are 16 pounds active ingredient per acre of Zinophos and 44 to 88 pounds active ingredient per acre of Bayer 25141. The materials should be uniformly distributed over the plant bed in enough water to wet the soil to a depth of 4 to 6 inches. Neither chemical should be expected to control diseases other than those incited by nematodes.

LITERATURE CITED


FUNGICIDAL TREATMENT OF GLADIOLUS CORMS

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Fungicidal treatment of gladiolus corms is necessary to obtain profitable production of flowers in Florida. Other disease control methods such as crop rotation, soil treatment, replacement of corm stocks, and warm curing of corms have been relatively ineffective without corm fungicides. During 1962 practically all of the 400 million corms planted in Florida were treated. That corm treatment is only partly effective is shown by the estimated annual loss of 25 percent of the flowers and 15 percent of the corms, caused mainly by Fusarium oxysporum f. gladioli Snyder and Hanson and Curvularia trifolii f. gladioli (Kauf.) Boed. Two other corm-borne fungi, Stromatinia gladioli (Drayt.) Whetzel and Botrytis gladiolorum Timm., are also controlled to some extent by corm treatments. The greatest losses, averaging $300 to $400 per acre, are caused by latent F. oxysporum infections of corms.

Corm diseases were studied in New York State as early as 1916 but not until Fusarium disease caused severe losses in the early 1940's were intensive studies initiated on control. Until 1944 corms were treated with inorganic mercury compounds and phenolic disinfectants. Then the organic mercury fungicide, New Improved Ceresan, recommended by Creager (3) was the standard pre-planting treatment until about 1955. Magie and Miller (5) suggested pre-storage treatments with chloranil and trichlorophenols to protect corms from infection during the cleaning operation. Aycock and Haasis (1), Besemer et al. (2), Forsberg (4), and Magie (6, 7) reported on numerous tests with other fungicides for the pre-planting treatment. Some of those fungicides are no longer available on the market; others are available for use in agriculture. At present the commonly used materials for corm treatment are Dowicide B, chloranil, thiram, ferbam, Emmi, Ceresan L, Elcide 73, folpet, and captan. Most corms in Florida are treated with Dowicide B or captan.

Since 1946, over 100 fungicides, including systemic and antibiotic chemicals, have been tested on large corms by various methods of application. Effectiveness of treatment was judged first by the quality and number of flowers produced and second by the yield of sound corms. The purpose of this paper is to discuss various methods of applying fungicides to corms and the timing of applications with respect to the harvest-curing-planting cycle.

METHODS AND RESULTS

For each experiment, corms of uniform size and history were chosen from one or more of the commercial varieties: Picardy, Spic and Span, Valeria, June Bells, Morning Kiss, and Spotlight. Corms were obtained from Florida plantings where the incidence of disease was noted before harvest. For some experiments, corms naturally infected with one or more diseases were chosen. In other tests healthy stocks were chosen for chemical injury tests or sound corms were artificially inoculated with Fusarium conidia.

Fungicidal solutions and suspensions were placed in galvanized iron tubs, and corms to be soaked therein were placed in citrus mesh bags.

*p-Cleaning of corm is the removal of "mother" corm and roots, either at the time of lifting or about two weeks later.
Dusts were applied to corms by tumbling them in a large paper bag with an excess of the dust. In most tests 100 corms per treatment were planted in 25-corm plots randomized in four blocks. Cultural practices were similar to those employed on commercial farms. Plantings were made in October-January periods. Flowers were harvested at least three times per week and graded for quality according to the standard grading chart (fancy, special, A, B, C and cull). The six grades were assigned numerical values 6 to 1, respectively) reflecting their market values. An index of flower production was obtained for each plot by multiplying the spikes in each grade by its assigned value. The identity of corm diseases was confirmed by isolation of the causal fungus in artificial culture. Statements regarding relative effectiveness of fungicides are based on differences that are statistically significant at the 5 percent level.

Methods of Applying Fungicides

The preferred method of treating corms usually is to dip them, but since their wetting interferes with the curing process and since dip treatments do not completely control the diseases, other methods of application were tested. Dusting of corms after harvest supplements the pre-planting dip treatment by reducing infections through corm injuries incurred at harvest and at cleaning. The use of a pre-storage treatment in addition to a pre-planting treatment gave little or no benefit to flower production, but resulted in greater corm and cormel production and earlier flowers than the pre-planting treatment alone (Table 1). Although dusting causes less chemical injury to large corms than dipping, disease control is usually better with dip treatments (Table 1). The Panogen 15 dip resulted in more corms than the captan-Spergon-Arasan dusting.

Treatment with fungicidal slurries was tested as another means of avoiding the excessive wetting of corms. Slurry treatment was as effective as dusting but inferior to dipping, even though solutions were thickened with methylcellulose to cause more fungicide to cling to corms.

Drenching corms with dilute solutions in the open furrow after planting has been less effective than the pre-planting dip. Phototoxicity was evident in all treatments, especially with corms planted in dry, warm soil.

Applications of fungicides to the surface of corms in the cormel stage of development was not effective.

### Table 1. Effects of fungicidal combinations and time of corm treatment on Picardy, Valeria, June Bells, and Morning Kiss gladiolus.

<table>
<thead>
<tr>
<th>Corm treatment (lb/100 gallons)**</th>
<th>Number of spikes cut first week</th>
<th>Total flower production</th>
<th>Number of corms harvested</th>
<th>Weight of corms, lb</th>
<th>Weight of cormels, oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaned and treated after harvest</td>
<td>on 4/16</td>
<td>Treatment after cleaning</td>
<td>on 4/29</td>
<td>Treatment before planting</td>
<td>on 11/16</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>none</td>
<td>73</td>
<td>684</td>
<td>182</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>N.I.Cer.**, 2</td>
<td>91</td>
<td>1005</td>
<td>332</td>
</tr>
<tr>
<td>none</td>
<td>N.I.Cer.**, 2</td>
<td>154</td>
<td>927</td>
<td>468</td>
<td>89</td>
</tr>
<tr>
<td>Dow., 3</td>
<td>none</td>
<td>N.I.Cer.**, 2</td>
<td>182</td>
<td>918</td>
<td>506</td>
</tr>
<tr>
<td>none</td>
<td>Spergon dust**</td>
<td>Dow., 6</td>
<td>227</td>
<td>976</td>
<td>453</td>
</tr>
<tr>
<td>none</td>
<td>captan dust**</td>
<td>Dow., 6</td>
<td>188</td>
<td>890</td>
<td>426</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>Dow., 6</td>
<td>127</td>
<td>915</td>
<td>403</td>
</tr>
<tr>
<td>none</td>
<td>Panogen 15, 4</td>
<td>none</td>
<td>69</td>
<td>1127</td>
<td>461</td>
</tr>
<tr>
<td>none</td>
<td>captan-Spergon-Arasan**</td>
<td>none</td>
<td>217</td>
<td>1009</td>
<td>360</td>
</tr>
</tbody>
</table>

L.S.D. 5% level | 24 | 120 | 50 | 11 | 12 |

*Dip treatments of Dow. (Dowicide B) and Panogen 15 were of 15-minute duration and of N.I. Cer. (New Improved Ceresan) was of one-minute duration.

**Spergon dust mixture contained 24 percent of chloranil; captan dust contained 25 percent active ingredient; and the special dust mixture contained 12.5 percent captan, 12 percent chloranil, and 19 percent thiram. The inert diluent in each dust was Pyrax (pyrophyllite).
corms and cormels did not cure latent infections of Fusarium. In order to introduce fungicides into the interior of corms and cormels, a series of experiments were made, using various techniques. Cormels submerged in fungicidal solutions were placed in vessels from which the air was pumped for one minute (6). The vacuum was then released, forcing the solution into air chambers of the husks. The degree of disease control was similar to that obtained with prolonged soaking of cormels.

Another method of introducing fungicides into corms attempted to exploit the transpiration path (6). Freshly lifted whole plants with roots attached were placed upright in shallow pans containing fungicidal solution in order that the transpiration of the leaves might pull the fungicidal liquids into the vascular tissue of the new corms, resulting in a systemic, curative action. In all those experiments, chemical injury was slight to severe and systemic action was not enhanced.

Fusarium control obtained by dipping corms in antibiotic or systemic fungicides was no more complete than that obtained with standard fungicides. For the purpose of promoting systemic action, pieces of cotton thread impregnated with the chemicals were inserted into the core or pith of large corms before or after inoculation with Fusarium. Systemic, curative action was not improved by that method.

The only method that improved the systemic action of fungicides was an overnight soaking period, even though concentrations of the chemicals were reduced, stunting of the plants resulted from all fungicides tested, including captan. The new corms were replanted and found to carry Fusarium diseases, indicating systemic action was incomplete with regard to disease control.

Timing of Corm Treatments

Experiments were made to determine the best time to apply fungicides during the pre-storage period. Corms are most susceptible to chemical injury at the beginning of the curing period; however, with susceptible varieties, disease control is better when corms are treated after being cleaned than when treated at a later time. The dip in Dowicide B immediately after harvesting is especially effective (Tables 1 and 2). The double treatment is generally more effective than either the pre-storage or pre-planting treatment.

Picardy corms cleaned and treated with Spergon or New Improved Ceresan on the day of harvest were healthier and more productive than

### Table 2. Flower and corm yields of Spic and Span, Valeria, June Bells, and Spotlight gladiolus corms treated with fungicides at different times.####

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Treatments made at</th>
<th>April 28</th>
<th>October 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 18</td>
<td>Cleaning</td>
<td>Planting</td>
<td></td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>none, control</td>
<td></td>
</tr>
<tr>
<td>Dowicide B,3/5*</td>
<td>none</td>
<td>N.I.Ceresan,2/1</td>
<td>105 310 223 40 57</td>
</tr>
<tr>
<td>Dowicide B,3/5</td>
<td>none</td>
<td>N.I.Ceresan,2/1</td>
<td>257 461 410 73 94</td>
</tr>
<tr>
<td>none</td>
<td>Dowicide B,3/5</td>
<td>N.I.Ceresan,2/1</td>
<td>306 518 456 83 103</td>
</tr>
<tr>
<td>none</td>
<td>captan 75,8/15</td>
<td>N.I.Ceresan,2/1</td>
<td>205 513 404 76 111</td>
</tr>
<tr>
<td>none</td>
<td>captan 75,8/15</td>
<td>Dowicide B,6/15</td>
<td>136 438 372 71 87</td>
</tr>
<tr>
<td>none</td>
<td>Spergon dust***</td>
<td>Dowicide B,6/15</td>
<td>139 484 376 75 101</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>Dowicide B,6/20</td>
<td>157 401 320 63 72</td>
</tr>
</tbody>
</table>

L.S.D. 5% level

--- 72 62 13 36

*Washed in water before treatment, then cleaned on April 28. The first figure denotes pounds of fungicide per 100 gals., the second shows duration of dip in minutes.

**Cleaned at harvest.

***Dust contains 24 percent chloranil.
those cleaned and treated two weeks later (Table 3). Experience indicates that corms cleaned after a period of curing are healthier when treated at harvest than when treatment is delayed until the cleaning operation.

Data on the effect of delaying corm treatment after cleaning (Table 4) indicate that flower and corm production are reduced when the dip treatment with Dowicide B or captan is delayed two days. In this test, treatments at cleaning time were as effective or more effective than the pre-planting treatments.

A comparison of dip treatments made three days before planting and on the day of planting (Table 5) shows that flower production is reduced and corm production is increased by the earlier treatments with New Improved Ceresan and Dow Seed Protectant 9B. There were no significant differences in flowering with Spergon and captan. The longer period of contact between corms and fungicide increased fungicidal effect, thereby reducing flowering and increasing corm production.

**Discussion and Conclusions**

The most practical and effective method of applying fungicides to gladiolus corms is the soaking of corms in the solutions or suspensions. Systemic action of the fungicides tested was improved by prolonging the soaking period, but
curative action was incomplete and phytotoxicity was increased.

Both the dusting and soaking of large corms are most effective in promoting flower and corm production when applied after harvest of corms. The harvest time treatment is effective whether corms are cleaned at harvest or after a period of curing. Treatment again before planting is usually necessary for maximum corm yields. Aycock and Haasis (1) emphasized the importance of applying treatments immediately after harvest. Their finding that Dowicide B is the best fungicide for pre-storage treatment is confirmed by the present study.

LITERATURE CITED


BOTRYTIS DISEASE CONTROL ON GLADIOLUS, CARNATIONS AND CHRYSANTHEMUMS

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Following the freeze and rains of the 1962-63 winter, the cut-flower industry of Florida suffered severe losses from post-harvest breakdown of flowers caused by Botrytis gladiolorum and B. cinerea. Although the plantings were well protected from Botrytis gray mold by frequent spraying, the spores produced by gray mold on older plantings drifted onto the flowers before harvest and caused them to rot enroute to market. Adequate protection of flowers by spraying was impractical because concentrated or frequent sprays injured and stained the petals. The effectiveness of ozone in controlling Botrytis rotting of cut flowers (5) suggested tests with other vapor-producing chemicals.

The use of volatile chemicals in plant disease control is not new. Diphenyl was developed in Palestine and the United States for use on citrus fruit to control post-harvest decay (3). Recently in California Chiarappa et al. (1) and Eckert and Kolbezen (2) found dibromotetrachloroethane (DBTCE) and certain volatile aliphatic amines were effective in controlling decay of grapes and oranges. Magie (6) noted in 1962 that the carbonate salt of 2-aminobutane was effective against Botrytis diseases of cut flowers. The present investigation was made to determine the effectiveness of volatile chemicals for treating cut flowers preparatory to shipment or storage.

EXPERIMENTAL METHODS

Freshly cut flowers were obtained from flower farms where Botrytis infection was general. Experimental units were six gladiolus spikes (Spic and Span, Friendship, White Excelsior, or Florida Pink); four chrysanthemum stems (Indianapolis White and Iceberg); and four stems of miniature carnations (Elegance varieties). In some experiments, flowers were artificially inoculated by placing diseased flowers heavily infested with gray mold in the bottom of a large plastic bag with the test flowers held within the closed top of the bag. Conidia were floated around the flower petals by manipulating the bag as a bellows. Healthy flowers were included in some experiments to estimate degree of chemical injury in the absence of disease.

Treatments were applied in most tests on the day of cutting the flowers. Instantaneous dip treatments were made by plunging the flowers into the fungicidal preparation made up in water containing one ounce of Triton X-100 per 100 gallons as a wetting agent. The flowers were drained five minutes and enclosed in plastic bags. Spray treatments were applied to flowers as they were rotated. The amount applied by an electric aspirator-sprayer to each flower unit was varied by altering spray time. The treated flowers were immediately placed in large polyethylene bags, one unit per bag, and held at 20°C for two days.