PLANT DISEASES IN A HOME GARDEN.[1]

E. B. MAINS, Purdue Agricultural Experiment Station.

The culture of flowering plants offers varied attractions. To some, it is the esthetic, the harmonious combination of form and color. To the collector, it is the multitude of varieties and species which he is able to bring together. To the culturist, it is the challenge of his skill, the discovery of the needs of various plants and their successful culture. To the breeder it is the possibilities for improvement by the combination of qualities through hybridization and selection. Often these interests are combined to a more or less extent. Usually, however, the diseases of plants awaken no interest other than that demanded by the necessity for their control. To a plant pathologist, however, the disease itself is of great interest. While he has the control of disease as the end in view, at the same time he is interested in the cause of the disease, the effect produced, the effect of environment conditions on its development, all problems challenging his curiosity and ingenuity and having important bearing on control.

It thus happens that the writer, as a pathologist, has an added interest in his flower gardening. While the gardener's interest has for the most part predominated, those of a pathologist have played a part, resulting in some observations which may be of interest to both gardeners and pathologists.

The following observations were made, for the most part, during 1926 and 1927 in a small garden, approximately 60 by 75 feet, in West Lafayette, Ind. This garden was started in the fall of 1925 so that there was no accumulation of diseases as might result in an older garden. Only the precautions against disease taken by the average gardener were practised. The situation, therefore, was similar to that which might occur in almost any small home garden.

CHINA ASTERS, *Callistephus chinensis*

Yellows. This disease was very abundant on China asters in 1924 resulting in a number of plants showing a shortening of the flower stalk, contortion and yellowing of the upper leaves, excessive branching and malformation of the flower heads. Plants of a species of Erigeron showed similar symptoms, and were probably the source of the disease. Kunkel[2] has shown that this disease, which is caused by a virus, winters over in biennial species of such genera as Erigeron, Sonchus, Chrysanthemum, Asclepias, Plantago, from which the virus is spread to asters

[1]Contribution from the Department of Botany, Purdue University Agricultural Experiment Station.

[2] Kunkel, L. O. Studies on Aster Yellows. Am. Jour. Bot. 13:646-705. 1926.

by leaf hoppers. He found no evidence of seed carriage. When this disease is present it is usually very serious, not only affecting the appearance of the plant but greatly reducing the blossoming. Kunkel recommends the removal and destruction of all weed hosts and diseased asters and spraying or dusting of healthy plants with nicotine or other insecticides to kill leaf hoppers.

Wilt. A slight wilting of asters was noted in the summer of 1924. A few blossoming plants showed a wilting of the lower leaves. There was a longitudinal brown streaking of the stems of such plants. The wilt progressed upward until the plants were dead. This disease is caused by *Fusarium conglutinans* var. *Callistephi.* It can persist in the soil for a number of years. Gloyer[3] states that the disease is seed carried. Jackson[4] recommends treating the seed with mercuric chloride 1:1000. Soil for seedling beds should either be steam sterilized or treated with mercuric chloride 1:1000 or formaldehyde 1:50. Mercuric chloride 1:2000 (*l.c.* 3) used on beds of seedlings showing infection, was found to check the disease. All diseased plants should be removed and destroyed and the beds should be soaked with formalin 1:50 to a depth of 10 inches before planting with asters again (*l.c.* 4).

Rust. The Rust of China asters, *Coleosporium Solidaginis,* was noted in 1925, 1926, and 1927. It appeared rather late in the season, usually in September. No very serious damage has been noted. It,

Fig. 1.—The rust of China asters, *Colcosporium Solidaginis.*

[3] Gloyer, W. O. Fungous Diseases of the China Aster. (Abstract) Phytopath 14:64. 1924.

[4] Jackson, A. B. The Fusarium Wilt of China Asters. Sci. Agr. 7:233-247. 1927.

however, affects the appearance of the plants, covering the leaves with the orange uredinia (fig. 1) and causing heavily infected leaves to turn yellow and die, a condition very undesirable for an ornamental.

This species of rust has been shown to live over winter on perennial species of Solidago (5, 6) and probably spreads from Solidago and wild asters to China aster.

Apparently differences in the susceptibility of China asters to this disease occur. A strain of Comet yellow was noted showing only a trace of the rust while the lower leaves of the surrounding plants were yellow. It is probable that resistant strains of asters can be developed by proper selection. Judging by the results obtained with other rusts this disease can probably also be controlled by dusting with sulphur.

BUTTERCUP, *Ranunculus septentrionalis*

Leaf Spot. A leaf spot caused by *Didymaria didymia* was very abundant during August and September on *Ranunculus septentrionalis*. The leaves showed many angular brown spots covered on the lower side with the white mass of conidiophores. The infection was so severe that many of the leaves were killed. Plants of *R. acris* and *R. repens* var. *flore pleno*, growing intermingled with the diseased plants of *R. septentrionalis*, showed no signs of disease.

DELPHINIUM.

Powdery Mildew. The powdery mildew of Delphinium, *Erysiphe polygoni*, developed to a slight extent during the late summer of 1927. Other than a slight mildewing of the lower leaves it caused no damage. It can be controlled by dusting with sulphur.

GLADIOLUS.

Scab. This very prevalent disease of Gladiolus, due to *Bacillus marginatus*, was noted during the summer of 1927 in the varieties Mrs. Frank Pendleton, Crimson Glow and America. It was severe on only a few plants. The infection first appeared on the leaves as reddish spots in early summer. As these spots enlarged, they became darker. With the death of the leaf bases, the leaves turned brown and the plants broke over without forming flower spikes. The corms of the infected plants showed a few dark brown pits from which the disease derives its name. The corms from infected plants were much smaller and produced very few bulblets. Miss McCulloch[7] recommends the treatment of diseased corms before planting with either mercuric chloride (1:1000) or formalin (1:80). The corms should first be soaked in water for 15 minutes and then allowed to stand for several hours in a moist condition

[5] Mains, E. B. The Wintering of *Colcosporium Solidaginis*. Phytopath. 6:371-372. 1916.

[6] Clinton, G. P. Report of the Botanist for 1907. *Colcosporium Solidaginis* Conn. Agr. Exp. Sta. Rep. 1907. pt. 6. 375-380. 1908.

[7] McCulloch, Lucia. A Leaf and Corm Disease of Gladioli Caused by *Bacterium marginatum*. Jour. Agr. Res. 29:159-177. 1924.

to soften the bacterial exudate. They should then be soaked for one-half hour in the mercuric chloride or formalin solution. They can either be planted at once or allowed to dry and planted later.

GOURD, *Curcurbita* sp.

Mosaic. In the spring of 1927 a packet of mixed gourds was planted along a boundary fence. While they were still small, mosaic appeared and spread rapidly, killing most of the plants before they were six inches high. A few reached a length of three feet but showed the typical mottling of mosaic diseases. Only a few flowers developed on these vines and no fruits were formed.

HOLLYHOCK, *Althaea rosea*

Cercospora Spot. The leaf spot of hollyhocks caused by *Cercospora althaeina* was prevalent during 1926 and 1927. It caused a brown angular leaf spot about one-eighth to one-quarter of an inch in diameter (fig. 2). No serious damage resulted, although heavily infected leaves

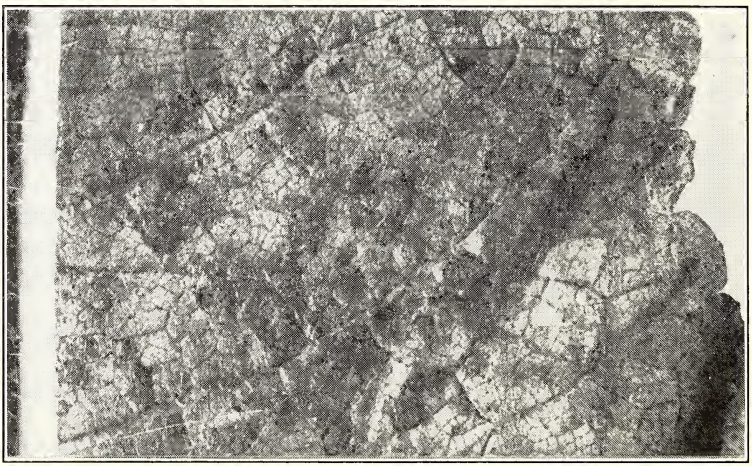

Fig. 2—Leaf spot of hollyhocks showing the brown angular areas produced by *Cercospora althaeina.*

turned brown and died. The spotting, however, is an undesirable condition for an ornamental. While most of the plants showed heavy infection on the lower leaves, two plants among them showed only a slight infection. Probably resistant strains can be developed by proper selection.

Rust. Although the rust of hollyhocks, *Puccinia Malvacearum,* has been noted in West Lafayette for a number of years, it first appeared in the writer's garden in the spring of 1927. Judging from the inquiries which have been received from over the state, this season has been very

favorable for the development of this disease, being for the most part unusually cool and wet. By June a number of the plants in the writer's garden were so severely rusted that many of the lower leaves were killed and the upper ones covered with the dark brown cushion shaped telia which turned white following the germination of the spores. During July and August there was a moderate development of the rust. With the hot weather of early September it was greatly retarded, the new leaves being relatively free. With the return of cool weather the disease again developed rapidly and by the end of October the older leaves of susceptible plants were covered with telia. Several plants, however, were very noticeable on account of their freedom from rust, (fig. 3), although

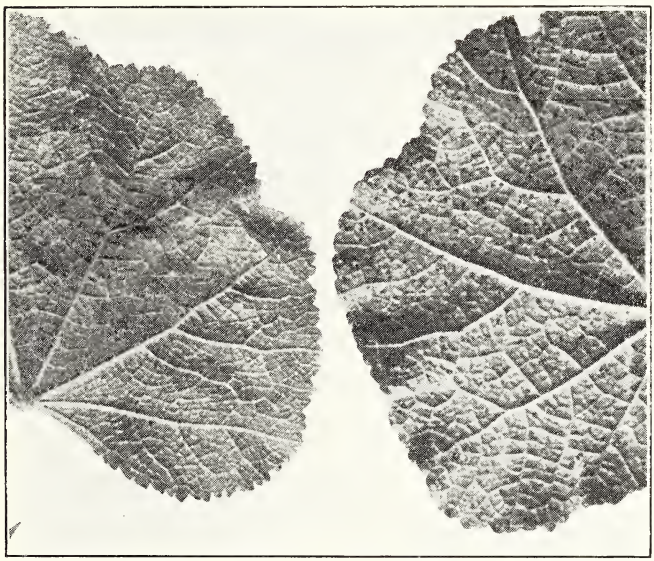

Fig. 3—Differences in susceptibility to hollyhock rust, *Puccinia Malvacearum*, the leaf to the right from a heavily rusted plant, the leaf to left from an adjacent slightly rusted plant.

surrounded by heavily rusted plants. By proper selection resistant lines can probably be developed. The rust has been shown to overwinter on the hollyhock plants and it is well to collect and destroy the old rusted leaves in late fall or very early spring. Dusting with sulphur should be effective in helping to control this disease.

IRIS

Leaf Spot. During 1926 and 1927 the leaf spot, *Didymellina Iridis (Heterosporium gracile)* has been the most prevalent disease of iris in the writer's garden. It first appeared following flowering as scattered spots varying from one-fourth to three-fourths of an inch in diameter. The center at first is light colored, later showing black condiophores and

a brown encircling ring (figs. 4 and 5). This disease not only makes the plants unsightly during the summer and fall but it must also considerably weaken susceptible varieties if they are defoliated for several years in succession.

There are evidently considerable differences in susceptibility between varieties. The most susceptible varieties showed a rapid development of

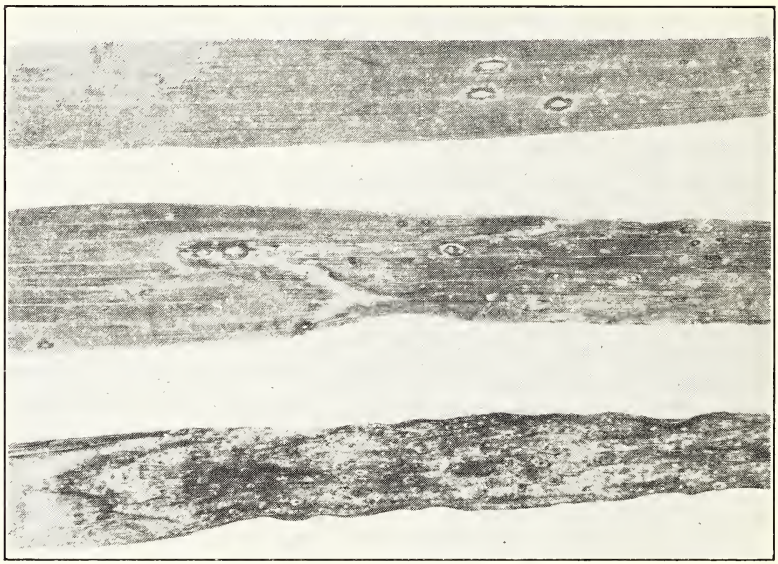

Fig. 4—The leaf spot of Iris, *Didymellina Iridis*, showing different stages of infection from a few diseased spots at the top to a leaf almost completely killed at the bottom.

Fig. 5—Leaf spot of Iris showing the light colored center with black condiophores.

the disease. The spots were large and abundant and the leaves were mostly killed by the last of August or September. Moderately susceptible varieties showed a slower development of the disease, oftentimes only the upper half of the leaves being killed by September. The slightly susceptible varieties showed very little development of the disease, the leaves, except for a few spots, remaining green. Some of the species of iris were extremely resistant, showing no effect whatever. Among the varieties of iris the following showed heavy infection (Fig. 6): Mrs. Neubronner, Iris King, Mrs. Darwin, Lent. A. Williamson, May Queen, Nine Wells, White Knight, Beethoven, Gypsy Queen, Perfection, Honorabile, Blue Boy, Sherwin Wright, Storm Cloud, Mary Garden.

The following showed moderate infection: Loreley, Dr. Bernice, James Boyd, Her Majesty, Mithras, Blue Jay, Queen Alexandra, Quaker Lady, Parc de Neuilly, Carthusian, Albert Victor, Purple King, Madame Chereau, Jacquesiana, Flavescens, Aurea, Rhein Nixe, Parisiana, Lohengrin, Celeste.

The following showed only a slight infection (fig. 6): Amas, Albicans, Juniata, Violacea grandiflora, Caprice, Monsignor, Fairy, Pallida dalmatica, Florentina alba, Ballerine, Georgia, Queen Caterina, Powhatan.

Fig. 6—Differences in susceptibility of Iris varieties to leaf spot. To the left a plant of the variety, Mary Garden, with leaves almost completely killed; to the right, Fairy, showing only a slight infection.

Of the Iris species *I. dichotoma* was heavily infected and *I. tectorum* moderately infected while *I. versicolor*, *I. halophila* and *I. pumila cyanea* showed only a slight infection. The species *I. siberica*, *I. fulva*, *I. pseudacorus*, *I. xiphium*, *I. xiphioides*, *I. Kaempferi*, *I. lacustris* and the variety Dorothea K. Williamson, a cross between *I. fulva* and *I. foliosa*, showed no infection.

Some writers[8] consider that this disease is favored by poor conditions of growth and recommend treatment with lime and phosphates to increase the vigor of the plant. The fungus lives over winter on the dead iris leaves and Tisdale[9] has found that the removal of the dead leaves in early spring was very effective in checking this disease.

[8] Hoare, A. H. Iris Diseases. Jour. Min. Agr. **32**:454-458. 1925.

[9] Tisdale, W. B. Iris Leaf Spot Caused by *Didymellina Iridis* Phytopath. **10**:148-163 1920.

Soft Rot. In both 1926 and 1927, soft rot was very troublesome on a few varieties. This disease which is apparently due to *Bacillus carotovorus*[10] attacks the rhizomes, flower stalks and leaves, reducing them to a pulpy, ill-smelling mass. It has been most prevalent about flowering time and was especially severe on the varieties Queen Caterina and Quaker Lady. The disease may be considerably retarded by soaking soil and rhizomes with organic mercury compounds as soon as infection is noted. If the disease has gained considerable headway it is best to dig the plants, clean away the decayed portion, soak in mercury compounds or with a pink solution of potassium permanganate and reset in a new location.

Sclerotial Rot. Another rot of the rhizomes and leaf bases is caused by a species of Sclerotium. During the summer of 1927 the variety Pallida dalmatica showed infection. The rhizomes and leaf bases are covered with a white mass of mycelium which produces abundant light brown sclerotia (fig. 7).

Fig. 7—Sclerotial rot of Iris showing the dead leaf bases with mycelium and sclerotia of the fungus.

GOLDEN-BANDED LILY, *Lilium auratum*

Botrytis Blight. In the spring of 1926, two stalks of *Lilium auratum* showed a blight which resulted in the rapid dying of leaves and stalk, apparently caused by a species of Botrytis. Since it was evident that the disease would follow the stem down into the bulbs, the plants were dug and the stalks cut off. The bulbs were then dusted with sulphur and reset in another location. Although the bulbs were unable to store much

[10] Richardson, J. K. A Study of Soft Rot of Iris. Ann. Rep. Quebec Soc. Prot. Plants 15:105-120. 1923.

food in 1926, they each produced a short flower stalk with three well developed flowers in 1927 and showed no signs of disease. A plant of *L. tenuifolium* showed a similar infection in 1927. This was not treated and when dug in the fall the bulb of the infected plant was found to be rotted.

PEONY, *Paeonia spp.*

Blight. During the spring of 1927, a blight of peony due to *Botrytis Paeoniae* was responsible for the blasting of a few buds.

Leaf Spot. A leaf spot due to *Phyllosticta commonsii* was noted during the late summer of 1927. It caused very little damage other than the effect on the appearance of the plants.

PETUNIA

Mosaic. Among a number of plants of giant ruffled petunia purchased in the spring of 1927, several showed the mottled and contorted leaves, characteristic of mosaic diseases. These all died before midsummer.

HARDY PINK, *Dianthus Allwoodii*

Anthracnose. About the middle of the summer of 1927, several plants of *Dianthus Allwoodii* showed a yellowing of the leaves of some of the lower branches. As the disease progressed the lower branches died and the leaves of upper branches turned yellow. Fruiting bodies of *Volutella Dianthi* (fig. 8) appeared upon the dying branches. The disease was also noted slightly infecting a plant of *D. Caesius*, Cheddar Pink.

Fig. 8—Anthracnose of pinks, *Volutella Dianthi*, showing the fruiting bodies of the fungus on a dying stem.

ROSES, *Rosa spp.*

Black Spot. This disease caused by *Diplocarpon Rosae (Actinonema Rosae)*, appeared as black spots on the leaves of some hybrid teas. Besides the unsightly appearance caused by the spotted foliage considerable damage may occur on account of the defoliation which results. The fungus lives over winter in the fallen leaves so that it is important that all infected leaves should be gathered and destroyed. For the control of this disease, Massey[11] recommends dusting with sulphur at weekly intervals, starting as soon as the first leaves are well out.

Powdery Mildew. This common mildew of roses, *Sphaerotheca pannosa rosae*, was severe on the variety Dorothy Perkins in the fall of 1927. The leaves were covered with the white powdery mat of mycelium and conidiophores. Many of the leaves were contorted and variously deformed and some of the young growing tips were covered with the fungus. While the plants were not noticeably injured they were unsightly. Dusting with sulphur as soon as the disease appears will prevent its development.

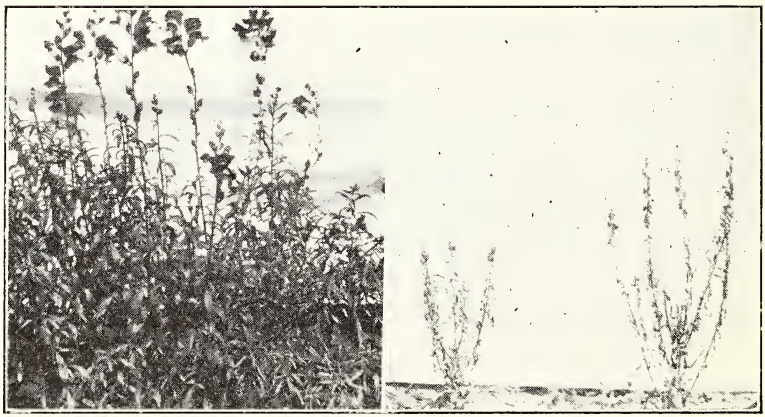

Fig. 9—Control of snapdragon rust by sulphur. Plants at left were dusted with sulphur and are free from the disease. At right, plants not dusted and killed by the rust.

SNAPDRAGON, *Antirrhinum majus*

Rust. For a number of years snapdragon rust, *Puccinia Antirrhini*, has been more or less prevalent in the garden. It has usually appeared about midsummer, apparently being blown from infected plots of a nearby florist. The rust infects the leaves, producing large dark brown, powdery uredinia on the lower surface and causing their premature death. On the stems, it produces large uredinia and oftentimes girdles the stem, causing the death of the upper portion. In cases of severe infection the plants may be entirely killed early in the season.

[11] Massey, L. M. Black-Spot and Mildew of Roses. Am. Rose Ann. **1922**:77-86.

The rust may occasionally overwinter in the uredinial stage if the infected host remains alive. In this locality, this very seldom occurs. Such plants should be destroyed. The rust is apparently heteroecious[12] and the alternate host probably does not occur in this region, so that the teliospores are probably functionless. If plants are started from seed there is little or no chance of this disease unless the rust is carried over winter in the uredinial stage either on overwintering plants outdoors or in greenhouses. There is some evidence that this disease may be controlled by resistant selections.[13] Dusting with sulphur (fig. 9) is also a very effective means for the control of this rust (*l.c.* 13).[14]

STAR OF BETHLEHEM, *Ornithogalum umbellatum*

Rust. Star of Bethlehem may serve as the aecial host of the barley leaf rust, *Puccinia anomala*.[15] When some plants of Star of Bethlehem were covered during the winter of 1926-1927, with barley straw bearing telia of this rust, aecia were produced on the young leaves in the spring. This rust will occur only when leaf-rusted barley straw is in the vicinity.

In 1925 another rust was discovered on Star of Bethlehem under very interesting circumstances. In the fall of 1924 an order of bulbs of Glory-of-the-Snow and Snowdrops were planted together. In the spring of 1925, Mrs. Mains called my attention to a rust on one plant which appeared to differ from the rest. This proved to be *Ornithogalum umbellatum* and the rust was found to be *Puccinia Liliacearum*. As far as I can determine this rust has never been noted before in North America. It occurs rather commonly in Europe. The rust is autoecious producing only teliospores which reinfect the Ornithogalum in the spring, and probably occurred on some leaf parts adhering to the bulb and was thus brought into this country from Holland. The infected plant has been watched for two years but the rust did not reappear and apparently has died out.

SWEETPEAS, *Lathyrus odoratus*

Black Root Rot. In the spring of 1926, attention was attracted to a few plants of sweetpeas which showed a stunting and considerable yellowing. An examination of the roots showed a black rotted condition. This was caused by *Thielovia basicola*.

Powdery Mildew. Powdery mildew, *Erysiphe Polygoni*, was prevalent on sweetpeas during the summers of 1926 and 1927. In late summer the foliage was covered with the white mycelium and spores and

[12] Mains, E. B. Notes on the Life-History of the Snapdragon Rust, *Puccinia Antirrhini*. Phytopath. 6:281-287. 1924.

[13] Mains, E. B. and Thompson, Dorothy, Snapdragon Rust. *Puccinia Antirrhini* (Abstract) Phytopath. 18: Jan. 1928.

[14] Butler, O. Experiments on the Field Control of Snapdragon Rust together with a Description of a Method for the Control of the Disease in the Greenhouses. N. Hamp. Agr. Exp. Sta., Tech. Bull. 22. 1923.

[15] Mains, E. B. and Jackson, H. S. Aecial Stages of the Leaf Rusts of Rye, *Puccinia dispersa*, and of Barley, *P. anomala*, in the United States. Jour. Agr. Res. 28:1119-1126. 1924.

many of the leaves turned yellow and fell off. Dusting with sulphur is a control for this disease.

TULIPS, *Tulipa spp.*

Botrytis Blight. Although we have been growing tulips for the past six years, practically no trouble was experienced until the spring of 1926. In 1926 and again in 1927 the botrytis blight, caused by *Botrytis Tulipae,* was severe. Both seasons were very wet and this probably accounted for the severity of the disease. Practically all parts of the plant may be affected. The disease first appears as small yellowish spots on the leaves which as they enlarge become reddish brown and finally covered by a gray mass of conidiophores. The flowers are somewhat similarly affected. When the infection appears early the flower buds are often blasted. On the bulb yellow or brown lesions are produced on the outer white bulb scale beneath the outer brown coating. Small black sclerotia are often produced on this outer covering. While all the varieties in the garden showed some infection, the varieties Picotee, Gesneriana ixioides, Cardinal Manning, La Merveille, William Pitt, Vermillion Brilliant, and Mon Tresor were the most severely infected, Pride of Haarlam, Mr. Farncombe Sanders, Mrs. Moon, Clara Butt, Lucifer, Golden Bronze, Orange King, Flamingo, showing only a moderate to slight amount of infection.

The studies of Hopkins[16] indicate that *Botrytis Tulipae* is specific to tulips. The disease is probably introduced with infected bulbs. The plants developing from these in the spring produce spores which infect neighboring plants. Hopkins recommends the removal and destruction of diseased plants as soon as they appear to avoid the secondary spread to healthy plants.

Diseases of Unknown Cause. A number of other plants were diseased but time was not available for a determination of the causes. In 1926 practically all the plants of Clarkia and Godetia were killed. Several plants of St. Brigids Anemone were killed by a root rot. In the seedling beds both in 1926 and 1927 nearly all of the seedlings of Perennial Flax, Iceland Poppy and Primrose damped off. In the late summer of 1926 several plants of the Yellow Ladyslipper were heavily infected with a leaf spot. Following hot weather in September, 1927, a number of the flower buds of dahlia were blasted (Fig. 10) whether by the hot weather or due to a fungus disease was not determined. A Penicillium was isolated but this was probably secondary. A number of leaf spots of peony, delphinium, lily of the valley were present to a slight extent. Doubtless if an intensive survey had been made a number of others would have been found. It is evident that there is no shortage of pathological problems when this number of diseases occur in such a small area.

While most of the diseases mentioned are apparently of minor importance as far as the effect on the development of the host is con-

[16] Hopkins, E. T. The Botrytis Blight of Tulips. Cornell Agr. Exp. Sta., Mem. 45. 1921.

cerned they are all undesirable in an ornamental garden since they are unsightly. Each, of course, presents a problem in itself. On account of the more pressing economic problems engaging public funds, most of the minor diseases will probably not receive much attention for some time. Those who are particularly interested in the lesser grown ornamentals should attempt to solve some of these problems themselves.

The eradication of a disease may not always be the best in the long run. The process may have to be continuously repeated. If there is

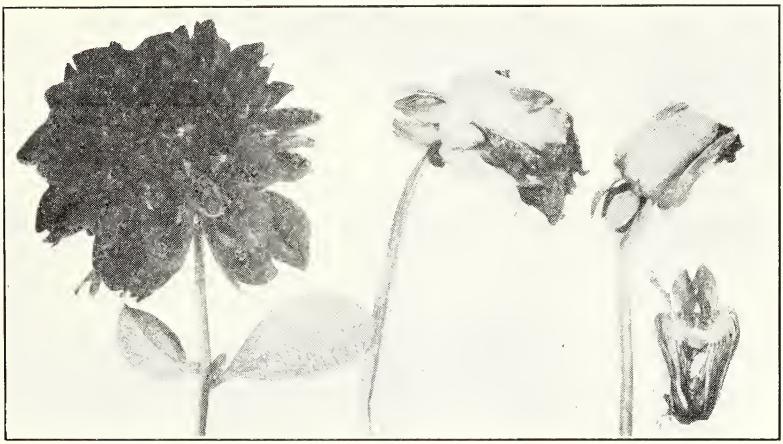

Fig. 10—Blighted buds of dahlia following hot weather in September. The flower to the left from a late bud. The blasted heads to the right from early buds which never opened.

any evidence of differences in susceptibility to a disease, the plants which survive may be of considerable importance. From such plants it may be possible to breed varieties resistant to the disease. To do so successfully the disease must be present in a severe form for a number of generations in order that the susceptible individuals may be eliminated. As Prof. L. R. Jones[17] has stated: "Disease resistant plants are all about us awaiting detection. Variations as to relative susceptibility, or conversely, as to relative resistance to disease, occur as commonly as do variations in other characteristics." In the two years of observation noted above there is evidence of resistance of hollyhocks to rust and Cercospora, Asters to rust and Iris to leaf spot. Professor Jones points out that in the development of our cultivated plants, the amateur has played a large part and that it is the amateur breeder, stimulated by the satisfaction of accomplishment rather than hope of financial rewards, upon whom the burden of plant improvement by disease resistance will fall. This is especially true in connection with our lesser grown flowering plants and many of these lend themselves to the limited space of the home gardener.

[17] Jones, L. R. Securing Disease Resistant Plants. How Important Is It? Whose Job Is It? Science 63:341-345. 1926.