SUMMARY OF CARNATION SOIL TREATMENTS WITH FUNGICIDES IN DENVER, 1951-1952

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The application of fungicidal chemicals to greenhouse soils for the control of soil-borne diseases of carnations has become an important field of investigation since 1946. Experimental test plots have been maintained in the Denver area since that time in an attempt to find a fungicide which would be effective against Fusarium diseases of carnations. After five years of testing it was reported in 1951 that zineb and copper-zinc-chromate fungicides, and a strain of Trichoderma lignorum (Tri-lig 74) effectively reduced losses due to these diseases.

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The control afforded by such compounds was not complete, however, and seldom decreased losses more than half. At best, however, complete

control by chemicals substituted for steam sterilization of soil cannot and should not be expected for some time. Once materials had been found which had some effect against fusarioses of carnations, it became necessary to find materials even more effective among the newer types of fungicides. For this purpose test plots were maintained in 1951-52, and are still being maintained.

Intensive screening tests in the laboratory in 1951 resulted in eight fungicides or antibiotic agents demonstrating high effectiveness against Fusarium oxysporum f. dianthi and Fusarium culmorum. These materials are listed in Table 1. Preliminary greenhouse tests established possible rates of application, and substantiated laboratory investigations. They were applied at the Kintzele Greenhouses at the rates indicated in Table 1 to a bench which was blocked off with dividers to provide 5 replications of four five-plant rows per treatment, including inoculated and uninoculated checks. The steam-sterilized soil in the benches was inoculated with a mass culture of the Fusaria just prior to planting rooted cuttings of Millers Yellow carnations. One week after planting the bench was treated with solutions of the eight materials using a hand-pressure Hudson sprayer from which the nozzle had been removed. A total of three applications three months apart were made during the year, final readings being made one year after the start of the test.

Another experiment was designed to test the economy of recommended materials, and to test further their efficiency under commercial conditions. Tri-lig 74, Dithane Z-78, Dithane D-14, and Crag 531 were applied to naturally infected benches at the R. Braun, Leo Holberg and Skyline greenhouses. A total of 500 sq. ft. were used in each bench, only one chemical being used per bench; one-fifth of this area in the center of the bench was untreated, serving as a check. The chemicals were applied in solutions with the growers' spraying equipment from which nozzles had been removed, drenching the soil soon after planting at recommended rates (Table 2).

Table 1.--Effect of soil treatments on yield and incidence of Fusarium wilt and root rot of carnations in Denver, 1951-52.

Treatment/1	Rate of application (oz./100 ft.^{2})	No. plants/2 infected	Pct. control	Yield/3
Actidione	2	3.6	14.3	77.0
Vancide 51	6	0.2	95.3	91.8
Neovita	4	0.0	100.0	91.6
Cadminate	2	0.0	100.0	90.6
Goodrite tcpa	4	5.2	0.0	86.6
Goodrite zac	2	0.2	95.3	94.0
Strep #115	6	1.0	76.5	90.8
Parzate	4	0.6	85.8	88.8
Check		4.2	----	83.0

/1 Materials used in test; composition and manufacturer.
Actidione (acti-dione carbon adsorbate, 3.5%) Upjohn
Vancide 51 (sodium salt of dimethyl dithiocarbamic acid and sodium salt of 2-mercapto benzothiazole, 30%) Vanderbilt.
Neovita (5.45% potassium polysulphide, 4.27% potassium thiosulphate), Re-mark.
Cadminate (Cadmium succinate, 60%) Mallinckrodt.
Goodrite tcpa (2,4,5,-trichloro phenyl acetate) Goodrich Chemical Company.
Goodrite zac (sodium ethylene bisdithiocarbamate, cyclohexamine complex, 60%) Goodrich Chemical Company.
Strep #115 (Culture 115 of Streptomyces sp.) Colorado A & M College.
Parzate (zinc ethylene bisdithiocarbamate, 65%) Dupont.
The cooperation of the above chemical concerns in furnishing these materials is acknowledged and appreciated.

/2 Average number of plants infected out of 10 plants per replication, 5 replications per treatment.

/3 Average number of salable blossoms (5 replications), excluding splits, from Sept., 1951 through May 1952.

The results in Table 1 show that Neo-vita and Cadminate were outstanding in their control, as no infection was evident. Vancide 51 and Goodrite z. a. c. provided 95.3 percent control as compared to 85.8 percent control afforded by Parzate (used as the recommended zineb type standard). Other materials used in the test were less effective than the recommended zineb type.

Injury was very evident in plants treated with actidione, while vigor was somewhat below that of the check plants in plants treated with Cadminate and Goodrite z.a.c. On the other hand, plants treated with Vancide 51, Neo-vita and Parzate were much more vigorous than were the check plants.

From the standpoint of total yield (Table 1), Goodrite z. a. c. treatment outyielded all other treatments, approaching significance. None of the materials, however, differed significantly from the check in total yield. On a monthly basis a peak yield resulted in the check in November, Cadminate in December, Neo-vita in January, and Vancide 51 in April. Plots treated with Parzate had a double peak in January and March, whereas those treated with Goodrite z.a.c. had a double peak in March and May.

On the basis of overall performance, Neo-vita was outstanding. This chemical, together with Vancide 51 and Goodrite z.a.c. will be tested further in growers' tests.

Table 2.--Results of commercial tests of soil treatments on carnations in Denver, 1951-1952

Treatment	Grower cooperating	Rate of applications (per 100 ft.^{2})	Pct./2 control	Rating
Tri-lig 74	R. Braun	2.25 oz.	62	1
Dithane Z-78	L. Hollberg	4 oz.	46	2
Dithane D-14/1	"	1 qt.	50	2
Crag 531	Skyline	4 oz.	33	3

/1 Dithane D-14 used without zinc sulphate or lime.

/2 Pct. control over check.

Results of the commercial tests (Table 2) indicated 62% control with Tri-lig 74. No outstanding differences in the effect of Dithane D-14 (nabam), and Dithane Z-78 (zineb) were observed; both materials approaching 50 percent control. Treatment with Crag 531 resulted in 33 percent control. This was less effective than in tests in previous years; the results, however, were confused by the presence of bacterial wilt in the plot. None of these materials have been found to be effective against bacterial wilt. On the basis of these results, these four materials remain the recommended soil treatments for the control of soil-borne Fusarium diseases of carnations.