Control of Phytophthora Root Rot of *Rhododendron chapmanii* A. Gray with Subdue[1]

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Abstract

Rooted cuttings of Chapman's rhododendron (*Rhododendron chapmanii*) in soilless medium were challenged with inoculum of the soilborne fungus, *Phytophthora cinnamomi* (Rands). A portion of the plants received a soil drench of Subdue 2EC (metalaxyl) at 0.16 ml/L (2.0 oz/100 gal) at 2 month intervals. Chapman's rhododendron was highly susceptible to *P. cinnamomi*, but five of six plants treated with Subdue did not develop symptoms of Phytophthora root rot. In the one plant which developed root rot symptoms, *P. cinnamomi* was recovered in culture.

Index words: rare and endangered species, Chapman's rhododendron, *Phytophthora cinnamomi*, metalaxyl, fungicide

Introduction

Chapman's rhododendron (*Rhododendron chapmanii* A. Gray), is a rare and endangered species (5, 8) with a very limited geographic distribution. Association of communities of *R. chapmanii* with wet habitats in Florida suggested that *R. chapmanii* might have genetic resistance to *Phytophthora cinnamomi* (Rands) that would allow re-introduction of the species in habitats naturally infested with the pathogen. Subsequent pathogenicity studies (4), however, showed that Chapman's rhododendron was highly susceptible to *P. cinnamomi* (4). The purpose of this study was to determine if a soil fungicide like Subdue (metalaxyl) would prevent infection of Chapman's rhododendron by *P. cinnamomi*, and thereby offer some promise for control of this disease in re-introduction of this species.

Materials and Methods

Experiments were conducted in the 1987 and 1988 growing seasons at University Research Unit 4 of North Carolina State University in Raleigh, N.C. Plants of Chapman's rhododendron in containers were placed in the nursery on a gravelled base at about a 30 cm (12 in) spacing. A 50% shade cloth cover was used. Sprinklers provided irrigation of 0.9 cm/day (0.3 in/day) split between a morning and an afternoon application. Results were similar between years so the most recent test in 1988 is reported.

Plant culture. Semi-hardwood stem cuttings of Chapman's rhododendron were rooted during fall and winter 1987–88 under intermittent mist and transferred to a pine bark medium in 10-cm-diameter (4 in) pots. Liners were grown in the greenhouse until spring 1988 when a well developed root system was present on test plants. In May, plants were transplanted to 2 L (6-in-diameter) containers containing a pine bark:sand medium (3:1 by vol) at pH 6.8 and placed in the nursery. The medium was amended with 3.3, 1.2, and 0.9 kg/m^3 (5.5, 2.0, and 1.5 lb/yd^3), of dolomitic limestone, superphosphate (0N–20P–0K), and C-trel micronutrients, respectively. Each pot was top dressed with 5 cm^3 (1 teaspoon) slow release 21N–2.6P–9.9K (21–6–12, a sulfur coated fertilizer) at transplanting.

Inoculum. Isolates 100 (from H. A. J. Hoitink, Ohio State University, Wooster, OH) 101 (ATCC 46292), 106, 128, and 150 of *P. cinnamomi* were cultured on sterilized oat grains for 3 weeks prior to use. Cultures of individual isolates were mixed together prior to inoculation. Inoculum was introduced to containers on June 9, 1988 as described previously (3). Containers were watered immediately after introduction of inoculum to prevent desiccation. Subsequent irrigation in the 48 hr after introduction of inoculum totaled 1.8 cm (0.6 in)/day.

Fungicide application. Subdue 2EC (metalaxyl) was used on June 9, 1988 after inoculation at 0.16 ml/L of water (2 oz/100 gal) by applying a 180 ml (6 oz) solution of fungicide as a drench to the 2 L (6 in diameter) container after each container had been watered and excess water allowed to drain. A second application of Subdue was made on August 9, 1988 at the same rate. Control treatments were plants not treated with Subdue but grown in infested or uninfested medium. There were six single plant replicates per treatment arranged in a randomized complete block design.

Plant growth and disease. Growth was measured by taking fresh top weight on September 19, 1988, 14.5 weeks after inoculation. Disease was assessed by rating roots for severity of Phytophthora root rot with a 1–5 scale where 1 = roots apparently healthy, 2 = small roots necrotic, 3 = coarse roots necrotic, 4 = crown rot, and 5 = dead plant (3). A sample of roots from each plant was collected and cultured on a selective medium as previously described (3) to determine percentage of plants in each treatment group infected with *P. cinnamomi*. Data for fresh top weight and root rot rating among treatments were analyzed with the PROC ANOVA procedure of PC-SAS. Mean separation was by Waller-Duncan Bayesian least significant difference test.

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Results and Discussion

Foliar symptoms of Phytophthora root rot were evident within 8 weeks on untreated plants of Chapman's rhododendron growing in media infested with *P. cinnamomi* (data not presented). Within 14.5 weeks all untreated, inoculated plants had either died or had severe symptoms of root rot. In contrast, plants treated with fungicide were similar in appearance to uninoculated controls (Fig. 1).

Striking differences in growth of inoculated, untreated plants occurred in comparison to uninoculated control plants (Table 1). However, no differences ($P = 0.05$) in growth between Subdue-treated, inoculated plants and uninoculated control plants were observed (Table 1). Root rot severity was greater ($P = 0.05$) in inoculated, untreated plants than in uninoculated, controls or fungicide-treated plants (Table 1). Although not assessed quantitatively, the size of the root systems of plants in the uninoculated control and fungicide-treated plants were similar (Fig. 1).

Subdue has been used successfully to prevent Phytophthora root rot on a number of other ornamental species in addition to azaleas and rhododendrons (*Rhododendron* spp.) (6, 7). The importance of application of Subdue at time of potting was demonstrated previously where the time between inoculation and fungicide application was varied from same-day application up to 7 days before and 28 days after inoculation. Prevention of Phytophthora root rot was greatest when fungicide was applied the same day that inoculum was introduced into containers.

One problem with systemic fungicides like Subdue that act as protectants is the occurrence of root infections without development of foliar symptoms (3). In this study, *P. cinnamomi* was recovered on selective medium from only one of six fungicide-treated plants (Table 1). This plant, however, showed severe symptoms of root rot. The five remaining plants treated with Subdue showed no foliar symptoms of root rot and *P. cinnamomi* was not isolated.

With certain cultivars of azalea and at higher than recommended rates of Subdue, phytotoxicity in the form of a marginal chlorosis and necrosis has been observed (1). No such phytotoxicity was observed on any test plant at the rate used in this study.

Attempts to re-introduce Chapman's rhododendron to its native habitat where soils infested with *P. cinnamomi* might occur should include use of a soil fungicide like Subdue that is effective against *P. cinnamomi*. Earlier work demonstrated the protective nature of Subdue when used as a broadcast treatment on landscape beds of azalea naturally infested with *P. cinnamomi* (2). Subdue was re-applied on a 2-month schedule during the growing season to maintain control.

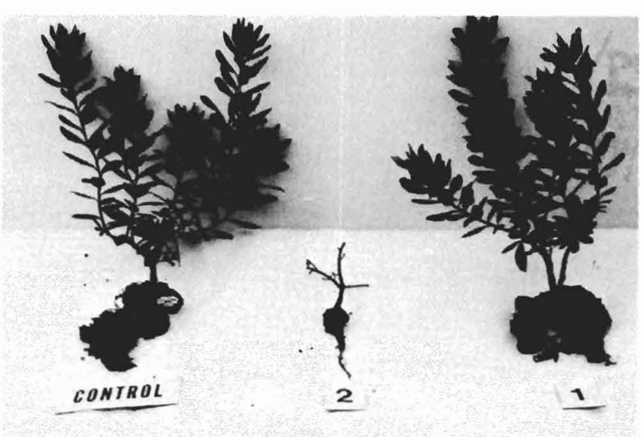

Fig. 1. Comparison of plants of Champan's rhododendron inoculated with *Phytophthora cinnamomi*, treated with Subdue, and grown for 14.5 weeks in containers in a nursery. Plant on the left marked control was the uninoculated control, the center plant was the inoculated untreated control, and the plant on the right was inoculated and treated with Sudue.

Table 1. Effect of Subdue (metalaxyl) on prevention of Phytophthora root rot of Chapman's rhododendron caused by *Phytophthora cinnamomi*.

	Chapman's rhododendron[w,y]		
Treatment	**Top weight (g)**	**Root rot[z] (1–5)**	**Plant infected (%)**
Inoculated, Subdue[x]	49.7 a	1.5 b	16
Inoculated, control	5.2 b	4.8 a	83
Uninoculated, control	45.8 a	1.7 b	0

[z]Root rot rating is on a scale of 1 to 5 where 1 = apparently healthy roots, 2 = small roots necrotic, 3 = large roots necrotic, 4 = crown rot, and 5 = dead plant.

[y]Mean separation within columns by Waller/Duncan k ratio t test; k = 100, $P = 0.05$.

[x]Subdue was used as a drench at a rate of 0.16 ml/L of water (2 oz/100 gal) by applying a 180 ml (6 oz) solution of fungicide to each container on 9 June and 9 August 1988.

[w]Each value based on 6 plants. Assessments were made after 14.5 weeks of growth in a pinebark:sand container medium (3:1 by vol) under nursery conditions.

Significance to the Nursery Industry

Chapman's rhododendron is highly susceptible to *Phytophthora cinnamomi*, a species causing Phytophthora root rot. Apparently, Chapman's rhododendron does not carry genetic resistance to *P. cinnamomi*. Therefore, attempts to re-introduce *R. chapmanii* to native areas or its use in landscape areas naturally infested with *P. cinnamomi* should include use of a soil fungicide like Subdue to protect the roots from infection and prevent mortality.

(*Ed note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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Chemical Growth Retardants Increase Seed Yield in Apple Trees[1]

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Abstract

In two experiments the effects of trunk drenches with two gibberellin biosynthesis inhibitors on vegetative growth, seed yield and quality of 'Delicious' and 'Golden Delicious' apple trees were studied. In the first experiment trunk drenches of either paclobutrazol or uniconizole were applied to 'Golden Delicious' apple trees in spring 1984. Both chemicals significantly reduced shoot length in 1985 and 1986. In 1986, fruit number tended to be higher in treated trees, but was less than untreated trees in 1985 and 1984. The estimated number of sound seeds produced in 1986 on treated trees was increased. Neither chemical significantly affected seed quality or seedling growth. In a second similar experiment paclobutrazol, applied as a trunk drench in spring 1984 at rates of 2, 4 or 8 g active ingredient (ai)/tree, significantly reduced shoot growth in 1985 and 1986. The number of sound seed/tree was significantly increased in 1986 at all paclobutrazol levels due to an increase in the number of fruit/tree. Paclobutrazol application had no effect on seed quality, rate of germination, final percent germination, or on seedling growth. Potentially, both compounds could be used to control vegetative growth without affecting seed yield or quality in deciduous seed orchards.

Index words: Seed orchards, seed quality, seed yield, growth regulator, uniconizole, paclobutrazol

Growth Regulators Used in this study: paclobutrazol, ((2RS,3RS)-1-4(4-chlorophenyl)-4,4-dimethyl-2-1,2,4-triazol-1-yl) pentan-3-ol); uniconizole, ((E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol).

Introduction

Seed orchards are used to package and mass produce superior genotypes (17). To date most seed orchards are of coniferous species. Some nursery managers have established seed orchards for selected angiosperm shrub species (Sheffield, personal communication). High fertility, supplemental irrigation and pest control are used to promote early seed production and maintain high seed yields. Vegetative growth under these conditions is vigorous. In seed orchards of small tree or shrub species vigorous growth is not a problem, however, with trees, vigorous growth makes orchard operations challenging.

Angiosperm fecundity tends to be greater than that of conifers; it has been estimated that 10 to 15 sycamore trees (on 30 by 30 ft spacing) would produce one million plantable seedlings yearly, while 100 loblolly pine trees would be required to produce a similar number of seedlings (J. B. Jett, North Carolina State University, Raleigh, N.C., personal comunication). Thus, a few angiosperm trees could produce the entire seed supply for the U.S. nursery industry. Caution should be raised at the potentially low genetic base. However, to plant enough trees to insure a broad genetic base (a minimum of 30 to 40 is suggested) would require at least one acre. A means of controlling tree size without decreasing seed yield (per unit land area) or seed quality would simplify orchard operations and allow many genotypes to be planted in a small space.

Chemical growth regulators are one means of controlling vegetative growth. Recently an inhibitor of gibberellin biosynthesis, paclobutrazol, has proven effective in controlling vegetative growth of fruit trees (2, 4, 5, 6, 8, 12, 13) and also of pecan (16) and black walnut (9). Trunk drench applications dramatically shortened internodes (8, 15, 16). Typically greater reductions in shoot length occurred the

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