ing tips of the plants will be damaged. The plants and fruit are then more susceptible to diseases.

The nutrient solution should be allowed to rise to within one inch of the surface of the gravel. This allows the surface to remain dry, preventing growth of algae over the surface and reducing evaporation, and diseases. The pumping cycle should not take more than 45 to 60 minutes.

It is often believed that plants growing in hydroponics are not attacked by insects or affected by fungus or virus diseases. This is far from true. Because of the concentration of plants and the continuous production of crops within this small area, diseases and insects build up in number rapidly if precautions are not taken. Most plants need to be sprayed or dusted at least once per week and during climatic conditions favorable for diseases and insects twice per week may be required to keep them under control. Sprays should be used with care because of the danger of toxicity to the root systems of the plants. Filling the beds with water just prior to the spray operation and immediately draining following the spray application sometimes helps to reduce the root injury.

The most important factor in the control of disease is sanitation. Sanitation is the elimination of sources of contamination from around the plants, the walk-ways and the vicinity of the installation. The removal of diseased plants, control of weeds in the gravel beds and walk-ways, the removal of all refuse from within and around the installation greatly decreases the sources of infections. If virus diseases are present the workers handling the plants should wash their hands in alcohol after handling any plant suspected of having virus. It would be best to wash with a dilute solution of alcohol after handling three or four plants when virus infections are present in the garden for it takes two or three weeks for the symptoms to become apparent after the plant is infected.

When crops are grown for extended periods in one area, soil-borne organisms accumulate in the gravel. Sometimes several crops may be grown before these conditions become serious but usually the build-up has reached serious proportions by the end of one crop. Chemical sterilization of the gravel beds and the walk-ways is used to eliminate these diseases and prevent a carry-over to the next crop. Several methods can be used which will give excellent control of many of the common soil-borne diseases.

It must be emphasized that some technical training and considerable experience are necessary for the commercial production of crops in hydroponics. Successful use of the methods requires the same general knowledge of the various phases of plant production that is necessary for growing plants in soil plus those phases that are peculiar to the hydroponic garden. Its use is confined to production of crops high in return, such as certain ornamentals (roses, carnations, and chrysanthemums), out of season vegetables (tomatoes, cucumbers), and seedlings for transplanting. Under favorable conditions yields may be expected to surpass yields in the soil, especially here in Florida.

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STROMATINIA DISEASE OF GLADIOLUS

ROBERT O. MAGIE
Bradenton
Gulf Coast Experiment Station

Dry rot of gladiolus, caused by *Stromatinia gladioli* (Drayt.) Whet., is widely distributed where gladiolus are grown and is one of the major diseases of the crop. The disease is believed to have occurred in Holland and in the United States since 1906 or earlier (2). All varieties appear to be susceptible, although some are more susceptible than others. The

fungus causes a rotting of the neck or stalk, a dry rot of corms and a rotting of the roots. Dry rot of corms is the important phase of the disease in western Washington and in some other northern states but in peninsular Florida corm infection is usually limited to surface lesions. The neck rot phase has occurred sporadically along the Gulf Coast of Florida since 1940 and was the only phase of the disease recognized in the State until recently.

The rotting of roots was observed in Florida and elsewhere (4, 10) but no special significance or importance apparently was attached to this phase of the disease until 1954 when severe root injury was found in fields *where neck rot* was scarce or absent. A large acreage on the Gulf Coast was ruined by Stromatinia root rot in that year. The finding of sclerotia on the rotted roots made identification of the root trouble relatively simple. This is the first report of the production of sclerotia in gladiolus roots.

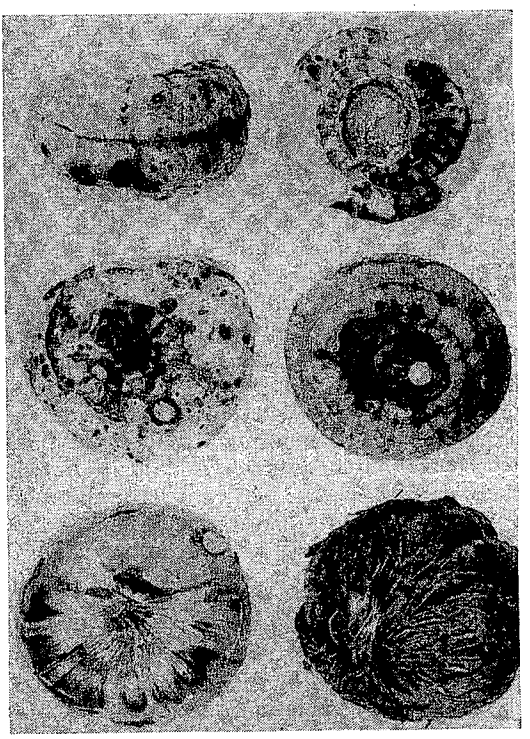

Figure 1. Stromatinia dry rot. (Upper four corms)—Small, reddish-brown and larger brown to black lesions; often found to be most numerous along lines of husk attachment and on upper surface of corm. (Lower left)—Tobacco-brown, oval stains on inner husks. (Lower right)—Dark brown, shredded husks are typical of Stromatinia disease.

Disease Symptoms

On corm.—Most of the lesions on infected corms develop after harvest and during storage. The spots are small, round, reddish-brown and slightly raised at first. As they grow in size, the centers become sunken and dark brown to gray or black in color, with well-defined edges slightly raised and lighter in color (Fig. 1). Several small spots may fuse and produce a large irregular black lesion. These lesions are usually found along the lines of husk attachment and are most numerous on the upper parts of corms. The smaller spots can be lifted out easily, leaving a shallow, clean depression.

On husk.—After being held in storage for several weeks the husks of infected corms become dull and dark-colored in comparison with healthy corms. Typically, husk lesions appear as oval brown stains (Fig. 1). Severely infected husks become brittle and shredded, especially at the top. Only after the husks are removed can the corm lesions usually be seen.

Neck rot.—Young plants from small corms are killed to a greater extent than older plants and plants from large corms. Leaf symptoms of infected plants resemble those of Fusarium yellows. As with the latter disease, the older or outer leaves yellow and die first, followed by the younger leaves. Unlike the Fusarium disease, though, the corm is found to be sound. Plants are often attacked in groups, especially when grown from cormels and planting stocks. Typically, the middle plant of a group is dead and on either side the symptoms grade up through more recently infected plants to the healthy plants. The rotted neck tissue is at first light brown and has a sharp, musty odor. A gray to white mold is seen between the infected leaf sheaths which tend to be glued together. Later, the rotted tissue becomes dark brown and the neck shrinks or becomes shredded and pulls away from the corm easily.

Infected roots turn brown and the cortex (bark) sloughs off readily, leaving the tough woody core which is typically light-colored and apparently unaffected by the disease. The very small, pimple-like, black sclerotia imbedded in the cortex of dead roots indicate that the roots were killed by the Stromatinia fungus. When the plant is pulled up, the only part of the root that usually retains the

cortex is that near the corm. That is the part to examine for sclerotia.

Sclerotia are produced abundantly in the rotted leaf bases, in the neck region and in the roots. Occasionally, they are also found in diseased corm and husk tissues. Sclerotia are resting bodies of the fungus and are capable of withstanding prolonged periods of unfavorable conditions in the soil. Nelson (10) reports an instance of the fungus living in the soil for ten years in the absence of gladiolus.

Disease Spread and Initiation of Infection

Corms which appear to be free of infections may carry the fungus to the soil. Only one or two plantings of gladiolus are required to develop a soil infestation sufficient to ruin the next crop under certain weather conditions. Such a development has occurred in the absence of neck rot or obvious corm symptoms. It is clear that enough sclerotia can be produced on the roots in one year to cause a heavy loss in the next planting.

The disease originates from infected corms as well as from sclerotia in the soil. Neck rot originating only from infected corms was found as early as September, while neck rot infections caused only by germinating sclerotia in the soil have not been seen in peninsular Florida before November or December. Tests indicate that air temperatures must be below 60° F. for several days each fall before many of the dormant sclerotia begin to germinate. Some of them germinated without the presence of host tissue.

Effect of Moisture and Temperature

Gould (4) considered moisture to be more important than temperature in the development of dry rot. Nelson (10) found dry rot to be more prevalent in heavy, poorly drained soils and in seasons of abundant rainfall. In Florida also, excessive moisture increases both neck rot and root infection. Neck rot is rare in seasons with less than normal rainfall. Root rot, however, can be severe in seasons of sub-normal rainfall because soil moisture is supplied by seep irrigation.

Massey (8) found the optimum temperature for growth of the fungus in culture to be near 77° F. Nelson (10) and Hawker et al (7) stated that warm soils increase dry rot. Observations in Florida show that the disease is most severe in cool weather and is seldom seen in spring, summer and early fall. In fact, warm weather seems to help the plants overcome the effects of the disease. A large planting of Valeria appeared to stop growing in January as a result of severe Stromatinia root rot which developed during a prolonged period of cool weather. With the onset of warm weather the plants put out new roots and produced a fair crop of flowers. In seasons with minimum temperatures above 65 to 70° F., the disease has not been a problem.

Control Measures

Crop rotation.—The most severe losses from Stromatinia neck rot and root rot on the west coast of Florida have occurred in fields planted to gladiolus the second or third time in succession. Even newly cleared land should not be planted in consecutive years. Older fields may apparently be planted to gladiolus every fourth year with relatively little danger of severe losses. During the years when gladiolus are not planted, the growth of volunteer gladiolus should be kept down by disking the field, at least during November, December and January when sclerotia are produced abundantly. Fields to be planted in winter should also be kept clear of volunteers during the fall. If infected volunteers were plowed down just before planting, the infection could spread to the young plants.

Time of planting.—It has been noted that neck rot is rare in plantings that flower before cool weather and in plantings made after January 1. If the soil or corms are infested, plantings should be made before September 1 or after January 1. Corms harvested from contaminated land should be planted on contaminated or questionable land rather than on soil that is believed to be free of the fungus.

Soil moisture.—It has been shown (7) that the fungus grows through wet soil at a greater rate than through moderately dry soil. This agrees with the observation that root rot is more severe at the lower end of a field. Therefore, plantings made in October, November and December should be kept somewhat on the dry side. The use of high beds is helpful. It may also help during those months to cover the corms with as little as one-half inch of soil and to gradually hill up until the spikes begin to develop.

Corm treatment.—The failure of corm treatments to control the disease was reported by Massey (8), Moore (9), Drayton (2) and

Forsberg (3). Nelson (10) and Gould (4, 5) reported fair to good control with pre-planting treatments including calomel, yellow oxide of mercury, phenyl mercury acetate, thiram, Dowicide B and N. I. Ceresan. All of these materials but thiram (Tersan) were found to cause plant injury in some cases. Haasis (6) treated corms shortly after harvest and reported very good control of dry rot in storage by immersing corms in a suspension of Ceresan M and fair control with Dow 9B and Dowicide B.

Gould (4) obtained erratic and inconsistent results with several materials and found thiram (Tersan) to be the most consistent. He pointed out the need of a more effective corm treatment. It has been shown in Florida that the standard, pre-planting treatment of corms (1/4% N. I. Ceresan as a 15-minute dip) failed to prevent the introduction of Stromatinia to hundreds of acres of land.

Because of its importance, the Fusarium disease must still be considered first in any corm treatment program. Fortunately, some of the materials which are most effective in Fusarium control are among the best of the dry rot controls.

Large and jumbo size corms of all varieties should be treated as outlined in either of the following schedules:

1. Cure corms with heat, if necessary, and clean them as soon after digging as possible. Wait 4 to 18 hours before soaking them 30 minutes in Dowicide B solution, 1½ lb. in 50 gallons water plus ½ cup of wetting agent such as Tergitol Dispersant TMN, Glim or Joy. (If a shorter dip is required, use 2 lbs. Dowicide B and soak corms 15 minutes). Just before planting, dip corms for 1 minute in N. I. Ceresan solution, using 1 lb. in 50 gallons with ½ cup wetting agent in order to wet the powder.

2. If not treated after digging, soak the corms for 30 minutes in Dowicide B before planting, using 3 lbs. to 50 gallons plus wetting agent. Use 4 lbs. for a 15-minute soaking. Renew solution completely once each week or oftener if loaded with trash.

Medium and small corms of all varieties should be treated as follows:

1. Cure corms quickly, using fans and heat if necessary. Clean them as soon after digging as possible and treat within 4 to 6 hours after removing the mother corms. Soak 30 minutes in one pound Dowicide B dissolved in 50 gallons water with ½ cup of wetting agent. Just before planting, dip for one minute in 1 lb. N. I. Ceresan dissolved in 50 gallons water with enough wetting agent to wet the powder.
2. If not treated after digging, soak corms 10 to 15 minutes in N. I. Ceresan, 1 lb. to 50 gallons plus wetting agent, just before planting.

Harvesting and curing.—Corms should be dug promptly when they have attained the desired size and maturity. Nelson (10) stated that rapid and thorough curing with artificial heat immediately after harvest prevented development of dry rot in storage. Gould (5) found that the degree of control obtained by the recommended curing procedures was unsatisfactory. The scarcity of corm loss due to dry rot in Florida is probably explained by the fact that the weather is usually favorable for curing corms. It is doubtful that artificial curing would help much in controlling Stromatinia disease in Florida.

Soil treatment.—Some of the best frost-protected land is seriously contaminated by Stromatinia. There is a definite and growing need of a soil treatment which will remove the risk of disease when gladiolus are grown in the usual 2 or 3 year rotation.

A satisfactory reduction of neck rot was obtained on a fine-sand soil by spreading and disking 1500 lbs. of calcium cyanamid per acre of land at least 60 days before planting. Less material would be required on heavier soils. Calcium cyanamid is dangerous to use unless corm planting is delayed until the chemical has broken down to its non-toxic by-products. Gladiolus are severely injured by one or more intermediate products of calcium cyanamid.

Discussion

Various treatments of soil and corms are being tested. It is probable that summer flooding of the land offers a means of killing the sclerotia. Treatment of corms after digging may control infections until the corms can be placed in cold storage where the 40° F. temperature suppresses further development of

the disease. A further corm treatment before planting may be necessary to obtain a coating of fungicide which will prevent growth of the fungus from the mother corm to the roots and new corm as suggested by Gould (4).

Until an effective treatment for cormels is developed, disease control will be severely handicapped. The heat treatment of cormels and planting stock developed in California by Bald and Roistacher (1) may be very helpful.

This disease is much more damaging and widespread than previously recognized and will tend to become more severe as fields and corms become more generally infested. The fact that the disease can build up to epidemic proportions after only one or two previous crops, makes this a major disease of the crop. The most important considerations in avoiding heavy losses from Stromatinia are 1) Rotate plantings so that gladiolus are planted in the same fields only once in three or four years; 2) Treat corms; 3) Avoid planting corms from "diseased" land in "new" land; 4) Plant infested corms or infested fields very early or very late in the planting season; 5) Use the minimum irrigation water necessary to produce quality spikes.

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VALUE AND LIMITATIONS OF SOIL TESTING TO THE GROWER OF ORNAMENTALS

ERNEST L. SPENCER AND S. S. WOLTZ

Gulf Coast Experiment Station

Bradenton

This paper, prepared at the request of your Chairman, is an endeavor to assist you in your thinking in regard to soil testing. To do so we give you our opinion of what soil testing, in its present state of development, can do and cannot do in guiding you in your fertilizing and liming practices. This subject is altogether too complex to deal with adequately in the few minutes that have been allotted us. All we can hope to consider is some of the more important aspects. For a more detailed discussion I might refer you to the Proceedings of the Soil Science Society of Florida (Vol. 13). This volume contains a complete account of all papers presented at a soil testing symposium held by that Society last January.

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First, let us define what is meant by soil testing. To most people soil testing means making a few simple chemical tests, and presto, we know what is present in the soil and just what we need to add to make it a perfect medium for the growth of plants. Unfortunately, as most of you growers know, life is not that simple and Mother Nature just not that cooperative.

In reality then, what is soil testing? The main objective of soil testing should be to obtain reliable data concerning the supply of available plant nutrients in the soil and the probable trend of availability over the growing season. With such data prior to and during the growing season, the specialist is in a better position to offer recommendations for fertilizing, liming and possibly spraying the crop with nutrients.

The actual chemical testing can be done in one of two ways: First, soil testing by rapid or quick tests utilizing one or more of the several commercial kits now available on the market; and second, testing by more reliable