Preemergent Weed Control in Container-grown Herbaceous and Woody Plants[1]

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Abstract

Six herbicides were applied to four woody and two herbaceous plant species to evaluate weed control effectiveness, effect on plant growth and phytotoxicity level. Surflan (Oryzalin) at 2.3, 4.5, 6.8 kg ai/ha (2, 4, 6 lb ai/A), Devrinol (Napropamide) at 5.5, 9.1, 13.6 kg ai/ha (4, 8, 12 lb ai/A) and Dual (Metolachlor), Rout (Oxyfluorfen + Oryzalin) and Snapshot (Isoxaben + Oryzalin) at 3.4, 6.8, 10.2 kg ai/ha (3, 6, 9 lb ai/A) were applied to container-grown *Fraxinus pennsylvanica* var. *lanceolata* (Borkh.) (green ash) and *Betula pendula* (Roth.) (European white birch). Additionally, Surflan at 2.3, 4.5 kg ai/ha (2, 4, lb ai/A), Ronstar (Oxadiazon) and Devrinol at 5.52, 9.1 kg ai/ha (4, 8 lb ai/A), Dual and Rout at 3.4, 6.8 kg ai/ha (3, 6 lb ai/A) were applied to container-grown *Acer tataricum* L. (Tatarian maple), *Philadelphus virginalis* L. (virginal mock orange), *Hemerocallis* L. sp. (daylily) and *Clematis recta* L. (clematis). Weed seed sown in both experiments included: *Setaria glauca* (L.) Beauv. (yellow foxtail), *Echinochloa crus-galli* (L.) Beauv. (barnyardgrass), *Poa annua* L. (annual bluegrass), *Stellaria media* (L.) Vill (common chickweed), *Capsella bursa-pastoris* (L.) Medic (shepherdspurse) and *Senecio vulgaris* L. (common groundsel).

Plants were grown in 2.5 l (#1) black plastic containers in a medium of sandy loam topsoil, plaster sand and sphagnum peat (1:1:1 by vol). Good weed control occurred in most cases with all herbicides except Devrinol and Dual. No visual foliage injury occurred in any treatment but significant growth reduction was observed with the 10.2 kg ai/ha (9 lb ai/A) rate of Snapshot with *Betula pendula* (white birch). Growth reduction of tatarian maple was also observed with 6.8 kg ai/ha (6 lb ai/A) rate of Dual and 4.52 kg ai/ha (4 lb ai/A) rate of Surflan.

Index words: herbaceous perennials, woody nursery crops, herbicides, weed control, container nursery production

Species used in this study: green ash (*Fraxinus pennsylvanica* var. *lanceolata* Borkh.); European white birch (*Betula pendula* Roth.); Tatarian maple (*Acer tataricum* L.); virginal mock orange (*Philadelphus virginalis* L.); daylily (*Hemerocallis* L. sp.); clematis (*Clematis recta* L.)

Herbicides used in study: Surflan (Oryzalin), 3.5-dinitro-N^4, N^4-dipropylsulfanilamide; Devrinol (Napropamide), N, N-diethyl-(1-naphthalenyloxy)-propionamide; Dual (Metolachlor), 2-chloro-N-(2 ethyl-6-methylphenyl)-N-(2 methoxy-1-methyethyl) acetamide; Oxadiazon (Ronstar), 3-{2,4-dichloro-5-(1-methylethoxy) phenyl}-5-(1, 1-dimethylethyl)-1, 3, 4-oxadiazol-2 (3H)-one; Rout (Oxyfluorfen + Oryzalin), 2 chloro-1-(3-ethoxy-4-nitrophenoxy)-4 (trifluoromethyl) benzene + 3,5-dinitro-N^4, N^4-dipropy sulfanilamide; and Snapshot (Isoxaben + Oryzalin), *a*, *a*, *a*-trifluoro-2, 6-dinitro-N-N-dipropyl-p-to-luidene.

Significance to the Nursery Industry

Our research indicates that herbicides can be used effectively in nursery-container production with relatively high crop safety. No herbicide applied at the manufacturers recommended rate (1 ×) caused visible foliar injury or growth reduction. However, caution should be exercised when applying herbicides to container grown plant materials. Improper application can cause poor weed control, plant or root damage. In these experiments, Rout and Snapshot provided better overall weed control (broadleaf and grass weed species) than the other herbicides tested. Adequate weed control also was obtained in most instances with Ronstar and Surflan.

Introduction

Weed control in container-grown nursery crops is important because weeds compete with container-grown plants for moisture, nutrients and space and are often unmarketable. Growth losses can range from 47–75 percent depending upon crop and/or weed species and weed densities (5, 8). Hand weeding is costly, highly labor intensive and removes soil from the containers. It takes 625 hours of manual labor for weed control to produce 0.4 ha (1 acre) of marketable plants grown in #1 containers (4, 5, 6).

Weed control with herbicides is used by most producers of container-grown nursery stock. Herbicides have proven to be effective and are considerably cheaper than hand labor (11). Hand labor can be reduced up to 50% with a single herbicide treatment (3). The objectives of this research were to evaluate selected herbicides for weed control in container-grown nursery crops and to determine plant species tolerance and provide data for specific label expansion efforts.

Materials and Methods

This research was conducted during the 1988 and 1989 growing seasons. In 1988, 40 cm (16 in) bare-root liners of green ash and white birch were potted into 2.5 l (#1) black plastic containers. Plant materials used in 1989 included: 45 cm (18 in) bare-root liners of Tatarian maple, 30 cm (12 in) bare-root liners of virginal mock orange, 15 cm (6 in) bare-root liners of clematis and 40 cm (16 in) containerized daylily. Growing medium consisted of equal parts plaster sand, sphagnum peat and topsoil (loam) (1:1:1 by vol). Containers were topdressed with Sierrablend 17N-

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Table 1. Weed species, number sown and germination percentages used in both 1988 and 1989 growing seasons.

Scientific name	Common name	Number sown per container	% Germination
Setaria glauca (L.) Beauv.	yellow foxtail	7–9	97
Echinochloa crus-galli (L.) Beauv.	barnyardgrass	7–9	98
Poa annua L.	annual bluegrass	8–10	97
Stellaria media (L.) Vill.	common chickweed	12–15	85
Capsella bursa-pastoris (L.) Medic.	shepherdspurse	10–12	93
Senecio vulgaris L.	common groundsel	10–12	90

2.85P-8.3K (17-6-10) plus micronutrients at 5 g (0.18 oz) per container. Plants were placed on approximately 30 cm (12 in) centers on 15 cm (6 in) raised lath frames over asphalt. Weed seeds were sown on the surface of the container to ensure a consistent weed population. The species, number of weed seeds sown and corresponding germination percentages are listed in Table 1.

Herbicides were applied four days after weed seeds were sown. Herbicide rates and formulations are listed in Table 2. The appropriate amount of each herbicide was applied volumetrically to each container. Granular herbicides were weighed and individually applied directly to the surface of the growing medium. Liquid herbicides were mixed with water to form a solution after which appropriate amounts of solution were drawn with a pipette and applied to surface of growing media with no contact on plant foliage. All herbicides were incorporated with approximately 2 cm (0.75 in) of water directly after application. Plants were watered by hand as needed throughout the season (approximately 1.3 cm (0.5 in) daily).

In addition to the herbicide treatments, two controls were used, one with weeds and one without, to evaluate the effects of weed competition on plant growth and to establish a standard for measuring weed control.

Data were collected throughout the 1988 and 1989 growing seasons on number of weeds per container, total plant growth, and phytotoxicity. In 1988, liners were planted on April 15; herbicide applications made on May 28 and plants harvested on September 1. In 1989, liners were planted on May 6; herbicide applications made on June 22 and plants harvested on September 22. Growth was measured by subtracting the initial height from the final height at the end of the growing season. Dry weights of above ground biomass were measured by cutting plants off at the soil level and drying at 65°C (149°F) for 36 hours. Phytotoxicity evaluation was made by visual observation throughout the growing season and at harvest (0 = no damage to 5 = plant death). Visual phytotoxicity was characterized as leaf chlorosis, leaf necrosis and/or leaf drop. Growth reduction is another valid phytotoxicity indicator.

Experimental design was a completely randomized design in 1988 and a randomized complete block in 1989 with four replications each year. Mean separation was performed by Student-Newman-Keuls (SNK) procedure at the 5% level of significance (9).

Table 2. Herbicide rates and formulations used in both 1988 and 1989 growing seasons.

Herbicide/formulation	Rate	kg ai/ha	lb ai/A
Devrinol 10% G	1×	5.5	4
(napropamide)	2×	9.1	8
	3×	13.6	12
Surflan 40.4% AS[z]	1×	2.3	2
(oryzalin)	2×	4.5	4
	3×	6.8	6
Dual 8E	1×	3.4	3
(metolachlor)	2×	6.8	6
	3×	10.2	9
Rout 3% G	1×	3.4	3
(oxyfluorfen + oryzalin)	2×	6.8	6
	3×	10.2	9
Snapshot 80% DF[A]	1×	3.4	3
(isoxaben + oryzalin)	2×	6.8	6
	3×	10.2	9
Ronstar 2% G	1×	5.5	4
(oxadiazon)	2×	9.1	8

[z]Applied in 35,000 l H_2O/ha (9247 gal/A).

Results and Discussion

In the 1988 experiments, Rout, Snapshot and Surflan controlled weeds better than Dual or Devrinol at the 1× rate in the green ash containers (Table 3). At the 2× rate in white birch, Rout, Snapshot and Surflan controlled weeds better than Devrinol or Dual. However, Devrinol was better than Dual (Table 3). No differences resulted between any of the other herbicide treatments. Dual and Devrinol controlled grass weeds, but poorly controlled broadleaf weeds. None of the broadleaf weed species used in this experiment are listed on the Dual label and shepherdspurse is not listed on the Devrinol label. Therefore, control of those weed species was not expected.

In the 1989 experiment, Rout provided better weed control than Dual (2× daylily), Surflan (1× daylily), Devrinol (daylily) and Devrinol (1× clematis) (Table 3). Weed populations were variable in the weedy control averaging 10 weeds/container in clematis, 17 weeds/container in daylily and only 3 weeds/container in Tatarian maple and virginal mock orange (Table 3). Low weed populations in Tatarian maple and virginal mock orange may have been due to heavy plant density covering the surface of the container. All herbicides tested resulted in acceptable weed control with Tatarian maple, virginal mock orange and clematis containers. As in 1988, weeds not controlled by Dual and Devrinol were broadleaf species.

Weed competition in the weedy control did not decrease growth or dry weight of white birch or green ash (data not shown). No decrease in growth or dry weight occurred with green ash as a result of any herbicide treatment. Snapshot caused growth reduction in white birch at the 3× rate (Table 4). No other herbicide treatment caused a growth reduction of birch. No visual foliar injury was recorded on green ash or white birch as a result of the herbicide treatments.

Table 3. **Weed control ratings[y] in container grown plants treated with different herbicides at three different rates.**

Herbicide	Rate	1988		1989			
		Green Ash	White Birch	Tatarian Maple	Virginal Mock Orange	Daylily	Clematis
Devrinol	1×	3.4 b[z]	2.9 a	1.0 a	1.0 a	3.4 b	3.0 b
Surflan	1×	2.4 a	1.2 a	1.1 a	1.0 a	3.2 b	1.2 a
Dual	1×	4.8 b	3.1 a	1.0 a	1.0 a	2.7 a	1.1 a
Rout	1×	1.1 a	1.1 a	1.0 a	1.0 a	1.0 a	1.0 a
Snapshot	1×	1.0 a	1.0 a	—	—	—	—
Ronstar	1×	—[x]	—	1.0 a	1.0 a	2.2 a	1.1 a
Control	—	5.0	4.1	2.4	2.5	5.0	4.0
Devrinol	2×	2.9 b	2.7 b	1.0 a	1.0 a	3.2 b	1.8 a
Surflan	2×	1.0 a	1.0 a	1.0 a	1.1 a	2.2 a	1.0 a
Dual	2×	1.7 a	3.8 c	1.0 a	1.0 a	2.7 b	1.1 a
Rout	2×	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
Snapshot	2×	1.0 a	1.0 a	—	—	—	—
Ronstar	2×	—	—	1.0 a	1.0 a	1.4 a	1.1 a
Control	—	5.0	4.1	2.4	2.5	5.0	4.0
Devrinol	3×	2.6 a	3.0 a	—	—	—	—
Surflan	3×	1.0 a	1.0 a	—	—	—	—
Dual	3×	1.5 a	2.9 a	—	—	—	—
Rout	3×	1.0 a	1.0 a	—	—	—	—
Snapshot	3×	1.0 a	1.0 a	—	—	—	—
Ronstar	3×	—	—	1.0 a	1.0 a	1.0 a	1.0 a
Control	—	5.0	4.1	2.4	2.5	5.0	4.0

[z]Means represented with different letters within columns are significantly different ($SNK_{.05}$).
[y]Rating Scale: 1) 0–1 weeds/container, 2) 2–4, 3) 5–10, 4) 10–15, 5) >15.
[x]Blanks represent treatments not applied to that plant species.

Table 4. **Total growth (cm) of *Betula pendula* as influenced by herbicide and rate.**

Herbicide treatment	Herbicide rate		
	1×	2×	3×
Weed free control	8.15 a[z]	8.15 a	8.15 b
Snapshot	5.75 a	6.00 a	2.75 a
Rout	6.00 a	7.50 a	7.25 ab
Surflan	6.67 a	6.00 a	7.00 ab
Devrinol	6.00 a	7.00 a	7.33 ab
Dual	8.75 a	7.00 a	7.67 ab
Weedy control	8.58 a	8.58 a	8.58 b

[z]Means represented with different letters within columns are significantly different. ($SNK_{.05}$).

Table 5. **Total growth (cm) of *Acer tataricum* as influenced by herbicide treatments.**

Herbicide treatment	Herbicide rate		Weed free control	Weedy control
	1×	2×		
Ronstar	51.6 a[z]	33.2 a	33.7 a	46.7 a
Rout	53.3 a	33.1 a	55.0 a	33.2 a
Surflan	37.8 ab	22.6 b	53.6 a	49.7 a
Devrinol	41.6 a	45.6 a	58.7 a	59.8 a
Dual	21.9 b	34.8 ab	44.9 a	49.5 a

[z]Means represented with different letters across columns are significantly different. ($SNK_{.05}$).

No visual foliar damage occurred on any of the plant species tested in either 1988 or 1989; therefore, data not presented. However, Tatarian maple growth was reduced by Dual and Surflan at the 2× rate (Table 5). Although several researchers reported foliar injury problems with Surflan (1, 7, 10, 12), this research does not confirm that observation. We did not observe any foliar injury with Surflan but recorded a reduction of growth at rates higher than label recommendations.

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.

Literature Cited

1. Akers, M.S., P.L. Carpenter and S.C. Weller. 1984. Herbicide systems for nursery plantings. HortScience 19:502–504.

2. Bing, A. 1980. Weed control in field grown bedding plants. Bedding Plant Industry News September:12–13.

3. Bingham, S.W. 1968. Influence of herbicides on Japanese holly and hand labor for weed control. Weed Science 16:478–481.

4. Carpenter, P.L. 1973. Chemical weed control in container-grown nursery stock. HortScience 8:385–386.

5. Fretz, T.A. 1972. Weed competition in container grown Japanese holly. HortScience 7:485–486.

6. Fretz, T.A. 1972. Control of annual weeds in container-grown nursery stock. J. Amer. Hort. Sci. 97:667–669.

7. Fretz, T.A. 1977. Evaluation of herbicide combinations for container nursery stock. Ohio Ag. Res. and Dev. Center Res. Cir. 226:43–46.

8. Gibson, J.D. 1985. Research explores possibilities for container weed control. Amer. Nurserymen 162:63, 66–67.

9. Snedecor, G.W. and W.G. Cochran. 1980. Statistical Methods. The Iowa State University Press. Ames, Iowa.

10. Wadsworth, G.L. 1975. Evaluation of eight herbicides in container nursery stock. Proc. Intern. Plant Prop. Soc. 25:471–475.

11. Weatherspoon, D.M. and W.L. Currey. 1975. Herbicide evaluations for woody ornamentals in containers. Proc. South. Weed Sci. Soc. 28:205–214.

12. Weatherspoon, D.M. and W.L. Currey. 1979. Response of weeds in container ornamentals to preemergence herbicides. Proc. South. Weed Sci. Soc. 32:172–175.

Leaf and Stem Cold Hardiness Estimates of Six Selections of Chinese Evergreen Oak over Two Winter Seasons[1]

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Abstract

Two of six selections of Chinese evergreen oak (*Quercus myrsinifolia* Blume) were identified through laboratory cold hardiness estimations to possess more spring cold hardiness potential than the other selections tested. The leaves and stems of all selections had similar cold hardiness levels in the fall and midwinter. Data collected over two winter seasons revealed that leaves reached a cold hardiness level of −15 to −18°C (5 to 0°F) during the midwinter. The stems were slightly less cold hardy than the leaves and attained a cold hardiness level of −12 to −15°C (10 to 5°F). In the spring, however, the cold hardiness levels of the leaves of two of the selections were 5 to 9°C (9 to 16°F) more cold hardy than the other selections, while their stems were 6 to 9°C (11 to 16°F) more cold hardy than those of the other selections. The data indicated that these two selections of Chinese evergreen oak may be able to avoid injury when exposed to late spring frosts better than other selections included in the study.

Index words: freeze tolerance, acclimation, deacclimation, *Quercus myrsinifolia* Blume

Significance to the Nursery Industry

The results of laboratory cold hardiness tests with six selections of Chinese evergreen oak indicated that certain selections retain greater cold hardiness than others during late winter and spring. Our data indicated that by using specific selections of Chinese evergreen oak, injury to the plant caused by low temperatures can be reduced or its cultivated range of distribution can be increased.

Multiple date laboratory cold hardiness testing holds great promise to provide an index of a plant's low temperature tolerance. With prudent use, it can provide useful information about the low temperature adaptability of a particular plant selection.

Introduction

Chinese evergreen oak is an attractive, small evergreen tree with potential use as a specimen or screening tree in urban landscapes (2, 4). One factor that limits the geographic distribution of this tree is its susceptibility to freeze injury. The Chinese evergreen oak is considered by Rehder (10) to be more cold hardy than two similar evergreen oak species, *Quercus acuta* Thunb. and *Quercus glauca* Thunb. Dirr (2) reported that Chinese evergreen oak is adaptable to conditions in USDA hardiness zones 7–9. One selection has survived exposure to −23°C (−10°F) without injury, at the U.S. National Arboretum in Washington D.C. (G. Eisenbeiss, personal communication). To potentially increase the range of adaptability, new selections must be screened for cold tolerance in the fall, midwinter and spring. Laboratory cold hardiness estimates have been successfully used for many years on stems and leaves of a variety of woody plant materials (1, 5, 6, 7, 8, 9, 11). Currently no information is available on the cold hardiness of specific selections of Chinese evergreen oak.

This study assessed the cold hardiness of leaves and stems of several seedling selections of Chinese evergreen oak during the fall, winter and spring. A second year of laboratory cold hardiness estimates, on the selections tested in the first year, were made to corroborate the first year results.

Materials and Methods

Seedlings, grown from seeds collected from Savannah, Georgia in 1967, were planted in the field at the Georgia

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