New Bacterial Disease Affects Chrysanthemums

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During the summer of 1950 our attention was drawn to a case of rather rapid and extensive rotting of greenhouse grown standard chrysanthemums unlike anything we had previously noticed. Laboratory studies soon demonstrated that the disease was caused by an undescribed bacterium, now known as Erwinia chrysanthemi* In all probability it had been causing limited trouble in chrysanthemums for several years but had been either unnoticed or incorrectly diagnosed. Since its identification, cases have been reported from several eastern and southern states and it is reasonable to suppose that it now occurs, or eventually will occur, wherever chrysanthemums are grown commercially in this country.

Extent of losses. Up to the present time losses from bacterial blight have in most cases been relatively minor. Usually, in normal soil culture, only 1 to 5 per cent of a given variety has been affected, though there have been some exceptions. Extensive losses have been noted in a few cases where some type of hydroponic culture or sub-irrigation was being employed.

Symptoms of blight. Cuttings infected with blight may show a slight brown to black rotting at the base. When cut open, the pith tissues in the center of the stem may be found partially rotted and reddish brown in color. Often the pith is completely dissolved, leaving the base of the stem hollow (Fig. 1). If the outer bark is peeled back, reddish streaks sometimes are seen running up the stem. Infected cuttings occasionally root and develop into apparently normal plants, but often they wilt and die. Of great importance is the fact that some-

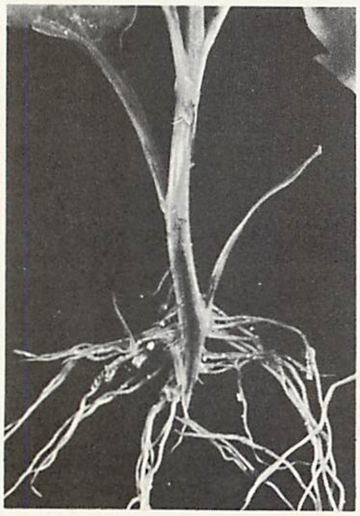

Figure 1. Base of chrysanthemum cutting with bacterial blight. Top of stem cut away to show how pith is rotted.

times--perhaps very commonly--cuttings may be infected and yet show no symptoms whatsoever.

Older plants may show the disease at any time up to full flowering. Commonly, the first symptom is a dull gray appearance of the stem at a point half or two-thirds of the way up to the tip. If pinched between the thumb and fingers this region collapses and is evidently hollow. Within a day or two the affected area becomes blackish and the terminal portion of the stem may wilt and fall over (Fig. 2). If conditions remain favorable for disease, the rotting may progress down the stem. The internal tissues are usually either completely disolved or partially digested and converted into a jelly-like mass. In some cases the stem may split open and in other cases reddish-brown sticky drops may exude from the infected tissues. Examination shows that part or all of the water-conducting tissues just beneath the bark are reddish-brown down to the root zone.

Figure 2. Bacterial blight of chrysanthemum from commercial greenhouse. Wilting of upper leaves and rotting and collapse of the soft stem tissues are typical.

While the first evidence of rot on older plants is usually well up on the stem, it is not uncommon to find infection developing first at the base of the plant. When such plants are not definitely blighted they remain stunted and are slow to mature. Often, too, the tissues first start to rot back from the point where the tip has been pinched out (Fig. 3). There appear to be many variations from the typical symptoms described above; for example, in some cases the only evident symptom seems to be a scorching of the leaf margins. It is possible that many cases which have been otherwise

* For a more complete technical account see, "A bacterial blight of chrysanthemums" by W. H. Burkholder, L. A. McFadden and A. W. Dimock. Phytopathology 43: 522-526. 1953.

Figure 3. Bacterial blight spreading down from infection which developed at point where terminal growth was pinched out.

diagnosed have actually been unusual symptoms of bacterial blight. The roots of affected plants usually are not conspicuously rotted, though in some cases the rotting may be extensive.

The degree of damage to an individual plant depends upon the variety and upon the environmental conditions. Often only one branch of a plant is affected, the other branch or branches remaining apparently healthy and flowering normally. Frequently the obvious rot may be confined to the upper part of the stem, and apparently healthy shoots will break from the base and produce normal flowers.

Plants affected. All of the 50-odd varieties of florists' chrysanthemums tested proved susceptible to artificial inoculation, though there were marked differences in severity of symptoms. Such differences were also noted in commercial plantings. Shasta, Grand Slam, Mary McArthur, Forty-Niner, Brocade, and J. W. Prince, for example, were seriously affected, while Blazing Gold, Masterpiece, Mary Lennon Hall, and Goldsmith were less so. Other species tested and found susceptible include Shasta daisy (chrysanthemum maximum), feverfew (C. parthenium), Clara Curtis chrysanthemum (C. rubellum), Paris daisy (C. frutescens), field daisy (C. leucanthemum), garland chrysanthemum (C. coronarium), and pyrethrum (C. cinerariaefolium). Besides the above chrysanthemum species, other plants found susceptible include the New York aster (A. novi-belgii), New England aster (A. novae-angliae), wild aster, golden marguerite (Anthemis tinctoria), pigweed (Amaranthus retroflezus), wild goldenrod (Solidago sp.), and a few other closely related plants.

A bacterium similar to the chrysanthemum blight organism, and capable of causing rot in chrysanthemums, has been isolated from a rotted sedum plant (S. spectabile). Also, somewhat similar bacteria have been isolated from diseased plants of celery and guayule (Parthenium argentatum), but it is believed that they are not the same as the chrysanthemum blight organism. Potato and tomato plants will rot when artificially inoculated with the chrysanthemum organism but no naturally infected plants have been observed. In fact, there appears to be no evidence that this bacterium occurs naturally on any common plant other than the florists' chrysanthemum.

Effect of environment and plant condition on disease development. Bacterial blight is extremely responsive to environmental conditions. Plants sometimes may be definitely infected, yet grow and flower normally. Also, rotting may start to develop in a stem and be almost completely and permanently checked by a shift in environmental conditions. Experiments and observations have shown that serious development of blight in an infected plant is dependent upon high temperature and high humidity. Infected plants may be placed at high temperature and low humidity or at high humidity and low temperature and show little or no disease development. Yet when similar plants are placed at high temperature and high humidity they may become severely blighted in less than 2 days! Though there is no sharp critical point in either temperature or humidity, there is little development at 65°F or below, while at 80°F or higher blighting is extremely rapid. As to humidity--the higher the better. The disease definitely is favored by actual moisture on the plants.

Plant condition also has a marked effect on disease development. In general, the more succulent the tissue the more readily it will be blighted if the plants are infected. It is therefore not surprising that the disease has been most severe in the most vigorous, luxuriant plants. The common initial development of rot in the upper parts of infected plants is thus explained. If conditions are not favorable for disease development until the plants are well grown the lower part of the stem becomes "hardened" and the most succulent tissues are near the top. Hence, even though the bacteria are present all up and down the stem the blight develops first in the succulent upper tissues. It is reasonable to assume, then, that any cultural factors (for example, heavy nitrogen fertilization, maintenance of high soil moisture, occurrence of prolonged high humidity) which would favor lush growth would also favor blight outbreak if the plants were infected. By the same token, previously healthy plants in such condition would be more susceptible to infection.

Methods of spread. Since plants can be infected and yet show no symptoms it is obvious that diseased cuttings might be taken from such plants. These cuttings would serve to spread the disease from one location to another. That this actually occurs has, in fact, been proved beyond question. When cuttings of the variety Mary McArthur were inoculated with the chrysanthemum bacterium prior to rooting in vermiculite, it was demonstrated that the cuttings were able to root even though infected. However, when these cuttings later were exposed to conditions of high temperature and humidity, 95% became blighted in 3 days. Since there is no evidence of common occurrence of the bacteria in any other host plant there is every reason to believe that the initial introduction into different growing areas has been on chrysanthemum planting stock of one sort or another.

Once introduced, local spread may occur in any of several ways. It has been shown that infection may occur through pinching wounds. Hence, if a diseased plant is cut through or pinched with the fingernails, contaminating bacteria may be picked up and carried to the next plant. Likewise, infection might be spread among older plants in cutting the blooms. If later used as stock, such plants might be a source of infected cuttings. Infection may be spread from diseased to healthy roots on any cultivating tools which injure the roots.

Another probable means of spread is in liquid dips. If a few infected cuttings are dipped in any non-bactericidal solution, some of the bacteria may ooze out into the liquid and serve to infect cuttings subsequently dipped. A somewhat similar situation would arise in any type of nutrient-culture growing program in which the plant nutrients are periodically pumped in among the roots from a central tank and then allowed to drain back into the tank. Although such a system would not seem to provide the root injury which is necessary for infection, the fact remains that there are 2 or 3 cases on record of disastrous spread of bacterial wilt of carnations in such methods of culture. Like bacterial blight of chrysanthemums, bacterial wilt of carnations also requires root injury for infection. It can only be concluded that there is sufficient "natural" root injury in such systems to permit escape of bacteria from diseased roots and their entry into previously healthy roots.

In addition to providing a rapid and efficient means of spread of blight bacteria, nutrient-culture methods probably would promote highly succulent, and thus more susceptible, plant growth. Whether the repeated daily flushing of the beds would provide higher humidities about the plants is not known. If this were the case, it too would favor disease development.

Survival of the bacterium. Laboratory studies have shown that the chrysanthemum bacterium can survive several months in soil, vermiculite, and white silica sand. The bacterium has also been isolated from "recovered" stock plants 8 months after the time of the initial infection. Isolations of the pathogen have also been obtained from the soil about the roots of such plants 15 months after initial infection. These findings indicate that the disease certainly could pass on through the roots when a new crop of chrysanthemums is planted within a short time after the old crop is pulled out, as in a tightly scheduled year-round production program.

Control suggestions. The most important step in control of bacterial blight lies in the development of methods for positively insuring against carry-over in cuttings. Although methods for guaranteeing 100 per cent success are not known, the major chrysanthemum cutting producers are employing every method currently available for reducing the hazard to a minimum.

The individual grower should sterilize his soil at least once a year even if the crops have appeared healthy, and certainly should sterilize immediately after any crop which shows signs of disease. In pinching, taking cuttings, or picking blooms, the stems should be snapped off and not cut with a knife or the fingernails. Cuttings should not be dipped in any solution until a safe bactericidal additive has been developed.

Growers considering nutrient-culture methods of growing should be advised of the hazard involved in this type of operation.