THE NATURE OF CARNATION DISEASES AND HOW THEY SPREAD

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The purpose of this talk is to review some of the basic information concerning the nature and spread of carnation diseases -- information upon which the development of successful disease programs depend. Because time is limited we will confine our remarks primarily to the diseases which are now, or threaten soon to become, of major importance in this area. Obviously, this selection of diseases must include Rhizoctonia stem rot or "wet stem rot," Alternaria blight, Fusarium wilt and bacterial wilt.

Rhizoctonia stem rot. While it would be difficult to single out any one of the above diseases as Carnation Enemy No. 1, Rhizoctonia stem rot is certainly a strong contender. Its importance is due in part to the fact that, unlike the others, it plays few favorites, attacking nearly all carnation varieties readily, as well as attacking scores of other plants. It spreads very rapidly in an infested bench. It is caused by a fungus, Rhizoctonia solani, which grows in the soil and is particularly active near the surface. Accordingly, the plants are initially attacked at or near the soil line. If a recent victim is examined, it is found that the bark tissues at the soil line are girdled by a dark brown, usually wet rot. This does not extend more than a short distance upward but may proceed downward to the roots in late stages of the disease.

The casual fungus produces a somewhat tenacious web of threads or filaments in the surface layer of soil and it does not commonly produce spores. Because of this, it is not normally spread by air currents and even splashed water probably plays a very minor role. Since it does not grow far upward within a plant, dissemination with properly handled cuttings is unlikely. The important means of spread is as fungus threads or hyphae, in the soil or the rooting medium. It may thus be carried in the rooting medium which adheres to the roots of cuttings, or in the soil of potted plants. In this way it may be introduced to the field or it may be picked up in the field and carried back into the houses since it is often found in soils in which carnations have never been grown. It may be carried on dirty tools, on the hands, or on the shoes of workmen.

At first glance, this would seem to be a disease for which soil sterilization would be a "natural." And the excellent results obtained by many growers would seem to support this view. However, the difficulties of obtaining adequate sterilization on old benches or beds and particularly the difficulties of avoiding recontamination make the practice of sterilization for Rhizoc control a difficult one to master except by the most careful and well equipped growers. For this disease, then the use of a surface soil treatment would appear to be a valuable and often essential supplement to sterilization. It is the only major carnation disease, in fact, which seems by its nature to be adapted to control solely by soil-surface treatment with the type of chemicals which have thus far been developed for the purpose.

Alternaria blight. This disease is well-known to all eastern carnation growers. It is recognized by the production on the leaves and stems of dead spots which become covered with a blackish crust of spores and spore-producing structures. It may result in the girdling and death of individual stems or in some cases of the entire plant. Cuttings may become infected at the base and eventually die. If the stem is sliced at the point of infection, the tissues are found to be dry and nearly black. The discoloration does not usually run very far up the stem.

Alternaria blight is caused by either of two species of the fungus genus Alternaria. Unlike Rhizoctonia, this fungus is not a common soil organism and would not be found in virgin soils, though it would persist in the plant debris left in an old carnation field. Alternaria produces spores on the infected tissues and these are carried to healthy plant surfaces in splashed or wind-blown water. Spread of the spores in dry air currents is a very minor factor. When the spores remain wet for several hours they will germinate and infect by penetrating directly through healthy leaf and stem tissues.

The dissemination of Alternaria blight, then, results primarily from splashed spores rather than from direct growth of the fungus through the soil. This may cause intensification of the disease within a planting, particularly in field-grown beds where splashing cannot be controlled. Alternaria may also be, and very often is, spread either as dormant spores on the cuttings or as established infections in them.

These well-established facts point to two general control programs. First, the disease could be virtually eliminated by continuous inside culture, providing all watering of the plants and cuttings were done by a method which would eliminate splashing. Sprays would have value only as a supplementary precaution, while soil treatment would function only as a safeguard against other diseases. Second, if field culture were employed or if splashings were not eliminated, foliage sprays and cutting treatments would be essential regardless of any known soil treatment. The latter would, however, have some value in reducing inoculum if old carnation soils were used.

Fusarium wilt. This disease has been very destructive in the varieties which are susceptible to it and has caused the abandonment of a number of them which were otherwise very fine. This disease causes a wilting which is usually at first one-sided but eventually takes the entire plant. The root system and stem may in early stages appear externally unaffected, but if split lengthwise a brown discoloration of the water-conducting tissues, just below the bark, may

be seen extending to the upper parts of the affected branches. In later stages, the bark may show a dry brown rot.

Fusarium wilt is caused by a fungus which may grow and persist for several years in the soil. It produces spores which may be spread by splashed water or washing of the soil, though they are probably air-borne to a very limited degree. Contaminated soil can, of course, be disseminated by any of the means mentioned for Rhizoctonia. Healthy plants may become infected by invasion through the root system, if set in infested soil. It is also probable that some infection occurs as a result of spores splashed onto wounds in the above-ground portions of the plants. Because the fungus grows upward within the stem, cuttings taken from diseased plants may already be infected when taken. Healthy cuttings could easily become infected by spores which had been splashed onto them while still on the parent plant. The disease is most commonly spread from place to place on diseased cuttings.

Because of the internal nature of the disease organism, neither soil sterilization or treatment, nor sprays provide a solution to the problem, though they may contribute to control. Rigorous rogueing and mother-plant selection is absolutely essential, but it must be coupled with the use of clean soil. Although there is promise that chemicals may eventually be available which will give reasonably good control by simple soil-surface treatments, these have not yet been developed commercially.

Bacterial wilt. This disease, though a newcomer, already has demonstrated its terrific destructiveness to susceptible varieties. Some of you made its acquaintance last year on the variety Virginia Irwin, others have encountered it on Miller's Yellow or Virginia Rose. It is much like Fusarium wilt in that it invades the water-conducting system and usually causes wilting first of one side and then of the entire plant. The tissues just below the bark are also dissolved far up into the branches. In contrast to Fusarium, the discolored tissues are definitely quite sticky and the root system may become completely rotted in a short time. The stickiness is due to the mucilaginous nature of the causal bacteria, which are present by the millions in the discolored tissues.

The bacteria may be spread by the splashing of infested soil or of the bacteria exposed on wounded surfaces. They may easily be transferred on the hands or on tools used to cut the stems. If cuttings are soaked in water prior to sticking in the rooting medium, it is entirely possible that infection might spread from a single diseased cutting to a thousand healthy ones. Thus, the presence of a few diseased plants in a propagating block might easily result in 100 percent infection in the second vegetative generation. The highly infectious nature of this disease cannot be over-emphasized.

These basic facts indicate the same general approach to control as with Fusarium wilt, but because of its highly infectious nature truly heroic measures are needed. Rogueing, selection, soil sterilization and care in the handling of parent plants and propagating stock require a degree of thoroughness not demanded with most diseases.

Discussion. There are several fundamental facts which stand out in considering these diseases. First, only one of them, Rhizoctonia stem rot, is caused by a non-specific surface-growing soil fungus and is not commonly disseminated on cuttings. It, then, is the only one which, by nature, would seem responsive to control by any chemical that has thus far been adequately investigated which might be applied to the surface of the soil. Second, only one of them, Alternaria, is caused by a fungus which infects by means of spores on the surface of the above-ground portions of the plants. It is thus the only one which could be adequately controlled by a fungicidal spray program, and it could not be controlled solely by any program of soil treatment. Third, two of the diseases, the Fusarium and bacterial wilts, are caused by organisms which may persist deeply within the soil and may permeate throughout the water-conducting system of the plants and thus be unwittingly transmitted with the cuttings. Neither sprays nor any investigated soil treatment would be adequate to control these diseases. Fourth, we have seen that none of the disease organisms discussed is commonly carried by dry air currents. The statement of a well-known grower that the air is laden with germs is correct enough, but his implication that these are carnation disease organisms is decidedly misleading.

Another factor not yet discussed which markedly affects the development and dissemination of carnation diseases is temperature. All of the above diseases are most active during hot weather but may be relatively inactive and produce little visible effect on the plants at low temperature. For this reason, any control treatments applied at the onset of cool weather may give very misleading results--since the diseases would have subsided anyway. For this reason also, plants may appear healthy at time of propagation in the winter and yet give rise to cuttings infected with one or the other of the wilt organisms.

One final word. Plant pathologists have recently been accused of opposing any control measure which they, themselves, have not developed. Such an accusation is not only false, but rather absurd. We have no illusions of omnipotence. We demand only that we must have proof, by tests which we know to be adequately replicated and basically sound, before we can recommend or condemn any control procedure.

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OTHER TALKS WILL BE PRESENTED IN THE NEXT ISSUE OF THE BULLETIN.