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SOME COMMON DISEASES OF ORNAMENTAL PLANTS

BY E. L. LeCLERG



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TABLE OF CONTENTS

	Page
Aster—Yellows	6
Wilt or Stem Rot	7
Carnation—Stem Rot	7
Rust	8
Chrysanthemum—Leaf Spot	9
Rust	10
Yellows	10
Clematis—Leaf Spot	10
Columbine—Powdery Mildew	11
Geranium—Blossom Blight and Leaf Spot	11
Gladiolas—Hard Rot	11
Penicillium Rot	12
Scab	13
Hollyhock—Rust	13
Hyacinthus—Root Rot	14
Iris—Leaf Spot	14
Soft Rot	16
Larkspur—Powdery Mildew	16
Narcissus—Root Rot	16
Peony—Blight	17
Leaf Spot	17
Phlox—Powdery Mildew	18
Rose—Black Spot	18
Powdery Mildew	20
Crown Gall	20
Bud Blight	22
Rust	22
Snapdragon—Rust	23
Snowberry—Anthracnose	23
Sunflower—Rust	25
Powdery Mildew	25
Sweet Pea—Powdery Mildew	25
Tulip—Blight	25
Violets—Leaf Spot	26
Virginia Creeper—Leaf Spot	27
Zinnia—Leaf Spot	27
Damping-off	27
Fungicides	28
Directions for Sending Plants for Identification	31

SOME COMMON DISEASES OF ORNAMENTAL PLANTS

BY E. L. LECLERG

Ornamental plants are subject to a number of diseases, but because of their lesser economic significance they have not received the attention given to the diseases of vegetables and field crops. The experiments that have been made on the diseases of ornamental plants and what is known concerning them is scattered thruout various books and magazines and is not generally available to the grower, especially the home gardener who may often be as much concerned about a disease of his flowers as the commercial grower.

In order to better understand the diseases commonly found on ornamentals, it must be recognized that while a few are caused by bacteria, most of them are caused by fungi or molds. These are microscopic organisms, colorless and thread-like in structure. They cannot make their own food and must live as parasites on green plants such as our flowers and shrubs. Some of these fungi or molds live on the surface of leaves as do the powdery mildews and can readily be killed by spraying; others penetrate into the tissues of the leaf, stem or root of the plant causing rots, blights or wilts. When a plant wilts or dies and there is no visible evidence of the action of an organism on stem or leaves, examination will usually show that the root is rotted. Such diseases of roots are practically impossible to remedy; the plants should be destroyed and a different kind of plant grown in their place. Diseased plants or parts of plants should be burned to prevent spread.

The fungi causing most of the diseases of ornamentals are spread by microscopic cells called spores, which correspond to the seeds of higher plants. These spores are spread from plant to plant by wind or rain or splashing water from the hose and start new infections.

While some generalities as the above can be made regarding plant diseases, specific treatment of each disease is preferable.

It is the purpose of this bulletin to bring together information regarding some of the more common diseases of ornamental plants found in Colorado. The plants attacked are arranged alphabetically and the diseases listed and discussed under these

headings. An attempt is made to make available brief descriptions of the diseases together with such methods as are known to aid in their control.

ASTER, *Callistephus chinensis*

YELLOW.—The cause of aster yellows is unknown. No organism has been found in any part of the plant to account for the disease. The affected parts of diseased plants do not die or wilt in the early stages of the disease, but exhibit only a "spindling" yellow growth. (Fig. 1.) "Yellows" begins to appear after



Fig. 1. "Yellows" disease of aster. A, diseased plant showing wilted condition of leaves and flowers which accompany the yellowing. B, healthy plant.

the plants have become well established in the permanent bed. A light, greenish-yellow color instead of the normal dark green appears at the growing tip of diseased plants. Leaves previously formed do not change their color, but from the point where the trouble begins the succeeding stem and leaves are affected. At the same time, similar yellow shoots begin to appear from the axils of the leaves on the main stem. Nothing has been found in any part of the plant to account for the disease and no remedy

can be recommended for its control. It is known that certain weeds are susceptible to yellows and that the disease can be transmitted from weeds to asters by some insects. All weeds, therefore, should be kept cut in the vicinity of aster plantings.

WILT OR STEM ROT.—Wilt or stem rot is caused by a fungus (*Fusarium conglutinans callistephi*) and is the most common and destructive disease of asters. It first appears soon after the plants are set out in the bed and is generally prevalent from that time on thruout the season. This disease is most noticeable at two periods of the plant's growth, namely, at the time of setting of the plants and the time of blossoming. To the casual observer the presence of this disease is first indicated by the death of the affected plants. A close examination of dead plants will show that the stem of the plant just at the surface of the ground is badly rotted and only the hard inner portion remains. This is the final stage of the disease; however, it may be recognized much earlier.

In the earlier stages of the disease the roots and stem appear perfectly sound and healthy and no indication of injury can be seen except in the wilted, dying lower leaves. Frequently on one side of the plant, one finds a dark discoloration in the outer edge of the harder, woody portion of the stem, where it joins the soft "bark" or cortex which covers it. The affected side of the plant is dull green, wilted or blighted in appearance. A reddish-brown streak is often noticeable up the stem of affected plants.

This disease can be avoided by starting with healthy plants, grown out-of-doors or in cold frames, rather than in greenhouses where the conditions are more favorable to the disease. Seed should be planted in good soil out-of-doors as early as the ground can be thoroly worked and in a place where asters have never been grown before. The young plants should be transplanted to the permanent bed as soon as they are large enough and when conditions are favorable. They should be planted in a cool soil, since the fungus causing this disease grows best in hot, dry soils.

CARNATION, *Dianthus caryophyllus*

STEM ROT.—Stem rot is caused by a fungus (*Fusarium sp.*) and may attack seedlings, cuttings or mature plants. The disease is characterized on seedlings by lesions which appear as small brown spots on the stem at the surface of the soil. These spots increase in size and eventually almost girdle the stem, thus resulting in the collapse of the plant.

Cuttings may be attacked several days after they have been placed in the sand. Similarly the cutting is attacked on the stem just above, or frequently just below, the surface of the sand. The leaves of affected cuttings wilt and the plants fall over. A soft, wet, progressive rot then usually develops at the collar and extends to the surface of the sand.

The symptoms of the disease on a mature plant show the gradual loss of green color and the foliage becomes pale. Wilting results in time, depending upon the condition of the weather. An examination of the stem at the surface of the soil reveals at this time a slimy, wet condition under the bark, which gives this disease its characteristic name "rot." A slight twist is sufficient to slough off the bark and expose the harder tissues underneath. Plants at this stage of the disease are injured beyond recovery.

Steam sterilization is the only effective measure that will eradicate this fungus from the soil. Dry steam forced thru soil at 40 pounds pressure for an hour will destroy the fungus. (See Colo. Sta. Bul. 321.)

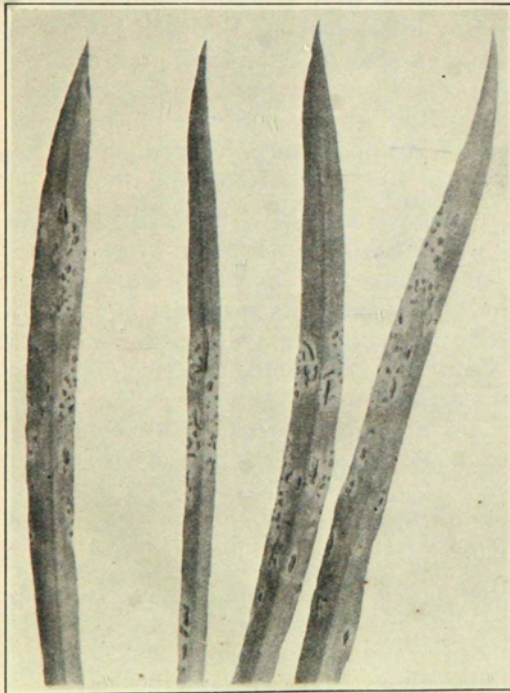


Fig. 2. Leaves of carnation plant showing pustules of rust.

RUST.—Rust is a common disease and is especially serious on greenhouse carnations. This disease is caused by a rust fungus (*Uromyces caryophyllinus*) and appears as elevated ridges about one-eighth to one-fourth of an inch long on the surface of the leaves (Fig. 2). These blisters eventually break and a reddish-brown, powdery mass of spores escapes, which spread the disease from one plant to another.

Watering aerial parts of the plants spreads the disease from leaf to leaf, and

therefore, surface watering should be practiced. Cuttings should only be made from healthy plants. The Enchantress, Mrs. C. W. Ward, White Perfection, Beacon, Matchless, White Wonder, Pink Delight and Benorah are said to be more resistant than others.

CHRYSANTHEMUM, *Chrysanthemum* sp.

LEAF SPOT.—This is a common disease of greenhouse chrysanthemums and is caused by a fungus. Leaf spot does not result in serious losses to growers. The disease is characterized by circular spots on the leaves. (Fig. 3). These spots first have a

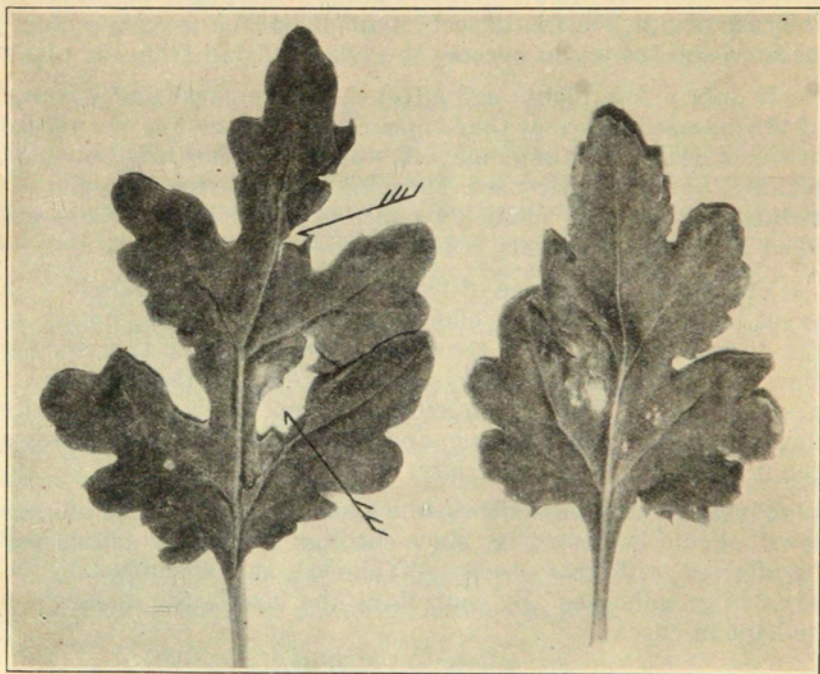


Fig. 3. Leaf spot of chrysanthemum. The affected tissue has dropped out in the areas indicated by arrows.

water-soaked appearance, later becoming brown. The lower leaves of the plants are usually attacked first and the disease spreads upward from leaf to leaf. In severe cases where spots become numerous, the leaves may turn yellow and drop.

The application of a 4-4-50 Bordeaux mixture (see Fungicides) will check the spread of the disease if it becomes serious. If only a few of the leaves show spots, they should be picked off and burned. This will tend to check a spread of the disease.

The organism causing leaf spot is spread from plant to plant by sprinkling the foliage. Therefore, surface irrigation should be practiced.

RUST.—This disease is caused by a rust fungus (*Puccinia chrysanthemi*) similar to that causing rust on grains. Like other rusts it forms small blisters which appear on the under surface of the leaf and to some extent on the upper surface. When these blisters mature they break open and expose a dark brown powder, which is a mass of spores. These spores are scattered by the wind and water while sprinkling the foliage. They are responsible for the spread of the disease from plant to plant. In the case of a heavy rust attack, most of the foliage may become affected and the leaves become shriveled and fall from the plant.

If only a few plants are affected, the removal and burning of the diseased leaves as they appear, will tend to stop the spread of this disease. No fungicide will stop this disease without hand picking, but if rightly used, spraying will prove a material assistance. Potassium sulfide (1 ounce to 2 gallons of water) applied at weekly intervals is beneficial.

YELLOW.—The cause of “yellows” is unknown and shows a great similarity to aster yellows. Due to the obscure nature of the disease it can only be recognized with certainty at flowering time. Diseased plants always produce flowers that are sickly green in color. This green color may not show in the entire flower, but half may be green and the other half of the blossom the normal color of the variety.

Plants grown out-of-doors which show any symptoms of “yellows” should be destroyed, since cuttings from these plants will be affected with this disease. “Yellows” is transmitted by insects in greenhouses. By controlling the insects the disease can be kept in check.

CLEMATIS, *Clematis* sp.

LEAF SPOT may be caused by one of several fungi. This disease is common on clematis. It does not cause serious damage, but only results in the loss of a few lower leaves from the badly infected plants. Leaf spot is limited to the foliage where discolored lesions are produced, similar to the leaf spots found on other ornamental plants.

Spraying with Bordeaux mixture will control leaf spot. Since this fungicide discolors the foliage, picking affected leaves is recommended where the disease is not serious.

COLUMBINE, *Aquilegia sp.*

POWDERY MILDEW is a very common disease on columbines wherever they are grown. It is caused by a fungus (*Erysiphe polygoni*) and as a rule causes very little damage. This disease, like other powdery mildews, forms grayish-white, powdery growths on the leaves. Often the disease becomes so abundant that entire leaves become covered. The fungus is generally most prevalent on the upper surface of the foliage. Due to the winds and the spattering of water, the disease spreads rapidly from leaf to leaf and in severe attacks the lower leaves fall prematurely.

Powdery mildew of columbine can be controlled by spraying with potassium sulfide or dusting with flowers of sulfur. The sulfur should be applied when the leaves are covered with dew.

GERANIUM, *Pelargonium sp.*

BLOSSOM BLIGHT AND LEAF SPOT.—This is the most common disease of geraniums and may cause serious losses in greenhouse stock. It is caused by a fungus (*Botrytis cinerea*). The disease causes the blossoms to dry up, a week or 10 days sooner than normal. In the early stages of the disease the petals begin to turn black on the edges; then they wilt and begin to drop. The infected petals very often cause infection on the foliage as they fall from the blossoms. Spots of varying sizes are formed on the leaves. These spots are brown and cause the plant to become weakened. If conditions are favorable, these spots increase in size and often infect the entire leaf. The disease is most prevalent on weakened plants and spreads quite rapidly in greenhouses, once infection takes place. Double varieties are most susceptible to the disease.

Sanitation and proper ventilation should be practiced. Diseased plants should be discarded as soon as observed.

GLADIOLUS, *Gladiolus sp.*

HARD ROT is caused by a fungus (*Septoria gladioli*). The disease becomes most apparent about the last of July or early in August. On the leaves it appears as minute brown or purplish-brown, more or less circular spots. These diseased spots later turn to a reddish-brown or almost black color.

The disease appears on the corms as small water-soaked spots. These spots are reddish brown to brownish black in color. They usually are limited to the sides and the lower half of the corm. These lesions can be more readily seen if the husks are

removed. In the early stages of the disease the lesions are limited to the surface and even in the very late stages do not enter more than one-quarter of an inch into the corm.

Hard rot overwinters on the dead tops of the plants, so all debris in infected fields should be raked up in the fall and burned. Care should be taken to use only disease-free corms. Crop rotation should be practiced. No successful treatment of the corms with chemicals has as yet been found.

PENICILLIUM ROT.—This is typically a storage disease and is caused by a fungus (*Penicillium gladioli*). This rot is present in many of the gladiolus storage cellars of Colorado. Diseased corms are somewhat softened and show reddish-brown, sunken spots. These spots are often roughened by wrinkles which are in concentric rings. Infection takes place most readily thru

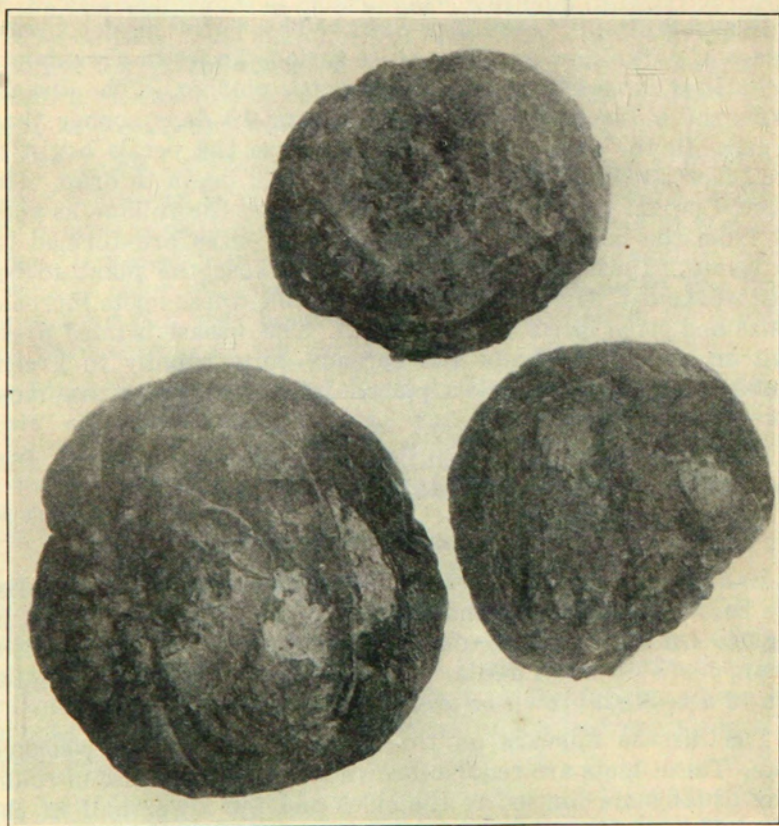


Fig. 4. Bacterial scab of gladioli on the corms.

wounds on the corm. Rot progresses most rapidly at temperatures between 53° and 73° F., and the corm is gradually destroyed. The fungus often grows on the exterior of the corm and forms a bluish covering over the surface.

No fungicides have been found that will control this disease. The most satisfactory method of control is to discard all diseased corms at time of storage. This will tend to check the spread in storage. Care should be exercised in digging and handling not to bruise the corms, since the fungus enters thru such wounds.

SCAB.—This disease is caused by a bacterium (*Bacterium marginatum*) and is widely spread where gladioli are grown. Scab may appear on any part of the leaf. The disease is first recognized by small raised, reddish-brown spots which come together forming large diseased areas. The stem tissue is soon destroyed and the leaves begin to turn yellow and gradually die. Infection is limited to the lower 6 to 8 inches of the leaves, the upper parts having but few spots.

The corms are often affected and show lesions on both the husk and the exterior. The lesions first appear as yellow to light-brown areas which later become almost black (Fig.4). The spots or lesions are mostly round, but may appear as oval or elongated streaks. These lesions become sunken, but do not extend very far into the corm.

Experiments on control have been too meager to indicate the most advisable methods for prevention of scab. Work from other states seems to indicate that some of the commercial organic mercury disinfectants are giving good control. Crop rotation, however, should be practiced, since the organism is thought to live over winter in the soil. Only disease-free corms should be planted.

HOLLYHOCK, *Althae rosea*

RUST.—Rust is the most common disease of hollyhocks and is caused by a fungus (*Puccinia malvacearum*). This disease is characterized by brownish, erumpent spots on the leaves. These spots are either circular or elongated as shown in Fig. 5. The pustules break open at maturity and a brownish mass of spores escapes. Wind and water spread these spores from plant to plant causing new infection. Only in severe cases do the plants wither and die.

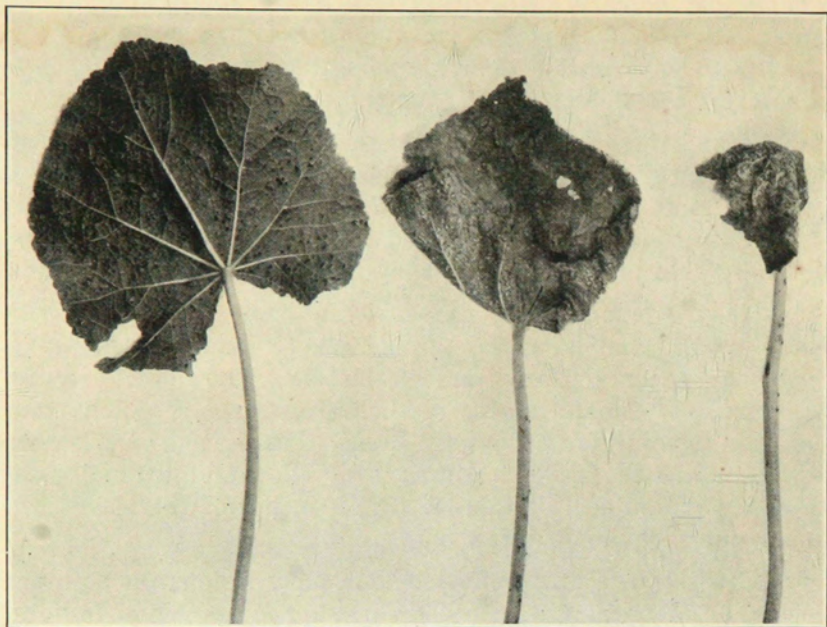


Fig. 5. Diseased hollyhock leaves showing the brown, erumpent pustules of rust and the final dried condition of the leaves.

In the spring care should be practiced to pick off and burn all diseased leaves as soon as they appear. It is best to destroy old plants that are severely attacked by rust and start with new stock. All the diseased plants should be burned in the fall. Rust can be checked by spraying with Bordeaux mixture, but since this spray discolors the foliage it is not frequently used. The effective use of sulfur in controlling rusts on other plants suggests its use on hollyhocks.

HYACINTHUS, *Hyacinthus orientalis*

ROOT ROT is caused by a fungus (*Fusarium sp.*). See root rot of Narcissus, page 16.

IRIS, *Iris sp.*

LEAF SPOT.—Leaf spot is caused by a fungus (*Didymellina iridis*) and is confined only to the leaves. The first sign of the disease is small brown spots surrounded by a water-soaked margin. The spots turn yellow later in the season. They are more abundant on the tips and spread downward. The terminal portions of the leaves often become brown and die (Fig. 6).

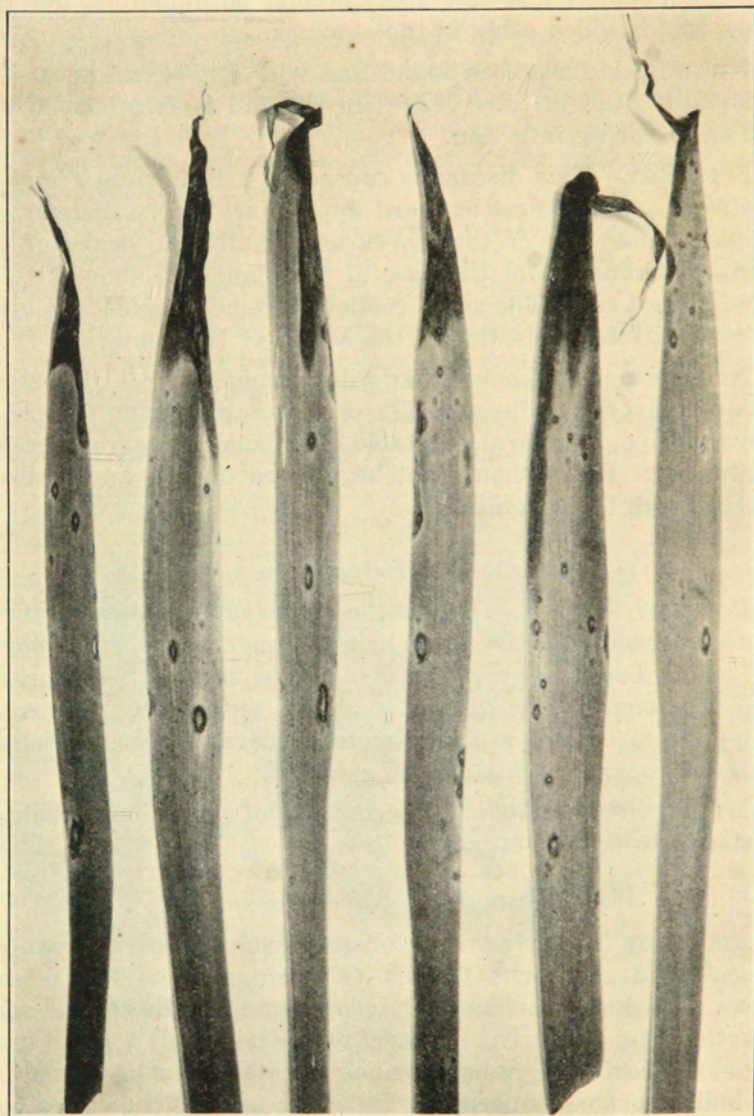


Fig. 6. Leaf spot of iris.

The spots may appear on either surface of the leaves. The diseased areas vary in size from one-quarter to one-half inch in diameter. Sometimes these spots become so numerous that the entire leaf is killed early in the summer.

No fungicide has been found that will control leaf spot. The removal of dead infected leaves in the fall is recommended to stop early spring infection.

SOFT ROT.—This disease is caused by a bacterium (*Bacillus carotovorus*). The first outward appearance of the disease is a complete yellowing of the leaves and finally the death of the plant. Examination at the base of the plant will show it to be jelly-like and soft. The small rootlets become decayed and often the bulb disintegrates, due to the action of the bacteria.

No treatment is known that will prevent soft rot. Excessive moisture favors the disease. The organism producing soft rot is known to live on several vegetable crops such as carrots, celery, turnips, etc. Bulbs should not be planted on soil known to be infected with this organism.

LARKSPUR, *Delphinium* sp.

POWDERY MILDEW.—This is the most common disease on cultivated larkspurs and is caused by a fungus (*Erysiphe polygoni*). The leaves become covered with a white, powdery network of fungus filaments. The disease is seldom serious, but may cause the plants to become a paler green. In severe cases the foliage turns yellow and gradually dies.

Mildew can be controlled by the use of potassium sulfide or dusting with flowers of sulfur.

NARCISSUS, *Narcissus* sp.

ROOT ROT is very common on narcissus in this state and is caused by a soil-borne fungus (*Fusarium* sp.). The disease causes a marked dwarfing of the plants and usually the blossoms do not develop properly. Diseased plants have only a small number of live roots, the remainder being rotted. The basal plate of the bulb is generally decayed. In severe attacks the entire bulb may become decayed.

Bulbs should be sterilized with bichloride of mercury (1:1,000) for one hour before planting. Crop rotation should be practiced, since the fungus lives over in the soil.

PEONY, *Paeonia* sp.

PEONY BLIGHT is caused by a fungus (*Botrytis paeoniae*). It is quite prevalent and often causes much damage. Plants are affected early in the spring and nearly all parts are attacked. On the stems and leaves it is characterized by large irregular spots, which cause a gradual dying of the leaves. Stems are often rotted near the ground and become girdled. Sometimes the young buds become blasted before they reach maturity, which causes them to blacken and die.

Blight is very difficult to control. All old diseased plants should be removed and burned in the fall. No dusts or sprays have been found effective in controlling this disease.

LEAF SPOT.—This is a common disease of peonia, and is caused by a fungus. It seldom causes very serious losses. The disease appears as chestnut-brown spots and may cover the larger part of the leaves (Fig. 7). On these spots the spores are borne which spread the disease from plant to plant.

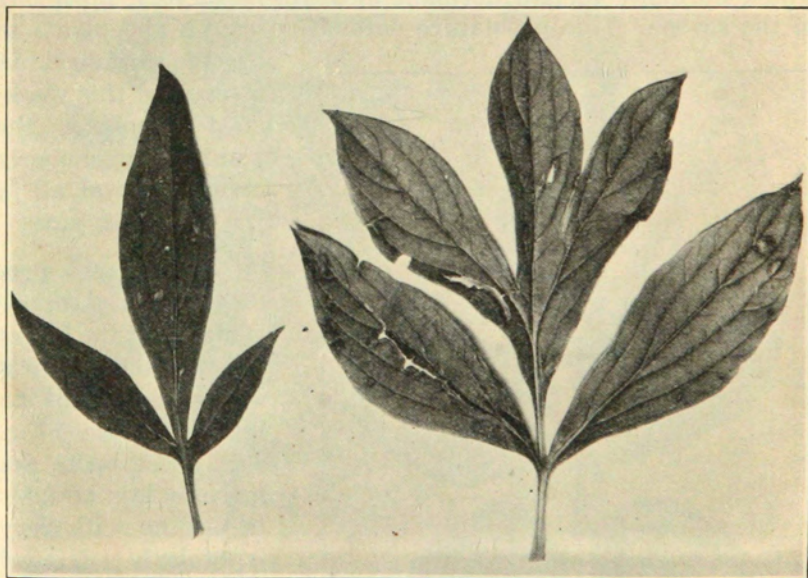


Fig. 7. Leaf spot of peonies.

Leaf spot can be controlled by spraying with Bordeaux mixture. Since this spray discolors the leaves, it is preferable to pick affected leaves instead of spraying when the attack is not serious and only a few plants are affected.

PHLOX, *Phlox sp.*

POWDERY MILDEW.—This is a common and often destructive disease of cultivated phlox. It is caused by a fungus (*Erysiphe cichoracearum*). The leaves and stems become thickly covered with a dirty white powdery growth. The disease starts on the lower leaves and gradually spreads to the upper parts of the plants. In severe attacks the lower leaves fall prematurely and the flowers become dwarfed.

Powdery mildew of phlox can be controlled by spraying with potassium sulfide or dusting with flowers of sulfur.

ROSE, *Rosa sp.*

BLACK SPOT is caused by a fungus (*Diplocarpon rosae*). The disease appears at any time during the growing season. Usually it does not become destructive until summer, and frequently continues damage during the autumn months. Plants which are attacked drop their leaves early in the season. The leaf buds which normally remain dormant until the next year, open late in the season. This premature defoliation causes the plants to

become weakened. As a result of this weakened condition the plants blossom poorly or even not at all in the following year.

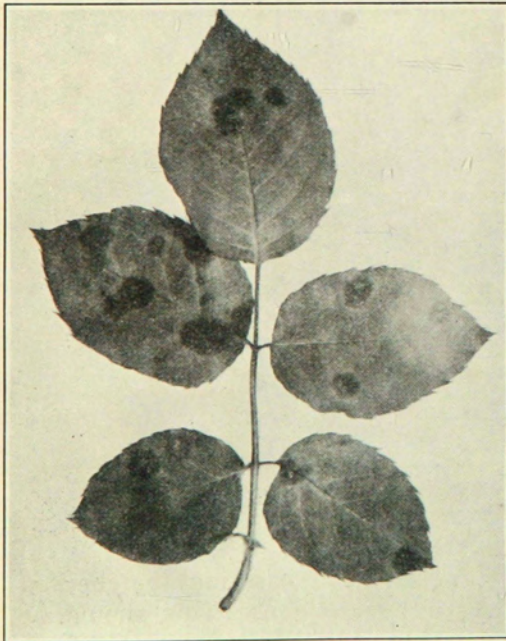


Fig. 8. Black spot of rose, showing the smoky black patches of the fungus on the leaves.

Spots are produced on the upper surfaces of the leaves which often attain a diameter of half an inch or more (Fig. 8). These spots are more or less circular in outline with very irregularly fringed borders. They are black in color and frequently coalesce, covering the whole leaves.

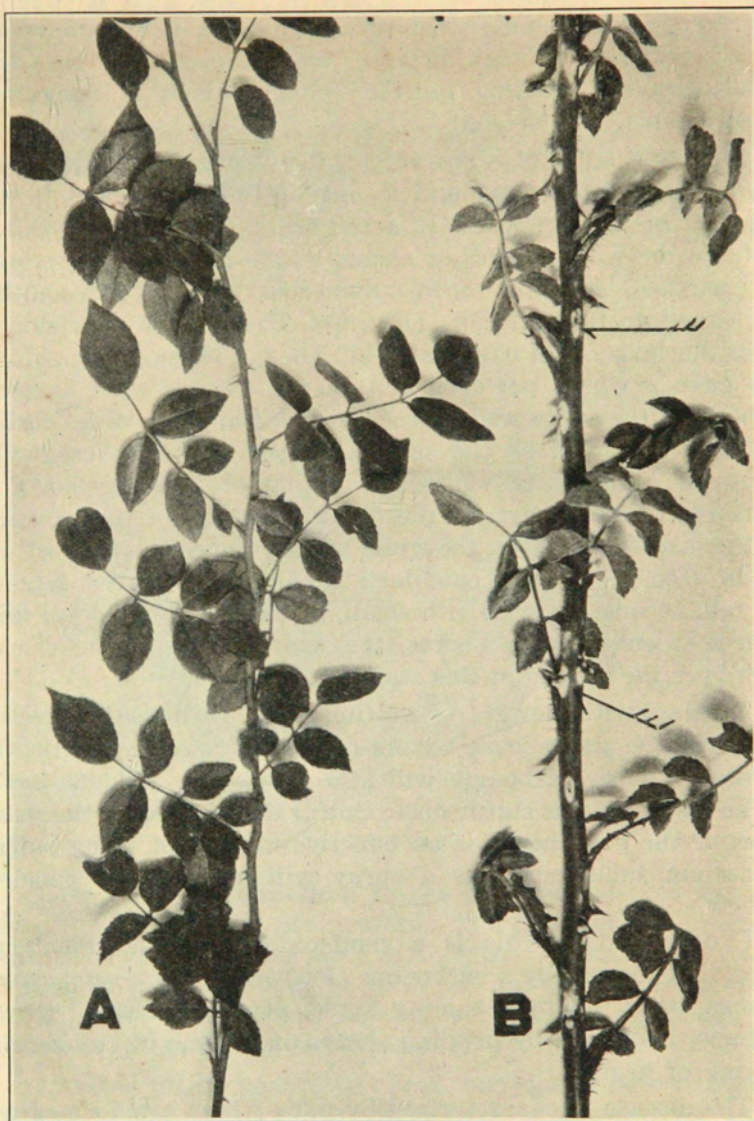


Fig. 9. Powdery mildew of rose. A, healthy plant; B, diseased plant, showing the shriveled condition of the mildewed leaves and the white patches of mildew on the stem and thorns as indicated by the arrows.

If only a few plants are grown the disease may be checked by gathering and burning all affected leaves. This should be done either late in the fall or early in the spring before the buds open. Spraying is beneficial in controlling black spot. Ammo-

niacal copper carbonate used once each week is recommended. Lime sulfur or Bordeaux mixtures may be used, but these fungicides leave a coating on the foliage which is sometimes objectionable.

POWDERY MILDEW.—Powdery mildew is caused by a fungus (*Sphaerotheca pannosa*) and is one of the most common and injurious diseases of roses. It is first noticeable as dusty, whitish spots on the young leaves or shoots where the mold grows over the surface, sending down numerous minute, thread-like branches into the leaf cells (Fig. 9). These draw nourishment from the leaves and eventually kill them. These spots enlarge and have a white, powdery appearance. The disease is often present on the stems and thorns, where it appears as a felt-like coating. The mold on the surface of the leaf is covered with enormous numbers of white spores that are readily blown or spattered to other parts of the plant and thus spread infection. As the disease advances, the white mildew appearance is lost and the injured portions become dark in color. The leaves, later in the fall, become covered with small, black, bead-like bodies filled with a second kind of spores, the winter spores. The disease lives over the winter in this stage.

Dusting with flowers of sulfur every 10 days is effective either in the greenhouse or out-of-doors. Spraying with ammoniacal copper carbonate will also control the mildew, but is not as easily used as sulfur dust. Sulfur dust placed on the steam pipes of the greenhouse is an effective method of using sulfur. Potassium sulfide used as a spray will also control powdery mildew.

CROWN GALL.—This is a common disease on greenhouse roses. It is caused by a bacterium (*Bacterium tumefaciens*) and attacks other plants, including apple, pear and peach. Crown gall may be spread by pruning shears or at time of cutting and making of grafts.

The disease is characterized by galls which are formed any place on the stem (Fig. 10) and sometimes on the roots. Crown gall progresses very slowly, beginning as small swellings and increasing in size until eventually the plant becomes stunted and finally dies. The organism causing this disease gains entrance into the plant thru wounds and lives from year to year in the diseased tissue. The crown-gall organism is known to live over winter in the soil.

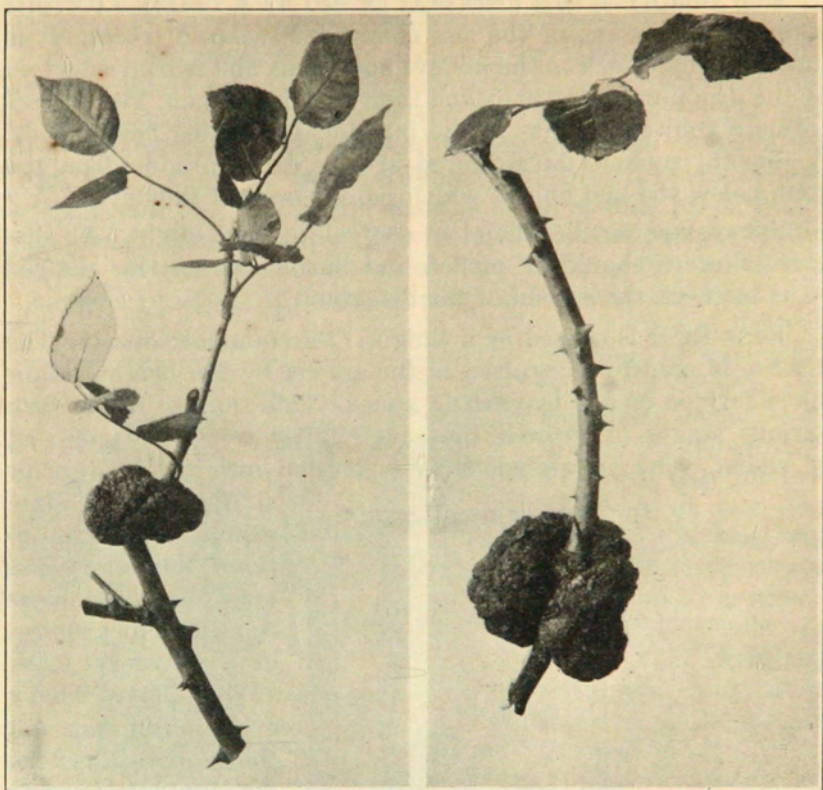


Fig. 10. Crown gall of rose.

Care should be practiced to use only disease-free stock, especially if the plants are grafted. The point of the union and scion is a very common place of infection in grafted stock. All grafts, therefore, should be wrapped and dipped in Bordeaux paste, which will prevent the entrance of the organism, until the union of scion and stock has calloused.

Infected plants cannot be cured, but should be removed and burned. Since the organism lives over in the soil for several years, roses should not be planted on infected soil. Soil infected with the crown-gall organism can be steam sterilized in greenhouses (See Colo. Sta. Bul. 321).

Pruning shears and grafting knives should be sterilized after being used on affected plants and before using on healthy material. Sterilization can be effected by dipping them in a solution of formaldehyde (1 ounce to 2 gallons of water).

BUD BLIGHT.—This disease is caused by a fungus (*Botrytis cinerea*) and is one of the less common diseases of roses. It is limited in its attack to the undeveloped buds and is characterized by the dropping of the buds and their failure to open. The fungus forms a cobwebby mass in the interior of affected flower buds. A smooth, sunken, dark-colored area is often produced on the stem below the bud and at which point the head falls over.

Sprays are not beneficial in controlling bud blight. All diseased flowers should be picked and burned as soon as noticed so as to check the spread of the disease.

ROSE RUST is caused by a fungus (*Puccinia speciosum*). The disease is readily recognized in the spring by the bright yellow spots formed on the leaves and stems. This fungus passes thru various stages of growth that are similar to black stem rust of wheat. The yellow spots soon develop into red blisters or

streaks in the late summer or early autumn. These red blisters contain many reddish-brown spores in a powdery mass (Fig. 11). They eventually break and the spores spread the disease from plant to plant. In the fall these blisters become black and contain the resting spores of the fungus, in which stage it passes the winter.

No fungicide has been found that will control this disease. Since the fungus overwinters on old leaves and stems, all diseased plants should be cut and burned in the fall.

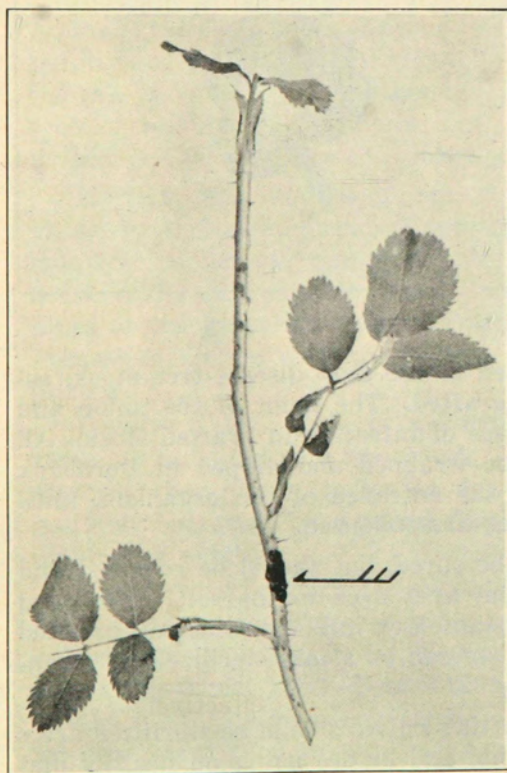


Fig. 11. Rose rust pustule on stem as indicated by arrow.

SNAPDRAGON, *Antirrhinum majus*

RUST.—Snapdragon rust is caused by a fungus (*Puccinia antirrhini*). It becomes extremely serious in greenhouses and also is an important disease in the field and garden. The disease is characterized by brownish blisters on the leaves and stem (Fig. 12). These blisters break and the brownish spores escape and are then spread by wind and the spattering of rains. Rust causes the most damage to the lower leaves because of the presence of excessive moisture and under favorable conditions it spreads rapidly. It finally causes the death of the plant.



Fig. 12. Snapdragon rust.

The use of healthy cuttings is advisable. Watering should be done from below, so as to keep the foliage dry. This will help materially to check the spread of the rust fungus. If the disease is not serious, the affected leaves should be picked off. Spraying with potassium sulfide will control the disease in the field.

Snapdragon rust can be controlled in greenhouses by dusting with sulfur. After dusting, the temperature of the house should be kept at 70° F. for three days and with a night temperature of about 60° F.

Finely powdered sulfur (sulfur that will pass thru a 200-mesh sieve) should be applied to the plants with a bellows. If the disease is serious and new foliage becomes affected, sulfur should be applied again. Under conditions of light attacks of this rust, dusting every two weeks will control it effectively.

SNOWBERRY, *Symphoricarpos* sp.

Anthracnose.—This disease is very common and is caused by a fungus (*sphaceloma symphoricarpi*). The disease has only re-

cently received the attention of investigators. Anthracnose is manifest on both the leaves and the berries.

Small, round, dark purple to black spots are produced on the leaves. The centers of these spots soon become lighter in color, changing to a dark gray. The spots slowly increase in size and eventually come together, forming large diseased areas. Very small lesions are often produced on the flower buds.

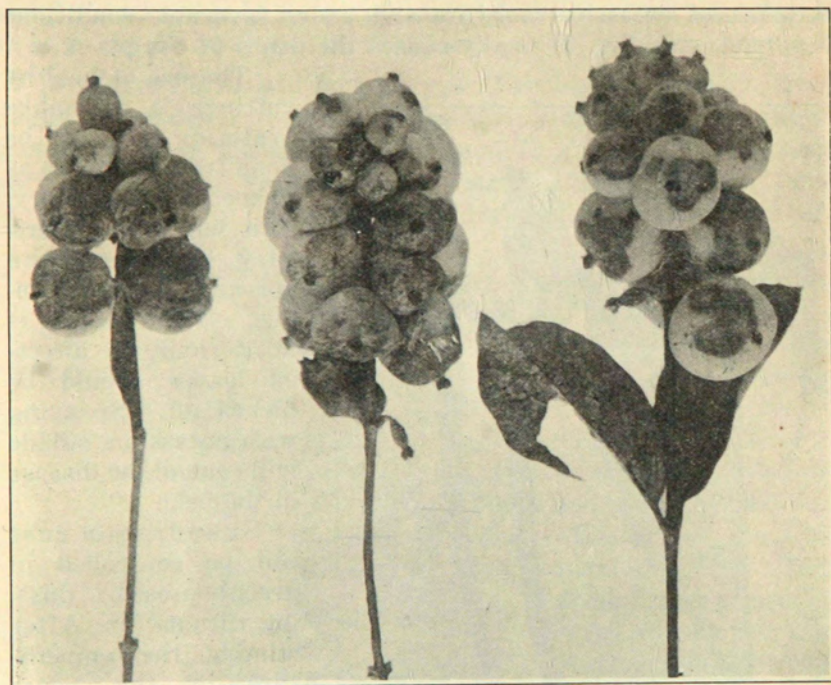


Fig. 13. Anthracnose of snowberry on the fruit.

Anthracnose appears on the berries as small, round, pinkish lesions (Fig. 13). These lesions or spots are slightly sunken and vary considerably in size. The diseased areas are very often attacked by another fungus (*Altenaria sp.*) which causes soft, watery lesions on the fruit. These water-soaked areas increase rapidly until the entire fruit has been affected. The diseased berries soon dry up and form hard, brown mummies.

No conclusive work is available on the control of anthracnose. The disease undoubtedly overwinters on dead leaves and in the mummies, so that all rubbish about the plants should be raked and burned in the fall.

SUNFLOWER, *Helianthus annuus*.

RUST.—This is a very common disease of sunflowers and is caused by a fungus (*Puccinia helianthi-mollis*). Rust is manifest on the leaves as small, yellowish or brownish pustules or blisters which later become black. These blisters contain the spores that spread the disease from plant to plant. The pustules frequently become so abundant on the foliage as to render the under surface quite brown. No fungicides have been found to control this rust, altho experience with sulfur on other rusts suggests its use on sunflower rust. Raking and burning all diseased plants in the fall is the most advisable recommendation.

POWDERY MILDEW is caused by a fungus (*Erysiphe cichoracearum*) and is very common on cultivated sunflowers in Colorado. It is conspicuous on the upper surface of the leaves as white patches. Often the disease spreads so as to cover the greater part of the leaf. Later in the summer the leaves become covered with small black bodies, in which stage the disease overwinters.

Powdery mildew can be controlled by spraying with potassium sulfide or dusting with flowers of sulphur.

SWEET PEAS, *Lathyrus odoratus*

MILDEW.—Like other mildews, this disease is caused by a fungus (*Erysiphe polygoni*). Mildew is a very common disease of sweet peas grown out-of-doors and in greenhouses. It starts as a white, powdery growth on the lower leaves. The leaves turn yellow and gradually die.

Mildew can be controlled out-of-doors by the use of potassium sulfide and in the greenhouse by dusting with flowers of sulfur.

TULIP, *Tulipa sp.*

BLIGHT.—Tulip blight (*Botrytis Tulipæ*) is a fungus disease which manifests itself on the flowers, bulbs, leaves and stalks. The first outward appearance of the disease on the blossoms is as small, white to light-brown spots on the petals. These spots enlarge until the petals become dry and wrinkled. This gives a blighted appearance to the entire flower. The flower is sometimes prevented from opening by infection taking place in the bud.

The disease appears on affected bulbs as small, hard, black bodies (sclerotia) which are about one-sixteenth of an inch in diameter. Lesions are produced on the bulb under these bodies.

The lesions or spots are brown and usually round and are generally less abundant on either end of the bulb.

Small, elongate, yellow spots are produced on the foliage, which later become white with a brown tinge. These spots are surrounded by tissue that has a watery appearance. They enlarge and coalesce and often infect the entire leaf.

On the stalks the lesions are small, brown and surrounded by a water-soaked area. These lesions may be produced anywhere on the stalk, where they penetrate into the stem and cause it to weaken. The plants fall over if the fungus enters at the base or the flower may topple over if penetration is higher up on the stalk.

No fungicide for spraying foliage or solution for sterilization of bulbs has been found. It is recommended that only clean bulbs be planted. Care in handling bulbs and proper storage conditions will materially check the disease. All diseased plants should be raked and burned in the fall.

VIOLET, *Viola odorata*

LEAF SPOT attacks the violet plants at any stage of growth thruout the growing season. It is caused by a fungus. Rapidly growing plants are most susceptible to leaf spot. It appears on

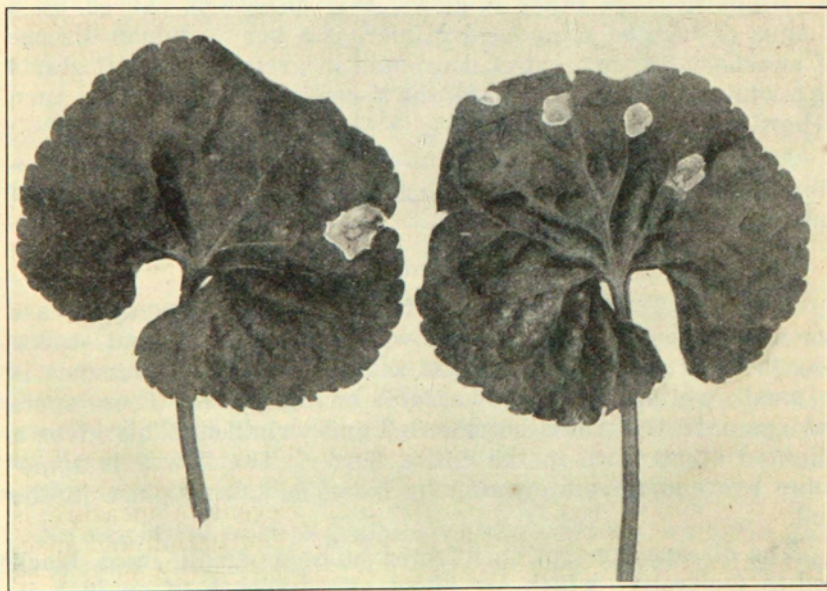


Fig. 14. Leaf spot of violet.

the leaves as small, round, yellowish spots (Fig. 14). The spots are usually surrounded by a narrow ring of discolored tissue. This surrounding tissue is usually dark at first, but soon changes to a lighter color with age. The spots coalesce until often the entire leaf is destroyed.

Sprays of any kind are of little or no value in controlling this disease. Care should be taken to use only healthy plants for propagation. Greenhouses and frames should be kept clean and well aired. All diseased leaves should be picked and destroyed.

VIRGINIA CREEPER, *Ampelopsis quinquefolia*

LEAF SPOT.—The disease is caused by a fungus (*Phyllosticta viticola*). Leaf spot is very common on Virginia creeper and is most abundant on foliage above 6 or 8 feet from the ground. Circular, dead, brown spots are produced on the leaves. These spots are about one-quarter to one-half inch in diameter. In severe cases the leaves turn yellow, wilt and eventually fall. It can be controlled by the same method as for leaf spot on peony.

ZINNIA, *Zinnia elegans*

LEAF SPOT.—Zinnia plants are generally quite free from disease in Colorado, but occasionally they are affected with a leaf spot. This disease is caused by a fungus (*Cercospora atricincta*). It is characterized by the presence of small irregular, angular spots on the foliage. These spots are grayish and have a definite brown border.

The control for this disease is the same as for leaf spot of violet.

DAMPING-OFF

A number of ornamental plants are subject to damping-off. The disease affects the plants in the seedling stage, causing them to rot off at the surface of the ground. The stems appear water-soaked and soft and the plant collapses and falls over on the ground.

The disease is caused by several soil fungi. These fungi live indefinitely in the soil and grow best in wet, warm soil. Damping-off usually occurs in seedbeds where the plants are crowded and the soil is too wet. Slow-drying soil and poor ventilation of the greenhouse or cold frames are conducive to the disease.

In controlling damping-off the first preventive measure is to get rid of surface moisture on the soil. Ventilation and spacing of plants or a thin layer of sand on the soil will tend to keep the surface of the soil dry and produce conditions unfavorable for the growth of the fungus.

Soil sterilization is effective in combating the disease; formaldehyde or heat may be used for this purpose.

The formaldehyde treatment consists of sprinkling the loosened soil with a solution of formaldehyde, 1 gallon to 50 gallons of water. Sprinkle 1 gallon of this solution to a square foot of the soil and then cover plot for 12 hours. Planting should not be made in the soil for 10 days after treating.

In a similar way copper sulphate or blue vitriol may be applied. One pound of the sulphate is dissolved in 25 gallons of water and applied at the rate of 1 pint to a square foot of ground. An equal amount of water should then be sprinkled on the soil to wash the copper into the ground.

Soil sterilization by heat is the most successful method of destroying the damping-off fungus. This can best be accomplished by turning live steam into an inverted iron pan over the seedbed. The soil is exposed to the steam for one-half to one and one-half hours. In testing the efficiency of the treatment, a potato may be buried in the soil 4 or 5 inches deep; the time necessary to cook the potato is enough to kill the damping-off fungi.

Steam pipes furnish a very satisfactory method of soil sterilization. The pipes are connected to a header or lead pipe direct from a boiler. Holes of about $\frac{5}{16}$ -inch diameter are bored in the pipes 6 inches apart and the steam escaping from these thoroly heats and sterilizes the soil. Smaller holes than $\frac{5}{16}$ inch tend to plug up and prevent the escape of steam. A low-pressure boiler of large capacity is most suitable for this work. Steaming should continue for two hours. (See Experiment Station Bul. 321.)

FUNGICIDES

1. BLUE VITRIOL-COPPER SULPHATE.—Copper has a very specific action on fungi and may be used in the form of copper sulphate for sterilizing cold frames, washing greenhouse walls, benches, etc.

Copper sulphate, 2 to 3 pounds.

Water, 50 gallons.

Dissolve the copper in a little hot water and then dilute to 50 gallons.

2. BORDEAUX MIXTURE.—a. Home-made. This consists of blue vitriol, lump lime and water in the following proportions: Blue vitriol (copper sulphate), 4 pounds; unslaked hot lime, 4 pounds; water, 50 gallons. This is known as a 4-4-50 mixture. The best

way to prepare home-made bordeaux is to dissolve the blue vitriol in 25 gallons of water. The chemical dissolves quickest if suspended in a sack at the top of the barrel or tank holding the water. Slack the 4 pounds of lime in just enough water to slack it well and mix with 25 gallons of water. Pour simultaneously the 25 gallons of blue vitriol solution and the 25 gallons of lime solution into a third barrel or tank. This insures thoro mixing and gives an excellent suspension of the small lime particles.

For convenience, the following method can be used in making home-made Bordeaux. This method results in about as good a mixture as the one just described. The blue vitriol is dissolved in 40 gallons of water the same as described in the above method. The lump lime is slacked in a small quantity of water and poured into the blue vitriol solution. Then enough water is added to bring the liquid up to 50 gallons.

b. Dry Bordeaux.—This is a commercial preparation of lime and blue vitriol. It is dissolved in water direct from the package. Directions for mixing are found on the container. Dry bordeaux is very useful for gardens where but a small amount of spray is needed.

3. AMMONIACAL COPPER CARBONATE.—Bordeaux mixture discolors the leaves; therefore ammoniacal copper carbonate is recommended in its place, since it will not remain on the foliage. This fungicide is very strong and should always be tested on a few plants.

Ammoniacal copper carbonate is prepared as follows:

Copper carbonate.....	6 ounces
Ammonia (26° Baume).....	3 pints
Water	50 gallons

The ammonia is diluted with about 2 gallons of water and the copper carbonate is made into a paste with a small quantity of water. These two are mixed and enough water added to make 50 gallons. This fungicide loses its strength rapidly and should be used immediately.

4. POTASSIUM SULPHIDE.—This chemical is effective in controlling the powdery mildews, altho it is not as effective as copper sprays for other fungi. It is prepared in the following proportions:

Potassium sulphide.....	3 ounces
Water	10 gallons

The spray should be prepared fresh each time it is to be

used. In the greenhouse a weaker mixture should be used, as the above strength tends to burn the young leaves.

5. SULFUR. (a) Flowers of Sulfur.—This is the ordinary yellow sulfur obtainable at any drug store. It is a very effective fungicide, being particularly useful for the powdery mildews. It should be dusted on in the early morning when dew is present.

(b) Atomic Sulfur.—This is a commercial preparation, more finely powdered than the flowers of sulfur, and is also more effective. It may be mixed with water and used as a spray, as well as in the dust form. This dust is so fine that it tends to lump and clog without a filler. When lime is mixed with sulfur as a filler the proportion varies from 50 to 90 percent sulfur, depending on the severity of the disease.

(c) Sulfur Plus Five Percent Potassium Permanganate.—Recent work on sulfur as a dust has shown that the addition of 5 percent potassium permanganate will hasten the action of the fungicide. While this mixture has not been tried on ornamental plants, it is mentioned as a possible dust for controlling mildews and some rusts.

6. SPREADERS.—Frequently fungicidal sprays do not stick well to plant leaves, but tend to collect in drops and run off. Several materials are useful to hold the spray on the leaves. These spreaders or stickers also tend to make the spray film thinner and are economical to use. Moreover, they hold the spray on the leaves for a longer time and prevent washing off by rain.

Common laundry soap shaved up and dissolved in spray solution makes an effective sticker. Skim milk has a similar effect. Commercial preparations of casein are also very effective as spreaders. Rosin and fish-oil soap are also boiled together and used as a sticker for fungicides.

NOTE: The approximate prices on the above-mentioned substances are listed below:

Copper sulphate.....	\$0.15	per	pound
Dry Bordeaux.....	.20	"	"
Corrosive sublimate.....	2.70	"	"
Formaldehyde24	"	"
Sulfur—flowers10	"	"
Rolled06	"	"
Precipitated35	"	"
Fish-oil soap.....	.25	"	"
Rosin15	"	"
Kaso (commercial casein preparation)20	"	"

DIRECTIONS FOR SENDING PLANTS FOR IDENTIFICATION

1. Send plenty of material. Send roots, stems and leaves of a diseased plant. It is difficult to properly identify a disease in many cases from fragments of a plant.

2. When sending soft-tissue plants, press out the leaves and wrap in oiled paper or moist newspaper, and then heavy dry wrapping paper, or put in a box. Mail as soon after gathering as possible.

In this way plants will arrive in good condition. Do not crowd a wad of the plant into an envelope for sending. Such material always arrives in poor condition and it is difficult or even impossible to identify.

3. When sending specimens of woody plants, collect material which shows not only the diseased portion, but adjacent healthy parts.

4. Send all material to:

Department of Botany,
Colorado Agricultural College,
Fort Collins, Colorado.