COLORADO FLOWER GROWERS ASSOCIATION

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CONTROL OF VASCULAR WILT DISEASES OF CARNATION: ERADICATION

Ralph Baker[1]

Since the advent of pathogen-free propagation procedures, the vascular wilt diseases of carnation have been almost eliminated from raised greenhouse benches. The reasons for this are easily understood: cuttings not "carrying" the pathogens are routinely planted in steamed soil confined to benches which are not recontaminated if reasonable sanitation practices are followed. There is a different situation in ground beds, however. Inoculum generated in a previously diseased crop probably is distributed in soil as deep as host roots penetrate. Steaming does not eradicate the pathogens at such depths and walks (which may also harbor inoculum) are often not adequately steamed because of soil compaction. Thus, in commercial carnation culture, losses occur from the vascular wilt pathogens in ground beds because inoculum is not eradicated even though conventional control measures are followed.

Experimental plots were set up over a six-year period in a commercial greenhouse to test the possibility of increasing the efficiency of eradication of inoculum in soil by introducing fumigants along with steam. These plots had a history of loss induced by the vascular pathogens and, thus, inoculum was already present.

One wk before steaming, metam-sodium, VAPAM® (sodium methyldithiocarbamate from Stauffer Chemicals, Dayton, New Jersey) was applied as a soil drench (1 qt/100 ft^2) at the ends of ground beds in a commercial greenhouse in which extensive losses from Fusarium wilt had occurred.

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Carnations from the preceding planting (transplanted 2 yr before) were still in these beds. The treated areas were watered thoroughly to aid penetration of the fumigant and provide a seal for trapping evolved volatiles. Five days later, plants from the preceding crop were uprooted and removed, the beds cultivated and preparations made for steaming.

One day before steaming, methyl bromide (The Dow Chemical Company, Midland, Michigan) was applied at a rate of 1 lb/100 ft^2 of soil surface to other plots and confined with a plastic cover. The cover was left in place for 24 hr, at which time steaming operations by the grower were begun.

Conventional surface steaming with steam confined under a cover, the Thomas method, (1) was employed. Temperatures achieved were 82 C (180 F) minimum, to a depth of at least 6 inches for at least ½ hr. All previously treated plots were steamed (according to the usual practices of the grower) together with controls which had not been treated with metam-sodium (VAPAM®) or methyl bromide.

Each plot was 20 ft in length and 3½ ft in width containing 210 plants. These plots extended across five beds and maps were prepared of the locations of losses induced by Fusarium wilt in the previous crop. There were three replications.

Disease losses were followed over a 2 yr period (Fig. 1). When losses occurred, they were not initially as great in the plots treated with methyl bromide as in the controls; however, at the end of 2 yr there was little difference in proportion of plants with symptoms. Disease in plots treated with metam-sodium and steam were not seen until the end of experiment.

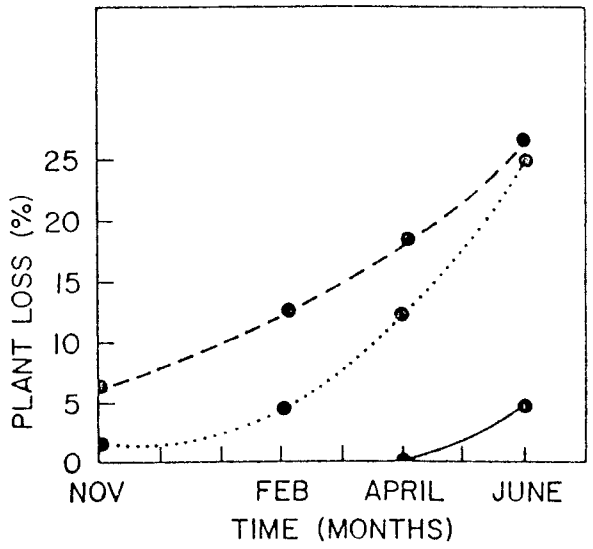

Figure 1: Losses in carnations due to Fusarium wilt in the second year after transplanting when beds were treated with fumigants. All plots were steamed after fumigation treatments. Each plot contained 210 plants and there were three replications. ●----● steamed only; O···O methyl bromide and steam; ●——● metam-sodium (VAPAM®) and steam.

When experiments (such as the one just described) are done in commercial greenhouses, it is difficult to adjust parameters so that they are uniform. For instance, it is difficult to insure that inoculum is uniformly distributed. Thus, Fig. 2 illustrates (in diagramatic form) the loss distribution occurring before treatments were applied and disease incidence at the end of the experiment. Diagrams of disease loss in each plot are also given adjacent to the appropriate plot. These data (condensed in Fig. 1) indicate good replication, when compared with the losses in the previous crops, in results among various treatments. They

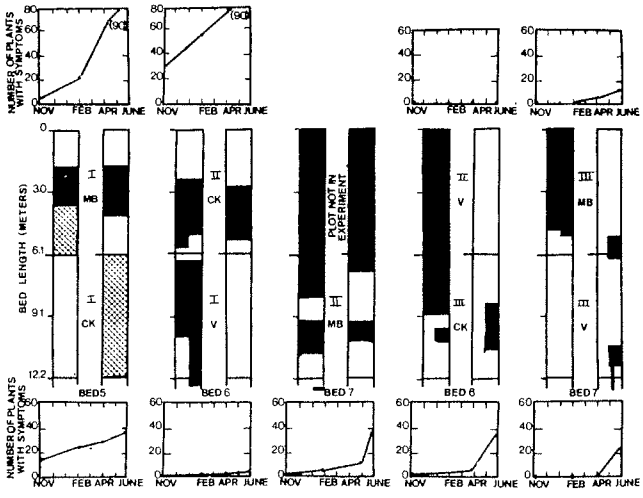

Figure 2: Diagramatic representation to scale of data obtained in plots for Fig. 1. Loss in each plot over time is presented above or below each plot. Figures in parentheses are total losses occurring in the methyl bromide treated plot in replication I and in the control (steamed only) plot in replicate II by June. In each case, dark areas on bench diagrams to the left illustrate dead plants in preceding crop and to the right, dead plants after 2 yr at the end of the experiment. Checkered areas indicate that disease was scattered through that section of the plot. CK = control V = metam-sodium (VAPAM®) MB = methyl bromide

also suggest that a large proportion of the loss in the metam-sodium plus steam treatment was from invasion in bed 7 (third replication) from an adjacent nontreated area. Inoculum appeared to be eradicated consistently when metam-sodium and steam were applied. In some plots, steam alone or this treatment combined with methyl bromide, apparently eradicated inoculum in some areas but not consistently.

Immediately following this experiment, the value of metam-sodium and steam treatments for control of Fusarium wilt was tested again in another area of the same greenhouse complex. This time, three beds (each one a replication) were used. All had a history of loss due to Fusarium wilt. Each treatment plot in this case was 50 ft long and 3½ ft wide with 525 plants. Metam-sodium was applied as in the experiment immediately above, and all beds were surface steamed 1 wk later as described previously.

Results (Fig. 3) indicated good control when metam-sodium was applied 1 wk before steaming in comparison to plots in which only steam was applied. (Fig. 3 also illustrates data accumulated for treatments with ethephon which were incorporated in the same experiment. This portion of the experiment will be treated in the next paper of this series.)

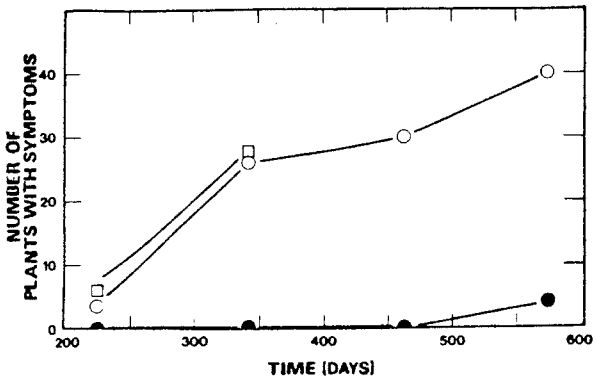

Figure 3: Losses in carnations due to Fusarium wilt when beds were treated with metam-sodium (VAPAM®) or drenched with ethephon. All plots were steamed before beds were planted and each contained 525 plants. Ethephon treatments were discontinued after 350 days because of phytotoxicity. O——O steamed only; ●——● metam-sodium (VAPAM®) and steam; □——□ steamed followed by drenches of ethephon.

The third experiment in another area of the same greenhouse complex, compared metam-sodium treatment with steam alone to control Phialophora wilt. Entire beds (150 ft long and each containing 1575 plants) were used for each of three replications for each treatment. Disease losses (primarily due to *P. cinerascens)* in the preceding crop were mapped before treatments. In this case, metam-sodium was applied at the rate used in the previous experiments, alone or in combination with steam. Steam was introduced through two tiles (each 4 inches in diameter) running the length of the beds and buried approximately 20 inches below the soil surface. Thus, penetration by the steam was deeper than in the previous experiments in which steam was introduced only on the surface.

The results are graphically illustrated in Fig. 4. Approximately 200 days after transplanting carnations into the beds, the proportion of diseased plants in the beds treated only with metam-sodium increased rapidly. Plant losses were so great in one of these beds by 500 days that the

grower took out the remaining symptomless carnations and used the space for bedding plants. This is the reason for the break in the curve (at 500 days) illustrating disease increase in plots treated only with metam-sodium in Fig. 4. Points after that time are for two replications rather than three. Proportions of disease in plots treated only with steam or metam-sodium and steam were relatively lower, but similar, reaching approximately 8% after 2 years.

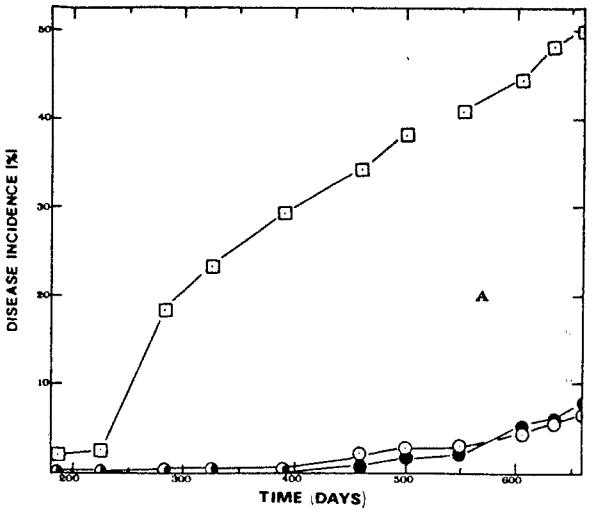

Figure 4: Loss in carnations due to Phialophora wilt when beds were treated with metam-sodium (VAPAM®) and/or steam. The break in the curve between 500 and 550 days for the metam-sodium treatment indicated elimination of one replication. Data for that treatment after 550 days include only two replications. O——O = steamed only; ●——● = metam-sodium and steam; □——□ = metam-sodium only.

Fig. 5 illustrates diagramatically the losses (graphically illustrated in Fig. 4) occurring in the previous crop before treatments were applied, 1 yr afterwards, and at the termination of the experiment (2 yr after treatments). Inoculum was apparently eradicated in some areas using metam-sodium and steam or steam alone but not in others. New centers of infection also were apparent when either treatment was used. For those areas in which eradication was not complete, subsequent disease proportions were usually as great or even greater than in the preceding crop. In the last 2 mo of the experiment, symptoms of Fusarium wilt began to appear in a small proportion of the plants. The location and numbers of plants with symptoms of this disease are given on the maps of the beds in Fig. 5.

In three other tests in commercial greenhouses, metam-sodium alone did not provide control of either Fusarium or Phialophora wilts. Grower experience also confirmed this result.

The Fusarium wilt pathogen apparently was eradicated more effectively by metam-sodium coupled with steam

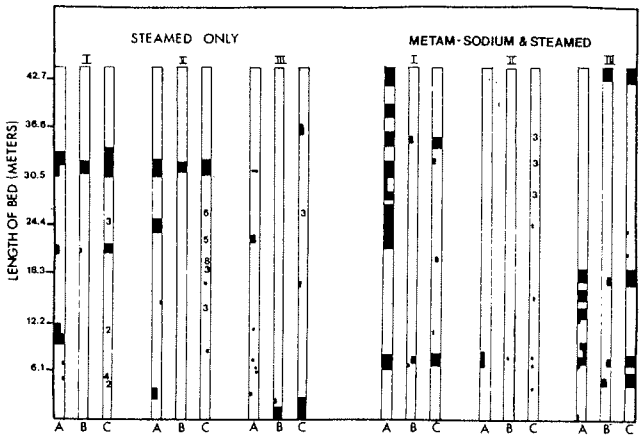

Figure 5: Diagramatic representation to scale of data illustrated in Fig. 4 for those plots in which metam-sodium (VAPAM®) plus steam and steam alone were applied. Roman numerals indicate replication numbers. Dark areas are locations where 100% death of plants occurred. Letters at the base of each plot of bed indicate: A) loss in preceding crop; B) loss approximately 1 yr after benches were planted; C) loss at completion of experiment approximately 2 yr after transplanting. Figures on plots refer to actual numbers of plants with symptoms of Fusarium wilt at the end of the experiment.

treatments than by steam alone (Fig. 2-4). Presumably, this resulted from deeper penetration in soil of volatiles toxic to survival structures of the pathogen. The addition of metam-sodium with steam, however, gave no further increment of control for Phialophora wilt (Fig. 4, 5). The most logical explanation for this is that the tiles in the beds distributed the steam to a much greater depth than in the beds infested with *F. oxysporum* f. sp. *dianthi* to which only surface steaming was applied. Thus, the addition of metam-sodium treatments to the beds harboring *P. cinerescens* gave no further advantage for penetration of toxic agents. Metam-sodium alone was not effective in control (Fig. 4). Methyl bromide and steam delayed development of Fusarium wilt, but losses were of the same proportion at the end of 2 yr as in those beds treated only with steam (Fig. 2).

Thus, more efficient eradication of inoculum of the vascular wilt pathogens may be accomplished through combinations of metam-sodium (VAPAM®) and surface steaming than by either one of these treatments alone. The results also suggest that steam introduced through tile at sufficient depths may substantially eradicate inoculum. There was no evidence, however that applications of metam-sodium (VAPAM®) alone provided control.

Literature Cited

1. BAKER, K. F. 1969. The U. C. system for producing healthy container-grown plants. Calif. Agr. Expr. Sta. Manual 23: 1-332.

10th ANNUAL ROCKY MOUNTAIN GROWERS SHORT COURSE AND EXPOSITION

OPPORTUNITIES FOR THE 80's

January 9, 10, 11, 1980
Colorado State University Student Center

WEDNESDAY, JANUARY 9

12:00 Trade Fair Setup, West Ballroom

6:00-9:00 PM Opening of Trade Fair and Reception

THURSDAY, JANUARY 10

8:00-9:30 Registration
2nd Floor North Hallway, Student Center
Trade Fair, West Ballroom Coffee and Rolls

Theme: IDEAS FOR THE 80's Room 230

9:30 MOTIVATING YOURSELF & OTHERS
William Strunk, Speech Specialist, Denver

10:30 EDUCATING THE PUBLIC, A MUST
Doug Crater, University of Georgia

11:30 ASSOCIATIONS DO IT
Doug Dillon, President SAF

12:00 Lunch - North Ballroom

1:00 Annual Grower Meeting, North Ballroom
Trade Fair, West Ballroom

THURSDAY AFTERNOON - CONCURRENT SESSIONS

	BEDDING & POT PLANTS Bob Briggs, Moderator	MISCELLANEOUS CUTS John Shelton, Moderator	MANAGEMENT Bill Piefer, Moderator
Theme:	"Bigger & Better Opportunities" Room 228	"New Horizons" Rooms 224-226	"Managing for Profit" Room 230
1:30	WHAT ARE THE TRENDS IN BEDDING PLANTS Ken Ludwig - Vaughan-Jacklin	YOU CAN CREATE MARKET DEMANDS WITH CUTS Seward Besemer, California	TIME MGMT. PART I ANALYZING YOUR TIME Gurdon Dennis, Michigan State
2:30	SOME POTS THAT SELL TRY 'EM Doug Crater	Panel: CUT FLOWERS YOU CAN SELL, EXPERIENCE SPEAKS! Bob Gallan - Mums Homer Hill - Freesia Gene Yoshihara - Snaps Eddie Kornfeld - Tulips Ken Tagawa - Single Crop Carn.	TIME MGMT. PART II CONTROLLING YOUR TIME Gurdon Dennis
3:30	Panel: NEW MARKET TRENDS AS I SEE IT Alex Gerace Dan Busch Mike Ditirro Discussion —	MAKING CUTS PROFITABLE THROUGH MECHANIZATION Seward Besemer	MONEY MAKING IDEAS THROUGH TAX SAVINGS, ESTATE PLANNING AND PERSONNEL MGMT. Dick Miller & Tom Brown Tampa, Florida (Note: Dick and Tom will be available in Rm. 232 Friday morning for a group question and answer period.)
4:15	Group Discussions Trade Fair	Group Discussions Trade Fair	

6:00 Happy Hour, North Ballroom.

7:00 Dinner — Program - North Ballroom.

FRIDAY, JANUARY 11

7:30	Big Breakfast, North Ballroom		
8:00	Trade Fair		
	GROWERS Gary Howard, Moderator		**MANAGEMENT** Al Gerace, Moderator
8:30	BACK TO BASICS Starting Your Plants Ken Ludwig Media Doug Crater Nutrition Dave Hartley CO_2 Ken Goldsberry Water Joe Hanan Light Ken Goldsberry Temperature Joe Hanan	8:30	TIME MGMT. PART III Time vs. Delegation
		9:30	TIME MGTM. PART IV Time vs Effective Management
10:30	**CSU REPORTS** Single Crop Carnations Split Rose Temps. Nutrition of Bedding Plants Miniature Carnations Rose Selections Mini Pot Poinsettias	10:30	DETERMINING YOUR PROFIT FOR 1980 TODAY - COMPUTER STYLE John Ellis, CSU Chmn., Dept. Finance & Real Estate
		11:30	THE SECRET OF MANAGEMENT John McKeever, CSU Professor, Business Management

FRIDAY, JANUARY 11 — TOURS

12:00-12:30	Lunch at Department of Horticulture Plant Environmental Research Center Greenhouses, 630 W. Lake
12:30	Start of Tours of New Greenhouse Facilities and View Research Facilities
1:45	Country Gardens Miscellaneous Cut Flowers, Bedding and Pot Plants
2:45	Jordons Greenhouses 55,000 sq. ft. of Rose Production
3:45	CSU State Forest Greenhouse (Growing trees from seed)

Registration	Pre-Reg.	Late Reg. (after Jan. 10)
First Person from a company	$30	$35
Additional Person	$22	$27
Students	$5	$8

Meals

Thursday Lunch	$ 5.25
Thursday Night Banquet & Program	$11.00
Friday The Big Breakfast Buffet	$ 4.00
Friday Lunch & Tour	$ 8.00

Make your motel reservations at University Motor Inn (3 blocks from center)
914 So. College
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Sgl. $23. Dbl. $30.

Private Residence Hall: (private baths)
Bromley Hall (3 blocks from center)
601 S. Howes
Ft. Collins, CO 80521
Phone 484-3704
Sgl. $12. Dbl. $18.

Who are the Out of State Speakers:

Doug Dillon — President Society American Florists, Alexander, Virginia

Doug Crater — Extension Floriculturist specializing in educating the consumer and evaluates new materials for pot plants. University of Georgia.

Seward Besemer — Extension Floriculturist, University of California - San Diego. Besemer has traveled in Europe and Israel and has fantastic suggestions for increasing returns on all cut flowers.

Ken Ludwig — Head of Seed Department and Sales Department, Vaughan-Jacklin Corporation.

Dick Miller and Tom Brown — Experts on tax saving ideas for the greenhouse operator, plus planning ahead for family operations. Two Floridians becoming well known to the greenhouse industry.

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