COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Richard Kingman, Executive Director
2785 N. Spear Blvd., Suite 230, Denver, Colorado 80211

Bulletin 274 March 1973

Fusarium Stem Rot of Carnations: Effects on Control by Solubilizing Benomyl and Thiabendazole with Acids

Chet H. Nash and Ralph Baker

Since benomyl and thiabendazole (TBZ) are relatively insoluble, it is difficult to apply these compounds at consistent rates in liquid rooting hormones (3) and in irrigation systems (4). Buchenauer and Erwin (2) solubilized the compounds in 70 ml of a 3% HCl solution per liter of suspension, reducing the pH to 1.5-3 and increasing uptake of the fungitoxins. This paper reports attempts to solubilize TBZ and benomyl to promote more favorable characteristics in application and control.

Solubilization of fungicides was achieved by lowering the pH of a liquid rooting hormone (used in a commercial propagative operation) to 2.7-3.0 using HCl or HNO_3 at 0.345 N. Cuttings were treated with 5% (active) benomyl or TBZ in this acidified rooting hormone solution and propagated in perlite infested with 1000 propagules/cm^3 of *Fusarium roseum* as described previously. Reduction of symptoms was obtained using the fungitoxins at low pH; however, control was not as complete as in the nonacidified treatments especially when HCl was used (Table 1). There is a possibility that the acid solutions damaged tissue at the cut surface of the cuttings thus predisposing the plants, but no obvious phytotoxicity was observed as measured by rooting index of noninoculated controls.

Systemic uptake, as measured by bioassay of stem and leaf tissue was also compared when acidified or neutral chemical solutions were applied to roots. The bioassay determined the presence of the fungicides in plant tissues. Sections of stems and leaves were taken. These tissues were placed on potato dextrose agar (PDA) seeded with conidia of *Verticillium albo atrum* (1). When fungitoxic substances diffused from the tissue, conidia did not germinate and a halo was formed about the section. The halo was easily detected 5 days after conidia were seeded in the plates.

Rooted carnation cuttings (cv Crowley's Sim) were placed in 1, 10, 100, 2000, and 4000 ppm of TBZ. Each concentration of the chemical was dissolved in 87.5 ml of acetone. One hundred thirty ml of 3% HCl or HNO_3 were added to the acetone-chemical mixture. The solution was added to 1½ liters of water. Controls with the same amounts of acetone and TBZ without acid were added to water. The chemical solutions or suspensions were poured (200 ml per container) into 105 plastic cups containing the rooted cuttings.

Stem sections were bioassayed at intervals between 0-48 hrs exposure to the fungitoxins (Figure 1). Larger halos about tissues occurred when acidified solutions were used. A relation was also noted with either length of application or concentration of fungicide and diameter of halos.

In experiments previously described (4), TBZ and benomyl were applied through irrigation systems to mother blocks from suspensions in concentrate (nutrient) tanks. Two minutes before application of nutrients and fungicides, air was bubbled through these tanks to mix the suspensions; even so, the question arises as to whether the fungicides were efficiently distributed through the proportioner, into the irrigation system, and eventually to the plants. Accordingly, bioassays using leaf and stem sections from treated and nontreated mother block plants were performed over a period 10 weeks from the

Table 1. Disease at end of two-week propagative period from treated inoculated and noninoculated cuttings with systemic fungicides added to conventional or acidified liquid root promoting hormone.[a]

Treatment	Noninoculated		Inoculated c	
	Disease	Root index b	Disease	Root index
	Percent		Percent	
Acidified with HCl				
Benomyl	4.7	4	38.1	4
TBZ	4.7	7	65.0	5
Control	4.7	4	87.5	3
Acidified with HNO_3				
Benomyl	0.0	5	9.5	7
TBZ	0.0	6	9.5	7
Control	4.7	4	80.9	4
Nonacidified				
Benomyl	0.0	6	0.0	7
TBZ	0.0	5	0.0	8
Control	0.0	3	90.5	2

a Total of 7 cuttings and 4 replications carried out two (2) times.
b Root rating from 1-10: 1 = no roots present on the cuttings after two-week propagation, and 10 = excellent rotting.
c Cuttings inoculated at the beginning of the propagative period at an inoculum density of 1000 propagules/cm³ of rooting medium.

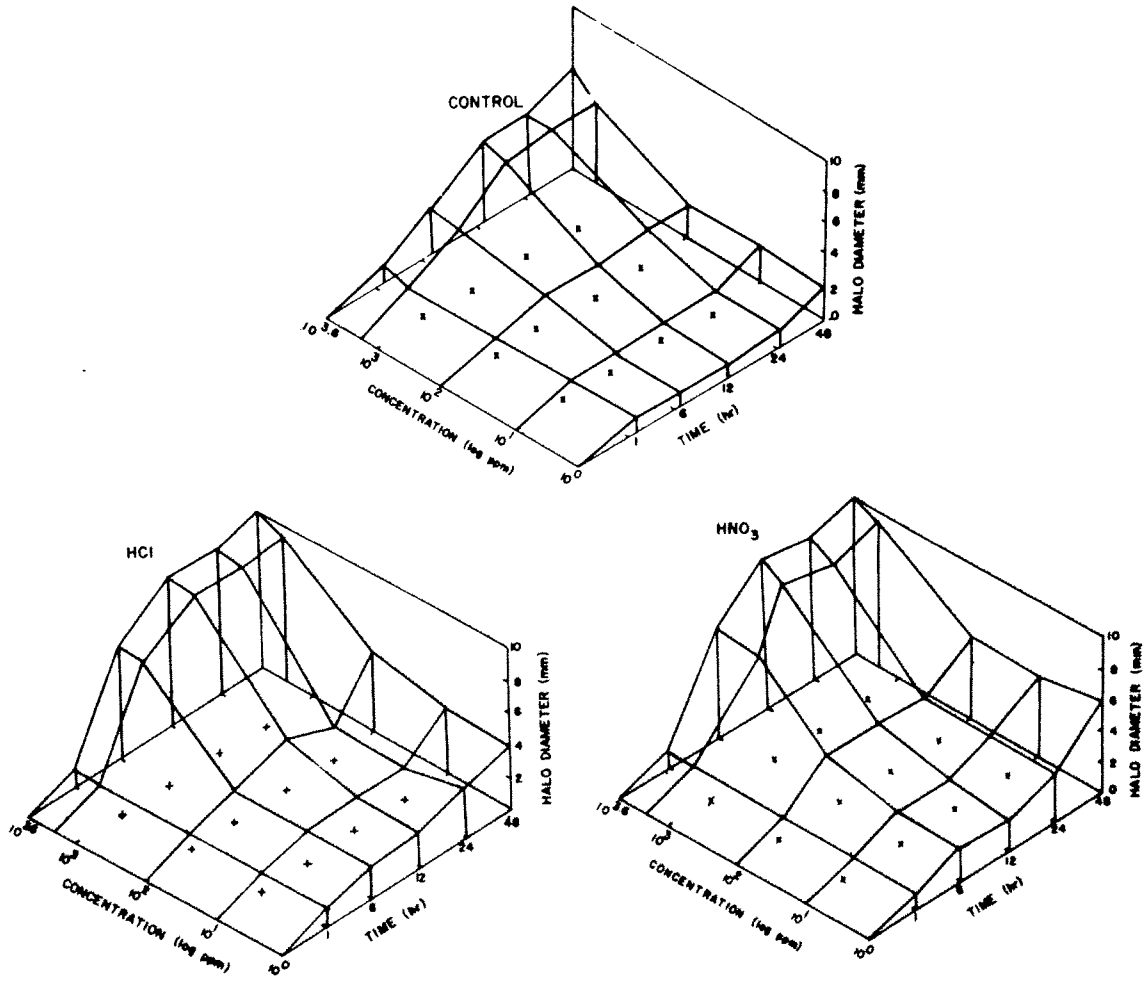

Figure 1. Halo diameters resulting from bioassay of stem sections of cuttings whose roots were exposed for various periods to neutral suspensions (control) and acidified solutions (HNO_3 or HCl) containing TBZ at various concentrations.

beginning of treatments. As shown in Figure 2, the halos increased in size with the application of the fungicides over a 10 week-period. Halos were larger around stem sections of plant material treated with TBZ while benomyl yielded the largest halos from leaf tissue.

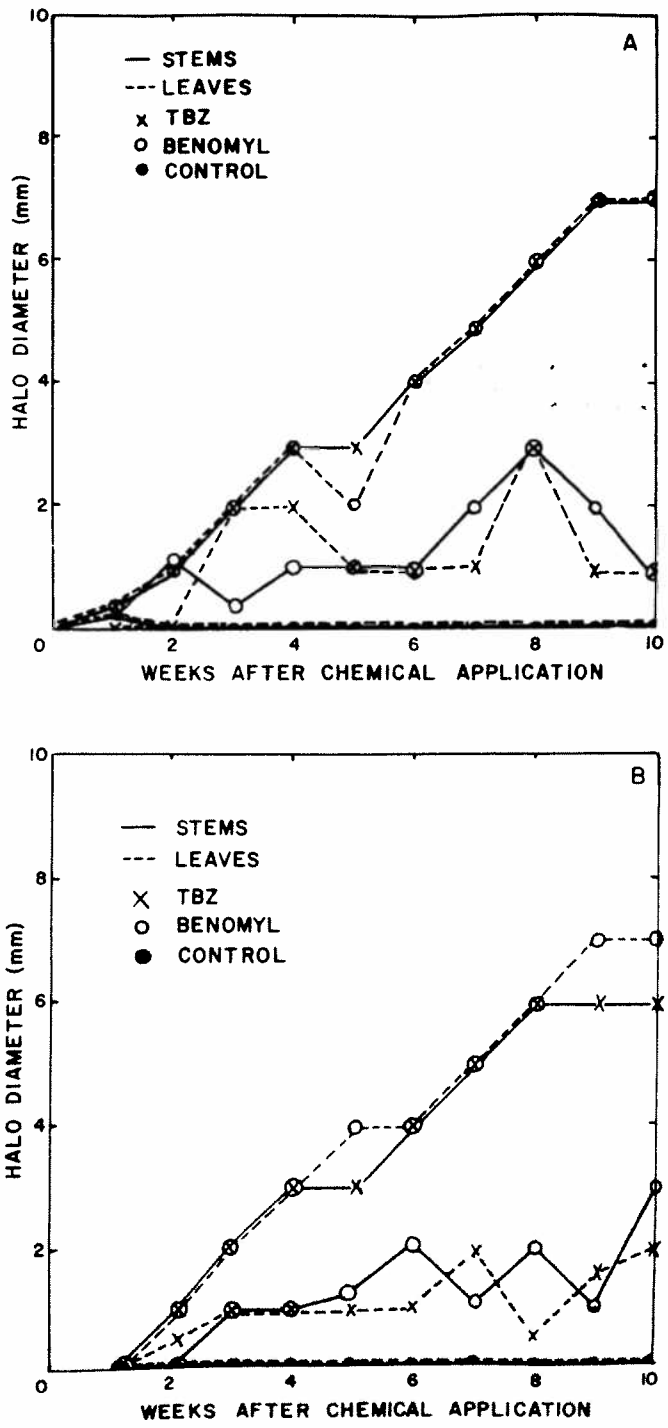

Figure 2. Halo diameters from bioassays of stem and leaf sections of mother block plants irrigated with nutrient solutions containing TBZ and benomyl. A) Gate watering system, and B) application to roots only.

Whether it is advisable to use acidified solutions of the normally insoluble systemic fungicides in control of Fusarium stem rot is not completely answered by these experiments. Certainly, the insoluble fungicides are effective in control when used in liquid rooting hormone although continuous agitation may be necessary to insure uniform suspension of the compounds. Indeed, acidified solutions of the fungicides in liquid hormone were less effective in control. While the results also indicate that uptake of solubilized systemics is increased, uptake of fungicides in mother blocks from suspensions applied through modern proportioners and irrigation systems has been demonstrated in bioassays. The additional complications of applying nutrients to plants at a relatively low pH, moreover, would presently preclude use of the solubilized systemic fungitoxins used in these investigations on a commercial basis.

Literature Cited

1. Brehn, W. L., and A. E. Dimond. 1970. Reduction of tomato Fusarium wilt symptoms by benomyl and correlation with a bioassay of fungitoxicant in benomyl-treated plants. Plant Disease Reporter 54:12-14.
2. Buchenauer, H., and D. C. Erwin. 1971. Control of Verticillium wilt of cotton by spraying foliage with benomyl and thiabendazole solubilized with hydrochloric acid. Phytopathology 61:433-434.
3. Nash, C. H., and R. Baker. 1972. Fusarium stem rot of carnations: control using systemic fungicides in rooting hormone. Colo. Flow. Grs. Assoc. Bul. 271. 1-3.
4. Nash, C. H. and R. Baker. 1973. Fusarium stem rot of carnations: chemotherapeutic control in propagated cuttings from mother blocks treated with systemic fungicides. Colo. Flow. Grs. Assoc. Bul. 273. 3-6.

New Research Tool

The Horticulture Department recently made one of the most significant capital purchases in ten years. This was a $7,800 programmable calculator that fits in little more space than an ordinary typewriter. Equipped with an expanded memory, and capable of printing, the machine has so improved our capability to summarize and analyze data that we wonder what we have been missing the last 20 years. In addition to ordinary calculations on the keyboard, programs may be written and stored on cards to run nearly any type of statistical analysis desired, as well as to summarize raw data. With other attachments, the calculator can be made to plot curves, operate a typewriter, or store data and programs on magnetic tape.

For example, one of our rose experiments requires a separate sheet for each day, whereby the stem lengths may be recorded for 3 varieties, 2 soil treatments, and 3 pruning treatments. From a single magnetic card, one of our undergraduates, with no training, can enter the data as the machine calls for it, which then automatically provides a labeled printout for each

variety, each treatment for the week — including a breakdown of stem lengths. In another experiment, stem lengths and weights of cut flowers are recorded, with lengths in centimeters. The operator merely has to enter each length and weight as called for by the program, and the machine then automatically provides average stem length, average weight, total yield and stem length distribution in inches for the week for three varieties and four treatments.

Since purchasing the machine last fall, 10 programs have been written for data summarization, with nearly an unlimited number of programs for various types of statistical analyses. It is being used so much that individuals must sign up. Before purchase, a single statistical analysis would take an entire afternoon — if simple — or several days if run through the computing center. Now, we can run a dozen analyses in less than an hour. A week's rose data may be brought up to date in less than 10 minutes. Not only has the machine reduced time, but has improved efficiency tremendously. Perhaps some day we can just wire our plants for sound and go fishing? — J. J. Hanan.

Your Editor,

W D Holley

COLORADO FLOWER GROWERS ASSOCIATION, INC.
OFFICE OF EDITOR
W. D. Holley
Colorado State University
Fort Collins, Colorado 80521

FIRST CLASS