HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

Effect of Preemergent Herbicide Application on Rooting and Subsequent Liner Growth of Selected Nursery Crops[1]

Fred T. Davies, Jr. and Sharon A. Duray[2]
Department of Horticultural Sciences
Texas A&M University
College Station, TX 77843-2133

Abstract

Unrooted cuttings of *Lantana* 'New Gold', *Hibiscus* 'White Lephrechaun', Asian jasmine and Burford holly were propagated under intermittent mist with flats treated with three rates (1/2×, 1× and 2× recommended rates) of oxyfluorfen:pendimethalin (OH2), oxadiazon (Ronstar), oxyfluorfen:oryzalin (Rout), metolachlor (Pennant), pendimethalin (Southern Weedgrass Control), isoxaben:oryzalin (Snapshot), prodiamine (Barricade) and dithiopyr (Dimension). After rooting, cuttings were removed from intermittent mist and grown on as liners. Rooting and liner growth of Hibiscus and Asian jasmine were the most and least herbicide sensitive, respectively. Hibiscus was sensitive to all dithiopyr (Dimension) rates, particularly during liner growth. Sensitivity to herbicides in the propagation of cuttings was dependent on the herbicide, rate and species. Herbicides applied at the recommended rates (1×) controlled all broadleaf and grass weed species evaluated, except for poor yellow woodsorrel control with metolachlor.

Index words: cuttings, landscape plants, propagation

Herbicides used in this study: OH2 (oxyfluorfen:pendimethalin), 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene:*N*-(1-ethylpropyl)-3,4-dimethyl-2,6 dinitrobenzenamine; Ronstar (oxadiazon), 3-[2,4-dichloro-5-(1-methylethoxy) phenyl]-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3H)-one; Rout (oxyfluorfen:oryzalin), oxyfluorfen:4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Pennant (metolachlor), 2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl) acetamide; Southern Weedgrass Control (pendimethalin), *N*-(1-ethylpropyl)-3, 4 dimethyl-2, 6 dinitrobenzenamine; Snapshot (isoxaben:oryzalin), *N*-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide:4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Barricade (prodiamine), N^3,N^3-di-n-propyl-2,4-dinitro-6-(trifluoromethyl)-m-phenylene diamine; Dimension (dithiopyr), *S*,*S*-dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridinedicarbothioate.

Species used in this study: Lantana (*Lantana camara* L. 'New Gold'); Hibiscus (*Hibiscus rosa-sinensis* 'White Leprechaun'); Asian jasmine (*Trachelospermum asiaticum* Siebold & Zucc.); Burford holly (*Ilex cornuta* Lindl. & Paxt. 'Burfordii').

Significance to the Nursery Industry

Rooting and subsequent liner growth of hibiscus was most sensitive to preemergence herbicides when applied prior to rooting while Asian jasmine was the most herbicide tolerant species. Hibiscus was sensitive to all dithiopyr (Dimension) rates, particularly during liner growth. Sensitivity of cuttings to herbicides was dependent on the herbicide, herbicide rate, and species. Preemergence applied herbicides effectively controlled weeds during propagation, however limited trials should be conducted to determine the most appropriate herbicide for their landscape crop mix.

Introduction

Herbicide use to control weeds during propagation of nursery crops is becoming more common, although some commercial nurseries remain reluctant to utilize preemergence herbicides in this manner. Concern exists about the safety of selected herbicides during the rooting process and the residual effects of these herbicides on subsequent liner plant growth. Some preemergent herbicides will volatilize in enclosed propagation houses causing potential damage to cuttings and health concerns for exposed workers (5). Previous reports have shown that some herbicides suppress adventitious root formation (1, 2, 4, 6, 7), while selected herbicides have been reported to have no detrimental effect on rooting (3).

The objective of this research was to determine the effects of commercially available and recently registered preemergence herbicides on efficacy during propagation, rooting and subsequent liner growth.

Materials and Methods

Rooting Experiment. Unrooted cuttings approximately 10 cm (4 in) in length were collected from *Lantana* 'New Gold', *Hibiscus* 'White Leprechaun', Asian jasmine, and Burford holly. No rooting hormones were used to avoid possible auxin-herbicide interactions. Cuttings were inserted in Jiffy trays (24 × 16 × 8.3 cm (9.5 × 6.3 × 3.3 in)) containing propagation media composed of pine bark:sphagnum peat:sand (3:1:1 by vol) and propagated under an intermittent mist system (4 sec every 8 min between dawn and sunset). All herbicides were applied to the containers after the cuttings were stuck and irrigated after application. Herbicides were applied as granules with the exception of isoxaben:oryzalin which was applied as a foliar spray with a hand held sprayer. Herbicides were applied at 1/2×, 1× and 2× recommended rates on a kg ai/ha (lb ai/acre) basis which included: 2% oxyfluorfen/1% pendimethalin (OH2) @ 1.1/0.6 kg (1/0.5 lb), 2.2/1.1 kg (2/1 lb) and 4.5/2.2 kg (4/2 lb), 2% oxadiazon (Ronstar) @ 1.7 kg (1.5 lb), 3.4 kg (3 lb) and 6.7 kg (6 lb), 2% oxyfluorfen/1% oryzalin (Rout) @ 1.1/0.6 kg (1/0.5 lb), 2.2/1.1 kg (2/1 lb) and 4.5/2.2 kg (4/2 lb), 5% metolachlor (Pennant)

[1]Received for publication April 16, 1992; in revised form June 18, 1992. We thank Tom Wilson and Lop Phavaphutanon for technical assistance and Delores Soto for typing the manuscript.

[2]Professor and Research Associate, resp.

@ 1.7 kg (1.5 lb), 3.4 kg (3 lb) and 6.7 kg (6 lb), 2.68% pendimethalin (Southern Weedgrass Control) @ 1.4 kg (1.3 lb), 2.8 kg (2.5 lb) and 5.6 kg (5 lb), 20% isoxaben/60% oryzalin (Snapshot) @ 0.5/1.3 kg (0.4/1.2 lb), 0.9/2.7 kg (0.8/2.4 lb) and 1.8/5.4 kg (1.6/4.8 lb), 1.25% prodiamine (Barricade) @ 1.7 kg (1.5 lb), 3.4 kg (3 lb) and 6.7 kg (6 lb), 1% dithiopyr (Dimension) @ 0.8 kg (0.8 lb), 1.7 kg (1.5 lb) and 3.4 kg (3.0 lb). The experiment was set up in a completely randomized design with 3 replications and a total of 30 cuttings per treatment (n = 30). Ten additional cuttings per treatment were used for the liner portion of the study and each cutting was shifted up into a liner container (n = 10). All ornamental species were analyzed as separate experiments.

To test for weed control, all herbicide treatments including an untreated control were applied separately to Jiffy trays containing propagation media. Trays were then overseeded with *Cardamine parvifolia* L. (smallflowered bittercress), *Oxalis stricta* L., (yellow woodsorrel), *Digitaria sanguinalis* (L.) Scop., (large crabgrass) and *Cynodon dactylon* (L.) Pers. (bermudagrass) and placed under intermittent mist, harvested after 4 weeks and analyzed for weed number and dry weight. The weed species were all evaluated at the same time.

Environmental conditions of the enclosed propagation house included: 30 ± 2 C (86 ± 4F) days and 23 ± 2 C (73 ± 4F) night temp, maximum PPF of 800–900 $\mu mol \cdot m^{-2} \cdot s^{-1}$, RH 30–95%. Cuttings were kept under long-day conditions by night light interruption. Lantana was stuck on February 27, 1990 and propagated for 4 weeks, hibiscus stuck on April 20, 1990 and propagated for 7 weeks, asian jasmine stuck on June 13, 1990 and propagated for 4 weeks and holly stuck on August 6, 1990 and propagated for 14 weeks. Cuttings were analyzed for percent rooting, root number, root dry weight and root quality (1 = no rooting, 2 = no rooting with callus formation, 3 = light rooting, 4 = medium rooting and 5 = heavy rooting).

Liner Experiment. To test for residual herbicidal effects, 10 rooted cuttings per treatment were potted up in 10 cm (4 in) standard pots containing pine bark:sand (4:1 by vol) and amended with slow release fertilizer (18N-6P-12K) at 3.7 kg m^{-3} (8 lb yd^{-3}) and fritted trace elements at 74.2 g m^{-3} (2 oz yd^{-3}). Liner plants were placed in a completely randomized design and grown under the same environmental conditions in the propagation house; each liner plant was a single replication (n = 10). After 4–6 weeks, liners were harvested and analyzed for shoot and root dry weight.

Results and Discussion

Lantana. None of the herbicides had any effect on percent rooting or root quality of lantana (Table 1). Root num-

Table 1. Adventitious root formation and liner development of *Lantana camara* 'New Gold' (Lantana) cuttings treated with preemergence herbicides at 1/2×, 1× and 2× recommended rates.

		Adventitious root formation[y]				Liner production[x]	
Herbicide	Rate (kg a.i./ha)	Rooting (%)	Root no.	Root[w] quality	Root dry wt. (g)	Shoot dry wt. (g)	Root dry wt. (g)
oxyfluorfen:pendimethalin	1.1/0.6	93	8.1 ± 0.7[z]	3.5 ± 0.2	0.03	2.5 ± 0.2	0.37 ± 0.04
(OH2)	2.2/1.1	100	9.1 ± 0.8	3.8 ± 0.1	0.03	2.7 ± 0.3	0.40 ± 0.04
	4.5/2.2	100	11.7 ± 0.9	3.9 ± 0.1	0.03	3.7 ± 0.2	0.65 ± 0.03
oxadiazon	1.7	90	8.7 ± 1.0	3.5 ± 0.2	0.03	3.5 ± 0.2	0.58 ± 0.05
(Ronstar)	3.4	100	11.1 ± 0.9	3.8 ± 0.1	0.04	2.9 ± 0.3	0.45 ± 0.06
	6.7	100	12.0 ± 1.1	3.9 ± 0.1	0.03	1.5 ± 0.3	0.26 ± 0.05
oxyfluorfen:oryzalin	1.1/0.6	100	10.2 ± 0.8	4.2 ± 0.1	0.03	3.4 ± 0.2	0.53 ± 0.06
(Rout)	2.2/1.1	93	9.0 ± 0.8	3.7 ± 0.1	0.03	3.1 ± 0.3	0.43 ± 0.04
	4.5/2.2	97	8.3 ± 0.8	3.4 ± 0.1	0.02	2.9 ± 0.2	0.47 ± 0.04
metolachlor	1.7	93	7.8 ± 0.7	3.5 ± 0.2	0.02	1.6 ± 0.3	0.25 ± 0.04
(Pennant)	3.4	100	10.9 ± 0.6	3.9 ± 0.1	0.03	2.1 ± 0.3	0.37 ± 0.07
	6.7	93	8.9 ± 0.9	3.7 ± 0.2	0.03	3.3 ± 0.1	0.49 ± 0.08
pendimethalin	1.4	97	11.2 ± 0.9	3.8 ± 0.2	0.04	2.8 ± 0.5	0.45 ± 0.08
(Southern Weedgrass	2.8	90	7.2 ± 1.2	3.1 ± 0.2	0.02	1.9 ± 0.6	0.28 ± 0.07
Control)	5.6	100	11.4 ± 0.9	3.7 ± 0.2	0.03	2.1 ± 0.3	0.36 ± 0.07
isoxaben:oryzalin	0.5/1.3	100	7.3 ± 0.7	3.4 ± 0.1	0.03	3.3 ± 0.3	0.55 ± 0.06
(Snapshot)	0.9/2.7	100	8.6 ± 0.6	3.6 ± 0.1	0.03	2.4 ± 0.3	0.35 ± 0.05
	1.8/5.4	90	5.5 ± 0.7	3.2 ± 0.2	0.02	1.9 ± 0.3	0.31 ± 0.04
prodiamine	1.7	97	10.1 ± 1.0	3.7 ± 0.1	0.03	3.5 ± 0.2	0.72 ± 0.07
(Barricade)	3.4	87	8.8 ± 1.0	3.3 ± 0.2	0.02	3.0 ± 0.4	0.47 ± 0.07
	6.7	100	10.2 ± 0.8	3.8 ± 0.1	0.03	4.4 ± 0.2	0.82 ± 0.05
control	0	97	9.2 ± 0.8	3.5 ± 0.1	0.03	2.5 ± 0.2	0.39 ± 0.06
Significance							
Herbicide (H)			0.0002	0.0130	NS	0.0001	0.0001
Rate (R)			NS	NS	NS	NS	0.0137
H × R			0.0001	0.0001	0.0002	0.0001	0.0001

[z] ± SE; Significance <0.01 or not significant, NS.

[y] Means based on 3 replications; n = 30.

[x] Means based on 10 replications; n = 10.

[w] Root quality scale of 1 to 5; 1 = no rooting, 5 = heavy rooting.

ber per cutting was not significantly lower than the control with any herbicide or rate evaluated with the exception of the 2× rate of isoxaben:oryzalin. Herbicides that slightly reduced the root dry weight included oxyfluorfen:oryzalin (2×), metolachlor (1/2×), prodiamine (1/2×) and isoxaben:oryzalin (2×). In the liner study, shoot fresh weight was reduced with the 1/2× rate of metolachlor, and the 1× rate of pendimethalin. Shoot dry weight was decreased by using oxadiazon (2×), metolachlor (1/2×) and isoxaben:oryzalin (2×). Root dry weight was suppressed with the 2× rate of oxadiazon and the 1/2× rate of metolachlor.

Hibiscus. Of the four species evaluated, hibiscus cuttings appeared to be the most sensitive to herbicide applications. Dithiopyr (2×) was the only herbicide that reduced rooting percentage (Table 2). Root number was lower than the control with the following herbicides: oxyfluorfen: pendimethalin (2×), oxadiazon (2×), oxyfluorfen: oryzalin (2×), metolachlor (2×), pendimethalin (1/2×, 1×), prodiamine (1×) and dithiopyr (2×). Root dry weight was adversely affected with the following herbicides: oxyfluorfen:pendimethalin (2×), oxadiazon (1/2×), oxyfluorfen:oryzalin (1×, 2×) metolachlor (2×), pendimethalin (1/2×), prodiamine (1×) and dithiopyr at all concentrations. Similar trends occurred in root quality.

In the liner study, shoot fresh weights were reduced by using oxyfluorfen:pendimethalin (1×), oxadiazon (2×), oxyfluorfen:oryzalin (2×), pendimethalin (1×) and isoxaben:oryzalin (2×). All rates of dithiopyr resulted in reduced shoot growth of hibiscus. Root dry weight was reduced by using oxyfluorfen:pendimethalin (1×), oxadiazon (2×), pendimethalin (1/2×, 1×) and isoxaben:oryzalin (2×). All rates of dithiopyr reduced subsequent root growth in hibiscus.

Asian Jasmine. Asian jasmine was the least sensitive species to herbicide application. None of the rooting or liner parameters were negatively affected by herbicide application (Table 3). However, in the liner study metolachlor (2×) reduced root dry weight.

Holly. Oxyfluorfen:pendimethalin at all concentrations reduced percent rooting of holly cuttings (Table 4). Root number was reduced by: oxyfluorfen:pendimethalin (1/2×), metolachlor (1/2×), pendimethalin (1×), isoxaben:oryzalin (1/2×) and prodiamine (2×). Root dry weight and quality was poor in all treatments including the control.

Table 2. Adventitious root formation and liner development of *Hibiscus rosa-sinensis* 'White Leprachaun' (Hibiscus) cuttings treated with preemergence herbicides at 1/2×, 1× and 2× recommended rates.

		Adventitious root formation[y]				Liner production[x]	
Herbicide	Rate (kg a.i./ha)	Rooting (%)	Root no.	Root[w] quality	Root dry wt. (g)	Shoot dry wt. (g)	Root dry wt. (g)
oxyfluorfen:pendimethalin	1.1/0.6	97	4.3 ± 0.4[z]	3.8 ± 0.1	0.04 ± 0	0.5	0.33 ± 0.04
(OH2)	2.2/1.1	100	6.0 ± 0.4	4.2 ± 0.1	0.06 ± 0	0.4	0.26 ± 0.04
	4.5/2.2	100	3.6 ± 0.5	3.5 ± 0.2	0.03 ± 0	0.8	0.47 ± 0.06
oxadiazon	1.7	93	4.2 ± 0.5	3.6 ± 0.1	0.03 ± 0	0.5	0.35 ± 0.06
(Ronstar)	3.4	97	5.3 ± 0.4	4.1 ± 0.1	0.05 ± 0.01	0.6	0.34 ± 0.03
	6.7	97	3.1 ± 0.5	3.2 ± 0.1	0.03 ± 0.01	0.3	0.24 ± 0.04
oxyfluorfen:oryzalin	1.1/0.6	97	4.9 ± 0.4	4.0 ± 0.1	0.05 ± 0.01	0.6	0.34 ± 0.05
(Rout)	2.2/1.1	97	4.5 ± 0.4	3.7 ± 0.1	0.03 ± 0	0.6	0.39 ± 0.04
	4.5/2.2	97	2.5 ± 0.4	3.1 ± 0.2	0.02 ± 0.01	0.5	0.33 ± 0.03
metolachlor	1.7	100	6.1 ± 0.4	4.2 ± 0.1	0.06 ± 0.01	0.6	0.33 ± 0.02
(Pennant)	3.4	93	5.0 ± 0.5	3.7 ± 0.1	0.03 ± 0.01	0.5	0.36 ± 0.04
	6.7	93	3.9 ± 0.6	3.4 ± 0.1	0.02 ± 0.01	0.6	0.35 ± 0.04
pendimethalin	1.4	100	3.9 ± 0.5	3.5 ± 0.2	0.03 ± 0	0.5	0.30 ± 0.03
(Southern Weedgrass	2.8	97	3.7 ± 0.5	3.5 ± 0.1	0.03 ± 0.01	0.5	0.31 ± 0.03
Control)	5.6	100	5.1 ± 0.3	4.1 ± 0.1	0.05 ± 0.01	0.8	0.41 ± 0.06
isoxaben:oryzalin	0.5/1.3	97	4.8 ± 0.4	3.9 ± 0.1	0.04 ± 0	0.6	0.34 ± 0.04
(Snapshot)	0.9/2.7	97	4.7 ± 0.4	3.8 ± 0.2	0.04 ± 0.01	0.9	0.46 ± 0.07
	1.8/5.4	93	4.3 ± 0.4	3.6 ± 0.1	0.03 ± 0.01	0.4	0.27 ± 0.04
prodiamine	1.7	97	4.9 ± 0.4	3.7 ± 0.1	0.03 ± 0.01	0.5	0.32 ± 0.05
(Barricade)	3.4	93	3.0 ± 0.5	3.2 ± 0.1	0.02 ± 0	0.7	0.41 ± 0.05
	6.7	100	5.1 ± 0.3	3.9 ± 0.1	0.04 ± 0.01	0.8	0.42 ± 0.05
dithiopyr	0.8	97	4.3 ± 0.6	3.5 ± 0.1	0.02 ± 0	0.3	0.23 ± 0.02
(Dimension)	1.7	100	4.7 ± 0.4	3.5 ± 0.1	0.02 ± 0	0.3	0.23 ± 0.02
	3.4	80	3.2 ± 0.4	3.3 ± 0.2	0.02 ± 0	0.1	0.08 ± 0.04
control	0	100	5.1 ± 0.4	4.1 ± 0.1	0.05 ± 0.01	0.7	0.41 ± 0.06
Significance							
Herbicide (H)			NS	0.0008	0.0006	NS	0.0001
Rate (R)			0.0002	0.0001	0.0085	NS	NS
H × R			0.0001	0.0001	0.0001	NS	0.0001

[z] ± SE; Significance <0.01 or not significant, NS.

[y] Means based on 3 replications; n = 30.

[x] Means based on 10 replications; n = 10.

[w] Root quality scale of 1 to 5; 1 = no rooting, 5 = heavy rooting.

Table 3. Adventitious root formation and liner development of *Trachelospermum asiaticum* (Asian jasmine) cuttings treated with preemergence herbicides at 1/2×, 1× and 2× recommended rates.

Herbicide	Adventitious root formation[y]					Liner production[x]	
	Rate (kg a.i./ha)	Rooting (%)	Root no.	Root[w] quality	Root dry wt. (g)	Shoot dry wt. (g)	Root dry wt. (g)
oxyfluorfen:pendimethalin	1.1/0.6	100	7.8 ± 0.6[z]	3.6 ± 0.1	0.02	0.3	0.18 ± 0.01
(OH2)	2.2/1.1	97	8.0 ± 1.1	3.2 ± 0.1	0.01	0.4	0.19 ± 0.03
	4.5/2.2	100	10.2 ± 0.9	3.7 ± 0.1	0.03	0.2	0.12 ± 0.01
oxadiazon	1.7	100	8.2 ± 1.1	3.5 ± 0.1	0.02	0.4	0.21 ± 0.02
(Ronstar)	3.4	100	10.8 ± 1.7	3.3 ± 0.2	0.02	0.3	0.13 ± 0.01
	6.7	97	11.6 ± 1.2	3.9 ± 0.1	0.03	0.4	0.18 ± 0.02
oxyfluorfen:oryzalin	1.1/0.6	100	7.1 ± 1.0	2.9 ± 0.2	0.01	0.4	0.18 ± 0.02
(Rout)	2.2/1.1	100	8.5 ± 0.6	3.7 ± 0.1	0.02	0.3	0.18 ± 0.03
	4.5/2.2	97	8.9 ± 0.9	3.6 ± 0.1	0.03	0.3	0.14 ± 0.02
metolachlor	1.7	100	10.0 ± 0.8	3.7 ± 0.1	0.02	0.2	0.11 ± 0.02
(Pennant)	3.4	97	9.5 ± 0.8	3.8 ± 0.1	0.01	0.2	0.10 ± 0.02
	6.7	93	6.5 ± 0.5	3.4 ± 0.1	0.02	0.1	0.07 ± 0.02
pendimethalin	1.4	100	10.2 ± 0.9	3.9 ± 0.1	0.03	0.4	0.16 ± 0.05
(Southern Weedgrass	2.8	100	10.7 ± 1.1	3.7 ± 0.1	0.03	0.4	0.21 ± 0.02
Control)	5.6	87	7.1 ± 0.8	3.4 ± 0.2	0.02	0.3	0.15 ± 0.01
isoxaben:oryzalin	0.5/1.3	93	7.1 ± 1.0	3.1 ± 0.2	0.02	0.3	0.18 ± 0.02
(Snapshot)	0.9/2.7	97	9.8 ± 1.1	3.6 ± 0.1	0.02	0.3	0.16 ± 0.02
	1.8/5.4	97	9.2 ± 1.2	3.7 ± 0.1	0.03	0.3	0.12 ± 0.02
prodiamine	1.7	100	7.2 ± 1.1	3.0 ± 0.2	0.01	0.3	0.15 ± 0.01
(Barricade)	3.4	93	11.2 ± 1.5	3.4 ± 0.1	0.02	0.3	0.17 ± 0.01
	6.7	100	8.3 ± 1.3	3.5 ± 0.1	0.02	0.4	0.21 ± 0.02
dithiopyr	0.8	97	8.3 ± 0.9	3.5 ± 0.1	0.02	0.3	0.18 ± 0.01
(Dimension)	1.7	93	9.2 ± 1.1	3.5 ± 0.1	0.02	0.2	0.15 ± 0.01
	3.4	83	7.6 ± 1.0	3.2 ± 0.2	0.02	0.3	0.17 ± 0.03
control	0	93	6.4 ± 0.9	3.0 ± 0.2	0.01	0.2	0.13 ± 0.01
Significance							
Herbicide (H)			NS	NS	NS	NS	0.0001
Rate (R)			0.0150	0.0488	NS	NS	NS
H × R			0.0017	0.0001	NS	NS	0.0001

[z] ± SE; Significance <0.01 or not significant, NS.

[y] Means based on 3 replications; n = 30.

[x] Means based on 10 replications; n = 10.

[w] Root quality scale of 1 to 5; 1 = no rooting, 5 = heavy rooting.

Table 4. Adventitious root formation and liner development of *Ilex cornuta* 'Burfordii" (Burford holly) cuttings treated with preemergence herbicides at 1/2×, 1× and 2× recommended rates. (continued)

Herbicide	Rate (kg a.i./ha)	Adventitious root formation[y] Rooting (%)	Root no.	Root[w] quality	Root dry wt. (g)	Liner production[x] Shoot dry wt. (g)	Root dry wt. (g)
oxyfluorfen:pendimethalin	1.1/0.6	43	3.5 ± 0.1[z]	2.4 ± 0.1	0.001 ± 0.000	0.9 ± 0.1	0.17 ± 0.03
(OH2)	2.2/1.1	40	6.5 ± 1.6	2.4 ± 0.2	0.002 ± 0.001	0.8 ± 0.1	0.18 ± 0.02
	4.5/2.2	50	5.7 ± 1.4	2.4 ± 0.2	0.001 ± 0.000	0.7 ± 0	0.15 ± 0.01
oxadiazon	1.7	93	10.5 ± 1.2	3.1 ± 0.8	0.003 ± 0.001	0.7 ± 0.1	0.15 ± 0.01
(Ronstar)	3.4	100	11.6 ± 1.6	2.8 ± 0.2	0.004 ± 0.001	0.8 ± 0.1	0.15 ± 0.03
	6.7	93	7.1 ± 1.2	2.6 ± 0.1	0.001 ± 0.000	0.6 ± 0.1	0.08 ± 0.03
oxyfluorfen:oryzalin	1.1/0.6	87	6.2 ± 1.5	2.3 ± 0.1	0.002 ± 0.001	0.8 ± 0.1	0.17 ± 0.03
(Rout)	2.2/1.1	97	9.2 ± 1.4	3.1 ± 0.1	0.003 ± 0.001	0.7 ± 0.1	0.16 ± 0.03
	4.5/2.2	77	5.6 ± 1.4	2.3 ± 0.2	0.004 ± 0.001	0.7 ± 0.1	0.12 ± 0.01
metolachlor	1.7	100	4.3 ± 1.3	2.1 ± 0.2	0.001 ± 0.000	0.5 ± 0.1	0.07 ± 0.02
(Pennant)	3.4	87	6.6 ± 1.0	3.0 ± 0.9	0.003 ± 0.001	1.0 ± 0.1	0.19 ± 0.04
	6.7	57	6.0 ± 1.6	2.6 ± 0.1	0.002 ± 0.001	0.8 ± 0.1	0.19 ± 0.03
pendimethalin	1.4	80	8.5 ± 1.4	2.9 ± 0.1	0.003 ± 0.001	0.7 ± 0.1	0.17 ± 0.02
(Southern Weedgrass	2.8	93	4.7 ± 1.1	2.5 ± 0.1	0.001 ± 0.001	1.0 ± 0.1	0.16 ± 0.02
Control)	5.6	90	8.1 ± 1.4	3.0 ± 0.1	0.002 ± 0.001	0.8 ± 0.1	0.16 ± 0.02
isoxaben:oryzalin	0.5/1.3	83	5.1 ± 1.2	2.6 ± 0.1	0.002 ± 0.001	0.8 ± 0	0.17 ± 0.01
(Snapshot)	0.9/2.7	80	6.5 ± 1.1	2.9 ± 0.1	0.002 ± 0.001	0.8 ± 0.1	0.19 ± 0.02
	1.8/5.4	93	12.9 ± 1.4	3.0 ± 0	0.004 ± 0.001	0.8 ± 0.1	0.15 ± 0.02
prodiamine	1.7	97	10.7 ± 1.5	3.0 ± 0.1	0.005 ± 0.002	0.7 ± 0.1	0.14 ± 0.02
(Barricade)	3.4	93	6.7 ± 1.4	2.6 ± 0.1	0.001 ± 0.000	0.6 ± 0.2	0.06 ± 0.03
	6.7	90	5.1 ± 1.3	2.6 ± 0.2	0.002 ± 0.001	0.8 ± 0	0.14 ± 0.02
dithiopyr	0.8	97	6.9 ± 1.7	2.4 ± 0.1	0.001 ± 0.001	0.9 ± 0.1	0.18 ± 0.02
(Dimension)	1.7	87	6.1 ± 1.2	2.6 ± 0.1	0.001 ± 0.001	0.8 ± 0.1	0.08 ± 0.04
	3.4	93	12.7 ± 1.5	3.3 ± 0.1	0.001 ± 0.001	0.5 ± 0.1	0.04 ± 0.02
control	0	93	8.6 ± 1.6	2.7 ± 0.1	0.002 ± 0.001	0.6 ± 0.1	0.12 ± 0.02
Significance							
Herbicide (H)			0.0010	0.0001	NS	NS	0.0007
Rate (R)			NS	NS	NS	NS	NS
H × R			0.0001	0.0001	0.0001	0.0001	0.0001

[z] ± SE; Significance <0.01 or not significant, NS.

[y] Means based on 3 replications; n = 30.

[x] Means based on 10 replications; n = 10.

[w] Root quality scale of 1 to 5; 1 = no rooting, 5 = heavy rooting.

In the liner study, shoot fresh and dry weights were not adversely affected by herbicide application. Root dry weight was reduced by using metolachlor (1/2×), prodiamine (1×) and dithiopyr (2×).

Weed Control. Weed control was generally acceptable among all the herbicides evaluated. However, oxyfluorfen:oryzalin (1/2×) and all rates of metolachlor did not adequately control yellow woodsorrel (Table 5). The 1/2× rate of metolachlor, pendimethalin and prodiamine did not control small flowered bittercress. Large crabgrass was not adequately controlled by the 1/2× rate of oxadiazon, oxyfluorfen:oryzalin, metolachlor or prodiamine. All herbicides effectively controlled bermudagrass.

Under our propagation system we had no problems with volatilization as has been reported with herbicides such as oxadiazon (5). However, air circulation may have been better under our fan and pad system then a propagation structure without a fan system. Undoubtedly no single herbicide is safe for all landscape plants. Oxadiazon was reported to be safer than oxyfluorfen:oryzalin (6), while we found both herbicides to be equally safe which agrees with Johnson and Meade (4). The landscape species, propagation system and environmental conditions play a role in herbicide safety. In most cases, with the exception of *Hibiscus*, herbicides used at the recommended rates did not have an adverse effect on adventitious root formation or subsequent liner growth. All herbicides at recommended rates controlled the weed species tested with the exception of metolachlor control for yellow woodsorrel.

(*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).

Table 5. Weed control of *Oxalis stricta* (yellow woodsorrel), *Cardamine parvifolia* (small flowered bittercress), *Digitaria sanguinalis* (large crabgrass) and *Cynodon dactylon* (bermuda grass) in propagation media treated with preemergence herbicides applied at 1/2×, 1× and 2× recommended rates; weeds were sown and later evaluated for number emerging and dry wt.

Herbicide	Rate (kg a.i./ha)	*Oxalis stricta* No.	*Oxalis stricta* Dry wt. (g)	*Cardamine parvifolia* No.	*Cardamine parvifolia* Dry wt. (g)	*Digitaria sanguinalis* No.	*Digitaria sanguinalis* Dry wt. (g)	*Cynodon dactylon* No.	*Cynodon dactylon* Dry wt. (g)
oxyfluorfen:pendimethalin	1.1/0.6	1.0 ± 0.4[z]	0	2.0 ± 1.1	0 ± 0	1.0 ± 0.7	0 ± 0	1.0	0.03
(OH2)	2.2/1.1	0.5 ± 0.5	0	0 ± 0	0 ± 0	0.3 ± 0.3	0 ± 0	0	0
	4.5/2.2	0 ± 0	0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0	0
oxadiazon	1.7	4.3 ± 2.0	0	1.8 ± 1.2	0 ± 0	2.8 ± 1.3	0.2 ± 0.1	1.5	0
(Ronstar)	3.4	0.5 ± 0.3	0	0.3 ± 0.3	0 ± 0	0.8 ± 0.5	0 ± 0	0.3	0
	6.7	0 ± 0	0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0	0
oxyfluorfen:oryzalin	1.1/0.6	7.0 ± 0.9	0	1.0 ± 0.6	0 ± 0	5.3 ± 2.3	0.1 ± 0.1	1.3	0
(Rout)	2.2/1.1	0.3 ± 0.3	0	0.5 ± 0.5	0 ± 0	1.8 ± 1.8	0 ± 0	0.3	0
	4.5/2.2	0.3 ± 0.3	0	0.5 ± 0.5	0 ± 0	1.0 ± 0.7	0 ± 0	0	0
metolachlor	1.7	10.8 ± 1.9	0	24.8 ± 2.6	0.3 ± 0	11.3 ± 2.1	0.2 ± 0.1	3.3	0
(Pennant)	3.4	17.0 ± 5.2	0	18.0 ± 2.1	0.2 ± 0	0.5 ± 0.5	0.1 ± 0.1	1.5	0
	6.7	10.8 ± 5.8	0	4.5 ± 1.0	0 ± 0	0.5 ± 0.3	0 ± 0	0	0
pendimethalin	1.4	3.3 ± 2.0	0	20.3 ± 5.3	0.4 ± 0.1	1.8 ± 0.9	0.1 ± 0.4	0	0
(Southern Weedgrass	2.8	2.2 ± 0.5	0	10.8 ± 4.3	0.1 ± 0	0 ± 0	0 ± 0	0	0
Control)	5.6	0 ± 0	0	0.8 ± 0.5	0 ± 0	0.5 ± 0.5	0 ± 0	0	0
isoxaben:oryzalin	0.5/1.3	0 ± 0	0	1.5 ± 1.5	0 ± 0	3.0 ± 0.7	0 ± 0	0	0
(Snapshot)	0.9/2.7	4.0 ± 3.1	0	1.3 ± 1.3	0 ± 0	1.0 ± 1.0	0 ± 0	0	0
	1.8/5.4	0 ± 0	0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0	0
prodiamine	1.7	2.5 ± 0.9	0	23.8 ± 5.2	0.2 ± 0	4.5 ± 1.0	0.1 ± 0	0.8	0
(Barricade)	3.4	0 ± 0	0	15.3 ± 2.5	0.2 ± 0	1.8 ± 0.6	0 ± 0	0	0
	6.7	0.3 ± 0.3	0	2.8 ± 1.1	0 ± 0	0 ± 0	0 ± 0	0	0
dithiopyr	0.8	1.0 ± 0.4	0	0.8 ± 0.8	0 ± 0	0.3 ± 0.3	0 ± 0	0	0
(Dimension)	1.7	2.0 ± 2.0	0	2.8 ± 1.1	0 ± 0	0 ± 0	0 ± 0	0	0
	3.4	0 ± 0	0	0.5 ± 0.5	0 ± 0	0 ± 0	0 ± 0	0	0
control	0	9.0 ± 2.7	0	27.0 ± 2.7	0.3 ± 0.1	11.5 ± 7.5	0.2 ± 0.1	13.3	0
Significance									
Herbicide (H)		0.0001	NS	0.0001	0.0001	NS	NS	NS	NS
Rate (R)		0.0421	NS	0.0001	0.0001	0.0001	0.0001	NS	NS
H × R		NS	NS	0.0001	0.0001	NS	NS	NS	NS

[z] ± SE; Significance <0.01 or not significant, NS.

Literature Cited

1. Ahrens, J.F. 1972. Rooting of rhododendron cuttings from container-grown plants treated with trifluralin and simazine. The Plant Propagator 18(3):12–18.

2. Fretz, T.A. 1973. Evaluation of several herbicides on subsequent rooting response of two container-grown azalea cuttings. The Plant Propagator 29(4):23–26.

3. Hull, R.J., J.J. McGuire and R.D. Wyman. 1977. Rooting capacity of herbicide-treated woody ornamental plants. Weed Science 25:452–455.

4. Johnson, J.R. and J.A. Meade, 1986. Preemergent herbicide effect on the rooting of cuttings. Proc. Intern. Plant Prop. Soc. 36:567–570.

5. Langmaid, M. 1987. Herbicides used in propagation at Wight nurseries. Proc. Intern. Plant Prop. Soc. 37:539–540.

6. Thetford, M., C.H. Gilliam and W.J. Foster. 1990. Herbicide use in propagation. Proc. Intern. Plant Prop. Soc. 38:479–481.

7. Thetford, M. and C.H. Gilliam. 1991. Herbicide use in propagation: Effects on rooting and root growth of stem cuttings. J. Environ. Hort. 9(1):21–23.