the seed treatment material is designated. Where these materials are available only in proprietary compounds obtainable on the market (as in the case of the organic mercury dusts), the directions given by the manufacturer should be followed. Small quantities of seed may be given the dry dust treatments by placing them in a tight can or fruit jar, adding

the correct amount of treatment material (dust) and shaking rapidly for a few minutes. For treatment of grain seed in large quantities one should consult such bulletins as U. S. D. A. Misc. Publ. No. 219, U. S. D. A. Farmers' Bulletin No. 1711, U. S. D. A. Misc. Publ. No. 330, or Circular No. 58 of the Minnesota Extension Service, University Farm, Minnesota. For treating cotton seed in large quantities, the U. S. D. A. Leaflet No. 198 gives complete directions and also includes a diagram for constructing a home-made seed-treating device which may be also used for seed other than cotton. Many of the seed-treatment materials are poisonous and treated seed should not be fed to animals or taken to oil mills. One should avoid breathing the dust while treating seed. If a considerable amount of dusting is to be done one should wear a mask.

Seed Treatment Chart

Crop	Treatment
Cotton	Ceresan (2%)*, New Improved Ceresan (5%)*, Spergon. Re-ginned or delinted seed may also be treated with one of these protectant dusts to advantage.
Corn	Arasan*, Semesan Jr.*, or Spergon*.
Sorghum	New Improved Ceresan*, Arasan*, **or** Copper carbonate dust (50%), 2 oz. per bu.
Wheat, Oats, Barley and Rye	New Improved Ceresan*, ½ oz. per bu. For smut, see special treatment described under these crops.
Flax	New Improved Ceresan*, ½ oz. per bu.
Peas (Cowpea)	Semesan* or Spergon*.
Peas (English)	Semesan*, Spergon*, **or** Yellow Cuprocide*..
Beans (except Lima)	Semesan*, Spergon*, or Arasan.
Lima beans	Arasan* or Spergon*.
Carrot	Spergon*, Yellow Cuprocide*, or Semesan*.
Cucumber Cantaloupe Summer Squash Watermelon	Yellow Cuprocide*, Semesan, Arasan*, or Spergon*. For anthracnose of watermelons, see page 43.
Cabbage Brussels Sprouts Broccoli Collards Cauliflower Turnip	Semesan*, Arasan*, or Spergon*. For black root and leaf spot, see page 8.

Seed Treatment Chart (Continued)

Crop	Treatment
Beet Eggplant Pepper Spinach Tomato	Yellow Cuprocide*, Semesan*, Spergon*, or Arasan*. For bacterial spot and canker of tomato, see page 42.
Potato (Irish)	Semesan Bel* (dip). For scab and scurf, see page 33 also.
Sweet Potato	Semesan Bel* (dip). For black rot and stem rot, see page 34 also.
Flower seeds	Most flower seeds can be safely treated with suitable dusts, such as Semesan*, Spergon*, Arasan*, or Yellow Cuprocide*. Follow directions on the container in all cases.

*The proprietary compounds mentioned here are the ones that have been most thoroughly tested by the Texas Station or found in these tests to be the most effective under average Texas conditions. Other similar compounds (such as Sanoseed, Barbak, Merc-O-Dust, Potat-O-Dip, etc.) may be just as good but have not been tested over a sufficiently long period to justify recommendation. In purchasing be sure to obtain the correct material for your particular kind of seed. Follow directions on the container as to use.

Fungicides

The most common materials now used to control plant diseases are copper compounds and sulphur. Other materials such as formaldehyde and compounds containing mercury or zinc also have practical uses as fungicides.

Copper Compounds

Many different copper-containing materials are used for foliage sprays or dusts; some are used for treating seed against damping-off and certain seed-borne diseases.

Bordeaux mixture is the best known copper-spray material. It has been used for many years, and is still one of our most efficient fungicides. This mixture is made in different strengths by mixing together solutions of copper sulphate (also known as bluestone or blue vitriol) with suspensions of hydrated lime in water. Such a formula as 4-4-50 means 4 pounds of copper sulphate, 4 pounds of hydrated lime, and 50 gallons of water. Small amounts of Bordeaux may be made by dissolving 3 teaspoonfuls of copper sulphate in 3 quarts of water in a wooden, earthenware, or glass vessel. In another container stir 5 teaspoonfuls of hydrated lime into 1 quart of water. The copper solution is then poured with rapid stirrings into the lime making one gallon of Bordeaux mixture. A convenient way to make Bordeaux mixture in the tank of a spray outfit consists in adding the desired amount of copper sulphate (already dissolved in water) into about two-thirds of a tankful of water. With the agitator running (but with pump cut off) the required amount of lime is washed through the strainer into the dilute copper sulphate solution, adding enough water to make up the desired amount of spray.

Finely pulverized forms of copper sulphate are more convenient for making Bordeaux mixture, since they do not have to be dissolved in

water previous to making up the spray material. Copper sulphate in the crystal form can be dissolved in a few hours, however, by suspending the crystals in a cloth sack so that the bottom of the sack merely touches the surface of the water. Soluble copper sulphate should never be used alone for spraying plants in foliage. High grade, fresh hydrated lime (60-70% calcium oxide) should be obtained for making Bordeaux.

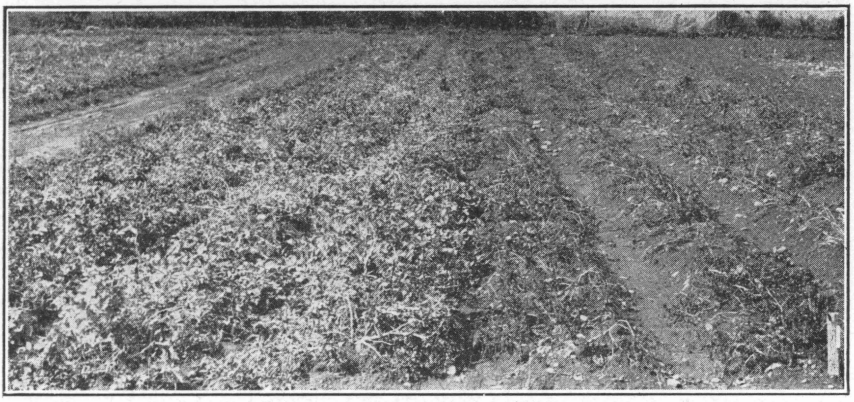


Fig. 30. Effects of spraying to control late blight of Irish potato plants: left, sprayed with Bordeaux mixture; right, unsprayed plants.

Bordeaux mixture deteriorates rapidly upon standing and should be used as soon as possible after it is prepared. Commercial Bordeaux mixtures that are very convenient to use can be purchased in the powdered form, ready to mix with water to make the complete spray material. Home-made mixtures are usually more effective as fungicides, however.

Copper-lime dust is frequently used in place of Bordeaux mixture when the grower wishes to dust his plants instead of spraying. It is made by thoroughly mixing 1 lb. of monohydrated copper sulphate (snow) with 4 lbs. of hydrated lime. When applied to moist foliage (early morning) a protective covering similar to Bordeaux mixture is formed on the plants.

Insoluble copper compounds are becoming more and more widely used, in place of Bordeaux mixture, as fungicides for plants. These materials can be purchased in the dry form and added directly to water to make a spray suspension or they may be mixed with an inert carrier such as sulphur, talc, or clay for use as a dust. (See page 71). Although in some cases these insoluble copper compounds may not be as effective fungicides as Bordeaux mixture, they are less likely to be injurious to the sensitive foliage of certain plants and they are much more convenient to use, since it is only necessary to add the dry powder to water in preparing the spray liquid. In many cases these insoluble coppers are desirable as spray materials because of the small amount of spray residue. Among these materials may be listed certain forms of red copper (cuprous) oxide, copper oxychloride, basic copper sulphate, basic copper chloride, copper ammonium silicate, copper phosphate, copper hydroxide, and copper zeolites. Trade names under which some of these materials are sold include: Yellow Cuprocide, Cupro-K, Copper-A Compound, Copper Hydro, Copper Oxy-

chloride-Sulphate, Spraycop, Tribasic Copper Sulphate, Copper Fungicide, Coposil, Basicop, Bordow, Oxo-Bordeaux, and others. While many of these proprietary copper compounds appear highly desirable as substitutes for Bordeaux mixture on many kinds of plants, it should be remembered that they have not yet been thoroughly tested under Texas conditions. Information concerning the use of these materials may be obtained from the Experiment Station.

Copper carbonate is an insoluble copper compound used chiefly for treating seed wheat for bunt.

Sulphur

As a fungicide, sulphur has many important uses especially in combating such diseases as the rusts, mildews and certain other foliage diseases. In an experimental way, sulphur has been found of value in combating certain rusts of the cereal crops. In the case of certain diseases which are more prevalent in alkaline soils, applications of sulphur to the soil often have given successful control of the trouble by increasing the soil acidity. The following forms of sulphur are commonly used in plant-disease control:

Dusting sulphur is a finely ground form the particles of which pass through a 325-mesh screen. Some grades (such as "Micronized" and "Mike" sulphur) are finer than certain other grades.

Wettable sulphur is also a finely divided product to which a wetting agent has been added. This wetting agent makes the sulphur form a uniform suspension throughout the water to which it is added. In making up a spray, wettable sulphur is usually added to water at the rate of 3 to 5 lbs. to 50 gals. or (for small amounts of spray) about 2oz. per gal.

Soil sulphur is usually a coarse grade with particles that pass a 16-mesh screen (including finer particles also). Commercial flour sulphur is composed of particles 90 percent of which pass an 80-mesh screen.

Lime-sulphur mixtures are obtainable either in liquid or dry form. In strong solution lime-sulphur is used as a dormant spray and in more dilute solutions is safe to apply to summer foliage of some plants, especially the apple. On dormant plants, 6 gal. of liquid lime-sulphur or 10 lbs. of dry lime-sulphur is used in 50 gal. of water. As a summer spray 1 gal. of the liquid or 3 lbs. of dry lime-sulphur is used in 50 gal. of water. Four pounds of dry lime-sulphur is equivalent to about one gallon of liquid lime-sulphur.

Sulphur-copper mixtures have given excellent results in the control of certain plant diseases. For several years, wettable sulphur has been added (about 3 to 5 lbs. to 50 gal.) to Bordeaux mixture for increasing the effectiveness of the Bordeaux. Combinations of wettable sulphur (2 oz. per gal.) and one of the insoluble copper compounds (1 oz. per gal.) have been suggested for the use of home gardeners in combating many diseases of ornamentals, such as conifer blight, rose black spot, and euonymus mildew. Ready-mixed sulphur-copper dusts are now available on the market for use by either home gardeners or commercial growers. They usually consists of 90 parts of a fine dusting sulphur and 10 parts of an insoluble

copper compound giving the final mixture a mettalic-copper content of about 3 to 5 percent depending on the type of copper compound used. These mixtures are often referred to as "rose dusts", since they were originally developed in Texas by the Experiment Station at Tyler for use in commercial rose fields.

Carbon bisulphide ("High Life") is a heavy, volatile, inflammable, explosive liquid used for treating soil against nematodes (See page 65).

Chloropicrin

(Tear Gas, one trade brand is called Larvacide). A liquid also used for treatment of soil for nematodes and soil-borne diseases (See page 65).

Mercury Compounds

Corrosive sublimate (Bichloride of Mercury) is often used for treating potatoes (both Irish and sweet) bulbs, corms, and seeds. It is usually used at a rate of 1 oz. to 8 gal. of water (or 1 tablet to a pint of water for small amounts of solution). In making a solution, first dissolve the powder or tablets in a small quantity of hot water. This material is poisonous and since it corrodes metals its solutions should be kept in glass, wooden ,or earthenware containers. The quicker method with Semesan Bel is often used instead of corrosive sublimate.

Yellow oxide of mercury is a relatively new fungicide material. It is used as a treatment for potato scab.

Organic mercury compounds are used in combination with various inert materials for seed treatment and for disinfectant dips. Their uses are mentioned frequently in the preceding pages. These proprietary materials are sold under such trade names as Semesan, Ceresan, Sanoseed and others. They commonly contain low percentages of mercury combined with various organic compounds that make these materials highly effective against disease germs both on the seed and in the soil.

Formaldehyde

Widely used as a soil or tool disinfectant (See page 64). It also has limited uses as a dip for potatoes and as seed treatment for bunt of wheat, oat smuts, etc.

New organic fungicides

Certain organic chemicals have been tested experimentally and are now on the market under various trade names for use in spraying or dusting of plants and for seed treatment. Among these are tetramethyl thiuram-disulphide (sold in wettable form as "Thiosan" and in dry form for seed treatment as "Arasan"); tetrachloro-para-benzo-quinone (sold as "Spergon" for seed treatments and as "Wettable-Spergon" for use in sprays, dips, or soil treatments); and ferridimethyl-dithiocarbamate (sold as "Fermate" for spraying or dusting).

Spreaders, Stickers and Inert Dust Carriers

Certain plants have smooth foliage to which ordinary sprays do not adhere well. Some fruits and stems likewise are difficult to wet. It is necessary in spraying such types of foliage or plant parts to add some wetting agent that will cause the spray to cover the surface and to adhere

after drying. Any grade of ordinary wheat flour can be used for this purpose at the rate of from 1½ to 2 lbs. to 50 gallons of water. (The flour is first made into a thin paste before adding to the spray material). Calcium caseinate is used at a rate of ½ lb. to 50 gallons or 4 teaspoonfuls per gallon. Powdered skim milk can be used instead of the caseinate and at the same rate. Two quarts of sweet skimmed milk added to each 50 gal. of spray solution also makes a good spreading and sticking agent for most sprays. A small amount (1 level teaspoonful per gallon) of glue added to a spray makes a liquid that spreads and sticks well. Fish oil or fish oil soap also are good spreaders and stickers and may be used according to directions on the container. When arsenical insecticides are not included in the spray, ordinary laundry soap may be used as a spreader at the rate of about ½ oz. per gal. Many wetting agents (spreaders) are available on the market under such trade names as Aresket, Santomerse, Penetrol, Fluxit, Orthex, Spread-ol, Stix-N-Spreads, and Vatsol.

At times it may be desirable to make a fungicidal dust that will drift well in the air, give good coverage of foliage and also adhere to dry plants. (It is usually better, however, to dust plants when they are wet or at least moist with dew or rain; and if possible dusting should be done while the air is calm). Such dusts usually consist of a finely ground copper fungicide diluted with an inert carrier such as sulphur, flour, fine clay, talc, or lime. For example, at the Winter Haven Station a dust that was used experimentally to control blue mold of spinach contained 1 lb. of an insoluble copper compound, 1 lb. of flour and 8 lbs. of talc thorouglhy mixed together. Another dust might contain 1 lb. of the copper material and 9 lbs. of flour. The selection of a proper inert carrier of the fungicide is of especial importance in dusting by airplane.

Equipment

Although many disease-control measures require no special equipment, such articles as sprayers or dusters are generally in use where protection against plant diseases is adequately provided. Small hand sprayers or dusters are satisfactory for gardens and these may be obtained in inexpensive models. Larger acreages of crops or orchards call for proportionally larger outfits operated by an engine and developing pressures of 300 lbs. per sq. in. or more. Often a particular crop may require some special type of spraying or dusting machinery. Before purchasing expensive equipment, the grower first should consult his County Agent, the Extension Service, or the Experiment Station as to the proper type of a machine for his particular needs. Airplane service is now available in many localities for the dusting of larger acreages.

Where to Obtain Materials and Equipment for Disease Control

Spray or dust materials, such as copper and sulphur compounds, seed treatment compounds, and the more common soil disinfectants may usually be purchased from local seedsmen, drug stores, hardware stores, or dealers in general agricultural supplies. Also, these same dealers usually have sprayers and dusters of various types for sale.

Cooperative Extension Work in Agriculture and Home Economics, Agricultural and Mechanical College of Texas and United States Department of Agriculture Cooperating. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

15M—5-44