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Herbicide Use During Propagation Affects Root Initiation and Development[1]

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Abstract

Two studies were conducted to evaluate the influence of herbicides on root initiation and development from stem cuttings of three woody landscape species. In the first experiment, *Rhododendron obtusum* 'Hino Crimson' rooting percentage was suppressed with Rout 3G (oxyfluorfen + oryzalin). Both root quality ratings and root lengths were lower for stem cuttings when herbicides were applied compared to untreated controls. Rooting percentages of *Rhododendron* × 'Trouper' and *Gardenia jasminoides* 'August Beauty' were not affected by herbicide application. Root quality ratings and root lengths were generally lower with Rout 3G, OH-2 3G (oxyfluorfen + pendimethlin), Snapshot 2.5TG (trifluralin + isoxaben), and Southern Weed Grass Control 2.68G (pendimethlin) when compared to untreated controls. In the second experiment, depth of sticking *Gardenia jasminoides* 'August Beauty' cuttings and herbicide treatments were evaluated. Cuttings in Rout 3G and Snapshot 2.5 TG treatments had improved root quality ratings when stuck to a depth of 2.5 cm (1.0 in) compared to 1.3 cm (0.5 in); however, all other herbicide treatments had similar root quality ratings to the untreated controls, regardless of depth of sticking.

Index words: stem cutting, cutting depth, nursery crops, weed control

Herbicides used in this study: OH-2 3G (oxyfluorfen:pendimethalin), 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene: N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; Ronstar 2G (oxadiazon), {3-[2,4-dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3H)-one}; Rout 3G (oxyfluorofen:oryzalin), 2-chloro-1-(3 ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene: 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Snapshot 2.5TG (isoxaben:trifluralin), N-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide: 2,6-dinitro-N-N-dipropyl-4-(trifluoromethyl)benzenamine; and Southern Weed Grass Control 2.68G (pendimethalin), N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine.

Species used in this study: 'August Beauty' gardenia [*Gardenia jasminoides* (Ellis) 'August Beauty']; 'Hino Crimson' azalea [*Rhododendron obtusum* (Lindl.) Planch 'Hino Crimson']; 'Trouper' azalea [*Rhododendron* × 'Trouper' (Glenn Dale Hybrid, USDA PI# 160121; 'Kagaribi' × 'Hinode Giri')].

Significance to the Industry

Weed control is a serious problem during the rooting of stem cuttings of woody nursery crops. These studies demonstrate the potential suppression of root development when granular dinitroaniline herbicides are used during stem cutting propagation. However, sticking 'August Beauty' gardenia cuttings 2.5 cm (1.0 in) into the soilless rooting medium compared to 1.3 cm (0.5 in) improved root development when the herbicides Rout 3G and Snapshot 2.5TG were applied just prior to cuttings being stuck. In contrast, cuttings stuck following medium treatment with OH-2 3G, Ronstar 2G, and Southern Weed Grass Control 2.68G herbicides had no improvement in root development when cuttings were stuck deeper than normal. Propagators should conduct small-scale tests evaluating specific herbicides and depth of sticking cuttings of individual species to be propagated prior to treating an entire crop.

Introduction

Limited information is available on the rooting response for stem cuttings of woody nursery crops when herbicides are used during propagation. While there is a need for weed control during this process, some research (2,6,8) has demonstrated negative responses when herbicides are used. Davies and Duray (2) reported rooting and subsequent liner growth of hibiscus were most sensitive to preemergence herbicides when applied prior to rooting while Asian jasmine was the most herbicide-tolerant species. Johnson and Meade (6) reported direct herbicide injury to some species when preemergence herbicides were applied over the top of stem cuttings. Other research (8) has shown potential uses of herbicides in propagation, but no one herbicide was safe on all species. Varying durations of root suppression occurred, up to 13 months, when preemergence herbicides were applied just prior to sticking of some plant species. In most cases of extended root growth inhibition, dinitroaniline herbicides were involved (8). The first objective of our work was to evaluate commonly used granular preemergence herbicides in woody container crop production and determine their influence on root initiation and growth for stem cuttings of selected woody ornamental species.

Research evaluating herbicide movement or leaching potential using bioassays indicates 2 herbicides commonly used in nursery crop production, Goal (oxyfluorfen) and Ronstar (oxadiazon), have limited downward movement in soilless media (4,5,7). Preliminary work with C^{14}-labeled oxadiazon has also shown Ronstar movement to be limited to soilless media (9). The second objective of our work was to determine if sticking the cuttings deeper into a soilless propagation medium would reduce or eliminate the negative effects of granular preemergence herbicides on rooting of selected woody nursery crops.

Material and Methods

Experiment 1. Terminal, 7.6 cm (3 in) single-stem cuttings of 'Hino Crimson' azalea, 'Trouper' azalea, and 'August Beauty' gardenia were prepared on June 5, 1990. Prior to

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sticking, cuttings were submerged in Daconil (chlorothalonil) (2.4 ml/l of water) and allowed to drain. The basal ends of cuttings were dipped into a 2000 ppm K-IBA for 5 sec and then inserted to a depth of 1.3 cm (0.5 in) in 479.3 cm^3 (29.3 in^3) plastic pots containing the propagation medium. Flats containing the pots were placed in a glass house under intermittent mist cycled on 4 sec every 8 min from 8:00 AM until 6:00 PM. Maximum and minimum temperatures in the greenhouse during the study were 32°C (90°F) and 20°C (68°F), respectively.

The propagation medium was 100% pinebark amended with 3.6 kg (6.0 lb) of dolomitic limestone, 1.2 kg (2.0 lb) gypsum, and 0.9 kg (1.5 lb) Micromax/m^3. Five granular preemergence herbicides were broadcast over the pots with a hand held shaker prior to the cuttings being stuck into the medium. These 5 herbicides included the 3 major herbicides used in container nursery crops: Rout 3G, OH-2 3G, and Ronstar 2G (3). Southern Weed Grass Control 2.68G (SWGC) (a granular formulation of pendimethalin), which was previously reported to have potential in propagation (8), and Snapshot 2.5TG (trifluralin + isoxaben), a recently registered herbicide from DowElanco, were also evaluated. An untreated control was also evaluated. Herbicides were applied at their normal use rate in container production (Table 1). With the exception of Ronstar, all of the herbicides tested were dinitroaniline herbicides or contained a dinitroaniline herbicide.

The experimental design was a randomized complete block with 6 replications of 12 cuttings per experimental unit. Data collected included: rooting percentage, root quality rating (1 = no roots, 2 = distorted, stunted, and/or clubbed roots; 3 = good primary and secondary root development; 4 = root development throughout the rootball; and 5 = root coverage of the entire rootball), and average root length of the 3 longest roots for each cutting. 'August Beauty' gardenia cuttings were harvested on July 9, 1990, and the 2 azalea cultivars were harvested on August 15, 1990. Data were subjected to analysis of variance (ANOVA) and treatment means were separated using Duncan's multiple range test ($p = 0.05$).

Experiment 2. 'August Beauty' gardenia was selected for evaluation of sticking depth on stem cutting root initiation and development because of its rapid rooting response in experiment 1 and sensitivity to selected preemergence herbicides. Cuttings were prepared on August 15, 1990, as described in experiment 1, with the exception of sticking depth. Cuttings were stuck at one of 2 depths, 1.3 cm (0.5 in) or 2.5 cm (1.0 in), into pots just treated with one of the 5 herbicides evaluated in experiment 1 or left as untreated controls. Untreated controls were also evaluated at each sticking depth. Medium type and cultural conditions were similar to those employed in experiment 1.

The experimental design was a split plot design with 6 replications of 6 cuttings per experimental unit. Cuttings were harvested on September 26, 1990. Data collection and analysis were as described in experiment 1 with the exception that root dry weights were determined at the completion of experiment 2.

Results and Discussion

Rooting percentage of 'Hino Crimson' azalea was suppressed with application of Rout 3G herbicide (Table 1). Rout 3G treated cuttings had a 55% rooting percentage compared to 95–100% for all other treatments. In work by Thetford and Gilliam (8), rooting percentages of 4 different plant species were not affected by herbicide application, with the exception of Surflan (oryzalin), a component of Rout herbicide. Root quality ratings and root lengths of 'Hino Crimson' azalea were suppressed by all herbicide treatments when compared to the control treatment. The lowest rating of root quality and shortest average root length occurred when Rout 3G herbicide was applied. In contrast to these data, other research showed Rout 3G to not affect either rooting percentage or root quality (6). Differences in these results may result from the time of application. In this study, herbicides were applied prior to sticking cuttings and some suppression of growth occurred with 'Hino Crimson' azalea. In the study where no injury or root suppression occurred to 'Hino Crimson' azalea (6), herbicides were applied after the cuttings were stuck. These data would suggest time of herbicide application may be an important consideration and that 'Hino Crimson' azalea is sensitive to herbicide applications applied prior to sticking of cuttings.

With 'Trouper' azalea, all treatments resulted in 100% rooting. However, Rout 3G, OH-2 3G, and Snapshot 2.5 TG reduced root quality ratings and root lengths of 'Trouper' azalea compared to the control treatment. SWGC 2.68G also reduced root length but not root quality rating when com-

Table 1. Effects of granular preemergence herbicides on root initiation and development of three woody nursery crops[z].

		'Hino Crimson' azalea			'Trouper' azalea			'August Beauty' gardenia		
Herbicide	Rate (kg ai/ha)	Rooting (%)	Root quality rating[x]	Root length (cm)	Rooting (%)	Root quality rating	Root length (cm)	Rooting (%)	Root quality rating	Root length (cm)
Rout 3G	3.36	55b[y]	1.2c	0.6c	100a	2.0c	3.2d	100a	2.7d	6.8d
OH-2 3G	3.36	100a	1.7b	1.9b	100a	3.0b	5.8b	100a	4.1ab	11.0ab
Ronstar 2G	4.48	92a	1.6b	1.7b	100a	3.1ab	6.3ab	97a	3.9bc	10.4ab
Snapshot 2.5TG	3.36	95a	1.5bc	1.4b	100a	2.3c	4.7c	100a	2.9d	8.2c
SWGC 2.68G	3.36	95a	1.6b	1.9b	100a	3.8a	5.8b	95a	3.8c	9.8b
Control	—	97a	2.1a	2.7a	100a	3.4a	6.9a	100a	4.2a	11.4a

[z]Cuttings were stuck June 5, 1990. Data collected for 'Hino Crimson' and 'Trouper' azaleas on August 15 and 'August Beauty' gardenia on July 9, 1990.
[y]Mean separation within columns by Duncan's multiple range test, P = 0.05.
[x]Root quality was rated on a scale of 1-5 where 1 = no roots and 5 = root coverage of entire medium surface inside the container.

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pared to controls. These data concur with other research where varying degrees of suppression in root development occurred with the use of Rout 3G, OH-2 3G, or SWGC 2.68G herbicides during stem cutting propagation (6,8). Ronstar 2G herbicide was the only noninjurious herbicide for 'Trouper' azalea in this propagation test. Ronstar 2G herbicide has also been shown to have no negative affect on root initiation and development for several other woody nursery crops (2,6,8).

'August Beauty' gardenia rooting percentage was similar among treatments, ranging from 95–100%. However, both root quality ratings and root lengths were reduced by Rout 3G, Snapshot 2.5TG, and SWGC 2.68G when compared to the control treatment. Rout 3G and Snapshot 2.5TG caused the greatest suppression in root quality ratings and root lengths. With these two treatments roots tended to be shorter and thicker compared to roots in the other treatments.

Generally, Rout 3G and Snapshot 2.5TG caused the greatest suppression of root development for all 3 cultivars evaluated. Previous work has also demonstrated a negative effect on root quality ratings for Japanese holly cultivars (6,8) and cotoneaster (6) when Rout 3G herbicide was used during stem cutting propagation. Intermediate suppression was caused by OH-2 3G and SWGC 2.68G. Rout 3G, OH-2 3G, and Snapshot 2.5TG herbicides contain dinitroaniline herbicides and SWGC 2.68G is a dinitroaniline herbicide. Herbicides in this group inhibit growth of the entire plant. However, this is apparently brought about by initially limiting root growth, especially the development of lateral or secondary roots. Primary roots that develop are thickened, stubby and have little or no lateral root development (1). Preliminary unpublished data from our laboratory showed that Surflan movement in soilless media is limited. Therefore, experiment 2 evaluated sticking the cuttings deeper in the medium to determine if the adverse effects of herbicides on root development would be reduced.

Only with root quality rating was there a significant herbicide × depth of sticking interaction (Table 2). With both Rout 3G and Snapshot 2.5TG, root quality ratings were improved for deep stuck cuttings when compared to shallow stuck cuttings. With all other treatments, the deep stuck cuttings had similar root quality ratings to those of the shallow stuck cuttings. These data support our preliminary unpublished data that downward movement of Surflan into a soilless container medium is limited.

With the other variables evaluated, results were similar to experiment 1. Rooting percentages were similar and root lengths were suppressed by Rout 3G, Snapshot 2.5TG, and SWGC 2.68G herbicides (Table 2). Only Rout 3G and Snapshot 2.5TG reduced root dry weights compared to the control treatment.

These studies demonstrate the suppression of rooting that may occur when granular dinitroaniline herbicides are used during propagation of woody nursery crops by stem cuttings. Sticking cuttings about 2.5 cm (1 in) into the medium compared to 1.3 cm (0.5 in) resulted in improved root development when Rout 3G and Snapshot 2.5TG herbicides were used; however, even when stuck deeper than normal, these herbicides reduced root development when compared to untreated controls.

Table 2. Influence of granular preemergence herbicides and sticking depth on root initiation and development of 'August Beauty' gardenia[z].

Herbicide	Rate (kg ai/ha)	Sticking depth	Rooting (%)	Root quality rating	Root length (cm)	Dry weight (gm)
Rout 3G	3.36	1[y]	100.0	2.0e[x]	16.0d	0.21b[w]
		2	—	2.4d	—	—
OH-2 3G	3.36	1	100.0	3.5ab	22.8ab	0.37a
		2	—	3.5ab	—	—
Ronstar 2G	4.48	1	100.0	3.6a	23.8a	0.40a
		2	—	3.4b	—	—
Snapshot 2.5TG	3.36	1	100.0	2.3d	18.5c	0.24b
		2	—	2.7c	—	—
SWGC 2.68G	3.36	1	100.0	3.5ab	21.6b	0.39a
		2	—	3.4b	—	—
Control	—	1	100.0	3.5ab	23.4a	0.41a
		2	—	3.4b	—	—
Depth						
Shallow (1.3 cm)			—	—	21.7a	0.35a
Deep (2.5 cm)			—	—	20.3b	0.32b
Significance						
Herbicide (H)			0.5664	0.0001	0.0001	0.0001
Depth (D)			0.1667	0.3804	0.0009	0.0237
H × D			0.5644	0.0001	0.0527	0.4702

[z]Cuttings were stuck on August 15 and data collected September 26, 1990.

[y]Sticking depths were 1 = shallow (1.3 cm) and 2 = deep (2.5 cm).

[x]Root quality was rated on a scale of 1-5 where 1 = no roots and 5 = root coverage of the entire medium surface inside the container.

[w]Mean separation within columns by Duncan's multiple range test, P = 0.05.

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