Control of Damping-Off Pathogens in Soilless Container Media

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ABSTRACT

Stephens, C. T., and Stebbins, T. C. 1985. Control of damping-off pathogens in soilless container media. Plant Disease 69:494-496.

Control of damping-off of impatiens seedlings with commonly used greenhouse fungicides was variable and dependent on the growing media in which the plants were grown. Damping-off caused by *Rhizoctonia solani* or *Pythium ultimum* was readily controlled in peat, composted pine bark, and composted hardwood bark media drenched with the more effective fungicides. Control of damping-off was least effective in processed pine bark. Metalaxyl outperformed several other fungicides in controlling Pythium damping-off in this study. PCNB was slightly more effective than ethazol plus thiophanate methyl or benomyl at low rates, but all provided excellent control of Rhizoctonia damping-off. There was less Pythium and Rhizoctonia damping-off in untreated composted hardwood bark than in other media tested, and addition of fungicides to this medium did not adversely affect its suppressive characteristics.

Use of soilless container media is gradually replacing steam-sterilized soil in the greenhouse industry. There are a number of commercially available container media that are composed of differing ratios of such materials as perlite, sand, vermiculite, expanded Styrofoam, peat, pine bark, and hardwood bark. These media use either peat or bark or a mixture of these organic components. In general, peat media are considered conducive to damping-off pathogens, whereas composted hardwood bark media (CHBM) are considered naturally suppressive (3,7,11). CHBM may be suppressive because of microorganisms that are hyperparasitic to plant pathogens (2,4,6,8,9) or that produce microbial inhibitors (5,8).

Although soilless container media are generally pathogen-free, infestation of these media by damping-off pathogens occurs in the greenhouse (1,13). *Pythium* spp. and *Rhizoctonia solani* (Kühn) anastomosis group 4 (AG-4) are the major cause of damping-off in bedding plant greenhouses in the Midwest (12,14). Although several fungicides are used to combat seedling damping-off, control of these two damping-off pathogens is variable.

The degree of control of damping-off pathogens in soilless media may vary for several reasons. As fungicides interact chemically either by being absorbed, inactivated, or decomposed with various components of container media, the availability of fungicides may vary according to the medium being used. Also, the amount of damping-off that occurs may vary depending on whether the medium being used is conducive or suppressive to damping-off. The objective of this study was to determine if the commonly used greenhouse fungicides are effective in controlling damping-off in soilless media, if the varied contents of these media affect efficacy of various fungicides, and if fungicide treatments affect the suppressive characteristics of these container media.

Michigan Agricultural Experiment Station Journal Article 11251.

Accepted for publication 6 December 1984 (submitted for electronic processing).

MATERIALS AND METHODS

The four soilless media were Metro Mix 350 and Metro Mix 300 (W. R. Grace, Cambridge, MA), Sure Mix (Michigan Grower Products, Galesburg, MI), and a CHBM. Metro Mix 350 contained processed (residue of bark burner) bark, Canadian sphagnum peat, no. 3 grade vermiculite, and granite sand. Metro Mix 300 was composed of composted pine bark, Canadian sphagnum peat, no. 3 grade vermiculite, and granite sand. Sure Mix consisted of expanded polystyrene, vermiculite, and Canadian sphagnum peat (2:3:5, v/v). The CHBM consisted of hammermilled composted hardwood bark (Paygro Inc., South Charleston, OH), Styrofoam particles, and Canadian sphagnum peat (5:3:2, v/v). To more accurately equalize the initial nutrients, all media were obtained from the manufacturers without the nutrient charge and amended with Osmocote 14-14-14 (Sierra Chemical Co., Milpitas, CA) slow-release fertilizer at a rate of 10 g/L of media.

Impatiens (*Impatiens wallerana* Hook. 'Dwarf Baby Mix' (Ball Seed Company, West Chicago, IL) seedlings were used in all experiments. Seeds were sown in the four types of media in a single 16-cm row at a rate of three seeds per centimeter in plastic trays measuring 17.8 × 13.3 × 5.8 cm (T. O. Plastic, Minneapolis, MN). All trays were adjusted initially with water to container capacity (16). The trays were placed in the greenhouse, covered with polyethylene to ensure rapid and uniform seedling germination, and watered daily. Polyethylene was removed during sunny hours to prevent overheating.

Fungicides were applied at the label rate (X), and at 1/2X, 2X, and 4X rates as follows: fenaminosulf, 0.43 g a.i./L (Lesan 35WP); ethazol, 0.11 g a.i./L (Truban 30WP); ethazol plus thiophanate methyl, 0.18 g a.i./L (Banrot 40WP); benomyl, 0.61 g a.i./L (Benlate 50WP); PCNB, 1.83 g a.i./L (Terraclor 75WP); metalaxyl, 0.01 g a.i./L (Subdue 2E, 25EC); and NTN-19701, 0.8 g a.i./L (experimental fungicide, 12.5WP). Chemical suspensions (115 ml) were used to drench each tray (5 L/m). Control trays received no fungicides. Ethazol plus thiophanate methyl, benomyl, PCNB, and the experimental NTN-19701 were evaluated for control of *R. solani*. Ethazol plus thiophanate methyl, fenaminosulf, ethazol, and metalaxyl were evaluated for control of *Pythium ultimum* Trow.

Cultures of *R. solani* (isolate 21 from *Impatiens*) and *P. ultimum* (isolate 248 from tomato), highly virulent on impatiens, were used throughout this study (12,14). Both cultures were maintained on potato-dextrose agar (PDA) (Difco Laboratories, Detroit, MI) and stored at 5 C. Before inoculation, cultures were grown on 20 ml of PDA in 10-cm petri plates for 2 days at 24 C. When seedlings emerged (usually after 10 days), the polyethylene was removed and the seedlings were drenched with fungicides and left uncovered for 24 hr to allow chemical uptake. Then seedlings were inoculated using a modified postemergence inoculum method (15). Mycelial disks 12 mm in diameter taken from the perimeter of the growing culture were used to inoculate the emerging seedlings in the trays. The disks were half buried next to the first seedling at the end of each seedling row. The flats were misted, placed individually in clear plastic bags, completely randomized on the benches, and kept at 18 C at night and 26 C during the day under natural lighting conditions. After 7 days of incubation, the length of the seedling row damped-off was measured and an analysis of variance performed with the means separated by the least significant difference test (LSD 5%). A preliminary experiment was conducted using similar methods and materials.

RESULTS

High levels of both Rhizoctonia and Pythium damping-off were obtained in these studies (more than 50% damped-off seedlings in all but the CHBM controls) so that accurate evaluation of control performance and the effects of fungicide treatments on suppressiveness could be evaluated. Ethazol, ethazol plus thiophanate methyl, and metalaxyl, were significantly more effective than fenaminosulf in controlling Pythium damping-off except in the CHBM (Table 1). Specifically, 1/2X and X rates of fenaminosulf provided significantly less control of Pythium damping-off than other tested materials (Fig. 1). Metalaxyl completely controlled all Pythium damping-off in all media tested.

Pythium damping-off was completely controlled with all rates of all chemicals in CHBM and peat media with the exception of fenaminosulf (Fig. 1). In the processed pine bark media, moderate amounts of damping-off occurred at 1/2X and X rates of ethazol and ethazol plus thiophanate methyl and high amounts of damping-off occurred with these same rates of fenaminosulf.

There was significantly less Pythium damping-off in the CHBM and peat medium than in either of the pine media in the absence of fungicides (Table 1). In combination with any of the fungicides used in this study, even at the lowest rate, there was less than 2 cm of Pythium damping-off in the CHBM (Fig. 1). Fenaminosulf provided significantly greater control of damping-off in the CHBM than in the other media tested.

There was less than 1 cm of Rhizoctonia damping-off occurring in the PCNB treatments except at the 1/2X rate in the peat medium (Fig. 2). Ethazol plus thiophanate methyl was equally effective in all media except at the 1/2X rate in the pine bark media. Benomyl provided excellent control in all media except the composted pine bark medium. At the X rate, control by benomyl in the composted pine bark medium was significantly less than PCNB or ethazol plus thiophanate methyl. The experimental NTN-19701 material provided significantly less control than other tested materials (Table 2).

The CHBM alone was significantly suppressive to Rhizoctonia damping-off compared with the other media tested (Table 2). There was excellent control of Rhizoctonia damping-off in CHBM, even at 1/2X rates with three of the four chemical drenches (Fig. 1). Damping-off was significantly reduced in the CHBM compared with the other media when drenched with NTN-19701 (Table 2). There was also less Rhizoctonia damping-off in the peat medium than in the processed pine bark medium. When the peat medium was chemically drenched, control was comparable to that achieved in the CHBM with the exception of the experimental compound NTN-19701 (Table 2).

DISCUSSION

Regardless of soilless media or rate of

Table 1. Control of Pythium damping-off of impatiens with several fungicides added to different soilless media

Container media	No fungicide	Ethazol plus thiophanate methyl	Fenaminosulf	Ethazol	Metalaxyl	Container media means
Composted pine bark	12.3[a]	1.0	5.5	0.4	0.0	3.8
Processed pine bark	9.6	2.2	5.7	1.3	0.0	3.9
Peat	7.4	0.0	4.0	0.0	0.0	2.3
Composted hardwood bark	6.2	0.0	0.4	0.0	0.0	1.3
Chemical means	8.9	0.8	3.9	0.4	0.0	···

[a] Numbers represent length (cm) of row (maximum 17 cm) with damped-off seedlings 7 days after inoculation. Numbers are means of four rates (1/2X, X, 2X, and 4X) and three replicates per rate. LSD (5%): container media means = 1.5, chemical means = 0.8, between chemicals on the same medium = 1.5, and between container media = 2.0.

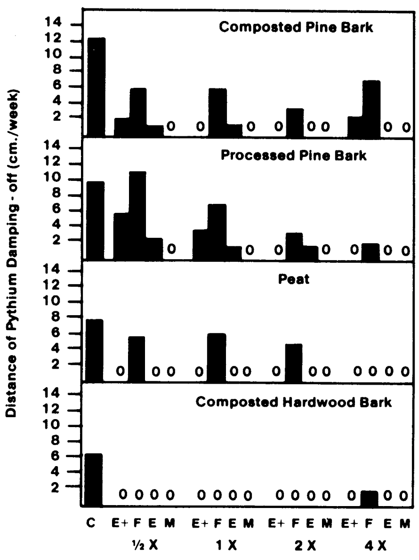

Fig. 1. Centimeters of damping-off occurring down a row of impatiens seedlings 1 wk after inoculation with *Pythium ultimum*. The media were drenched with ethazol plus thiophanate methyl (E+), fenaminosulf (F), ethazol (E), metalaxyl (M), or no chemical control (C) at 1/2, 1, 2, or 4 times the recommended label rate (X). LSD (5% between controls, mean of 12 replicates) = 2.2, and all other comparisons between media or between fungicides (mean of three replicates) = 4.5.

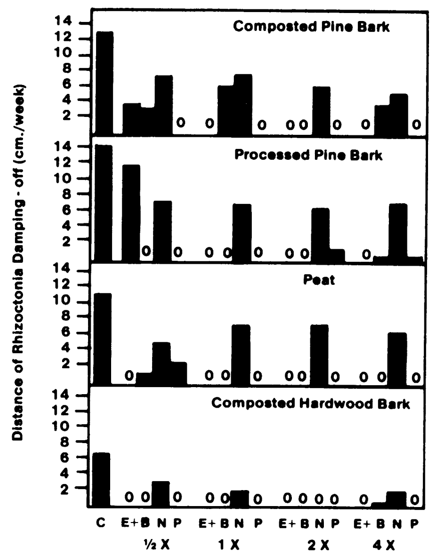

Fig. 2. Centimeters of damping-off occurring down a row of impatiens seedlings 1 wk after inoculation with *Rhizoctonia solani*. The media were drenched with ethazol plus thiophanate methyl (E+), benomyl (B), NTN-19701 (N), PCNB (P), or no chemical drench (C) at 1/2, 1, 2, or 4 times the recommended label rate (X). LSD (5% between controls, mean of 12 replicates) = 2.0, and all other comparisons between media or between chemicals (mean of three replicates) = 4.1.

Table 2. Control of Rhizoctonia damping-off of impatiens with several fungicides added to different soilless media

Container media	No fungicide	Ethazol plus thiophanate methyl	Benomyl	NTN-19701	PCNB	Container media means
Composted pine bark	12.7[a]	0.9	3.3	6.8	0.0	4.7
Processed pine bark	14.1	3.0	0.0	6.9	0.4	4.9
Peat	10.5	0.0	0.1	6.3	0.5	3.5
Composted hardwood bark	6.1	0.0	0.0	1.6	0.0	1.5
Chemical means	10.9	1.0	0.9	5.4	0.2	···

[a] Numbers represent length (cm) of row (maximum 17 cm) with damped-off seedlings 7 days after inoculation. Numbers are means of four rates (1/2X, X, 2X, and 4X) and three replicates per rate. LSD (5%): container media means = 1.9, chemical means = 1.2, between chemicals on the same medium = 2.5, and between container media = 2.8.

fungicide used, metalaxyl outperformed other fungicides in controlling Pythium damping-off in this study. Ethazol and ethazol plus thiophanate methyl provided good control, whereas fenaminosulf was less effective except in CHBM. In the experiments with *Rhizoctonia*, PCNB provided the most consistent control. Benomyl and ethazol plus thiophanate methyl also provided excellent control, whereas control by NTN-19701 was poor.

There were significant differences in the efficacy of these fungicides depending on which medium was being used. In general, Rhizoctonia and Pythium damping-off were most difficult to consistently control in the pine bark media. These data may explain why recommended rates of fungicide may not adequately control damping-off in all media. With the more effective fungicides, damping-off was easy to control in the peat, composted pine, and CHBM. In peat and CHBM, the 1/2X rates of these same fungicides were highly effective.

There was less Pythium and Rhizoctonia damping-off in the CHBM medium than in the other media tested. The addition of fungicide treatments did not appear to adversely affect the suppressive characteristics of this medium; less damping-off occurred in the fungicide-treated CHBM than in the untreated CHBM. The CHBM greatly enhanced the effectiveness of fenaminosulf and NTN-19701 for control of Pythium and Rhizoctonia damping-off, respectively, over the other three media. Fenaminosulf and NTN-19701 gave better control in CHBM than expected considering their ineffectiveness in peat, which was closest to the CHBM in natural suppressiveness. Either the fungicides were not active against the suppressive microorganisms present in the CHBM medium (9,10) or pathogen inhibition by microbial products already present in the CHBM was the mechanism responsible for suppression. In either case, these data indicate the use of media containing composted hardwood bark may have merit as a disease control measure in commercial bedding plant operations.

ACKNOWLEDGMENTS

This research was supported in part by Bedding Plants Incorporated, Western Michigan Bedding Plant Cooperative, and the W. R. Grace Company. We wish to thank Jim Tuinier for guidance and many helpful suggestions in relation to this research.

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