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SOIL FUNGICIDES FOR TROPICAL FOLIAGE PLANTS—EFFICACY AND OTHER CONSIDERATIONS[1]

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Abstract. **Diseases caused by soil-borne fungi account for major economic losses in the ornamental tropical foliage plant industry. Of specific importance are species of** Pythium, Phytophthora, Rhizoctonia, **and** Sclerotium rolfsii. **Research conducted over the years has produced data on the relative efficacy of various soil fungicides for the control of these pathogens. Recent results with one non-ionic, biodegradable surfactant indicate that surfactants, at times, may assist in control of pythiaceous plant pathogens. Results of research also indicate benzimidazole-type fungicides applied to soil may cause increased severity of diseases caused by non-target, pythiaceous pathogens. Fungicides found to be active in control, suggested concns, and their rates of application are included.**

A good deal has been written and stated about the potential for control of soil-borne fungal plant pathogens of ornamentals without employing soil fungicides. This philosophy has been expounded primarily by individuals who have not experienced soil-borne disease development in ornamental tropical foliage plants (OTFP) under prevailing cultural and environmental conditions in Florida's industry. Control of soil-borne diseases without employment of soil fungicides is desirable, but for the present, unrealistic for OTFP production in Florida. Growers should, however, strive to achieve the max degree of disease control, wherever possible, with a judicious and sensible use of chemicals. An excellent treatment on nursery management and cultural methods for disease control can be found in Manual No. 23 of The University of California Agricultural Experiment Station (4).

The following discussion is a partial review of past and current studies in the area of soil fungicides and their employment in control of some major soil-borne fungal pathogens that affect OTFP. Specific suggestions, rules of application, and recent research findings are included.

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Soil Fungicides and OTFP Production

The most extensive utilization of disease-control chemicals in the OTFP industry occurs with the attempted control of soil-borne fungal pathogens. Due to the wide variety of plants grown and the presence of an environment so conducive to the development of plant pathogens, Florida foliage growers are faced with the prospects of controlling many different soil-borne fungal pathogens, often at the same time on the same plant. Past research on OTFP has indicated the major soil-borne fungal pathogens to be species of *Pythium* (7, 8, 13, 15, 16, 20, 22), *Phytophthora* (3, 11, 12, 14, 18, 22), *Rhizoctonia* (6, 9, 10, 22), and *Sclerotium rolfsii* Sacc. (1, 2, 22). This same research has provided soil fungicide efficacy and phytotoxicity data that have provided the basis for the listing of fungicides in Table 1.

For the most part, soil fungicides have been applied as drenches to pots, flats, and propagative beds. The timing, concn and volume (rate) of drench application are critical for successful disease control. Growers often repeat drench applications far too frequently causing excessive accumulation of the compound in the soil which in turn can cause reduction in plant growth and production losses. The suggestions offered in Table 2, when followed, will assist in providing effective disease control while eliminating many risks that can be connected with soil fungicide applications to OTFP.

Table 2. Suggested drench volumes of soil fungicides to tropical foliage plants.[z]

Applied to	Volume (pints) required/ft² soil surface
Mini pots or shallow flats	0.75
Other pots to 4-inch size and propagative beds or flats to 4 inches in depth	1.0
Pots > 4-inch size and beds or flats > 4 inches deep	1.5-2.0

[z]Never exceed drench volume of 1.0 pint/ft² when soil mix contains less than 50% peat moss.

Table 1. Soil fungicides for tropical foliage plants.

Fungicide	Effective concn (oz)[z]	Pathogens controlled	Additional comments
Banrot 40 WP	8-12	*Pythium, Rhizoctonia* & *Fusarium* spp.	Will not control *Phytophthora* in Florida.
Benlate 50 WP	8-16	*Rhizoctonia* & *Fusarium* spp.	Must be used in conjunction with Truban or Dexon if *Pythium* or *Phytophthora* present.
Dexon 35 WP	8-16	*Pythium* spp.	Will not control *Phytophthora* in Florida.
Fermate 76 WP	16-24	*Rhizoctonia* spp. & *Sclerotium rolfsii*	May cause stunting of seedlings & cuttings.
Terraclor 75 WP	12-24	*Rhizoctonia* spp. & *Sclerotium rolfsii*	Apply only once a year, may cause stunting.
Truban 30 WP	8-12	*Pythium* spp.	Will not adequately control *Phytophthora* spp. in Florida.

[z]Based on amount of formulated product/100 gal water.

In addition to the information found in Table 2, the following rules are suggested.

1. Drench applications with the same compound should not be repeated sooner than every 8-12 weeks.
2. Do not apply to plant foliage, but where this cannot be avoided, come back and lightly rinse off foliage as soon after applications as possible.
3. When soil drenches must be applied to areas with leafy unrooted cuttings, apply to the propagative medium prior to sticking the cuttings. Have all workers wear "Playtex"-type rubber gloves when planting cuttings in media previously drenched.

Drenches and Non-Target Species

Currently fungicides are under investigation by federal agencies for their effects upon non-target macro- and microorganisms present within the environment. Non-target refers to any organism that might be affected other than those for which the compound is employed. This is only proper and this consideration of soil fungicides is an important area of concern.

Benzimidazole-type compounds, commonly used in the OTFP industry, have been demonstrated to increase the severity of soil-borne diseases caused by non-target pythiaceous pathogens. This effect is often dramatically evident where pythiaceous pathogens are already present in soils receiving applications of benzimidazole compounds. Published (5, 21) and unpublished observations of this increase in disease prove it to be common. Work conducted at this research center involving *Pythium splendens* Braun on pothos (8) and unpublished work with *Pythium myriotylum* Drechs. on caladium, has demonstrated that benzimidazole-type compounds TBZ (Mertect®) and benomyl (Benlate®) are capable of increasing the severity of Pythium diseases (Table 3). The cause of this disease stimulation has yet to be proven conclusively, but it appears not to be a direct effect on the pythiaceous fungal pathogens themselves, but possibly on other fungi and actinomycetes (19) existing in the soil that may be antagonistic to, parasitic upon, or competitive with the pythiaceous pathogens. It is important for growers to realize that increased disease may occur and that it will probably be rectified by including a soil fungicide active against pythiaceous fungi whenever benzimidazole compounds are applied to soils containing foliage plants known to be hosts of pythiaceous pathogens.

Another non-target effect that was recently discovered (8, 17) in research conducted on soil fungicides employed in OTFP production was the beneficial activity that Dexon drenches have in providing control of *Erwinia carotovora* (L. R. Jones) Holland. This discovery can be important in selection of the proper disease control where both *Pythium* spp. and *E. carotovora* are present in the same soil.

Table 3. Selected data from chemical control experiments conducted at ARC-Apopka which demonstrate the increased severity of *Pythium* diseases in the presence of benzimidazole fungicides.

Pythium splendens—pothos[z]		*Pythium myriotylum*—caladium[y]		
Drench treatment	% Cuttings rotted of total planted	Drench treatment	Total no. tubers produced	Wt. tubers (% of control)
Truban	29	Truban	69	569
Truban + Benlate	47	Benlate	31	55
Truban + Mertect	44	Truban + Benlate	70	383
Control	53	Control	40	100

[z]Data taken 45 days after sticking cuttings in naturally-infested beds. Three plots comprised each treatment with 390 cuttings total/plot. Drenches applied at rate of 1 pt/ft² after sticking cuttings.
[y]Data taken 7 months after planting. Fumigated soil and naturally-infested tubers used. Four plots comprised each treatment with 16 tuber pieces planted/plot. Treatments applied in-row at planting and as band treatment twice after planting.

Surfactants and Their Value

Surfactants, or wetting agents, increase the ease of wetting mixes containing a high percentage of organic matter such as peat moss. They are also suggested as beneficial, either alone or in combination with soil fungicides, in the control of certain soil-borne pathogens. Surfactants, especially Aqua-Gro® (Aquatrols Corp. of America, Box 385, Delair, NJ 08110) have been employed in northern greenhouses for years to provide more rapid and uniform wetting of soil media. They are applied in both liquid and granular form.

Of interest in our tests was the question of whether or not Aqua-Gro (AG) will assist in control of pythiaceous plant pathogens. The method of AG application was incorporation of the granular form into the soil medium at 1 1/2 lb/yd³ prior to planting and infestation with the pathogen. The experimental materials and methods employed to produce disease and in the application of fungicides were similar to those employed in previous work (1, 2, 11). Typical results obtained are listed in Table 4 where it is noted that the addition of AG to soils may increase disease control in both the absence and presence of soil fungicides.

Table 4. The effect of the surfactant Aqua-Gro (AG) under experimental conditions upon soil-borne diseases of tropical foliage plants caused by pythiaceous fungi.

Pythium splendens—schefflera[z]		*Phytophthora parasitica*—peperomia[y]		
Treatment	Total # seedlings remaining	Treatment	Avg disease rating	Fresh wt. top (% of total)
Control — I	4	Control — I	2.2	51
Control — I + AG	51	Control — I + AG	1.6	71
Control — NI	126	Truban — I	2.2	48
Control — NI + AG	132	Truban — I + AG	1.0	98
CGA 48988 — I	38	Control — NI	1.0	100
CGA 48988 — I + AG	79			

[z]Data taken 68 days after pots infested. Ten pots comprised each treatment with 20 seeds/pot. Letter designations AG = Aqua-Gro, I = infested with pathogen, NI = not infested with the pathogen, CGA 48988 = expt. fungicide.
[y]Data taken 79 days after pots infested. Five pots comprised each treatment with 1 plant/pot. Disease severity determined on rating scale of 1-4 with 1 = no symptoms of stem decay and 4 = severe blackening and collapse of the stem.

Concluding Remarks

The selection of the proper fungicide and its method of application for control of soil-borne diseases of OTFP is not a simple matter. As was noted earlier, fungicides may have both detrimental (influence of benzimidazoles on pythiaceous fungi) and beneficial (control of *E. carotovora* by Dexon 35 WP) effects on nontarget microorganisms. Growers should be aware of these consequences. It also appears that non-ionic, biodegradable surfactants such as Aqua-Gro may assist in the control of pythiaceous pathogens. The mechanism for the control is not fully understood at present but the existence of the effect can be experimentally demonstrated.

In conclusion, the intent of this report is to provide a guideline in the proper selection and utilization of fungicide drenches for control of soil-borne fungal pathogens of OTFP. Growers must realize, however, that soil fungicides are not a cure for poor culture. Proper management of soil-borne diseases in Florida can only be achieved by the proper and sensible employment of a control strategy developed and based upon available information on cultural, biological and chemical control. The information presented here on soil fungicides, when applied properly, will serve to assist in control of soil-borne fungal pathogens of ornamental tropical foliage plants.

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CHEMICAL DISBUDDING OF CHRYSANTHEMUM MORIFOLIUM RAMAT. WITH P-293[1]

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Abstract. **2,3-dihydro-5,6-diphenyl-1,4-oxathiin (P-293), applied to chrysanthemum plants grown under short day conditions, was ineffective in consistently disbudding 10 standard chrysanthemum cultivars grown in a polypropylene shade structure. Concentrations of 0.4, 0.6, 0.8, 1.0, 1.2, and 1.4% a.i. P-293 produced highly variable results when applied on 4 separate dates. High concn stunted the plants or aborted the terminal meristem. Low concn appeared to elongate the laterals. Only 'Orange Bowl,' 'Mountain Snow,' and 'Trident' showed favorable disbudding response with P-293, but the response was not significant enough to be of practical use.**

Chrysanthemum (*C. morifolium* Ramat.) growth can be modified by chemicals which: 1) disrupt or kill the apical meristem and allow normal growth of the lateral meristems, such as fatty acid esters (1, 3); 2) reduce cell elongation, such as SADH (13) and ancymidol (4, 8); 3) promote peduncle elongation without affecting the terminal meristem, such as gibberellic acid (14); and 4) retard internode elongation of the laterals without affecting development of the terminal meristem, such as xylene or kerosene-type emulsifiable oils (6) or alkylnapthalenes (7). Introduction of 2,3-dihydro-5,6-diphenyl-1,4-oxathiin (P-293), which acts as a localized growth inhibitor, has renewed interest in a method to chemically disbud standard chrysanthemums. Previous chemicals used to prevent lateral shoot development or disbud chrysanthemums produced highly variable results and were effective only under controlled conditions (5, 6, 7, 10). Recent reports indicate that P-293 can arrest the development of axillary meristems without affecting the terminal meristem in chrysanthemums (2, 9, 11, 12, 15). Concn of chemical and times of application were critical for specific cultivars for the successful retardation of lateral inflorescences.

Purpose of this research was to determine the effect of P-293 on disbudding standard chrysanthemums grown in black polypropylene shade structures in Florida.

Materials and Methods

General: Rooted chrysanthemum cuttings were planted in 15 cm high and 75 cm wide ground beds of Myakka fine sand (pH 6.2 after liming) in a shade house covered with black polypropylene cloth (25% shade). Plants were spaced 15 cm apart across the bed and 10 cm apart down the bed. Plants were maintained vegetatively for the first 4 weeks of each experiment by use of natural photoperiods supplemented with 4 hr light from incandescent lamps which provided 120 lux at plant height from 2200 to 0200 hrs daily. To induce flowering, the lights were removed. Single superphosphate and dolomite, at 560 and 1120 kg/ha respectively,

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