Colorado Flower Growers Association

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Thinking About Carnation Diseases - 1956-1957

By Ralph Baker

Since the last summary on the disease situation in the Colorado carnation industry (2), several revolutionary cultural practices have been adopted. Mist propagation, liquid injection feeding, permanent type irrigation systems, and air conditioning are a few of the recent innovations. The extensive application of such practices has necessitated a new look at some of the old problems. It is the purpose of this paper to review again the recent investigations on diseases of carnations at Colorado State University and to apply them in the light of the present cultural practices.

Vascular Diseases

The control of vascular diseases (Fusarium wilt, causal agent Fusarium oxysporium f. dianthi and bacterial wilt, causal agent Pseudomonas caryophylli) through the cultured-cutting technique (17) appears to be a reality. During the past 2 years many plants with symptoms of various diseases have been received at the experiment station and collected on field trips. In no instance has either of the vascular pathogens been isolated from such material.

While this situation is favorable, the presence of cuttings which do not harbor the vascular pathogens does not imply that they are resistant. Thus every effort should be made to prevent reintroduction of these organisms. In this regard it is especially desirable that stock introduced from other parts of the country be isolated until such time as it is known to be free from pathogenic organisms.

Recent investigations carried out in cooperation with Dr. Paul Nelson* has thrown new light on the means of carry-over of the vascular pathogens. During attempts to obtain pathogen-free carnations by means of the cultured cutting technique, a surprisingly small number of cuttings were found to harbor F. oxysporium f. dianthi. In subsequent controlled experiments, it was found that this organism did not invade stems to heights greater than 6 inches without symptoms being apparent. There were exceptions however. These exceptions may explain the few instances in which organisms have been isolated from apparently healthy cuttings. Further investigations are con-

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cerned with the environmental factors which contribute to the height to which the vascular parasites are able to invade carnation stems without inciting symptoms.

Leaf Disorders

Alternaria leaf spot (causal agent Alternaria dianthi) has been observed especially on young plants. While its presence is by no means desirable, the symptoms soon disappear under greenhouse conditions. For this reason the disease has not been especially important.

The pathogen is favored by moist conditions on the foliage: a situation which is certainly present in mist propagation (12) and in some cases under air conditioning.

Control of Alternaria leaf spot may be assured by injecting certain fungicides or antibiotics into the water of the mist system (13,15,16). At present this method of control is not recommended as these materials retard rooting to some extent. In nurse beds or producing benches spread of the pathogen is checked by close attention to ventilation and by weekly sprays of Zineb or Captan.

ALMOST ANYONE CAN PROPAGATE SUCESSFULLY UNDER MIST

In some cases the incidence of rust (causal agent, Uromyces caryophyllinus) has increased in air conditioned ranges. Spread of rust has been checked by cutting off the water to the air conditioning pads 1 to 2 hours before turning off the fans in the late afternoon. Sprays of Zineb or Captan may also be applied on a 7 to 10 day schedule.

Fusarium Stem Rot

Fusarium stem rot (causal agent, Fusarium roseum f. cerealis) continues to be the most widespread and destructive disease of carnations in this area. Intensive efforts have been made in control but these have not been effective consistently. Thus research at Colorado State University has concerned itself largely with the various facets of this particular problem.

A practical approach to the control of any plant disease must be concerned with a comprehensive study of the interrelationships of host, pathogen, and environment. In the first phase of investigations on Fusarium stem rot, at least 2 factors were considered important in considering appropriate control measures: 1) the period during the life history of the host when it is susceptible to the pathogen, and 2) the means by which the inoculum gets about.

Timing of control measures.--Carnations are very susceptible to F. roseum f. cerealis when they are in the propagative bed. Indeed in 1 test only 1 spore in 10 cc of perlite at the time of "striking" was sufficient to induce lesions 21 days later at the end of the propagative period. If rooted cuttings are inoculated on the day of transplanting, however, there is evidence that 100 times as much inoculum is required to kill the plants (after 45 days). Soon after transplanting plants become even more resistant. Apparently different varieties are susceptible for varying periods after transplanting however. This may explain why some are more resistant than others. Thus Miller's Yellow was still susceptible 24 days after transplanting while William Sim was moderately resistant 4 days after transplanting (3,7). These investigations have made it possible to apply control measures at the proper time: that is immediately before and during propagation and for a short period thereafter.

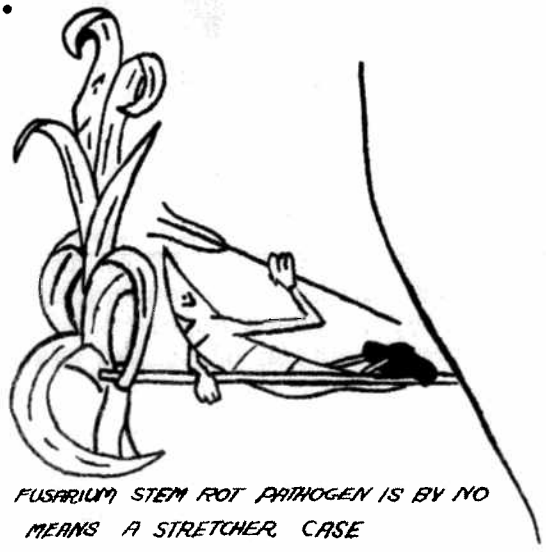
Carry-over of inoculum.--It has been emphasized, especially in the field of ornamental crops, that inoculum may be carelessly distributed by the unsuspecting operator in a variety of ways. Thus rigid enforcement of the conventional sanitation practices must be the rule and common denominator in the discussion that follows.

It may be assumed with reasonable certainty, however, that sanitation measures are more conscientiously applied in the commercial mother block houses(2) than in the flower producing ranges. Thus some explanation is needed for the sporodic occurrence of Fusarium stem rot on rooted cuttings produced in the former. The presence of inoculum on mother block cuttings has been postulated as an important means of carry-over (1,2).

In general Fusarium stem rot has been observed more frequently on cuttings and plants derived from mother blocks than from other sources. There are probably several factors which may account for this. Cuttings on mother blocks are grown much closer to the soil (which may be infested with F. roseum f. cerealis) than those on

flower producing plants. Due to the dense growth of mother blocks, the microclimate is more conducive for growth and reproduction of the pathogen on the plant itself. The lower leaves are soon shaded and die thus providing a nutrient base for the fungus. Again, the continuous cropping of cuttings affords more avenues on the mother plant for entry of the pathogen through wounds. In one instance at least, the Gates System of watering is utilized. This system has been observed to splash water and soil particles to a distance of 1 to 3 feet above the bench. Further, as a fertilizer solution is injected into the system, the plant is inundated with a nutrient solution which may contribute to the food base of the fungus. Add to this the fact that in all probability only 1 spore of the strain of the fungus commonly found in this area may be sufficient to incite death, and it is apparent that control is by no means simple.

The most convenient and readily applicable control measure would appear to be a spray program designed to eradicate the inoculum from cuttings while they are still on the mother plants. The recommended spray material has been Captan (2). Investigations at the University have been undertaken to critically evaluate the effectiveness of a spray program and to test some of the newer fungicides (10,14). Results have indicated that several compounds are effective in reducing losses. Further, some of the newer compounds may not only be more effective than Captan but are able to stimulate rooting.



THE FUSARIUM STEM ROT PATHOGEN IS BY NO MEANS A STRETCHER CASE

Evidence so far accumulated in the field and in controlled experiments have indicated that certain sprays are capable of significantly reducing the inoculum potential on the cuttings. However, these have not eliminated the pathogen completely. Experience has demonstrated that even with the spreaders now available, fungicides do not cover the entire surface of a carnation plant. This is especially true in the leaf axils where inoculum is likely to lodge. This has led to a series of experiments designed to investigate the possibility of insuring complete wetting of the cuttings through the use of dips (4,5,9,11). Currently Panodrench 4 (2 teaspoons/3 gallons of water) is recommended as a dip material. Tests have indicated that the presence of a suitable spreader in the solution is quite important and that the cuttings should be agitated during the 5 minute dip period.

Due to the unique system (2,17) by which the members of the Colorado Flower Growers Association obtain cultured stock, another means of control is possible. With a suitable means for the detection of F. roseum, any mother plant found to be "carrying" the pathogen can be eradicated. This is not possible with the conventional culturing procedures (1). A simple tool for the detection of small infestations of F. roseum has been developed and applied in the nucleus stocks at the University (8). Thus it may be possible to eradicate the stem rot pathogen from selections just as the vascular pathogens have been detected and eliminated by other methods.

Other considerations.--A factor which could modify all of the above generalizations on Fusarium stem rot is environment. Investigations on this phase have been initiated only recently.

Initially pathologists and growers alike accepted mist propagation with reservations. Experience had underscored the catastrophic results which accompanied the unrestrained use of water in any cultural operation. The fears have been alleviated to some extent by observations over a period of years. Certainly some diseases are favored under mist; however, there apparently have been no widespread epidemics in this area which can be traced to the use of this propagative system. On the contrary, preliminary evidence has indicated that carnations rooted under mist are more resistant to the Fusarium stem rot pathogen than those rooted by means of older conventional methods (16). The near-optimum conditions under mist of temperature, light, and humidity together with the use of a well drained rooting medium certainly gives at least a partial explanation for this situation.

There is a considerable amount of evidence that some varieties of carnations are quite resistant to the Fusarium stem rot pathogen shortly after the rooting period. Several factors may modify this condition however. Depth of planting of rooted cuttings apparently influences their susceptibility in the period following

transplanting (6). Other factors which may influence the resistance of carnation are under investigation.

The lowering of temperatures during the summer as a result of air conditioning would be expected to favor the host rather than the pathogen. The use of the air conditioning fans without wet pads for ventilation during cooler portions of the year when the relative humidity is low may lead to complications however. No critical experimental evidence is available in this regard but a high incidence of Fusarium stem rot has been observed under such conditions. Certainly carnations should not suffer undue stress when F. roseum f. cerealis is known to be present.

Occasionally plants from producing benches 6-12 months or older have been observed to wilt suddenly and die. When these plants were examined, they were found to have a rot of the stem at the ground level (Figure 1B). Relatively healthy tissue was observed above and below the rot in many instances. Isolates of F. roseum were obtained from the periphery of the rotted area.

The type of symptom described in the paragraph above has been reproduced at the experiment station greenhouses. Rooted cuttings were transplanted to flats containing sand and inoculated with F. roseum f. cerealis (1000 spores/cc of sand). They were watered intermittently with a weak nutrient solution. Evidences of infection were noted after a period of 3 weeks as superficial lesions on one side of the stem. After 75 days some of the plants had died but others had no obvious top symptoms of Fusarium stem rot. When the stems of the latter were observed in cross section, however, some had a rot extending from the original superficial lesion into the pith (see plant at left of Figure 1A). Extremes of wetting and drying as well as fluctuations in temperature at the ground level may account for tissues in this area being more susceptible to infection than the surrounding tissues.

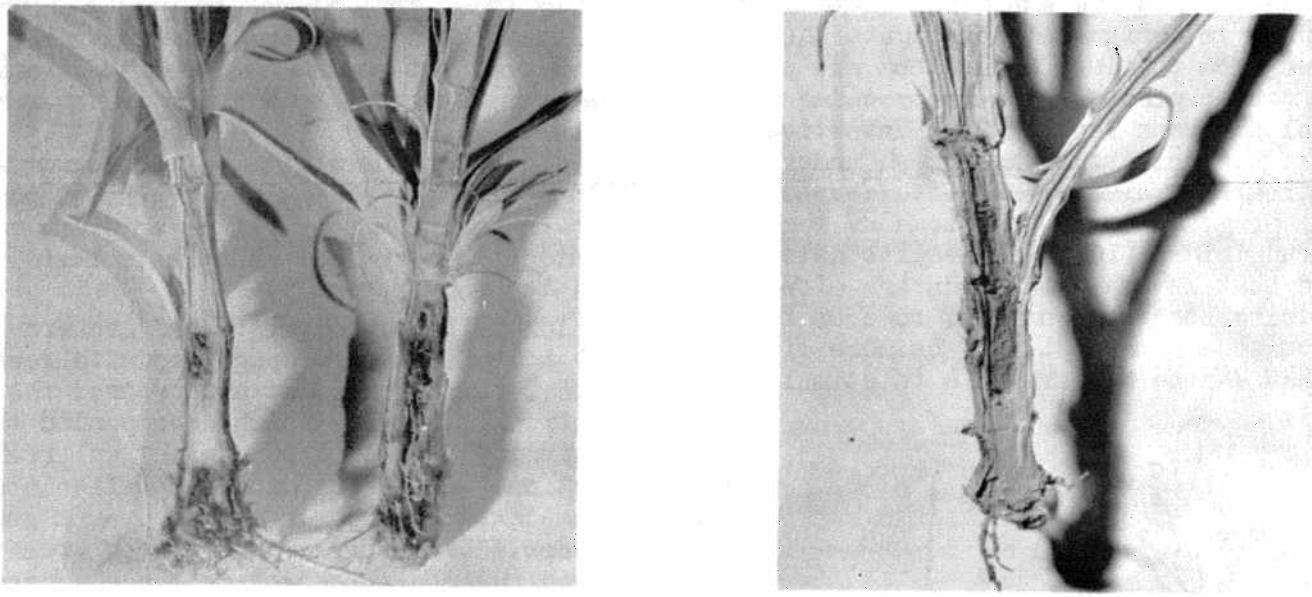


Figure 1.--Rot at ground level induced by Fusarium roseum f. cerealis on carnations. a) Carnations 75 days old (no top symptoms apparent) showing 2 means by which infection may spread from base of plant to tissues at ground level. Note superficial lesion on the left side of the stem on the plant at the left. Plant at right has rot extending from the base through the pith. b) Cross section of wilted plant 6 months old showing rot at ground level.

Future Prospects

At present Fusarium stem rot continues to be the most important disease problem in Colorado. While other diseases have been noticed on occasions, these have not been present on stock originating from the University.

Several methods for the control of Fusarium stem rot have been worked out but there is evidence that no single one of these will eliminate the problem. Research efforts thus must continue to be centered about more efficient methods of control. An even more important consideration, however, is the basic mechanisms of resistance in carnations to the stem rot pathogen and how it is influenced by environment. Only through a basic understanding of these factors can control measures be applied intelligently.

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