

at some point reaches a threshold value and plant response becomes visible. The plant response may be visible before harvest or it is possible that potential injury is short of the threshold point for damage at harvest, and reduction in quality may occur through reduced shelf life or the development of necrotic tissue after harvest. Therefore, to maintain maximal quality, it is suggested that the minimal number of chemical applications necessary for good disease and insect control be made, the number of materials and rates be kept as low as possible, the safest known materials to the plants be

applied, and effective materials be alternated in a disease control program.

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## CONTROL OF BOTRYTIS CINEREA DISEASE ON CUT FLOWERS OF GLADIOLUS BY SUBLIMATION OF FUNGICIDES

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#### ABSTRACT

Two "thermal dust" fungicides, Termil and Thiabendazole (TBZ), and a liquid, Tutane, were found to be promising in controlling *Botrytis* disease on cut flowers. They are not only effective; they leave no visible residues. Termil and TBZ dusts were more effective than Botran and captan sprays in protecting gladiolus cut flowers from infection. Tutane applied after initiation of infection was more effective than captan, Botran and Daconil 2787 sprays applied before inoculation. The control of *Botrytis* by Tutane spray was increased as much or more by doubling spray volume as by doubling concentration.

An out-door test of Termil applied with a Carmel fogging gun showed that flowers were protected by the dust better than by sprays of captan, Botran and Daconil 2787. The test sprays and dust were applied to mature chrysanthemum stock plant beds where cut gladiolus flowers were placed among the chrysanthemums as indicator plants and then inoculated.

#### INTRODUCTION

Flowers of various kinds grown during the

winter in Florida are often subjected to cool, moist conditions that are ideal for the spread of the gray-mold fungus, *Botrytis cinerea* Fr. Leaves and stems as well as flowers may be rotted in the field or, more important, in the package of cut flowers and in storage. Although *B. cinerea* attacks gladiolus flower petals readily, it is not usually destructive on other parts of the plant, as is *B. gladiolorum* Timm. However, the gladiolus makes a good test plant for studying *B. cinerea* infection and control because the petal lesions are discrete and easily counted two days after inoculation.

The principal control measure for *Botrytis* diseases on flower crops grown out-of-doors is spraying or dusting with fungicides such as captan, maneb, zineb, Daconil 2787, and Botran (1, 2, 3, 6). When the weather favors *Botrytis* epiphytotics, field spraying does not always prevent incipient infections from spreading and developing in transit and storage (4). Post-harvest dip treatments with captan and Botran have been unsatisfactory in effectiveness as well as in acceptance by the trade. The chemicals often injure the flowers or leave unsightly residues. Tutane (2-aminobutane, carbonated), a water-soluble, volatile fungistat, was recommended as a post-harvest flower treatment for chrysanthemums and gladiolus (1, 5).

This paper presents the results of experiments which were carried out in 1965-1967 for the purpose of comparing "thermal dusts" made

from Termil and Thiabendazole (TBZ) with certain recommended fungicides in control of *Botrytis* disease.

#### GENERAL METHODS

'Spic and Span' or 'Friendship' gladiolus flowers were cut in tight bud and held with stems in water. Fungicides were sprayed on flowers with an aspirator-atomizer and air-pump. Thermal dusts were applied in a small refrigerator room by subliming test chemicals on a hot plate at 400-500 F. Flowers were held in the room for 20 to 30 minutes and the room was ventilated between treatments. Tutane spray or dip treatments were applied 2 to 8 hours after inoculations. Daconil 2787, Botran, and captan were used as standard fungicides with which the performance of Tutane, Termil, and TBZ were compared.

*B. cinerea* spores were obtained from diseased chrysanthemum or gladiolus flowers and flowers were inoculated by dipping in a spore suspension containing 250-600 conidia per ml or by releasing dry spores in a small, closed room at a height of six feet about the flowers held upright on a moving turntable. The latter procedure deposited about 75 spores per square centimeter on a horizontal surface.

After inoculation or treatment with Tutane, flower spikes were partly dried before placing in plastic bags. In the case of dry-spore inoculations, bags were moistened before introducing flowers.

Two to four days after flowers were inoculated and held in plastic bags at 65 to 73 F, petal infections were counted. Data were treated by analysis of variance and significant differences determined by Duncan's Multiple Range Test.

#### LABORATORY TESTS OF TERMIL AND THIABENDAZOLE AS THERMAL DUSTS

**Results**—In four of the six experiments comparing Termil and Thiabendazole (TBZ) thermal dusts with the recommended sprays or dips, Termil at 1 or 2 grams per 1000 cubic feet was more effective than captan and Daconil 2787 sprays in controlling *Botrytis* infections (Table 1). In three experiments TBZ at 4 grams per 1000 cubic feet was superior to captan or Daconil but was less effective than Daconil in two other tests. Tutane was also superior to Daconil and

Table 1. Effectiveness of fungicides in controlling *Botrytis cinerea* petal infections when applied before or after inoculation of cut gladiolus

Fungicides	Test No:	Number of petal infections					
		I	II	III	IV	V	VI
Uninoculated control	---	1 <sup>a</sup>	---	---	2 <sup>a</sup>	---	---
Inoculated control	391d	517d <sup>3</sup>	156 <sup>a</sup>	150 <sup>a</sup>	339 <sup>a</sup>	144 <sup>c</sup>	58 <sup>b</sup>
Captan 50W, 1 1/2 lb/100 gal	72 <sup>c</sup>						
Daconil 2787, 1 lb/100 gpl	25 <sup>b</sup>	15 <sup>c</sup>	25 <sup>b</sup>	15 <sup>b</sup>			
Tutane, 4 oz/gal as spray			4 <sup>a</sup>	1 <sup>a</sup>	14 <sup>ab</sup>		
Tutane, 1 oz/gal as dip <sup>1</sup>			7 <sup>ab</sup>	5 <sup>ab</sup>			
Termil, 2 g/1000 cu ft <sup>2</sup>			3 <sup>ab</sup>		22 <sup>bc</sup>	18 <sup>a</sup>	
Termil, 1 g/1000 cu ft <sup>2</sup>	13 <sup>a</sup>		6 <sup>b</sup>				
TBZ, 8 g/1000 cu ft <sup>2</sup>						37 <sup>c</sup>	
TBZ, 4 g/1000 cu ft <sup>2</sup>	4 <sup>a</sup>	2 <sup>ab</sup>	50 <sup>c</sup>	36 <sup>c</sup>	87 <sup>d</sup>	11 <sup>a</sup>	
TBZ, 2 g/1000 cu ft <sup>2</sup>			78 <sup>d</sup>	58 <sup>d</sup>		16 <sup>a</sup>	

<sup>1</sup>Tutane applied 2 to 8 hours after inoculation of flowers.

<sup>2</sup>Grams of active ingredients placed on hot plate and sublimed to form "dust" in closed room containing uninoculated flowers.

<sup>3</sup>Values within a column followed by the same letter(s) are not significantly different at the 5% level.

Botran sprays. Nearly perfect disease control was obtained in four of the experiments where Tutane or Termil were used (Table 1).

#### TEST OF TERMIL DUST IN OUTDOOR PLANTING

**Methods and materials**—Although Termil was developed for use in enclosed space, the possibility of using it to control diseases on the dense growth of flowering plants such as chrysanthemums grown in out-door beds was tested because fungicidal coverage of such plants by spray booms has been unsatisfactory. Two experiments were conducted in a 15 week-old chrysanthemum stock planting to compare Termil with the recommended sprays of captan, Botran, and Daconil 2787 applied at 2 lb/100 gal with knapsack

Table 2. Effect of Termil dust and spray fungicides as applied to chrysanthemum stock plants in controlling *Botrytis* disease on cut gladiolus placed among the stock plants<sup>1</sup>

Treatment	Test No:	Avg no. infections/floret		
		I	II	Sum
Control, water spray		243	105	348 <sup>e</sup>
Captan 50W, 2 lb/100		90	39	129d <sup>2</sup>
Botran 75W, 2 lb/100		76	31	107cd
Daconil 2787, 2 lb/100		65	26	91bc
Termil, 2 g/48 sq ft		54	21	75ab
Termil, 4 g/48 sq ft		48	14	62 <sup>a</sup>

<sup>1</sup>Three Spic and Span gladiolus spikes, used as indicator plants, were placed in the middle area of each 3 x 16 ft plot of chrysanthemum stock plants (about 30 in. tall) to which the sprays and dust were applied.

<sup>2</sup>Numbers followed by a common letter are not significantly different at the 5% level.

sprayer. The sprays were applied from both sides and top of bed, but Termil was applied from one side of bed only. Two and four grams of Termil per bed were sublimed and blown forcibly by modified Carmel fogging gun into the 30 inch-high plants. Three gladiolus spikes were placed in the center area of each bed to serve as indicators of disease control and of the degree of fungicidal coverage obtained on the flowers so placed among the dense growth of stock plants. The gladiolus were removed and inoculated with dry spores of *B. cinerea* at 70 per sq. cm. Petal lesions were counted three days later.

**Results**—Termil at 4 grams per 48 square feet of bed was superior in disease control to captan, Botran, and Daconil 2787 (Table 2). At the 2 gram dosage, Termil was not statistically better than Daconil spray.

#### EFFECTIVENESS OF TERMIL DUST IN RELATION TO DISTANCE FROM SOURCE

**Methods and materials**—Two spikes each of 'Friendship' and 'Valeria' varieties cut in tight bud were either sprayed or treated with Termil one day before the flowers were inoculated by spraying a spore suspension containing 600 *B. cinerea* conidia/ml. Sprays applied with aspirator—atomizer and air pump were Botran 75W at 1 1/3 lb and Daconil 2787 at 1 1/2 lb/100 gal. Termil was sublimed at 6 grams/1000 cu ft in a 40 x 20 x 9 foot room. Two spikes of each variety were placed at 4, 10, 18, and 32 feet

Table 3. Effectiveness of standard fungicides and the effect of distance from Termil dust source on control of Botrytis disease on two varieties of cut gladiolus

Fungicidal treatment <sup>1</sup>	Number of petal infections		
	'Valeria'	'Friendship'	Sum
Control, inoculated	400	542	942 <sup>d</sup>
Botran 75W, 1 1/2 lb/100	48	60	108 <sup>c3</sup>
Daconil 2787, 1 1/2 lb/100	39	59	98 <sup>c</sup>
Tutane, 2 oz/gal as dip	2	7	9 <sup>a</sup>
Termil source at 4 ft <sup>2</sup>	19	33	52 <sup>b</sup>
Termil source at 10 ft	27	56	83 <sup>bc</sup>
Termil source at 18 ft	53	45	98 <sup>c</sup>
Termil source at 32 ft	46	63	109 <sup>c</sup>

<sup>1</sup>All materials except Tutane were applied one day before inoculation with Botrytis spores. Tutane dip was given seven hours after inoculation of flowers.

<sup>2</sup>Flowers were placed on floor at stated distances from hot plate on which were placed two grams Termil per 1000 cubic feet of enclosed space. The movement of air in the closed room was not helped by artificial means.

<sup>3</sup>Numbers followed by a common letter are not significantly different at the 5% level.

Table 4. Relation of concentration and dosage of Tutane spray to Botrytis control and petal injury on 'Spic and Span' gladiolus

Ounces of Tutane per gallon of water	No. of petal lesions <sup>1</sup>			
	Volume (ml) applied/spike <sup>2</sup>			
	1	2	4	8
Water check	713	848	740	768
1	96	49	21	7
2	54	34	8	0 <sup>3</sup>
4	33	15	1	0 <sup>3</sup>
8	22	0	0 <sup>3</sup>	0 <sup>3</sup>

<sup>1</sup>Flowers were sprayed with inoculum containing 260 *B. cinerea* spores per ml four hours before Tutane sprays were applied. Four flower spikes per treatment were enclosed separately by treatment in plastic bags immediately after inoculation and again immediately after Tutane spraying.

<sup>2</sup>Only about one-third of each spray volume applied actually adhered to the flower spike, as determined by added weight.

<sup>3</sup>Slight to moderate petal injury on some open florets.

from the hot plate where the Termil was sublimed. The air of the room was not mechanically moved. One lot of inoculated spikes, otherwise untreated, was dipped in Tutane at 2 ounces/gal seven hours after inoculation.

**Results**—Tutane gave the best control, followed by Termil treatment at the 4 foot distance, both of which were better than Botran or Daconil and the three lots of flowers placed at 10, 18, and 32 feet from Termil (Table 3).

#### CONCENTRATION AND DOSAGE OF TUTANE SPRAY IN RELATION TO DISEASE CONTROL AND PETAL INJURY

**Methods and materials**—Five concentrations (0, 1, 2, 4, and 8 oz/gal) and four dosages (1, 2, 4, and 8 ml/spike) of Tutane solution were tested factorially on 'Spic and Span' gladiolus spikes, four per treatment. Spikes cut in loose bud were inoculated by spraying each group of 8 spikes with 16 ml Botrytis suspension (260 spores/ml). Four hours later the Tutane sprays were applied. All sprays, including spore suspension, were applied with an aspirator-atomizer and air pump. After holding spikes at 66 F for five days, petal lesions were counted.

**Results**—Even the lowest concentration/volume tested reduced infection markedly (Table 4). Doubling the volume of solution applied reduced infection more than doubling the concentration. The solutions of higher concentrations and volumes that were most effective in con-

trolling infection also tended to injure petals on the oldest open florets because treated flowers were bagged immediately. However, florets cut in tight bud, as practiced commercially, were not injured.

#### DISCUSSIONS AND CONCLUSIONS

Sublimation of Termil at 2 grams or of TBZ at 4 grams per 1000 cubic feet protected gladiolus flowers from *B. cinerea* as well as or better than captan or Botran sprays. The data indicate that Termil and TBZ dusts were similar in effectiveness where twice as much TBZ as Termil was sublimed. Daconil 2787 spray protected flowers better than captan and in two experiments Daconil was better than TBZ thermal dust at 4 grams per 1000 cubic feet. Daconil spray was inferior to Termil dust at 1 or 2 grams in two other experiments.

Tutane was superior to TBZ dust, captan, Botran, and Daconil, and in one test significantly better than Termil. Tutane and the sublimed chemicals were superior to the fungicidal sprays also in that the petals were not disfigured by visible residues. The results obtained for the control of *B. cinerea* disease on gladiolus petals parallel those obtained on chrysanthemums, carnations, roses, snapdragons, and orchid flowers (7).

The results obtained with Termil in plantings

under saran cloth suggest the possibility of improving disease control in dense plantings of bedded crops that are difficult to protect with sprays, especially on the underside of leaves. In addition, less labor would be required to apply the thermal dust than for sprays, rapid coverage at critical periods for protection would be possible, and the light weight equipment would not tend to pack the soil.

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## CHARACTERISTICS OF RETAIL OUTLETS SELLING NURSERY PRODUCTS IN FLORIDA

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#### ABSTRACT

As the second phase of activity in the Southern Regional Project on Marketing Woody Ornamentals (SM-33), researchers in Florida and seven other cooperating states studied the characteristics of retail nurserymen. The operations investigated were those which purchased for

resale most of the nursery products marketed. Preliminary results of the Florida phase of the study are reported here.

Sixty-three firms were surveyed—31 sales yards, 18 landscape nurseries and 14 garden centers. These retail nurseries had average gross annual sales of \$43,000, \$75,000 and \$255,000, respectively, with woody ornamental plants accounting for 52, 54 and 7 percent of their total revenue. Factors affecting decisions by retail nurserymen to purchase nursery stock, methods of purchase, advertising and promotion practices and other characteristics of the industry investigated are also presented.