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NEW FUNGICIDES FOR CONTROL OF ASCOCHYTA BLIGHT OF CHRYSANTHEMUM[1]

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Abstract. **New and/or recently available foliage fungicides were evaluated for control of Ascochyta blight on chrysanthemum** (chrysanthemum x morifolium **Ramat.) plants grown outdoors under 30% saran shade. Good and significantly similar disease control was obtained with weekly sprays of propiconazol 3.6E-A (Tilt) at 6 and 4 fl. oz/100 gal, vinclozolin 50W (Ornalin) at 1.5 and 1.0 lb./100 gal, and iprodione 50W (Chipco 26019) at 1.5 and 1.0 lb./100 gal. Similar control was obtained with biweekly sprays of propiconazol 3.6E-A at 6 fl. oz and iprodione 50W at 1.5 lb./100 gal. Fenarimol 12.5% (Rubigan) at 12 fl. oz and bitertanol 25W (Baycor) at 2.0 lb./100 gal provided significantly less disease control than the above but were significantly better than the water-sprayed control treatment. In one experiment the commonly used tank-mix treatments, benomyl 50W (Benlate) plus chlorothalonil 2787 75W (Daconil) at 0.25 plus 0.75 lb./100 gal and benomyl 50W plus mancozeb 80W (Manzate 200) at 0.25 plus 0.75 lb./100 gal had a trend toward less control than the best treatments. These 2 standard treatments routinely have given good disease control, so the reduced control may indicate the possibility of a low level of resistance of the pathogen to benomyl.**

Ascochyta blight (*Didymella ligulicola* (Baker, Dimock & Davis) von Arx.) (7) has long been one of the most serious fungus diseases (2, 4, 5, 6) of chrysanthemum. The disease occurs on outdoor and greenhouse grown plants. Flower buds, petioles, leaves, stems and cuttings are attacked by the pathogen (1, 2, 3, 4, 5, 6). Losses to 100% of a planting occur on highly susceptible cultivars.

Leaf spots on mature leaves occur as irregular shaped, dark brown to black necrotic lesions which are usually located along the margins. They frequently have a V-shape. Dark colored stem lesions occur. They usually start at nodes and extend up and down the stems. When they occur on one side of the stem near the terminal, the familiar "shepherds crook" curvature occurs at the terminal. When the lesion develops around the entire circumference of the stem the top dies. Conidia develop on the stem tissue but infrequently on the attached leaves. When flower infection occurs on the closed bud the entire bud turns black and necrotic. Infection occurring on the side of a developing flower causes a one-sided development, giving rise to the name Ascochyta ray blight.

These studies were conducted to evaluate new fungicides (5) for disease control and phytotoxicity and to explore the possibility of extending the interval between sprays.

Methods and Materials

Experiment 1. Rooted cuttings were planted February 27, 1980 on raised (6-inch) beds in methyl bromide-fumigated EauGallie fine sand under black polypropylene 30% shade cloth at the Gulf Coast Research and Education Center, Bradenton, FL. Each plot was split and planted to 18 'Improved Fred Shoesmith' and 9 'Manatee Iceberg' plants. The former were grown single stem and the latter were pinched and pruned to 3 stems. The plants were maintained on long days for 2.5 weeks to keep them growing vegetatively. Plots were arranged in a randomized complete block design with 4 replications.

Plants were inoculated April 7, 3 days after the first foliage fungicide application, by spraying with a hand sprayer over the top and each side of the beds with 3 gal of a spore suspension containing 3.26 x 10^7 conidia and ascospores/fl. oz. Plots not sprayed with fungicide but inoculated were left adjacent to all treated plots as a source of inoculum for disease development in the test area.

Disease level was assessed by counting the total number of lesions on the leaves, stems and flowers of the 'Improved Fred Shoesmith' plants on May 23 and 'Manatee Iceberg' plants on May 27.

Foliage sprays were applied weekly from April 4 to 1 week before harvest on all treatments except iprodione 50W (Rovral) at 1.0 and 0.5 lb./100 gal and benomyl 50W (Benlate) + mancozeb 80W (Manzate 200) at 0.25 + 0.75 lb./100 gal which were applied every 2 weeks. All applications were made with a hand-held boom pressured with CO_2 at 55 psi. The treatments are listed in Table 1. Insecticide cover sprays were applied separately over the entire crop when needed.

Experiment 2. This experiment was conducted in the same saran covered house and under the same conditions as Experiment 1 except for the following: unrooted cuttings of the cultivars 'No. 2 Indianapolis Dark Bronze' and 'Stingray' were stuck on September 6, 1983. The beds of unrooted plants were covered for 9 days with a piece of saran cloth that provided 30% shade. The split plots consisted of 9 plants of each cultivar. Both cultivars were grown single-stem and disbudded to produce one flower per plant. The plants were maintained on long days for 1 month (lighted 10PM to 2AM) to keep them vegetative.

All plants in the test area (4 beds, each 72 ft x 3 ft) were inoculated during a rain on October 11 by spraying 3 gal of spore suspension (2.8 x 10^8 conidia/fl. oz) with a hand sprayer over the top and each side of the beds. The suspension was prepared by soaking dried, diseased chrysanthemum plant tissue and from conidia produced on potato dextrose agar in Petri plates. All the inoculum source material was filtered through 3 layers of cheese cloth to remove large particles. Plots not sprayed but inoculated were left adjacent to all fungicide treated plots.

The first fungicide treatment was applied 3 days after the plants were inoculated. Foliage sprays were applied weekly on October 14, 18, 25, November 1, 8, 15, 22 to both cultivars and on November 29 only to 'No. 2 Indianapolis Dark Bronze.' However, sprays were applied biweekly with propiconazol 3.6E-A (Tilt) 6 fl oz/100 gal and iprodione 50W at 1.5 lb./100 gal. The treatments are listed in Table 2.

Disease was assessed by counting all infection spots on leaves, stems and flowers of the cultivar 'Stingray' on December 2 and of the cultivar 'No. 2 Indianapolis Dark Bronze' on December 9.

Results

Experiment 1. A low level of disease occurred on plants

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Table 1. Ascochyta blight control with fungicides sprayed on outdoor grown chrysanthemum plants in a preventive test.

Treatment	Rate/100 gal	Disease control (%) 'Improved Fred Shoesmith'	'Manatee Iceberg'
Chlorothalonil 75W (Daconil)	1.5 lb.	97 a[z]	100 a
Benomyl 50W (Benlate) + chlorothalonil 75W (Daconil)	0.25 + 0.75 lb.	93 ab	100 a
Thiophanate methyl 15% + mancozeb 60% (Zyban 75W)	1.0 lb.	80 abc	100 a
Iprodione 50W (Rovral) biweekly[y]	1.0 lb.	78 abc	94 a
Benomyl 50W (Benlate)	0.5 lb.	76 abc	94 a
Mancozeb 80W (Manzate 200)	1.5 lb.	82 abc	100 a
Copper hydroxide 77W (Kocide 101)	2.0 lb.	82 abc	100 a
Copper hydroxide 77W + permethrin (Ambush 2L)	2.0 lb. + 0.2 qt	79 abc	100 a
Thiophanate methyl 15% + mancozeb 60% (Zyban 75W)	0.5 lb.	80 abc	94 a
Tribasic copper sulfate + permethrin (Ambush 2L)	2.0 lb. + 0.2 qt	78 bc	94 a
Tribasic copper sulfate	2.0 lb.	77 bc	69 a
Benomyl 50W + mancozeb 80W biweekly[y]	0.25 lb. + 0.75 lb.	61 cd	100 a
Permethrin EC (Ambush 2L)	0.2 qt	68 cd	83 a
Iprodione 50W (Rovral) biweekly[y]	0.5 lb.	58 d	83 a
Control—water		0 e	0 a
Mean number of lesions/replication		7	4

[z]Mean separation within columns by Duncan's multiple range test, 5% level.
[y]Sprayed every 2 weeks. All other treatments were sprayed weekly.

in this experiment as was expected during a season which lacked rainy weather conducive to disease spread and development. Also, the foliage of the widely planted cultivar 'Manatee Iceberg' has a high level of tolerance to Ascochyta blight. The tolerance of 'Manatee Iceberg' combined with the relatively dry weather resulted in no significant differences occurring among the treatments on the cultivar (Table 1).

Differences did occur among the treatments sprayed on the more Ascochyta blight-susceptible cultivar 'Improved Fred Shoesmith.' All treatments had significantly less disease (better control) than the water sprayed control plants (Table 1). Among the better treatments sprayed weekly were the following in numerically descending order of disease control: chlorothalonil 75W (Daconil) at 1.5 lb./100 gal, benomyl 50W (Benlate) + chlorothalonil 75W (Daconil) tank-mixed at 0.25 lb. + 0.75 lb., thiophanate methyl 15% + mancozeb 60% (Zyban 75W) at 1.0 lb., benomyl 50W at 0.5 lb., mancozeb 80W (Manzate 200) at 1.5 lb., copper hydroxide 77W (Kocide 101) at 2.0 lb., and thiophanate methyl 15% + mancozeb 60% at 0.5 lb./100 gal. Iprodione 50W (Rovral) at 1.0 lb./100 gal, (but not at 0.5 lb.) was not significantly different than the above treatments when sprayed only biweekly. Benomyl 50W tank-mixed with mancozeb 80W at 0.25 + 0.75 lb. was not significantly different than iprodione 50W at 1.0 lb./100 gal when both were sprayed biweekly. Phytotoxicity was not associated with any of the treatments.

Experiment 2. A higher level of disease developed in Experiment 2 than in Experiment 1. In addition, the plants were inoculated 3 days before the first spray was applied. Ascochyta leaf spots 1-2 mm in diameter were visible on younger leaves when the first sprays were applied.

Spraying weekly, propiconazol 3.6E-A (Tilt) at 6 and 4 fl. oz/100 gal, vinclozolin 50W (Ornalin) at 1.5 and 1.0 lb./100 gal and iprodione 50W at 1.5 and 1.0 lb./100 gal all provided equally good Ascochyta blight control on both cultivars while tank-mixed benomyl 50W + chlorothalonil 75W at 0.25 + 0.75 lb./100 gal was as effective as the above only on the cultivar 'Giant No. 2 Indianapolis Bronze.' Propiconazol 3.6E-A at 6 fl. oz and iprodione 50W at 1.5 lb./100 gal sprayed biweekly also provided excellent disease control no different from the best treatments above (Table 2).

Table 2. Ascochyta blight control with fungicides sprayed on outdoor grown chrysanthemum plants in a 72-hr eradicant test.

Treatment	Rate/100 gal	Disease control (%) 'Giant No. 2 Indianapolis Dark Bronze'	'Stingray'
Propiconazol 3.6E-A (Tilt)	6 fl. oz	100 a[z]	94 a
Propiconazol 3.6E-A (Tilt) biweekly[y]	6 fl. oz	100 a	91 a
Propiconazol 3.6E-A (Tilt)	4 fl. oz	99 a	88 a
Vinclozolin 50W (Ornalin)	1.5 lb.	99 a	92 a
Iprodione 50W (Chipco 26019)	1.5 lb.	98 ab	86 a
Iprodione 50W (Chipco 26019) biweekly[y]	1.5 lb.	96 abc	82 a
Vinclozolin 50W (Ornalin)	1.0 lb.	98 ab	80 ab
Iprodione 50W (Chipco 26019)	1.0 lb.	99 a	80 ab
Benomyl 50W + chlorothalonil 2787 75W (Benlate + Daconil)	0.25 + 0.75 lb.	83 abc	63 bc
Fenarimol 12.5% E (Rubigan)	12 fl. oz	76 cd	64 bc
Benomyl 50W + mancozeb 80W (Benlate + Manzate 200)	0.25 lb. + 0.75 lb.	78 bcd	63 bc
Bitertanol 25W (Baycor)	1.0 lb.	57 e	53 c
Fenarimol 12.5% E (Rubigan)	6 fl. oz	61 de	51 c
Bitertanol 25W (Baycor)	2.0 lb.	53 e	48 c
Control—water	—	0 f	0 d
Mean number lesions/replication		62	100

[z]Mean separation within columns by Duncan's multiple range test, 5% level.
[y]Sprayed every 2 weeks. All other treatments were sprayed weekly.

Benomyl 50W + mancozeb 80W at 0.25 + 0.75 lb., fenarimol 12.5% (Rubigan) at 12 fl. oz, bitertanol 25W (Baycor) at 2.0 and 1.0 lb./100 gal all provided progressively less disease control but all had less disease than the water-sprayed control plants. No phytotoxicity symptoms were related to any of the treatments.

Discussion

The new names in the fungicide arsenal for good control of Ascochyta blight on chrysanthemum plants are iprodione (Rovral, Chipco 26019), propiconazol (Tilt, Banner), and vinclozolin (Ornalin, Ronilan). The outstanding features of these fungicides based on these 2 experiments include: 1) excellent Ascochyta blight control when sprayed on a weekly schedule, 2) no difference in disease control when iprodione and propiconazol were sprayed on a weekly vs. biweekly schedule, 3) good eradicant disease control in Experiment 2 when plants were inoculated 72 hr before the first spray was applied, and 4) apparent safety to chrysanthemum plants.

The below expected performance of the standard treatments benomyl + chlorothalonil and benomyl + mancozeb in Experiment 2 may have been due to mild resistance of the pathogen to benomyl since the inoculum which was introduced into the test area included Ascochyta obtained from a grower who was experiencing poor control in his crop.

Bitertanol and fenarimol did not demonstrate great promise for outstanding Ascochyta blight control.

In the future, rate of application vs. extended spray schedules need to be studied to determine the most efficacious rate and frequency of the new promising fungicides. Of special significance, these new fungicides represent 2 areas of chemistry (iprodione and vinclozolin are related) different from benomyl which has long been used and therefore means of control probably are available if resistance to benomyl occurs.

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COMPUTER ASSISTED FERTIGATION DILUTION CALCULATIONS[1]

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Abstract. **Interactive computer programs have been developed to perform dilution calculations for nursery operators dissolving dry water soluble fertilizer for injection or injecting liquid fertilizers through irrigation systems. Required inputs include the fertilizer analysis (grade), injector dilution ratio(s), weight/volume ratio of concentrated liquid fertilizer or the number of gallons per ton of concentrated fertilizer, and the desired parts per million (ppm) of fertilizer element in irrigation water. The computer program calculates the dilution ratio needed to achieve desired ppm of fertilizer element in the irrigation water, indicates how to dilute the concentrated fertilizer before injection, or indicates the analysis of fertilizer you should use with the given dilution ratio to achieve desired ppm of a fertilizer element in irrigation water.**

Computations that are lengthy, cumbersome, and require several conversion factors are required before fertilizer can be accurately injected into irrigation water. Consequently, many nursery operators are reluctant to use fertilizer supplied in irrigation water. The computer programs described below have been developed to perform these calculations thus reducing risk of error and time required to make these calculations.

The first program described is to be used when fertilizers purchased as liquids, not suspensions, are to be injected into irrigation water. The second program is used when dissolving dry water soluble fertilizers for injection. The latter program is divided into 2 options based on type of fertilizer. Option A is used when dissolving blended dry fertilizers such as Peters' 20-20-20 or Miller's 20-20-20 and option B is used when dissolving individual fertilizer compounds (ammonium nitrate, calcium nitrate, etc.) to supply specific nutrients for injection into irrigation water.

Materials and Methods

Both programs were written in VAX-BASIC utilizing the Institute of Food and Agricultural Sciences' Computer Network and a VT-100 (Digital Equipment Corporation, Bedford, MA 01730) terminal. The programs will be available in the future for microcomputers using the PC-DOS or MS-DOS operating systems.

The user must obtain the analysis or grade of fertilizer, and determine the parts per million (ppm) N, P or K desired in irrigation water before using the first program or option A of the second. When purchasing true liquid fertilizers, the weight/volume ratio of the fertilizer must be obtained from the manufacturer or the label and total volume of solution in the dilution tank must be known when dissolving dry fertilizers. The injector dilution ratio must be known for both programs. For option B of the second program, the user must obtain the name of fertilizer compound used and the desired concentration of a selected fertilizer element in irrigation water.

Programs Operation

The first program described below is used when injecting fertilizers that are purchased as liquids, not suspensions. The program begins with an introduction [1] that explains the purpose of the program and what the user can obtain by using the program (Fig. 1). The grade or analysis of the fertilizer [2] is entered and the user is asked to input the element [3] for which calculations are based. The ppm [4] of desired element in irrigation water is also entered along with the naturally occurring concentration [5] of the desired element in irrigation water. If the naturally occurring concentration equals or exceeds the desired concentration [6], the fertilizer would not be needed [7]. Units for the weight/volume ratio, such as lb. of fertilizer per gal are selected [8] then the numerical weight/volume ratio [9] is entered. A default of 10 lb. of fertilizer per gal may be used. Utilizing the inputs, a maximum concentration of the desired element is computed [10] and compared with the desired concentration. If the computed maximum concentration is less than desired [11], a fertilizer containing a larger percentage

[1]Florida Agricultural Experiment Stations Journal Series No. 5973. Trade names are mentioned with the understanding that no discrimination is intended and no endorsement by the authors or University of Florida is implied. The authors gratefully acknowledge Jason Goldman, Ivan Milman, and Justine Wetherington for programming assistance.