COLORADO FLOWER GROWERS ASSOCIATION

Bulletin 353 Edited by David E. Hartley November 1979

CONTROL OF VASCULAR WILT DISEASES OF CARNATION: RESISTANCE

Ralph Baker[1]

Plant disease losses from the vascular wilt pathogens of carnation (*Dianthus caryophyllus* L.) induced by *Fusarium oxysporum* Schlecht f. sp. *dianthi* (Prill et Del.) Snyd. & Hans. and *Phialophora cinerescens* (Wr.) van Beyma were reduced in greenhouse operations in this country many years ago with the advent of pathogen-free culture programs (1, 5, 7, 10). In most instances, pathogen-free propagative stock in commercial operations was planted conventionally into steamed soil in raised benches. With increased costs of materials for construction of benches and the improved quality of carnations grown without containment, however, there has been a tendency among growers to grow plants in so-called ground beds, i.e., greenhouse coverings constructed over soil with carnations planted in the "floor." In such cases, the vascular wilt pathogens, once introduced, are very difficult to eradicate with conventional control measures (5) such as steaming. This difficulty also has been experienced with other greenhouse crops, e.g., tomatoes (11). Thus, the vascular wilts have become the most important diseases in ground beds in Colorado and Fusarium wilt was reported in inducing the most loss in carnations in Great Britain (4).

Control of the vascular wilt pathogens of carnation has been attempted with several methods. Cultivars resistant to the vascular wilt pathogens (3) could aid in control, although commercial growers have been very slow to accept new cultivars. In some cases, the systemic fungicides have demonstrated potential for reduction of wilt diseases (e.g. 4). Soil fumigation with methyl bromide also was reported effective (e.g. 2, 10). Applications of ethephon were used to control Fusarium wilt of tomatoes by Orion and Hoestra (8).

[1]*Professor, Department of Botany and Plant Pathology, Colorado State University.*

Matta et al. (6) found naphthaleneacetic acid (NAA) to have endotherapeutic activity against both of the vascular wilt pathogens. The purpose of the research reported in this series of papers was to explore these recommended control measures and develop innovative procedures for control of the vascular wilt pathogens especially applicable to carnation culture in ground beds.

Tests were initiated to determine the relative resistance characteristics of various varieties and clones of Sim cultivars to Fusarium wilt.

Over a period of 5 yr, selections of carnations grown in the pathogen-free program at Colorado State University (5, 9) were propagated and planted in soil infested with *F. oxysporum* f. sp. *dianthi*. Periodically, the number of plants with symptoms was recorded over a 1 yr period. Cumulative losses at the end of the year are reported here, however, since they represent general trends of the results. Replications were used in all cases and only small variation occurred among these.

Various cultivars of carnation were planted in infested soil. Among cultivars used most frequently in the trade, CSU Red was most resistant and CSU Pink was susceptible; white cultivars were intermediate (White Pikes Peak) or susceptible (CSU White) in reaction (Fig. 1). Dusty and Atlantis, not frequently commercially grown, were resistant.

To determine whether clonal selections were variable in resistance, preliminary tests were done using three cultivars with two selections of each. There was a total of 30 plants of each selection exposed to the pathogen in two replications. Again, lower disease incidence occurred in selections from

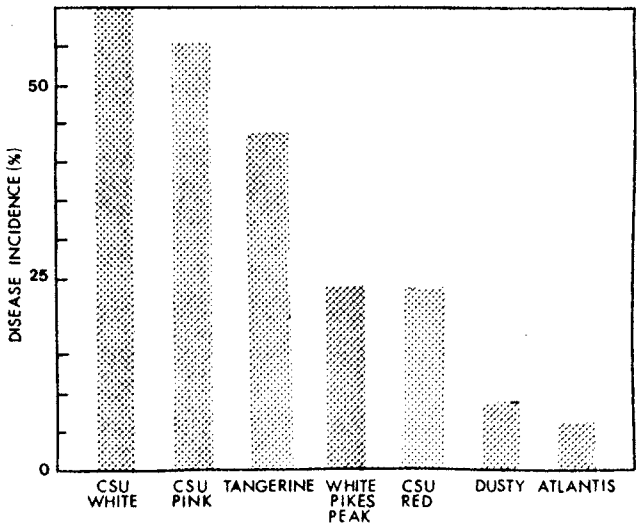

Figure 1: Disease incidence among cultivars of carnation planted in soil infested with Fusarium oxysporum f. sp. dianthi after 1 yr. Ninety plants of each cultivar were divided into three replications.

Table 1: Relative resistance among selections of carnation cultivars to *Fusarium oxysporum* f. sp. *dianthi*

Color of cultivar	Number of selection	Disease incidence[a] (%)
Red	R 1	67
	R 7	63
White	WS 8	33
	WP 9	70
Pink	P 8	77
	P 11	90

[a]Disease incidence expressed as percentage of plants with symptoms after 1 yr from 30 plants of each clone in two replications.

red than in those from pink cultivars (Table 1); however, the most resistant was a white selection (WS 8).

A large scale test was initiated to test selections among pink and white cultivars for resistance to *F. oxysporum*. The results (Table 2) indicated small differences in resistance.

Cultivars of carnation originating from William Sim apparently are periclinal chimeras (5). Thus, interior tissue, inhabited by the vascular wilt pathogens, could be closely related genetically among these cultivars and little differences in resistance expected. Even so, cultivars of Sim had different susceptibilities (Fig. 1). The data also suggest that there are small differences in resistance even among selections of cultivars (Tables 1, 2).

There are several considerations, however, that reduce the feasibility of using resistance as a practical control for the vascular wilt diseases. The management of commercial pathogen-free floricultural operations considers the most important factor to be maintenance of quality selections of cultivars (5). Thus, selections are constantly being disposed of when they do not measure up to vigorous standards of plant and flower quality. Routinely, proportions of selections eliminated are 50% or more each year. Thus, by the time resistant selections are detected, they may no longer exist in the trade. Furthermore, development and detection of resistant cultivars and clones is a time-consuming and expensive operation which has potential benefits for only a relatively small proportion of growers who use ground beds.

Table 2: Relative resistance of selections of carnation cultivars to *Fusarium oxysporum* f. sp. *dianthi*

Selections of pink cultivars	Disease incidence[a] (%)	Selections of white cultivars
	0	WS1A1-D, WS1A1-E, WS9C1-C, WS10B1-A
	1	WS9C-B, WS9C1-A, WS10B1-D
P4C-2, P8B-5 P13B-2	2	WS1A1-A, WS1A1-B, WS9C1-B, WS9C1-E WS10B1-B
P8B-3, P8B-2 P13B-3, P13B-1	4	WS1A1-C
P4C-6	5	
P4C-4, P8B-1	6	WS10B1-C
P8B-6, P4C-1, P8C-2	7	WS10B1-E
P4C-5	8	
P4A-1, P8B-4	9	
P4C-3, P8C-1	11	

[a]Disease incidence expressed as percentage of plants with symptoms after 1 yr from a total of 140 plants in four replications.

Perhaps the only constructive and practical recommendation related to use of resistance for control of vascular wilt diseases of carnation is to plant red flowered cultivars of Sim in areas known to be heavily infested with the pathogens.

Literature Cited

1. BAKER, R., and D. J. PHILLIPS. 1962. Obtaining pathogen-free stock by shoot tip culture. Phytopathology 52: 1242-1244.
2. BESEMER, S. T., and A. H. McCAIN. 1978. Carnation fusarium wilt: control with soil fumigation and fungicides. Bromides in Agr. 41: 16-18.
3. CARRIER, L. E. 1977. Breeding carnations for disease resistance in southern California. Acta Horticulturae 71: 165-168.
4. EVANS, S. G. 1976. Evaluation of benomyl soil drenches for the control of verticillium and fusarium wilt of carnations. Pl. Pathol. 25: 81-84.
5. HOLLEY, W. D., and R. BAKER. 1963. Carnation production. Wm. C. Brown Co., Dubuque, Iowa, 142 p.
6. MATTA, A., A. GARIBALDI, and M. PALENZONA. 1969. Impiego dell'acido naftalenacetico contro le tracheomicosi del Garofano, pages 218-222 *in* Atti del Primo Congresso dell'Unione Fitopathologica Mediterranea, Part I. Unione Fitopathologica Mediterranea, 271 p.
7. NELSON, P. E., J. TAMMEN, and R. BAKER. 1960. Control of vascular wilt diseases of carnation by culture-indexing.
8. ORION, D., and H. HOESTRA. 1974. The effect of root-knot nematodes and Ethrel on fusarium wilt of tomatoes. Neth. J. Pl. Pathol. 80: 23-36.
9. PHILLIPS, D. J. 1968. Carnation shoot tip culture. Colorado State Univ. Expt. Sta. Tech. Bul. 102. 22p.
10. VIGODSKY, H. H., and L. KLEIN. 1976. Influence of methyl bromide soil fumigation method on fungicidal efficiency and bromide residues. Phytoparasitica 4: 123-129.
11. WESTSTEIJM, G. 1973. Soil sterilization and glasshouse disinfection to control Fusarium oxysporum f. lycopersici in tomatoes in the Netherlands. Neth. J. Pl. Pathol. 79: 36-40.