NYSFG New York State Flower Growers
INCORPORATED
BULLETIN 201 Secretary, Charles Wilton, Prattsburg, Steuben Co., N. Y. AUG., 1962

Diseases of Geranium

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The geranium (*Pelargonium hortorum, Bailey*) is one of the major pot-plant crops grown in the United States. The production of high quality geraniums is often difficult or impossible because of the widespread occurrence of several geranium diseases. Since diseases can be and often are the limiting factor in geranium production, it is important that growers be able to recognize and correctly identify the symptoms of these diseases. This article is intended to be an aid in identifying the important geranium diseases by providing both written descriptions and photographic illustrations of their symptoms.

Published papers of several investigators have been used in preparing this article. Their work is cited at specific points in the text by reference numbers in parentheses. Several general papers (3, 5, 11 and 12), not specifically cited in the text, were also used in the preparation of this article.

BACTERIAL STEM ROT AND LEAF SPOT

One of the most serious geranium diseases is Bacterial stem rot and leaf spot caused by the bacterium *Xanthomonas pelargonii.* An excellent paper (7) on this disease was published recently by Dr. D. E. Munnecke and much of the information that follows is taken from his paper.

Two types of symptom expression occur on leaves infected with the bacterial leaf spot organism. In one case symptoms first appear as small water-soaked spots on the underside of the leaf (Fig. 1, A). After a few days, these spots become slightly sunken and well defined. These symptoms are followed by wilting (Fig. 1, B) and death of the affected leaf. The bacteria from the leaf spots may spread down the water conducting tissue in the leaf petiole into the stem and then back up to the top of the plant, eventually causing the death of the plant from the stem rot phase of the disease.

In other cases affected leaves wilt at the margins of the leaf blade and the leaf petiole initially remains turgid. Infected areas of the leaf rapidly die in angular areas bounded by the veins. This symptom is common in geranium and may be caused by several other factors. However wilting of the affected leaves is always associated with bacterial infections. The affected leaves may drop off immediately or may hang on the plant for a week or more.

The stem rot phase of this disease is often called black rot by growers. In plants attacked in this manner the water conducting tissues in stems and branches become brown to black 2 to 4 weeks after the plant is infected. At this time one or more leaves on a branch usually wilt (Fig. 2). Later the bacteria spread from the water conducting tissue located just under the cortex inward to the pith and outward to the cortex, causing a brown to black discoloration in the stem. At this stage the exterior portions of the stem are gray and dull in appearance and defoliation of the plant (Fig. 3, A) continues until only the tips of the branches have leaves. The stem rapidly blackens (Fig. 3, B) and shrivels into a dry rot leaving the stem fibers and epidermis intact but destroying the rest of the stem tissue (Fig. 4). At this time affected plants consist of almost completely defoliated, blackened branches with only a few tufts of leaves on the tips (Fig. 5). The roots are blackened but not decayed. Occasionally a plant will partially recover and produce new healthy appearing branches. However, in a few months these branches also will die.

Cuttings infected with *X. pelargonii* fail to root and slowly rot from the base upward. The leaves wilt and often show typical wilt symptoms as described previously. A few weeks after these cuttings are placed in the rooting medium the stems become a dull black-brown as with typical stem rot and the cuttings die.

Apparently most of the common commercial geranium varieties are susceptible to the stem rot phase of this disease. In greenhouse inoculations Munnecke (7) found Radio Red to be the most susceptible of the varieties he used. Pink Fiat and Olympic Red were almost as susceptible while Improved Ricard, Madam Landry, Madam Buchner, and Red Fiat were moderately susceptible. Salmon Supreme and Better Times were slightly susceptible. Tests at the Cornell Ornamentals Research Laboratory on Long Island have shown that the varieties Springfield, White, Penny, Genie and Irene are also susceptible to *X. pelargonii.*

The bacterium causing this disease is most commonly carried over in infected cuttings. Cuttings taken from stems showing obvious symptoms of the disease are almost always infected and serve as a means of infecting clean cuttings in the propagation bed. Most of these cuttings fail to root and die. However, cuttings taken from infected plants showing no obvious symptoms may also be carrying

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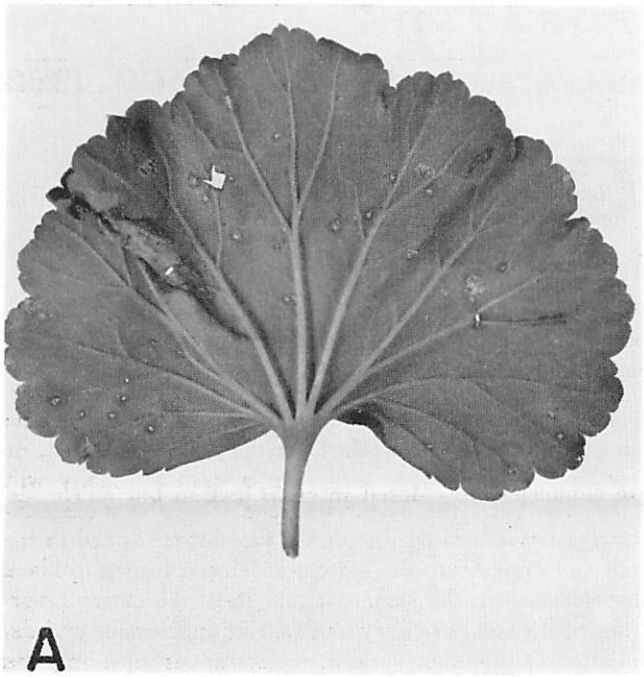


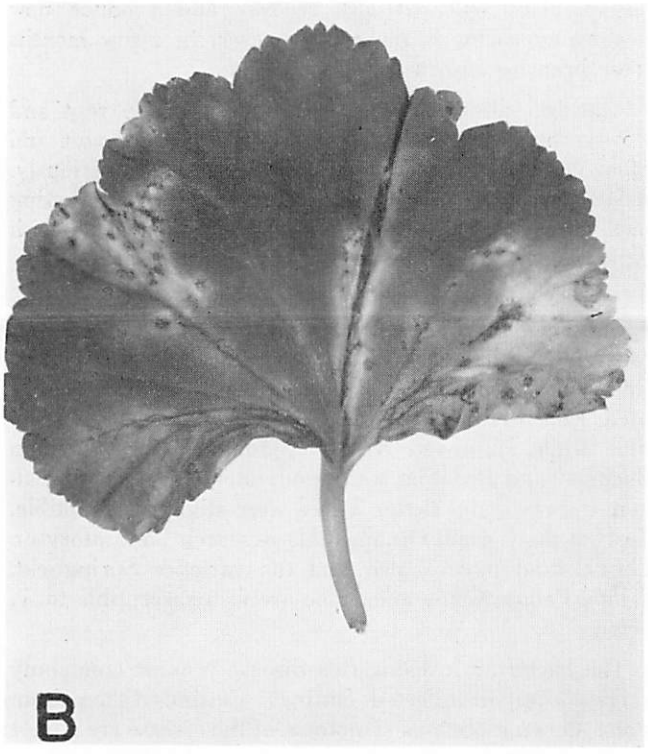


Fig. 1. Bacterial stem rot and leafspot. A) Small water-soaked spots developing on lower leaf surface. B) Later stage in development showing slightly sunken, well defined spots. Notice leaf has begun to wilt.

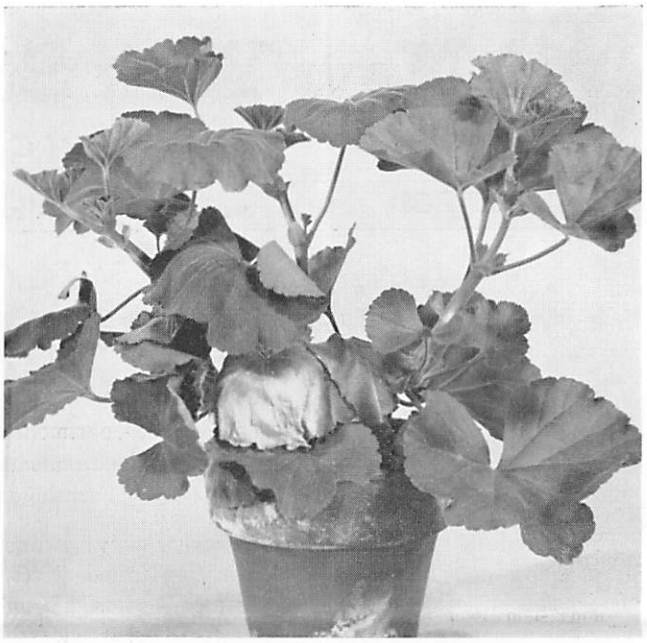
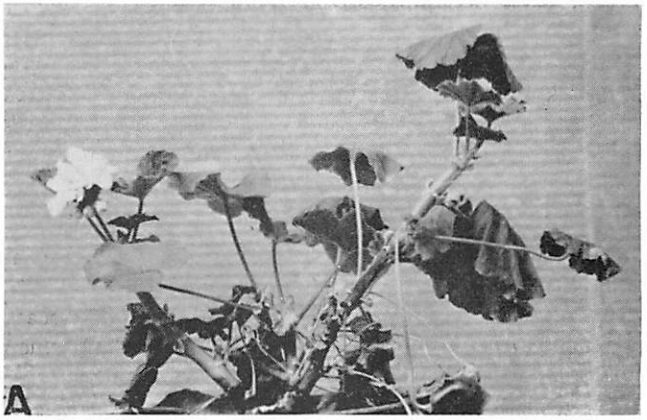


Fig. 2. Bacterial stem rot and leaf spot. Early symptoms of stem rot phase on variety Irene. Notice leaves wilting on left side of plant.



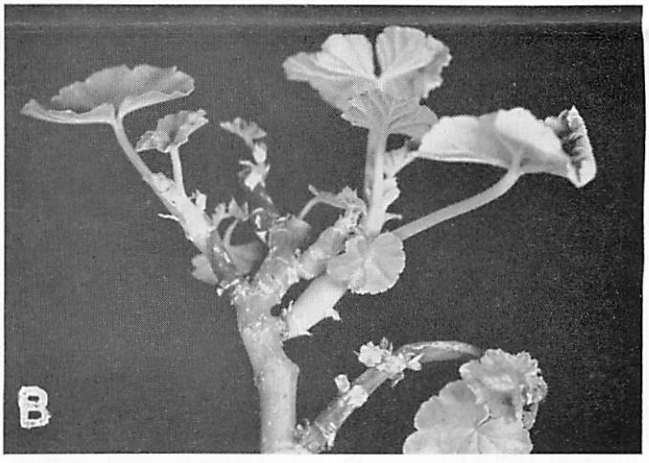


Fig. 3. Bacterial stem rot and leaf spot. A) Variety Springfield White showing defoliation. B) Blackened and shriveled areas on stems resulting from infection by *X. pelargonii*.

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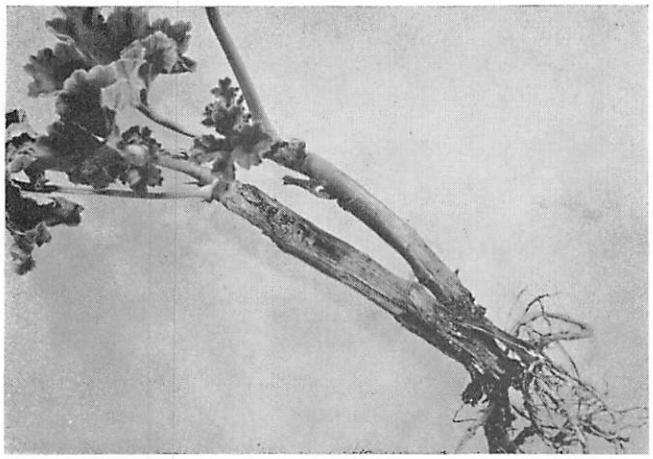

Fig. 4. Bacterial stem rot and leaf spot. Stem of plant infected with *X. pelargonii* cut longitudinally to show rotting of the inner stem tissue.

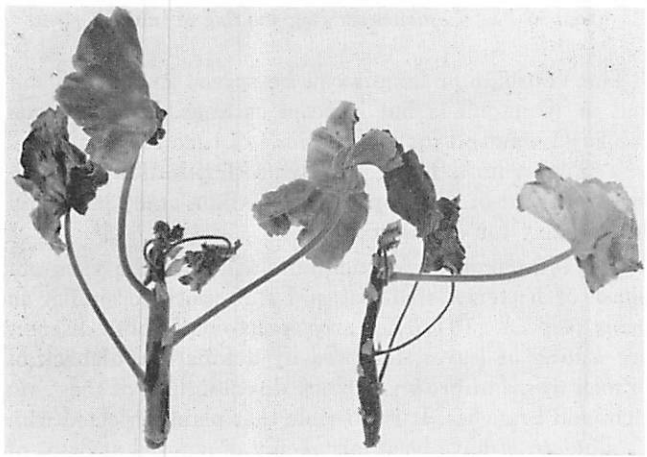

Fig. 5. Bacterial stem rot and leaf spot. Shoot tips from infected plants showing typical symptoms of systemic invasion by *X. pelargonii*.

bacteria. Those cuttings may carry the organism for some time before showing symptoms, especially during cool weather. In addition to spread by infected cuttings the bacterium causing this disease can also be spread by the use of infested cutting knives. This is probably the most efficient means of transmitting the organism. Rapid spread of the disease occurs when overhead watering is used or whenever there is excessive splashing during watering. The disease may also be spread by plant contact and through the use of infested tools and equipment.

VERTICILLIUM WILT

Verticillium wilt, caused by the fungus *Verticillium albo-atrum,* attacks many greenhouse crops including chrysanthemums, rose and snapdragon. This pathogen is known to attack both *P. hortorum* and *P. domesticum* (Lady Washington geranium) and the disease has been reported from New York (4), California (2), and Oregon (9, 17). In the past few years the disease has been observed primarily on *P. domesticum* in greenhouses on Long Island.

The first symptoms of the disease on *P. hortorum* consist of the collapse of a few leaves in the middle or upper portion of the main stem or side branches of the plant (Fig. 6). At first the petioles of the affected leaves remain turgid, but after a day or two wedge-shaped areas on affected leaves turn yellow, or the entire leaf may turn yellow, and the petioles wilt. This is followed by a gradual drying of the affected leaves and petioles resulting in leaf drop. As the disease progresses, more leaves collapse, yellow, dry up and drop resulting in the defoliation of the affected area of the plant (Fig. 7). The growth of affected plants may also be stunted. The progress of the disease varies from plant to plant. In cases where progress is rapid the plant soon loses most of its leaves and the remaining, unwilted leaves are pale green in color and may show interveinal yellowing which looks very much like a nutrient deficiency or a virus disease symptom. In the final stages an affected plant may show dieback or drying of the tips of branches and brown to black discoloration of the main stem and branches (Fig. 8). These stem areas are completely discolored in cross section but above the externally discolored area the browning is limited to the vascular tissue.

Fig. 6. Verticillium wilt. Leaf from infected plant. (var. Springfield White) showing wilting and yellowing, one of the early symptoms of the disease.

Fig. 7. Verticillium wilt. Variety Springfield White with healthy plant (right) and infected plant (left) showing extensive defoliation of infected plant.

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Fig. 8. Verticillium wilt. Variety Springfield White showing severe symptoms. Notice brown to black discolored areas on branches.

In some cases an infected plant may not show symptoms for weeks or even months. However, after this period of time, the entire plant may suddenly collapse as shown in Fig. 9. Shortly thereafter the plant will die.

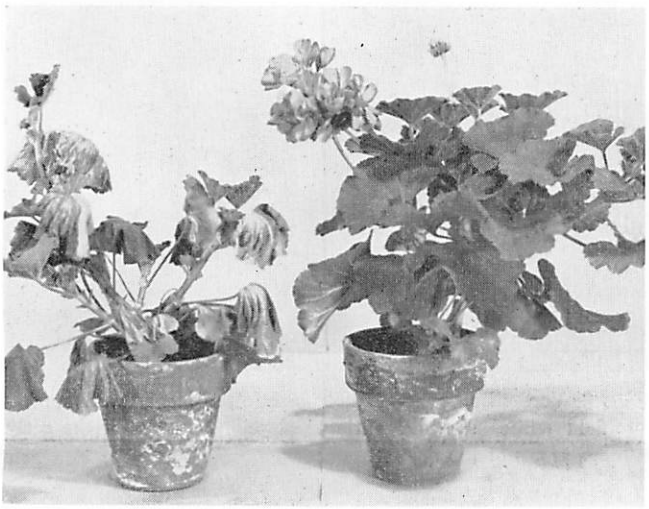

Fig. 9. Verticillium wilt. Variety Irene showing healthy plant (right) and infected plant (left). Notice collapse of all foliage on infected plant.

Symptoms of Verticillium wilt on *P. domesticum* are much the same as those on *P. hortorum* except that the wilting and collapse of leaves does not occur as readily. Affected leaves turn yellow but often do not wilt for several days. With some varieties the defoliation is not severe, but the stunting of infected plants is often pronounced (Fig. 10).

The *P. hortorum* varieties Better Times, Olympic Red, Ricard, Wendy Ann, Diddon's Improved Picardy, Springfield White, Radio Red, Penny, Genie, Irene and Dark Irene have been inoculated with the *V. albo-atrum* and all varieties were found to be susceptible. The *P. domesticum* varieties, The Princess, Marie Vogel, Graf Zeppelin and Mrs. Layal were also tested and all found to be susceptible to attack by the fungus.

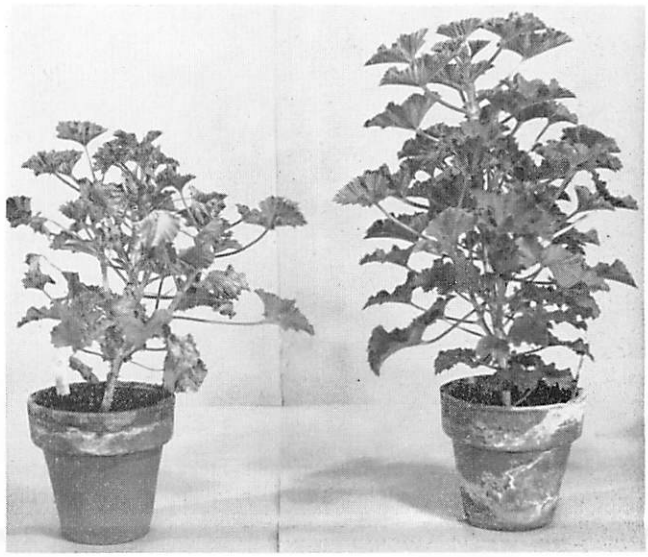

Fig. 10. Verticillium wilt. Healthy (right) and infected (left) plants of *P. domesticum* showing stunting of infected plant.

The Verticillium fungus can be spread in infested soil and in symptomless but infected cuttings. The pathogen can survive in soil for long periods of time in the absence of a suitable host. Therefore, steam sterilization or chemical treatment of the propagating medium and potting soil is necessary for disease control.

The symptoms of Verticillium wilt and the stem rot phase of bacterial stem rot and leaf spot are similar in many respects (10). The early symptoms of both diseases are wilting of leaves, followed by defoliation, dieback of branch tips, and brown to black discoloration of the main stem and branches. It is possible that plants infected with *V. albo-atrum* have been mistakenly diagnosed as cases of bacterial stem rot and vice versa. It is also possible that one plant could be infected by both organisms at the same time. The only way to make a positive diagnosis is by making a culture from the plant in question.

CONTROL OF BACTERIAL STEM ROT AND LEAF SPOT AND VERTICILLIUM WILT

At present the only practical method available for control of these diseases is the use of pathogen-free propagating stock in conjunction with a thorough sanitation and soil sterilization program. Production of pathogen-free cuttings involves culture-indexing cuttings, establishing an increase block of plants started from culture-indexed cuttings, and producing cuttings under good growing and strict sanitation practices. This subject is thoroughly discussed in recent articles by Dr. James Tammen (15) and Dr. F. P. McWhorter (10) and for a complete description of this process I refer you to their papers. Some of the reasons for such a program are discussed below.

Bacterial stem rot and Verticillium wilt are both systemic diseases and the pathogens invade the roots, stems or leaves of the geranium and colonize the water conducting system of the plant. Infection and colonization of the geranium by both pathogens may occur without the appearance of external symptoms. At present there are no

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chemical treatments that can be used to successfully "cure" geranium plants once they become infected with either *X. pelargonii* or *V. albo-atrum*. The majority of the available commercial varieties are susceptible to the diseases. Therefore, the only way of eliminating the pathogens from geranium stock at present is by means of culture-indexing. Fortunately some commercial propagators have become interested in this problem and pathogen-free cuttings are now available in limited quantities. Until such material is generally available to the grower the only methods of control are rogueing of infected plants, selection of the best cuttings possible, use of careful sanitation practices and a thorough steaming of soil, pots, tools, propagating medium, etc., used in the growing operation.

BOTRYTIS BLIGHT

Botrytis blight is caused by the fungus, *Botrytis cinerea*, which usually lives on injured or aging plant tissue such as flowers, leaves, broken stems and cutting stubs. Under the proper conditions this fungus can attack the leaves, stems, and flowers of healthy plants, especially if these plant parts are soft and succulent.

Flowers attacked by Botrytis exhibit premature fading and drying of the petals. These flowers turn dark, wilt and drop prematurely. Under moist conditions the fungus may sporulate on infected flowers resulting in a fuzzy, matted growth on the flowers (Fig. 11).

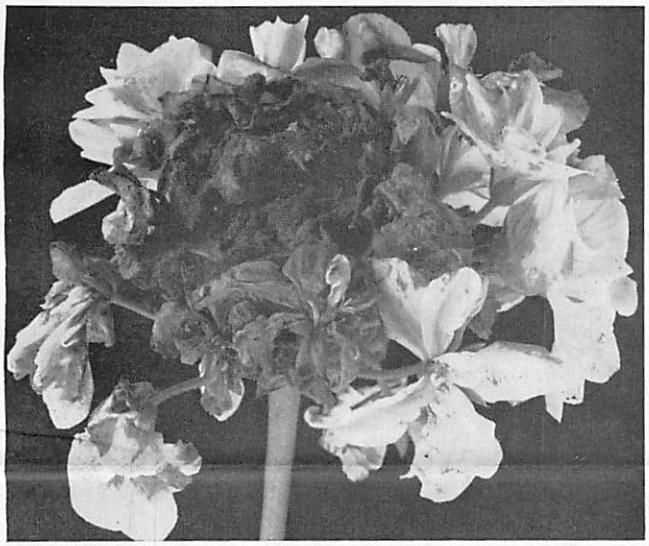

Fig. 11. Botrytis blight. Flower attacked by Botrytis showing matted, fuzzy growth of the fungus on the petals.

The leaf spot phase of this disease often occurs when petals from affected flowers fall on the leaves and the Botrytis fungus grows into the leaf from the infected petal. The resulting leaf spots are irregular, brown, and have a water-soaked appearance (Fig. 12). If the humidity is high or if the leaves are wet, the spots may enlarge and become covered with grayish-brown masses of spores.

Botrytis spores, produced on infected flowers and leaves, are very light and can be spread by air currents and splashing water. These spores can then infect other flowers, stubs where cuttings have been removed and in some cases, healthy plant tissue. Cutting stubs on stock plants are often attacked by Botrytis and the resulting brown rot may extend several inches down the stem.

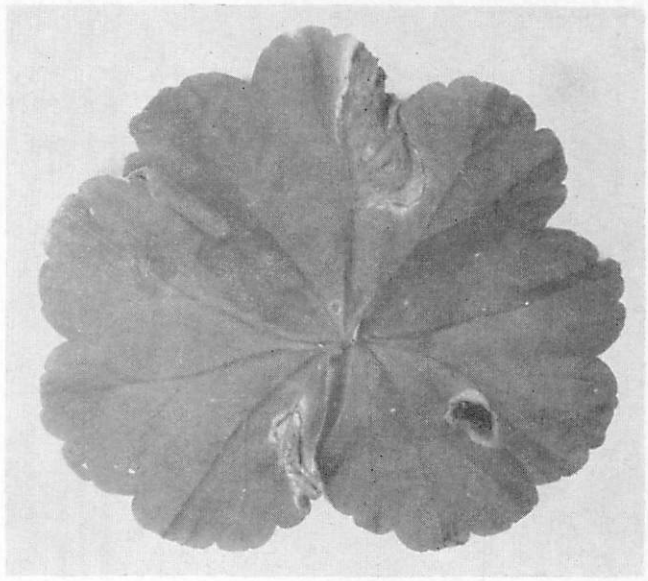

Fig. 12. Botrytis blight. Leaf spots caused by Botrytis. Notice rotted flower petals initiating leaf spots.

Spores may also adhere to the surface of stems where they remain dormant until cuttings are taken and stuck in the propagating medium. Here the spores germinate, infect the cutting, and cause a cutting rot (Figs. 13, A, B). The rot caused by Botrytis is light to dark brown in color and not shiny coal-black as that of the Pythium blackleg disease.

Sanitation and proper heating and ventilation practices are the most important factors in the control of Botrytis blight. All debris around the greenhouse should be cleaned up as dead plant material can serve as a food base for the fungus until conditions are favorable for it to attack living plants. Plants on the bench should be spaced to provide adequate air circulation. Avoid overhead watering or sprinkling since water on the foliage encourages the development of the fungus. Venting and heating should be done in such a way so as to reduce the relative humidity and prevent the formation of dew on the leaves and flowers. Stock plants should receive a protective fungicidal spray at weekly intervals. Use Zineb (Parzate, Dithane Z-78, Ortho Zineb) or Captan 50W at 1½ pounds per 100 gallons of spray. If Botrytis is a problem on plants just coming into flower, mist-spray foliage with ¾ pound of Zineb or Captan per 100 gallons of spray.

PYTHIUM BLACKLEG

The blackleg disease of geranium is caused by the fungus *Pythium*. This disease does not occur frequently but losses are extensive when the disease is present. It is not unusual to find as many as 90 to 100% of the cuttings in a propagation bench killed as a result of infection by the pathogen (Fig. 14). This is primarily a disease of cuttings and young plants.

Cuttings attacked by Pythium usually rot rapidly and are often killed in a week. The first symptom usually is a brown water-soaked rot at the base of the cutting (Fig. 15). This rotted area enlarges rapidly and turns coal-black, progressing 3 to 4 inches up the stem from the base, resulting in the death of the cutting in the propagation bench (Fig. 14).

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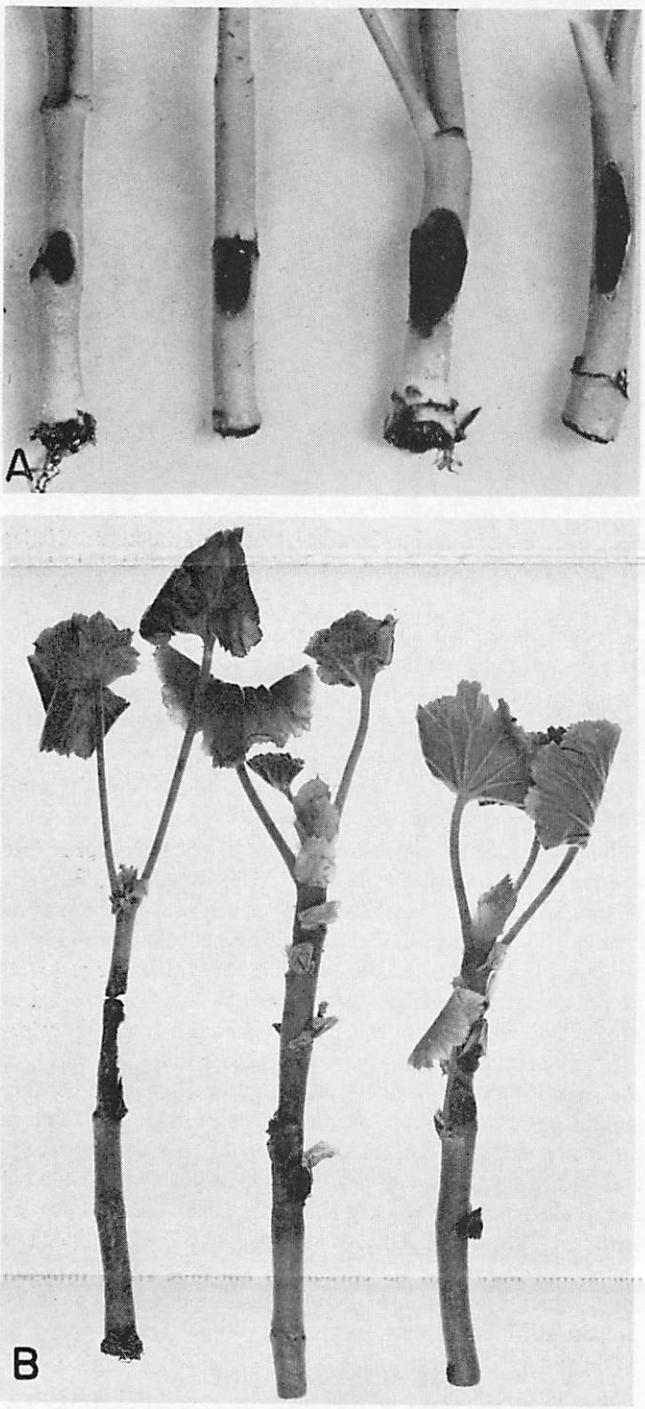

Fig. 13. Botrytis blight. Damage on cuttings. A) Lesions on stems of cuttings. B) Stem rot on cuttings.

Young plants are attacked first at the base of the plant which rots rapidly. The rot soon spreads to the branches and leaf petioles and the affected parts blacken, shrivel and rot.

The blackleg disease is sometimes confused with the cutting rot phase of bacterial stem rot, and in some instances cuttings may be infected with both organisms. It is very difficult and often impossible to tell which organism is attacking the cuttings from the symptoms expressed. Cuttings attacked by *Pythium* usually rot rapidly and are often killed in a week. *Pythium* produces a soft stem rot in contrast to the dry stem rot produced by *X. pelargonii*. Stems attacked by Pythium usually are a shiny coal-black color while those attacked by *X. pelargonii* are more likely to be a dull brownish-black color.

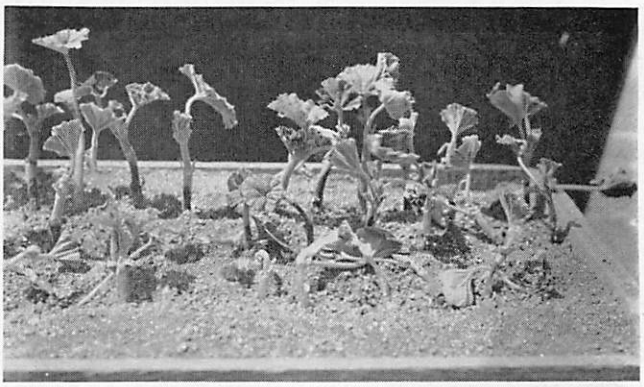

Fig. 14. Pythium blackleg. Coal-black basal rot of cuttings in the propagating bench.

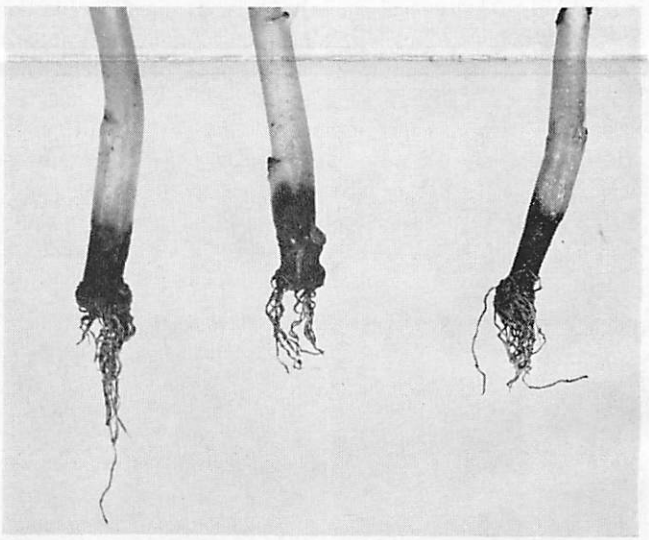

Fig. 15. Pythium blackleg. Brown to black water-soaked rot at base of cutting.

The *Pythium* fungus is spread primarily through the use of infested propagating media and potting soil. The fungus may also enter pots through the drainage hole when pots are set on infested sand, cinders or soil. There is also some chance of spread through the use of cuttings from diseased plants.

Sterilization of the propagating medium is essential to control this disease. After sterilization every effort should be made to avoid the reintroduction of *Pythium* and to keep the medium clean. The same precautions hold true for the soil used in potting rooted cuttings. *Pythium* is also favored by overwatering; this practice should be avoided.

BACTERIAL FASCIATION

The bacterial fasciation disease, caused by the bacterium *Corynebacterium fascians* was first found in the United States on sweet pea in 1935 (16). Prior to this time it had been observed in England in 1927 (6). In addition to geranium, the organism attacks many other plants.

Symptoms of the disease on geranium are distinctive and usually quite obvious. Many short, fleshy, thick, aborted stems with misshapen leaves develop at or below

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Geraniums

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the soil level on affected plants (Fig. 16, A, B). The mass of fasciated growth on old plants resembles a "witches-broom" and may reach a diameter of one to three inches. In other cases the growth at the base of the plant resembles a gall and no aborted shoots develop (Fig. 17). The aborted shoot or gall development is usually visible above ground but in some cases the major portion occurs below the soil level and little or no growth is visible (Fig. 18).

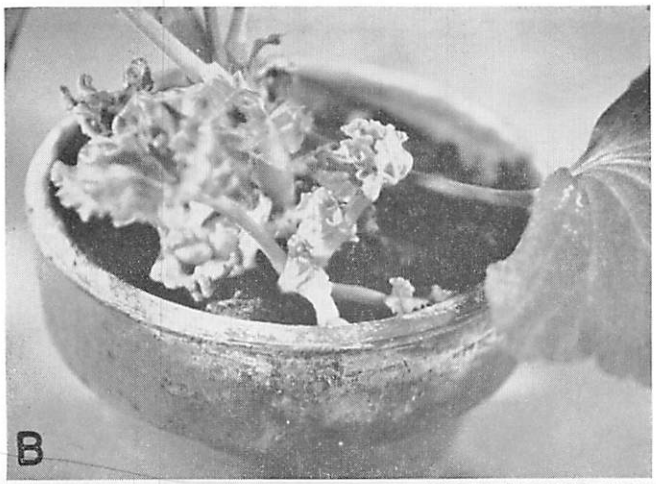

Fig. 16. Bacterial fasciation. A, B) Short, fleshy, thick aborted stems with misshapen leaves developed at soil level on an infected plant.

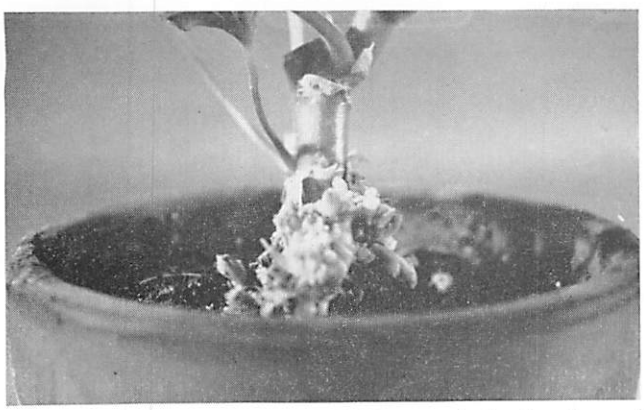

Fig. 17. Bacterial fasciation. Gall-like growth developed at soil level on infected plant.

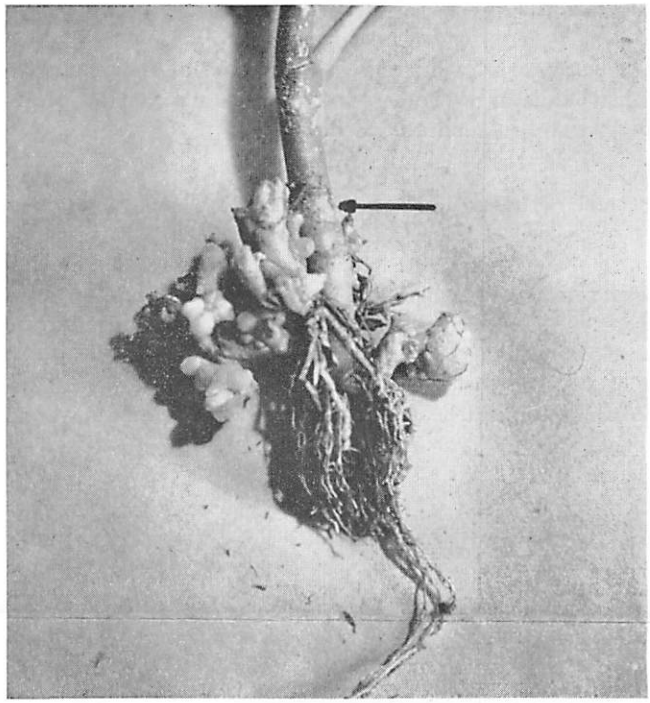

Fig. 18. Bacterial fasciation. Aborted shoots and gall-like growth developed below the soil level on an infected plant. Arrow indicates soil level.

The above ground portions of the aborted shoots and galls are a normal green color similar to the color of the rest of the plant. The underground portions are usually pale yellow. Apparently the main stem of an affected plant continues to grow normally, but there is some evidence to indicate that this growth is stunted or dwarfed and that the number of flowers is reduced. Affected plants seem to live as long as healthy plants.

The bacterium affects only the meristem tissue of buds and causes the buds to break dormancy. Wounds are not required to initiate disease development. Conditions which favor aborted shoot and gall development are moisture and moderately warm temperatures. The organism is water-borne and carries over on the surfaces of affected buds and in infested soil. It can be spread in watering, in handling infected plants, and by infested soil. The bacterium may also be spread in cuttings from infected plants but at present there is no conclusive evidence to support this belief.

Control measures consist of sterilization of all propagating medium and potting soil and careful sanitation practices to prevent the reintroduction of the bacterium into the treated soil. Any stock plant exhibiting symptoms of this disease should be discarded. Pathogen-free cuttings should be used whenever possible.

At present this disease is of minor importance but if its spread is not checked it could become a serious problem in geranium culture. The bacterium has a wide host range (1) which includes such varied plants as lily, gladiolus, Viburnum, chrysanthemum (*C. indicum, C. morifolium, C. maximum*), dahlia, sweet pea, Buddleia, hollyhock, forsythia, phlox, primula, delphinium, and petunia. This list includes many plants commonly found in the home garden. Infected geraniums purchased by the homeowner as

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bedding plants could serve as a source of inoculum for other plants in the home garden and as a means of infesting the soil in such a garden.

OEDEMA

Oedema is a non-parasitic condition resulting when roots absorb water at a more rapid rate than it is evaporated from the leaves. It can occur on the undersides of leaves, on petioles and on stems and appears as tiny, water-soaked pimple-like blisters which later turn brown and corky (Fig. 19). These blisters occur when the leaf cells become distended and burst and the corky tissue forms as the leaf heals. Severely affected leaves may yellow and drop off.

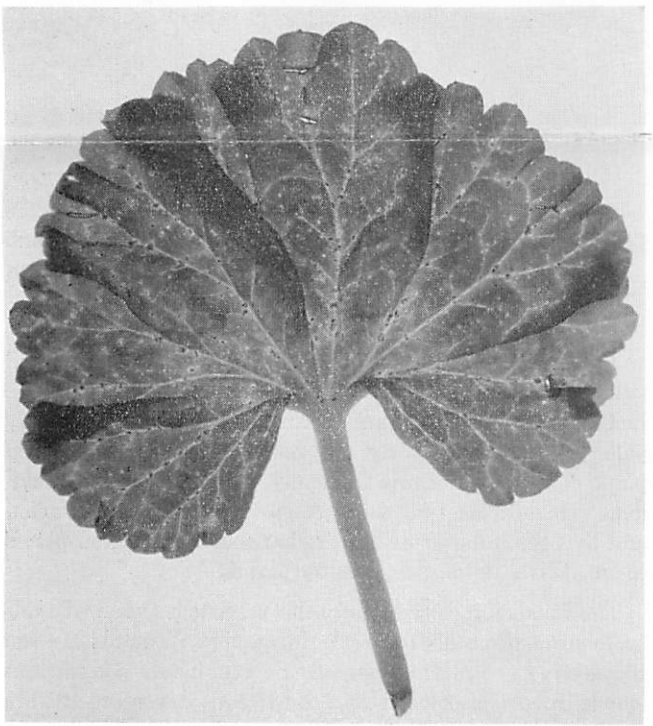

Fig. 19. Oedema. Small brown, corky spots developing on the underside of a geranium leaf.

Oedema usually occurs during periods of cloudy, cool weather and is difficult to control. The occurrence of this trouble can be limited somewhat by spacing plants to provide good air circulation, by keeping the foliage dry, and by using care in watering so as to avoid overwatering during cool cloudy weather.

VIRUS DISEASES

Virus diseases in geranium are quite common and infected plants may contain one or several viruses. Several papers (8, 13, 14) have been published recently concerning this topic and those by Reinert (13), and Reinert, Hilderbrant and Beck (14) contain excellent illustrations of symptoms in virus infected geraniums. No attempt will be made to discuss each virus disease separately in this paper and the reader is referred to the papers cited above for a complete discussion of geranium virus diseases. In this case the virus diseases will be discussed as a group and a few general control recommendations will be given.

Symptoms of the virus diseases are most severe in young plants and are usually seen in winter and early spring in the Northeast. However, symptom expression varies with the virus involved and symptoms may occur throughout the year. Symptoms on infected plants may be expressed in several ways. On some affected leaves symptoms may be expressed as chlorotic or yellow spots as shown in Figs. 20, 21 and 22. Several viruses or strains of viruses are thought to be responsible for causing chlorosis symptoms. The geranium crinkle virus causes large star-shaped spots or lesions in the older mature leaves. Several days later the young leaves develop small brown spots which develop into holes or cracks and as the healthy tissue around these cracks or holes grows the leaf becomes curled and malformed. Geranium mosaic is a virus symptom associated with wrinkling or mottling in the leaf. In some cases the leaves become distorted (Fig. 23), resulting in misshapen and malformed plants. In other cases the mosaic symptom can occur without leaf distortion (Fig. 24). Sometimes the leaf symptom is masked but infected plants are usually stunted, have short internodes and small leaves. Vein clearing or yellow net vein is a virus symptom due to patterns resulting from the complete yellowing of the veins (Fig. 25). This symptom can be observed throughout the year and is not masked although the symptoms may become faint during the summer. Leaf cupping is a virus disease characterized by an upward cupping of the leaves as well as misshapen and distorted leaves (Fig. 26).

Fig. 20. Virus. Plant showing chlorotic spot symptoms which generally appear on mature leaves.

During certain times of the year some of the aforementioned symptoms may disappear from infected plants. This does not mean that the plants are now free of the disease but simply that the symptoms are being masked by current environmental conditions (light, heat, etc.) Cuttings taken from virus infected symptomless

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plants may still carry the virus and can show symptoms again when environmental conditions are favorable.

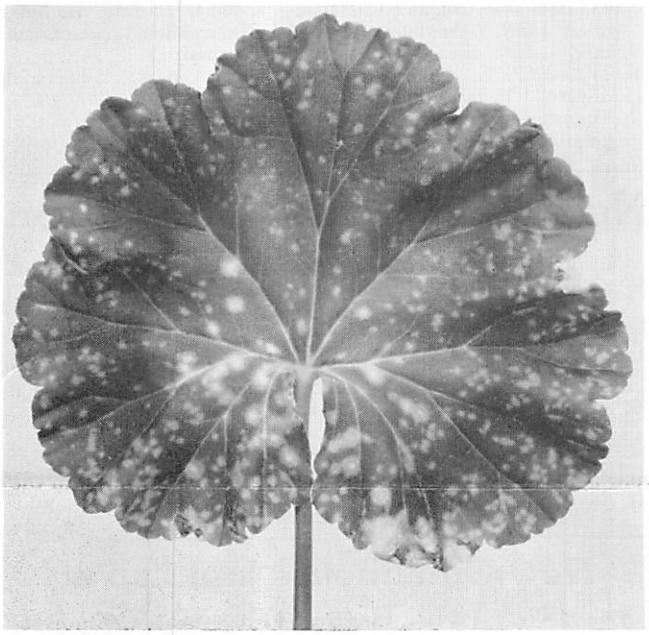

Fig. 21. Virus. Chlorotic spot symptoms on a single mature leaf.

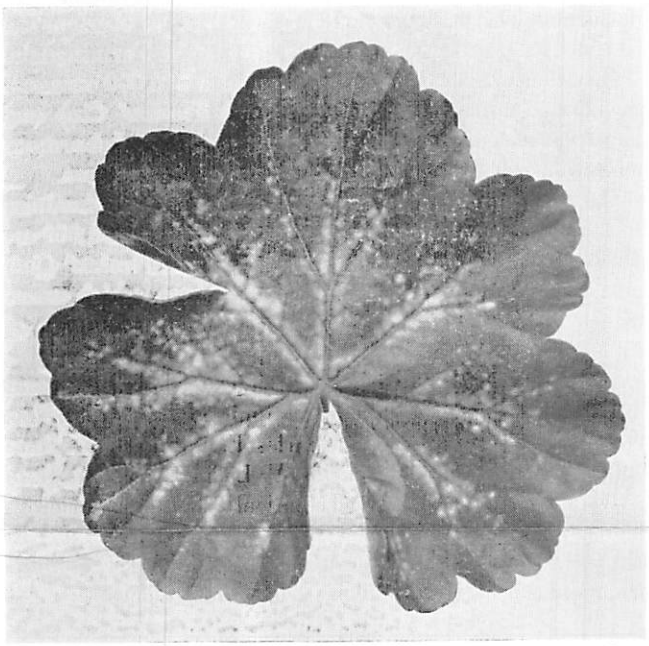

Fig. 22. Virus. Geranium leaf showing chlorotic spotting along the larger veins.

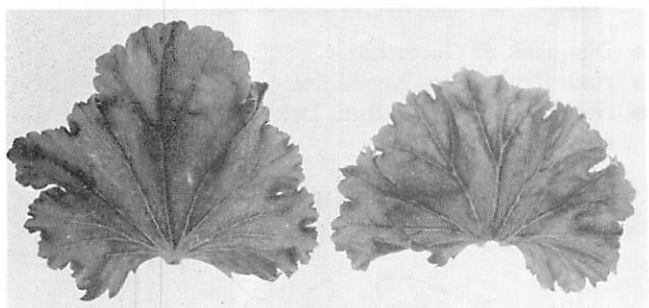

Fig. 23. Virus. Geranium leaves showing loss of zonation and misshapen character typical of virus-induced leaf breaking mosaic.

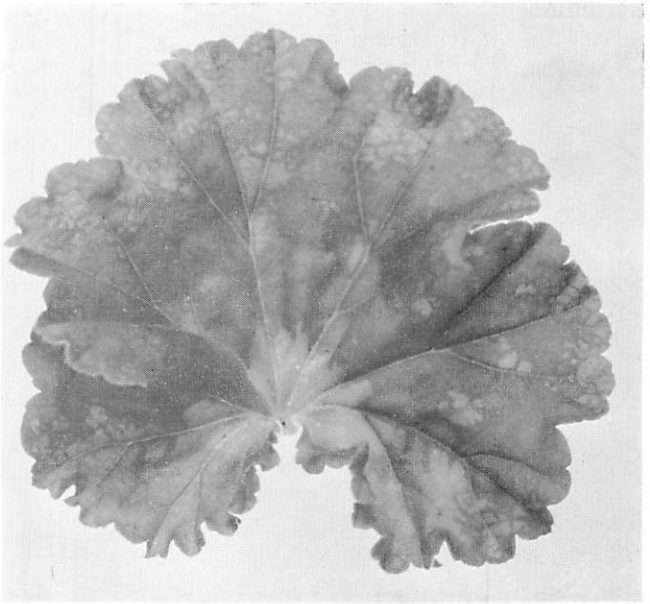

Fig. 24. Virus. Mosaic symptom in a geranium leaf showing no distortion.

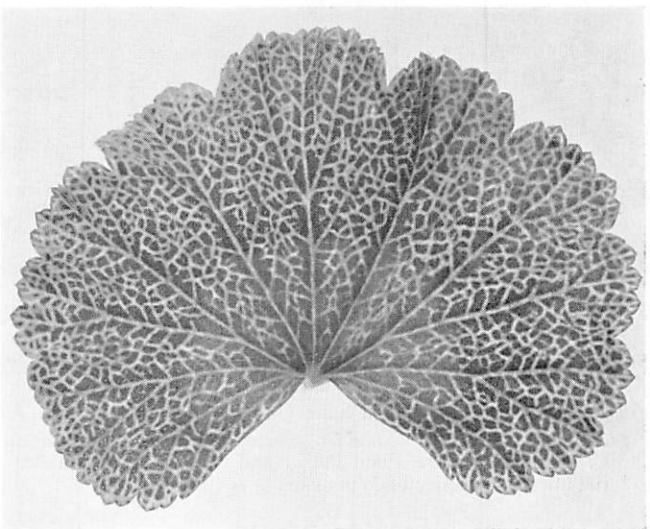

Fig. 25. Virus. Geranium leaf showing the yellow net vein virus symptom.

Virus diseases can be carried or spread in infected cuttings, by insects, by mechanical means such as handling the plants, in seed and in wild plant hosts. Control of the virus diseases of geranium therefore is based on the use of proper cultural practices in the growing operation. Such cultural practices should include adequate spray programs to control insect populations, handling of plants as infrequently as possible and a careful soil sterilization and sanitation program. The extensive build up of viruses in many commercial geranium varieties may be partially attributed to the fact that viruses are carried in cuttings. Therefore the only sure means of control is the use of virus-free cuttings. However, such material is not now available to the grower and may not be for some time. Each grower can alleviate his own problems by observing his stock plants very closely at all times, but especially during the periods most favorable for symptom expression. Any suspicious looking stock plants should be removed and destroyed to prevent the further spread and build up of virus diseases.

(*continued on page 10*)

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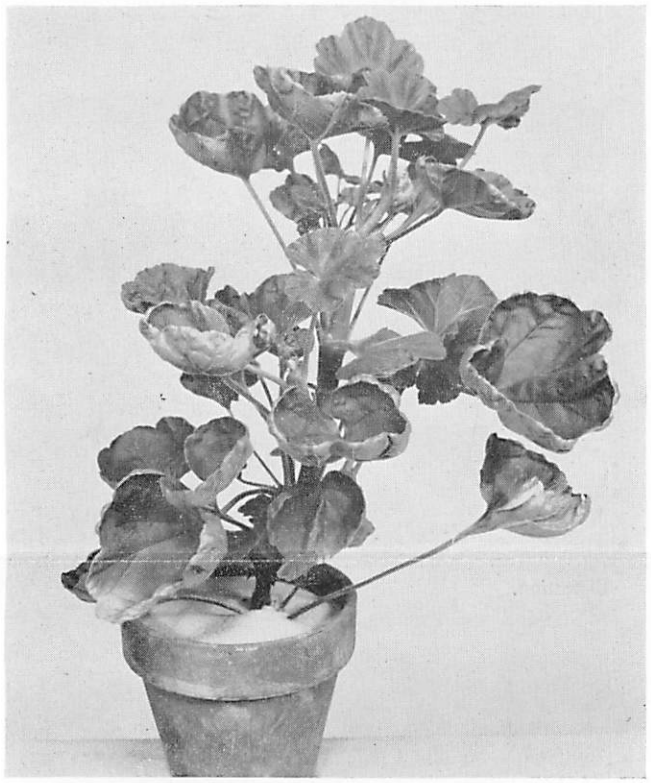

Fig. 26. Virus. Geranium plant showing the leaf-cupping virus symptom.

Photograph Credits

Figs. 1, A,B; 5; 11; 13, B; 15; and 19 courtesy Herbarium, Dept. Plant Path., Cornell Univ.

Figs. 3, A,B; 4; 12; 13, A courtesy James Tammen, Dept. Botany & Plant Path., Pennsylvania State Univ.

Fig. 14 courtesy Pennsylvania State Univ., Agric. Ext. Service.

Figs. 20, 21, 22, 23, 24, 25 and 26 courtesy R. A. Reinert and A. C. Hildebrant, Dept. Plant Path.; and G. E. Beck, Dept. Horticulture, University of Wisconsin.

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New York State Exposition

Kenneth Felthousen, Chairman of the New York State Flower Growers State Exposition Committee reports that the Exhibition for the New York State Exposition is just about ready to go. The title of the display this year is "Language of Flowers." The date of the Exposition is August 28-September 3.

In addition to the ten designers, Mr. Felthousen will be helped by Mr. Russell Mott and Mr. Howard Haring both of Ithaca, New York.

New Greenhouse and Lab at Ornamentals Research Laboratory

New facilities at the Ornamentals Research Laboratory of Cornell University and the U. S. Dept. of Agriculture were dedicated in ceremonies on July 10 at Farmingdale.

The event marked the completion of a $16,000 research greenhouse donated by the New York Florists' Club and the ground-breaking for a new plant pathology laboratory being built by the N. Y. State College of Agriculture.

The laboratory, to be equipped with the latest facilities for studying plant diseases, will be added to a $30,000 research structure donated by the New York Florists' Club in 1951. The new all-aluminum greenhouse, which measures 25 by 100 feet, will aid studies in the production of nursery and commercial florist crops.

Principal speakers included: Mel Dauerheim, program chairman, laboratory advisory committee; Ed Nutile, New York Florists' Club; Dean Charles E. Palm, N. Y. State College of Agriculture; Charles W. Laffin, president, State University Agricultural & Technical Institute, Farmingdale; Paul B. Orvis, executive dean, State University Institutes and Community Colleges; and Floyd F. Smith, ornamental crop insects, U. S. Dept. of Agriculture.

In This Issue

YOUR EDITOR,

Bob Langhans