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CONTROL OF VASCULAR WILT DISEASES OF CARNATION: SYSTEMIC FUNGICIDES AND CHEMOTHERAPEUTICS

Ralph Baker[1]

Control of the vascular wilts of carnation has been reported with applications of appropriate systemic fungicides to soil (2, 3). Growth regulating chemicals have also been reported to control vascular wilt diseases. In Holland, Orion and Hoestra (6) used applications of ethephon to control Fusarium wilt of tomatoes. Matta et al. (5) found naphthaleneacetic acid to have endotherapeutic activity against the carnation vascular wilt pathogens. The purpose of the research reported in this paper was to test systemic fungicides and growth regulating chemicals for their chemotherapeutic properties in control of the carnation vascular pathogens found in the greenhouse industry in Colorado.

Fusarium oxysporium f. sp. *dianthi* and *Phialophora cinerescens* were isolated from carnations exhibiting typical symptoms of the vascular wilts. These fungi were increased on sterilized leaves and stems of carnation (4) and added to soil when tests were run at Colorado State University. In other experiments, plots were set up in commercial greenhouses. The beds in these cases had a history of loss induced by the vascular pathogens and, thus, inoculum was already present.

As typical symptoms of the wilts appeared, the number of infected plants was recorded periodically. In the few cases where symptom expression alone was not adequate for diagnosis, culture techniques were employed to determine the causal agent.

In repeated experiments both in commercial greenhouses and under the more controlled conditions in the university greenhouses, the incidence of vascular wilt diseases was reduced using systemic fungitoxins. Typical experiments are reported below.

A high incidence of Phialophora wilt was observed in a commercial greenhouse. Benches, in this case, were raised; however, the grower did not wish to steam and replaced the soil in the benches between each crop. Even though the soil used in the previous crop was removed and benches thoroughly hosed down, recontamination occurred so that there was a history of consistent loss. Plots were set up in these benches, each 20 feet long and 3.5 feet wide (the bench width), and treatments were replicated three times. Each treatment in each replication contained 189 plants.

Benomyl (Benlate®) (E. I. du Pont de Nemours & Co., Wilmington, Delaware) at 4 lbs/1000 ft^2 (product), ethazol and thiophanate-methyl at 10 lbs/1000 ft^2 (product) and ethazol at 4 lbs/1000 ft^2 (product) were mixed into the soil by hand-tools before transplanting carnations. The product, benomyl, has a 50% active ingredient of methyl 1-(butylcarbamoyl)-2 benzimidazolecarbamate. The product, ethazol, is 30% active 5-ethoxy-3-trichoromethyl-1,2,4-thiadiazole. The product, ethazol and thiophanate-methyl, is a 15% mixture of this active ingredient and 25% dimethyl 4,4-0-phenylenebis(3-thioallophanate).

Cuttings were planted December 17, 1974 and by January 6, 1975 phytotoxicity, as evidenced by bleached tips of leaves and death of plants, was apparent in plots treated with the mixture of ethazol and thiophanate-methyl. Dead plants were replaced and other injured plants recovered, however.

The results of this experiment are illustrated in Fig. 1. After 364 days, loss in control plots or in those treated with

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

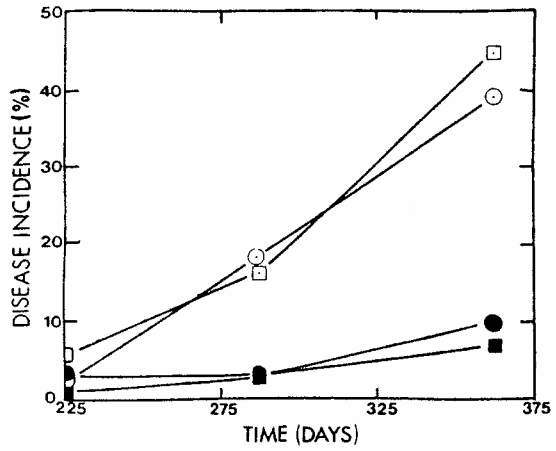

Figure 1: Control of Phialophora wilt by mixing benomyl or ethazol thiopanate-methyl in soil before transplanting rooted carnation cuttings. 0——0 inoculated control; ●——● benomyl; □——□ ethazole; ■——■ ethazole and thiophanate-methyl.

ethazol was approximately 40% whereas less than 10% loss was experienced in those treated with benomyl or thiophanate-methyl.

An experiment done at Colorado State University illustrates the control achieved for Fusarium wilt using benomyl. Each plot in conventional greenhouse benches contained 25 plants (five rows of five plants each row) with buffer rows on each side of the plot. There were four replications. Soil was infested with inoculum of *F. oxysporum* f. sp. *dianthi*, benomyl mixed in the soil at the same rate as above, and rooted cuttings transplanted.

In addition to an inoculated control, two other chemical treatments were incorporated in this test. Following the recommendations of Orion and Hoestra (6), ethephon (2 chlorothane phosphonic acid, Amchem Products, Inc., Ambler, Pennsylvania) at the rate of 10 mg/plant was applied as a drench. This treatment was repeated at monthly intervals. In another treatment, plants were sprayed (5) at 10 day intervals with a 50 μg/ml water solution of napthalene acetic acid (Nutritional Biochemicals Corp., Cleveland, Ohio). After four applications, plant growth regulative effects were observed and spray concentration was reduced to 10 μg/ml water.

Control of Fusarium wilt was achieved using benomyl (Fig. 2). Applications of ethephon or napthalene acetic acid had no effect on development of Fusarium wilt.

Ethephon also was applied in a commercial greenhouse at the same rate at monthly intervals as a part of another experiment involving combination metam-sodium (VAPAM®) and steam treatments. Results, presented in Fig. 3 of CFGA Bulletin 354, (1) are typical of the failure of ethephon to control Fusarium wilt of carnations in repeated experiments. Carnations treated with ethephon were stunted, axillary shoots were retarded, and excessive bullheading and splits in calyxes of flowers occurred.

Thus, the systemic fungicides, which are components of benomyl and the mixture of ethazole thiophanate-methyl, provided good control of the vascular wilt diseases of carnation and are cost-effective at present economic levels. At the rates used in these experiments, however,

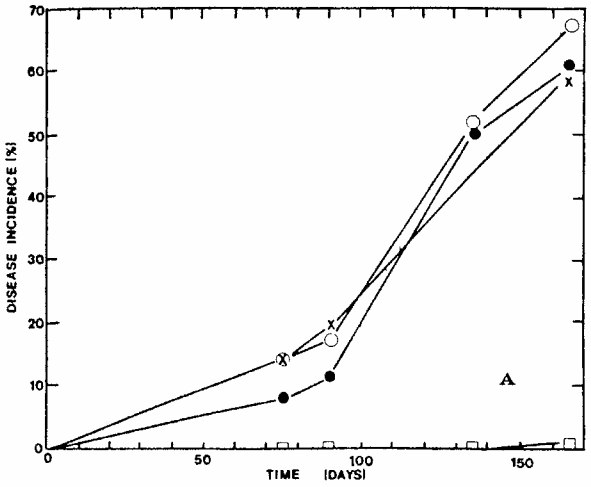

Figure 2: Control of Fusarium wilt by mixing benomyl in soil before transplanting root carnation cuttings in soil infested with *Fusarium oxysporum* f. sp. *dianthi*. Other plots were treated with either sprays of napthalene acetic acid (NAA) or drenched with ethephon solutions. 0——0 *inoculated control;* ●···● NAA; X——X ethephon; □——□ benomyl.

there was no chemotherapeutic effect exerted against Fusarium wilt by either ethephon or naphthaleneacetic acid.

Benomyl is sold under the trade name of Benlate®. Since it is almost insoluble, it should be rototilled into soil before transplanting. At temperatures achieved in steaming soil, it does not decompose and thus can be incorporated with fertilizers (like phosphate and lime) before soil treatment. The rate usually used, as given in a previous report, is 4 lbs/1000 ft^2 of bed and this can be brought up with drenches to 6-10 lbs/1000 ft^2/year. The mixture, ethazole thiophanate-methyl, is sold under the trade name of Banrot® and should be incorporated into soil in a manner similar to benomyl. No single application should exceed 2-3 lbs/1000 ft^2, however, and the ethazole component may be decomposed during steaming.

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