Fusarium Stem Rot of Carnations: Chemotherapeutic Control in Propagated Cuttings from Mother Blocks Treated with Systemic Fungicides

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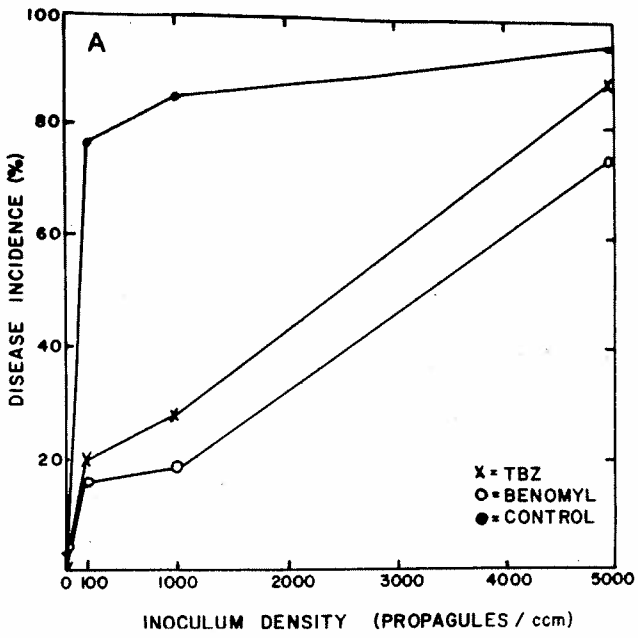
Previous papers in this series have treated the possibilities of using the new systemic fungicides to control stem rot of carnations (causal agent, *Fusarium roseum*) in rooting hormone (3) and in sprays applied to mother blocks (1). This paper describes experiments designed to test the possibility of applying these fungicides so that they are taken up systemically by mother plants and thus render cuttings more resistant to invasion by the pathogen. Such chemotherapy is most appropriate since the pathogen is carried over on cuttings (4) and enters the wounded stem during propagation (2).

Mother blocks were established in gravel and watered automatically through a Gates system for 1½ min twice daily with a nutrient solution injected by a proportioner (1:200). The nutrient solution applied to the plants contained 4 lb ammonium nitrate, 0.25 lb sodium nitrate, 2 lb muriate potash, 0.5 lb epsom salts, and ½ ozs borax/1000 gal water. The fungicides were injected into the line containing the nutrient solution after 75 days, when plants were firmly established and were producing side breaks. Using these automatic systems, one mother block received 3 ppm (active) benomyl and another 1 ppm (active) TBZ at each watering. A third, watered only with the nutrient solution, served as a control. Cuttings produced on the mother block were taken periodically, inoculated, and propagated as described previously (3).



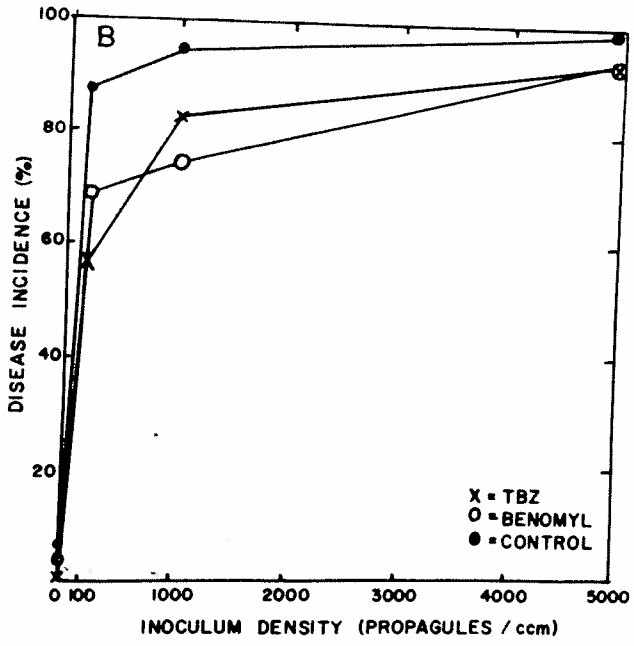


Figure 1. Disease observed on cuttings from mother blocks irrigated with nutrient solution containing benomyl or TBZ and inoculated with various inoculum densities of *Fusarium roseum* in the propagative medium. A) disease at the end of the propagative period, and B) disease 3 weeks after transplanting into a nurse bed.

Reduction of symptoms in cuttings propagated from mother blocks watered by the Gates system with the fungicides in the nutrient solution was observed. Cuttings were taken from plants so treated and propagated in perlite infested with various inoculum densities of the pathogen. Fewer treated cuttings had symptoms at the end of the propagative period especially at inoculum densities below 1000 propagules/cm^3 of the propagative medium (Figure 1A). Three to 4 weeks after transplanting, disease incidence increased in treated and nontreated plots (Figure 1B), however.

Complete control in repeated experiments was obtained when rooting hormones containing 5% (active) concentrations of either fungicide were applied to cuttings from treated mother blocks. A typical experiment is illustrated in Figure 2. In this case rooting hormone containing benomyl or TBZ was applied to cuttings from mother blocks previously treated with benomyl and TBZ, respectively.

Due to the characteristics of the system, fungicides applied through the irrigation systems were deposited on leaves and stems as well as to the planting medium. To determine whether applications to stems and leaves as well as roots was a factor in control, mother plants in pots were watered on the same time schedule and at rates comparable to those watered by the irrigation system except that fungicides and nutrient

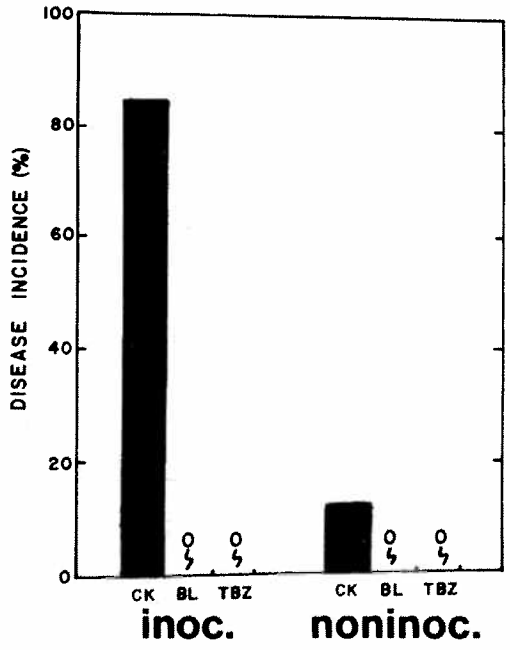


Figure 2. Percent disease observed on cuttings after removal from the propagative bench. Cuttings were obtained from mother blocks irrigated with either TBZ or benomyl and dipped in hormone powder containing either TBZ or benomyl respectively.

solutions were applied to gravel and roots only through drip tubing. The results (Table 1) indicated no difference in disease control between the two methods of application.

In commercial propagative operations, storage of cuttings is a routine practice. After 2 weeks storage at 2°C, cuttings derived from mother blocks treated with TBZ or benomyl were just as susceptible as non-treated controls (Table 1). A model system was also set up to determine how long cuttings in storage would retain chemical resistance to the pathogen. Sections of treated and nontreated cuttings were surface sterilized and inverted in sterile perlite contained within a sterile plastic specimen dish. A single conidium of *F. roseum* was placed on the exposed cut surface of each cutting. These were incubated at 25°C and progress of rot observed. Rot progressed rapidly in inoculated nontreated detached stems (Figure 3A). Progress of rot, however, was delayed in stems from fresh cuttings of mother blocks treated with TBZ or benomyl. After cuttings had been stored at 2°C for 4 weeks, there was no difference in rate of increase of rot between treated cuttings and controls (Figure 3B).

These results indicate that an additional increment of control of Fusarium stem rot in propagative beds may be obtained through application of benomyl or TBZ to roots of mother plants. Cuttings from plants so treated are more resistant to invasion by the pathogen. Practical use of this control measure, however, may be limited by the lack of persistence of systemic control during storage of cuttings.

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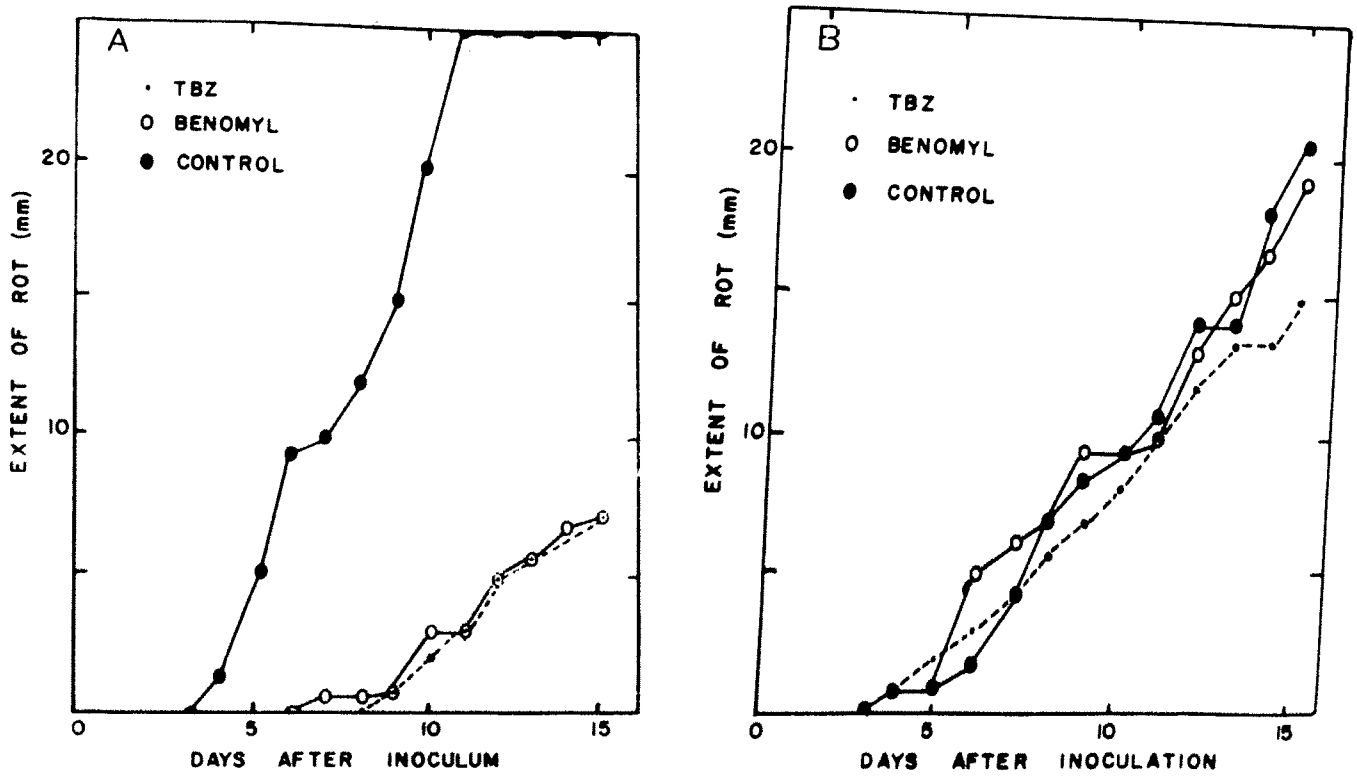

Figure 3. Rot progression down inverted stems from cuttings removed from mother blocks irrigated with the systemic fungicides. A) stem sections inoculated immediately after taking cuttings, B) stem sections stored 4 weeks and then inoculated.

Table 1. Percent disease observed in cuttings stored unrooted 0, 2, 3, and 4 weeks after removal from mother block and treated with nutrient solution containing TBZ or benomyl. A comparison of root application and irrigation system (Gates) was made.[a]

Method of application end treatment	Inoculated[b]				Noninoculated			
	End of propagative period[c]	Two weeks	Three weeks	Four weeks	End of propagative period	Two weeks	Three weeks	Four weeks
	%	%	%	%	%	%	%	%
Root application only								
Control	78		85		0		12	
Benomyl[d]	9		35		0		0	
TBZ[d]	9		35		0		0	
Applied through irrigation system								
Control	65	85		85	1	0		0
Benomyl[d]	0	57		71	0	0		0
TBZ[d]	14	28		42	0	0		0

aTotal of 9 cuttings and 4 replications.
bCuttings inoculated at the beginning of the propagative period at an inoculum density of 1080 propagules/ccm of rooting medium.
cPropagative period was 2 weeks
dBenomyl applied through irrigation system at the rate of 3 ppm; TBZ applied at 1 ppm

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