Fungicides for Control of Rhizoctonia Stem Rot of Poinsettia in Oasis Rooting Cubes

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Rhizoctonia stem rot of poinsettia caused by *Rhizoctonia solani* Kuhn is a widespread and destructive disease (Farr et al., 1989). Although most growers have developed management strategies including sanitation and preventative fungicide programs to avoid epidemics, the pathogen continues to cause endemic losses in poinsettia. Recently, Powell (1988) described the effectiveness of Benlate and Terraclor as soil drenches for control of Rhizoctonia stem rot of poinsettia cuttings stuck directly in the finish container. In each experiment, Benlate or combinations of Benlate plus Truban gave better control of stem rot than Terraclor (Powell, 1988).

A large segment of the poinsettia crop is produced from cuttings taken from stock plants and stuck in rigid soilless rooting cubes (e.g. Oasis Rootcubes, Smithers-Oasis USA, Kent, Ohio). Organic debris containing inoculum of *R. solani* that has contaminated the rooting cube or cutting may be a source of inoculum for development of stem rot during propagation.

The purpose of this research was to evaluate the effectiveness of several fungicides as foliar sprays or rooting-cube soaks during propagation of poinsettia in prevention of Rhizoctonia stem rot and to determine if the fungicides applied at the start of propagation inhibited root development.

Materials and Methods

Stock plants of poinsettia (*Euphorbia pulcherrima* Willd. 'Gutbier V-14 Glory') were maintained in 6-liter polyvinyl containers on a shaded greenhouse bench as a source of cuttings.

Strips of five foam rooting cubes (Oasis Rootcubes, Smithers-Oasis U. S. A., Kent, Ohio) were saturated with water or soaked in a 200 ml fungicide solution as described below. A five-cube strip absorbed 200 ml of water when dry. Each strip was then placed in a styrofoam sleeve secured by rubber bands.

Rhizoctonia solani isolate RS3 from poinsettia was grown on petioles of poinsettia as inoculum. Prior to sticking poinsettia cuttings, the petiole inoculum was placed on the cube surface at right angles to the long axis of the strip about 2 cm away from pre-formed holes in which the cutting was placed.

Cuttings were stuck in the rooting cubes as soon as the inoculum segments were in place with care to avoid contacting the cutting with the colonized petioles. A mist system was used to wet the cutting and cube for 2 min twice a day on a shaded greenhouse bench. Initially, cuttings wilted during the warmest portion of the day but after a few days, foliage on healthy cuttings remained turgid.

Foliar sprays and rooting-cube soaks were used to apply fungicides. Foliar sprays were applied to run-off in the afternoon after foliage had dried from the initial misting in the morning following sticking. Fungicide contacted both foliage and top surface of the cubes during spraying. For foliar sprays, 60 ml of fungicide solution was used for each five-cube strip. For rooting-cube soaks, 200 ml of solution was used since this amount was absorbed completely by five dry cubes.

The following fungicides with rate of product per 100 gallons of water used as foliar sprays were: Benlate 50W, 8.0 oz/100 (benomyl, DuPont Chemical Co., Wilmington, Del.); Banrot 40W, 8.0 oz/100 (ethazole+thiophanate methyl, W. R. Grace Co., Cambridge, Mass.); Daconil 2787 40.4F, 1.5 pt/100 (chlorothalonil, Fermenta Plant Protection Co., Cleveland, Ohio); flutolanil 50W, 8.0 oz/100 (N-[3-(methylethoxy)phenyl]-2-(trifluoromethyl)benzamide, Nor-Am Chemical Co. Wilmington, Del.); Chipco 26019 50W, 16.0 oz/100 (iprodione, Rhone-Poulenc Agr. Co., Research Triangle, N.C.); Subdue 40W + Benlate 2W, (Varsity 42W), 16.0 oz/100 (metalaxyl + benomyl, Ciba-Geigy Agr. Division, Greensboro, N.C.); and Terraclor 75W, 8.0 oz/100 (quintozene, PCNB, Uniroyal Chemical Co., Middlebury, Conn.). There were three replications per fungicide with five observations per replication arranged in randomized complete block design. The experiment was repeated once.

In another experiment, the following fungicides were applied as a foliar spray or as rooting-cube soak treatments: flutolanil, 8.0 oz/100; Chipco 26019, 6.5 oz/100, and Varsity, 16.0 oz/100. For rooting-cube soaks, an application rate of 2 pt/ft^2 (947 ml/929 cm^2) was chosen in which 24 ml of fungicide solution mixed with 176 ml of water was absorbed completely by the five-cube strip. The strips were soaked prior to sticking the poinsettia cuttings. There were three replications per treatment and the experiment was repeated once.

Root development was assessed on a scale where 1 = no roots formed on cutting, 2 = roots initiated but not growing through to outside surface of cube, 3 = roots growing through one outside surface of cube, 4 = roots growing through two outside surfaces of cube, and 5 = roots growing through all three outside surfaces of the cube.

Poinsettias were rated for extent of Rhizoctonia stem rot after 29 days. A stem rot scale where 1 = no stem lesion, 2 = lesions on <25% of stem surface, 3 = lesions on <50% of stem, 4 = lesions on <75% of stem, and 5 = stem completely girdled, cutting collapsed, was used.

Results

Comparison of fungicides as foliar sprays. Untreated cuttings exposed to petiole inoculum of *R. solani* developed extensive stem rot and collapsed within 7–10 days (Table 1, 2). Poinsettias treated with foliar sprays of Daconil 2787, flutolanil, Chipco 26019, or Varsity had stem rot ratings of 1.3 or less and were not different from the untreated, uninoculated control after 29 days (Table 1). Terraclor and Banrot gave the least control of Rhizoctonia stem rot of any fungicides tested (Table 1). Stem rot was intermediate for cuttings treated with a Benlate spray.

Rooting of cuttings treated with flutolanil and Varsity was equivalent to rooting for the untreated, uninoculated control (Table 1). Rooting of poinsettias treated with Daconil 2787, Chipco 26019, Benlate, Banrot, and Terraclor was less due to stem rot than the untreated, uninoculated control (Table 1).

Comparison of foliar sprays with rooting-cube soaks in fungicide. Soaking rooting cubes in fungicide solutions was as effective in preventing stem rot as foliar sprays. For example, stem rot ratings for the Varsity combination was

Table 1. Efficacy of foliar fungicide sprays on control of Rhizoctonia stem rot of poinsettia and on rooting of poinsettia cuttings in Oasis Rootcubes after 29 days.

Fungicide	Rate (per 100 gal)	Disease rating	Rooting rating
Chipco 26019 50W	16.0 oz	1.0 d	3.8 cd
flutolanil 50W	8.0 oz	1.0 d	4.9 ab
Daconil 2787 40F	1.5 pt	1.3 cd	4.3 bc
Varsity 42W	16.0 oz	1.3 cd	4.6 ab
Benlate 50W	8.0 oz	1.7 c	3.7 cd
Banrot 40W	8.0 oz	2.6 b	3.3 de
Terraclor 75W	8.0 oz	2.6 b	3.0 e
Inoculated	--	5.0 a	1.0 e
Control	--	1.0 d	5.0 a

Disease ratings: 1 = healthy through 5 = stem girdled, cutting collapsed. Rooting ratings: 1 = no roots formed on cutting through 5 = roots evident on the three exterior sides of rooting cube. Values followed with the same letter are not significantly different as tested by F-protected Waller/Duncan k ratio; k = 100, P = 0.05.

1.0 for either mode of application (Table 2). Stem rot was less than the untreated, inoculated cuttings for all fungicides tested. However, only cuttings treated with flutolanil and Varsity had stem rot ratings as low as the untreated, uninoculated control (Table 2).

Rooting ratings between fungicide-soaked cubes and foliar sprays were not different (Table 2). Rooting was not different among the untreated-uninoculated control, flutolanil, and Varsity treated poinsettias (Table 2). However, less rooting occurred on cuttings exposed to Chipco 26019 (Table 2).

Discussion

The excellent control of Rhizoctonia stem rot of poinsettia observed with foliar sprays of Daconil 2787, flutolanil, Chipco 26019, and Varsity and rooting cube soaks of flutolanil and Varsity was probably due to the contact of fungicide with rooting cube. On untreated rooting cubes, *R. solani* grew on and through the cube to infect cuttings. Foliar sprays of effective fungicides contacted the rooting cube surface as well as the cutting during application.

The effectiveness of the rooting-cube soak provided further evidence of the importance of protecting the rooting cube from colonization by *R. solani*. With rooting-cube soaks the cutting is exposed to fungicide only at the point of contact where cutting meets rooting cube. It is unlikely that enough fungicide is transferred to the cutting to protect it, instead hyphae of *R. solani* must be prevented from growing out from the petiole inoculum which was applied about 2 cm from the cutting.

Previous research on control of Rhizoctonia stem rot of poinsettia demonstrated that soil drenches to rooted and unrooted cuttings and root dips in Benlate were more effective than incorporation into the medium (Powell, 1988; Raabe and Hurlimann, 1971; Strider, 1977). Incorporation of granular fungicides in the medium may reduce effectiveness of control since on a per unit area basis less fungicide may actually contact the cutting surface.

Chipco 26019 as a drench effectively controlled Rhizoctonia stem rot on rooted cuttings of poinsettia in soilless peat medium at rates of 5 to 21 oz/100 gal in Florida, although control did not improve significantly with increase in rate (Snowden and Engelhard, 1982). In the present study, increasing the rate of

Table 2. Comparison of foliar fungicide sprays versus rooting cube soaks on control of Rhizoctonia stem rot of poinsettia and on rooting of poinsettia cuttings in Oasis Rootcubes after 33 days.

Fungicide	Rate (per 100 gal)	Disease rating spray	Disease rating soak	Rooting rating spray	Rooting rating soak
Varsity 42W	16.0 oz	1.0 c	1.0 c	4.9 a	4.3 ab
flutolanil 50W	8.0 oz	1.3 c	1.3 c	4.3 ab	4.2 b
Chipco 26019 50W	6.5 oz	2.1 b	2.1 b	3.3 c	3.5 c
Inoculated	--	5.0 a		1.0 e	
Control	--	1.3 c		4.6 ab	

Disease ratings: 1 = healthy through 5 = stem girdled, cutting collapsed. Rooting ratings: 1 = no roots formed on cutting through 5 = roots evident on the three exterior sides of rooting cube. Values followed with the same letter are not significantly different as tested by F-protected Waller/Duncan k ratio; k = 100, P = 0.05.

Chipco 26019 as a foliar spray from 6.5 to 16.0 oz/100 gal resulted in an observable decrease in stem rot ratings from 2.1 to 1.0.

Powell (1988) reported that Benlate at rates effective in control of *Rhizoctonia spp.* did not inhibit root development on poinsettia cuttings. In the present study, foliar sprays or rooting cube soaks of the most effective fungicides, Varsity and flutolanil did not affect root development of cuttings. However, lower rooting values found for other less effective fungicides should not be construed as due to phytotoxicity, since the root development rating is correlated negatively with extent of stem rot. Therefore, cuttings with more stem rot would have less root development. On the other hand, Powell (1988) found that Truban (ethazole, one component of the Banrot mixture) was phytotoxic to poinsettia cuttings, since addition of Truban with Benlate drenches resulted in better disease control than Benlate drenches alone but root development was less. Since Banrot did not adequately control stem rot in the present study, phytotoxicity due to ethazole could not be assessed. For any but the most effective fungicide tested here, additional experiments in the absence of *R. solani* would be needed to assess phytotoxicity.

Strider (1977) demonstrated the importance of fungicide applications prior to introduction of inoculum for control of Rhizoctonia root rot of rooted poinsettia cuttings. Timing was more important than method of Benlate application (Strider, 1977). A delay of 1 day in drenching rooted cuttings with Benlate in a medium infested with *R. solani*, resulted in a 35% increase in the number of dead plants 30 days after transplanting. Delaying the drench 4 days after transplanting resulted in 90% mortality (Strider, 1977). The rapid growth rate of hyphae of *R. solani* from a food base through soil (up to 3 cm per day [Benson and Baker, 1974]), would account for the poor control observed with delayed applications of fungicides.

In this study, *R. solani* was able to colonize the rooting cubes. In commercial greenhouses, where rooting cubes are used, *R. solani* contaminating rooting cubes from crop debris sources could grow throughout the rooting cube infecting cuttings. Effective fungicides afforded protection against Rhizoctonia stem rot either as foliar sprays or as rooting cube soaks applied at the time of sticking cuttings.

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