Evaluation of Weed Control and Phytotoxicity of Preemergence Herbicides Applied to Container-grown Herbaceous and Woody Plants[1]

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Abstract

Six different preemergence herbicides were used with eight different plant species to evaluate weed control efficacy and possible phytotoxicity. The species used were *Stachys byzantina* C. Koch (lamb's ears), *Campanula persicifolia* L. (peachleaf bellflower), *Achillea millefolium* L. 'Summer Pastel' (common yarrow), *Coreopsis lanceolata* L. (Lance coreopsis), *Gypsophila pacifica* Kom. (baby's breath), *Wisteria sinensis* Sims (Chinese wisteria), *Syringa vulgaris* L. (common lilac), *Phlox paniculata* L. (perennial phlox), *Dahlia* Cav. x *hybrida* (garden dahlia). Herbicides were applied to the soil surface at rates of 1x and 2x as recommended by the label. The herbicides and rates were as follows: Pennant (Dual) 7.8 Liquid, 4.6, 9.1 kg ai/ha (4, 8 lb ai/A); Gallery 75DF, 1.1, 2.3 kg ai/ha (1, 2 lb ai/A); Ronstar 2G, 4.5, 9.0 kg ai/ha (4, 8 lb ai/A); Rout 3G, 3.4, 6.8, 13.6 kg ai/ha (3, 6, 12 lb ai/A); Surflan AS, 2.3, 4.6 kg ai/ha (2, 4 lb ai/A); and Treflan 5G, 4.5, 9.0 kg ai/ha (4, 8 lbs ai/A). Weed seeds of *Setaria glauca* (L.) Beauv. (yellow foxtail), *Echinochloa crus-galli* (L.) Beauv. (barnyardgrass), *Poa annua* L. (annual bluegrass), *Capsella bursa-pastoris* (L.) Medik. (shepherdspurse), *Senecio vulgaris* L. (common groundsel), and *Amaranthus retroflexus* L. (redroot pigweed) were sown on the soil surface. Two control treatments (no herbicide and no weed seeds applied, or no herbicide but with weed seeds) also were evaluated. Plants were grown in #1 black plastic containers in a medium of clay loam soil, plaster sand and sphagnum peat (1:1:2 by vol). Weed counts at the end of the season indicated that weed control was variable according to the herbicide used. Rout and Ronstar at both the 1x and 2x rates controlled over 99% of the weeds (compared to the control treatment with weeds). Weed control for the other herbicides were as follows: Surflan 1x = 92%, Surflan 2x = 95%, Pennant 1x = 93%, Pennant 2x = 98%, Gallery 1x = 35%, Gallery 2x = 43%, Treflan 1x = 88%, and Treflan 2x = 96%. Evaluations also indicated that herbicides utilizing oryzalin resulted in phytoxicity or stunting to *Phlox* (appearance declined 88% at the 1x rate and 93% at the 2x rate compared to the control treatment), *Gypsophila* (dry weights for Surflan 1x was 27% less and Surflan 2x was 39% less compared to the control treatment), and *Stachys* (appearance declined 55% for 1x rate and 60% at the 2x rate). Gallery (isoxaben) resulted in stunting in *Stachys* (dry weights for Gallery 1x were 75% less compared to control plants and Gallery 2x was 80% less).

Index words: herbaceous perennials, woody ornamentals, preemergence herbicides, weed control, phytotoxicity

Herbicides used in this study: Pennant (metolachlor), 2-chloro-*N*-(2 ethyl-6-methylphenyl)-*N*-(2 methoxy-1-methyethyl) acetamide; Gallery (isoxaben), *N*-[3-1(-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide; Ronstar (oxadiazon), 3-[2,4-dichloro-5-(1-methylethoxy) phenyl]-5-(1, 1-dimethylethyl)-1, 3, 4-oxadiazol-2 (3-*H*)-one; Rout (oxyfluorfen and oryzalin), 2 chloro-1-(3-ethoxy-4-nitrophenoxy)-4 (trifluoromethyl) benzene + 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Surflan (orzalin), 4-(dipropylamino)-3,5-dinitrobenenesulfonamide; and Treflan (Trifluralin),2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine.

Species used in this study: Common yarrow, (Achillea millefolium L. 'Summer Pastel'); peachleaf bellflower, (*Campanula persicifolia* L.); lance coreopsis, (*Coreopsis lancelota* L.); garden dahlia, (*Dahlia* Cav. x *hybrida*); baby's breath, (*Gypsophila pacifica* Kom.); perennial phlox, (*Phlox paniculata* L); lamb's ears, (*Stachys byzantina* C. Koch), common lilac, (*Syringa vulgaris* L.); Chinese wisteria, (*Wisteria sinensis* Sims).

Significance to the Nursery Industry

Unless noted otherwise, the preemergence herbicides examined in this study provided very effective weed control with no crop injury. However, certain herbicides control some weeds better than others. In particular, Gallery allowed significantly more weeds (grasses were by far the predominant species). Gallery at the 1x rate only controlled 35% of the weeds and 43% at the 2x rate (compared to the control treatment with weeds). Rout and Ronstar at both the 1x and 2x rates controlled over 99% of the weeds. Weed control for the other herbicides were as follows: Surflan 1x = 92%, Surflan 2x = 95%, Pennant 1x = 93%, Pennant 2x = 98%, Treflan 1x = 88%, and Treflan 2x = 96%.

In general, the herbicides evaluated did not adversely affect crop performance. However, products containing oryzalin caused foliage injury and sometimes death in perennial phlox (appearance declined 88% at the 1x rate and 93% at the 2x rate compared to control) and lamb's ear (appearance declined 55% for 1x rate and 60% at the 2x rate). Reduced plant growth also was attributed to oryzalin in baby's breath (dry weights for Surflan 1x was 27% less and Surflan 2x was 39% less compared to control treatment). Isoxaben also resulted in smaller plants when used with lamb's ears (dry weights for Gallery 1x were 75% less compared to control plants and Gallery 2x was 80% less). The variability between species and specific herbicides as indicated by this study and other research (6,7,9,10) suggest that labels should be read thoroughly and trial runs completed before making large scale applications.

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Introduction

The importance of effective weed control is well known among landscape horticulturists. It is of special concern among growers of containerized plants since weeds can be very competitive for water, nutrients and root space—all of which are limited in a container environment.

The economics of such a situation is significant. Container grown plants with weeds are often unmarketable. Growth reduction may be as high as 50% (4). One alternative is to use hand weeding but this removes soil, results in poor quality plants and is highly labor intensive. To produce 0.4 ha (1 acre) of marketable plants in #1 containers, it will require 625 hours of hand weeding (8). Herbicides are more economical. Hand labor for weed control can be reduced up to 80% with the use of herbicide regime (2). Although herbicides may be an economical method of weed control, some also may cause phytotoxicity problems to certain species (1,3,5,12). Therefore, the purpose of this study was to evaluate selected herbicides for weed control and to determine plant species tolerance to selected herbicides.

Materials and Methods

1990 Season. Three herbicides (Ronstar, Route and Surflan) were evaluated using four different plant species (perennial phlox, garden dahlia, Chinese wisteria, and common lilac). The herbaceous plants were obtained in 5.7 cm (2.25 in) pots. The lilac and wisteria were transplanted as 85-150 cm (height) bareroot plants. All plants were potted into #1 pots May 11, 1990. The potting media consisted of soil (clay loam), plaster sand and sphagnum peat (1:1:2 by vol). Each plant was fertilized with 8 gm of Sierrablend 17N-2.58P-9.96K (17-6-12) on June 1, 1990 and 4 g of Osmocote 18N-2.58P-9.96K (18-6-12) on August 1, 1990. Two herbicide rates were used as well as two control treatments which included "0x/no weed" plants that received no herbicide and no weed seeds. The only weed control utilized for this treatment was to pasteurize the soil mix before planting. The other control treatment represented plants with no herbicide applied after weed seeds were sown on the soil surface (0x/with weed). One treatment had weed seeds sown on the surface and received the recommended herbicide rate (1x) (Table 1). A second treatment included the herbicide at a (2x) rate after the weed seeds were sown (Table 1). Granular herbicides were weighed and individually applied to the soil surface. Liquid herbicides were measured in ml for each pot, diluted with 100 ml of water and uniformly applied as a drench to the surface. Herbicides were activated by applying 2 cm (0.75 in) of water. Weed seeds were sown June 13, 1990 and the herbicides were applied June 15, 1990.

The following methods were used during both seasons. All plants were placed on wire mesh platforms raised 4" above the asphalt surface and spaced on 45 cm (18 in) centers. Each plant species was watered as needed during the growing season. Weed counts and phytotoxicity evaluations were taken every 4 weeks. Height and width measurements were recorded in cm before the treatments were applied and as the seasons end. Dry weight of the above ground biomass were measured by cutting at the soil level and drying at 70°C (158°F) for 48 hours. Experiments were in a randomized complete block design, data subjected to analysis of variance and means separated by Fisher's (protected) LSD.

1991 Season. Six herbicides (Ronstar, Rout, Surflan, Pennant, Gallery and Treflan) were evaluated using five different plant species (baby's breath, lance coreopsis, lamb's ears, common yarrow, and peachleaf bellflower). Growing media, pot size, and plant size were the same as used in the 1990 study. Treatments were identical except for the Rout herbicide. A 4x rate (four times the suggested rate with weeds) was used instead of the 2x rate. Granular and liquid herbicides were applied utilizing the same method as the 1990 experiment. All plants were planted into #1 pots before April 20, 1991 and fertilized with 9 g of Sierrablend 17N-258P-9.96K (17-6-12) on May 13, 1991. Weed seeds were sown May 26, 1991 and herbicides were applied May 28, 1991.

Table 1. Herbicide rates and formulations used in 1990 and 1991

Herbicide/formulation	Rate	kg ai/ha	lb ai/A
Pennant 7.8 E	1x	4.6	4
(Metolachlor)	2x	9.1	8
Gallery 75DF	1x	1.1	1
(Isoxaben)	2x	2.3	2
Ronstar 2G	1x	4.5	4
(Oxadiazon)	2x	9.1	8
Rout 3G	1x	3.4	3
(Oxyfluorfen + Oryzalin)	2x(1990)	6.8	6
	4x(1991)	13.6	12
Surflan 40AS	1x	2.8	2
(Oryzalin)	2x	4.5	4
Treflan 5G	1x	4.5	4
(Trifluralin)	2x	9.1	8

Results and Discussion

During 1990 Chinese wisteria, garden dahlia and common lilac were not significantly injured by any of the herbicides.

Perennial phlox, however was more sensitive to some of the herbicide treatments than the other plants tested. Plant height was 79% less with Surflan 1x as compared to Rout 1x (Table 2). At the 2x rate, plant height was 89% less with the Surflan treatments as compared to both Rout and Ronstar treatments (Table 2). Phlox exhibited a visual phytotoxic reaction to Surflan with the typical symptoms appearing as interveinal chlorosis, darkened veins, death of lower foliage first and followed by death of the entire plant. Plants treated at the rate of 2x rate exhibited these symptoms 1-2 weeks sooner than the 1x treatments. The 1x and 2x treatments of

Table 2. Change in height (cm) of *Phlox paniculata* as influenced by herbicide treatments.

	Herbicide rate	
Herbicide treatment	1x	2x
Weed free control	11.00 bc[2]	11.00 bc
Ronstar	11.20 bc	9.60 bc
Rout	20.00 a	9.20 bc
Surflan	4.20 cd	1.00 d
Weedy control	14.30 ab	14.30 ab

[2]Means represented with different letters are different. (Fishers protected $LSD_{0.05}$ = 8.2).

Surflan resulted in chlorosis ratings (a symptom of phytotoxicity) greater than all the other herbicides (Table 3). Several researchers have reported phytotoxicity problems with Surflan (1,11,12). This research confirms those observations. Rout also caused some chlorosis to perennial phlox (Table 2). This could be related to the oryzalin component common to both Rout and Surflan.

Weed control provided by the three different herbicides in the 1990 season was very good (Table 4). Ronstar, Rout and Surflan at both rates controlled at least 98% of the weeds (compared to control treatments with weeds) and no differences were found statistically. There were no significant differences in weed control by increasing the rate from 1x to 2x.

Results from the 1991 season revealed peachleaf bellflower, common yarrow and lance coreopsis were not adversely affected by any of the herbicides tested.

Baby's breath average height was 32% shorter with the Surflan 2x treatment when compared to all other treatments (Table 5). Surflan 1x and 2x treatments also resulted in lower dry weights compared to all but Ronstar 2x, Gallery 1x and 2x (Figure 1). No visual phytotoxicity was observed with baby's breath.

Phytotoxicity symptoms resulted on lamb's ears with Surflan (Table 3) as noted by chlorosis and death in some cases. Appearance declined 55% for 1x rate and 60% at the 2x rate. A visual inspection of the roots also revealed unusual stubs at the root ends. Gallery also adversely affected plant growth in that the mean dry weights were significantly less for the Gallery treatments when compared to all the other treatments except for Pennant 1x (Figure 2). Dry weights for the Gallery 1x rate were 76% less than the average of the other herbicide treatments and 80% less at the 2x rate.

Weed control for the 1991 season was variable depending on the herbicide used (Table 4). Gallery was not effective in controlling the grass weeds (data not shown) and resulted in a efficacy rate of only 35% at the 1x rate and 43% at the 2x rate when compared to the control treatment with weeds. Rout and Ronstar gave excellent weed control at both rates (greater than 99% of the control). Pennant resulted in significant weed control (1x = 93%, 2x = 98% of the control) while Treflan (1x = 88%, 2x = 96% of the control) and Surflan (1x = 86%, 2x = 91% of the control) were somewhat less effective. Weed counts of individual weed species indicated that Surflan and Treflan do not effectively control common groundsel (data not shown).

Table 3. Chlorosis ratings as a measure of phytotoxicity for *Phlox paniculata* and *Stachys byzantina*. 1 = healthy plant, 5 = dead or dying plant.

	Herbicide rate			
	Stachys		Phlox	
Herbicide treatment	1x	2x	1x	2x
Weed free control	1.0 c[2]	1.0 c	1.1e	1.1e
Weedy control	1.0 c	1.0 c	2.5cd	2.5cd
Ronstar	1.0 c	1.6 b	2.1d	1.2e
Rout	1.1 bc	1.6 b	3.2bc	3.5b
Surflan	3.2 a	3.4 a	4.6a	4.8a
Gallery	1.1 bc	1.1 bc	—	—
Pennant	1.0 c	1.1 bc	—	—
Treflan	1.0 c	1.6 b	—	—

[2]Fishers protected $LSD_{0.05}$ = 0.85 for *Phlox* and 0.62 for *Stachys*

Table 5. Growth as measured by change in height (cm) for *Gypsophila pacifica* as influenced by herbicide treatments.

	Herbicide rate	
Herbicide treatment	1x	2x
Weed free control	87.30 bcd	87.30 bcd
Pennant	81.20 cde	87.86 abcd
Gallery	84.76 bcde	90.38 abc
Ronstar	88.38 abcd	86.44 bcd
Rout	84.80 bcde	86.12 bcde
Surflan	73.98 e	60.84 f
Treflan	85.66 bcde	99.62 a
Weedy control	88.50 abcd	88.50 abcd

Means represented with different letters are significantly different. (Fishers protected $LSD_{0.05}$ = 12.2).

Table 4. Mean weed counts in container grown plants with different herbicide treatments.

		1990				1991				
Herbicide treatment	Rate	Phlox	Dahlia	Wisteria	Lilac	Lamb's ears	Bellflower	Achillea	Coreopsis	Baby's breath
Rout	1x	0.00 b	0.00 b	0.20 b	0.00 b	0.00 c	0.00 c	0.00 b	0.00 b	0.00 d
	2x	0.80 b	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.00 b	0.00 d
Ronstar	1x	0.00 b	0.00 b	0.04 b	0.00 b	0.00 c	0.00 c	0.00 b	0.00 b	0.00 c
	2x	0.04 b	0.00 b	0.00 b	0.00 b	0.20 c	0.00 c	0.00 b	0.00 b	0.00 d
Surflan	1x	0.00 b	0.00 b	0.20 b	0.00 b	0.60 c	0.80 c	3.20 b	0.00 b	0.40 cd
	2x	0.20 b	0.00 b	0.00 b	0.00 b	1.00 c	1.40 c	0.80 b	0.00 b	0.00 d
Pennant	1x	—	—	—	—	0.60 c	0.40 c	1.20 b	0.00 b	0.40 cd
	2x	—	—	—	—	0.40 b	0.00 c	0.00 b	0.00 b	0.40 cd
Gallery	1x	—	—	—	—	7.20 b	4.60 ab	8.00 a	0.36 b	3.20 b
	2x	—	—	—	—	6.40 b	4.00 b	7.80 a	0.20 b	2.00 bc
Treflan	1x	—	—	—	—	2.40 c	1.60 c	0.00 b	0.00 b	0.40 cd
	2x	—	—	—	—	0.40 c	0.40 c	0.60 b	0.00 b	0.00 d
Control	(weedy)	6.40 a	8.80 a	8.60 a	8.67 a	10.60 a	6.40 a	9.20 a	1.00 ab	8.60 a
$LSD_{0.05}$ =		1.96	3.09	1.91	2.23	3.29	2.08	3.20	0.84	1.82

Means represented with different letters within columns are different. $LSD_{0.05}$ for each species is listed at bottom of each column.

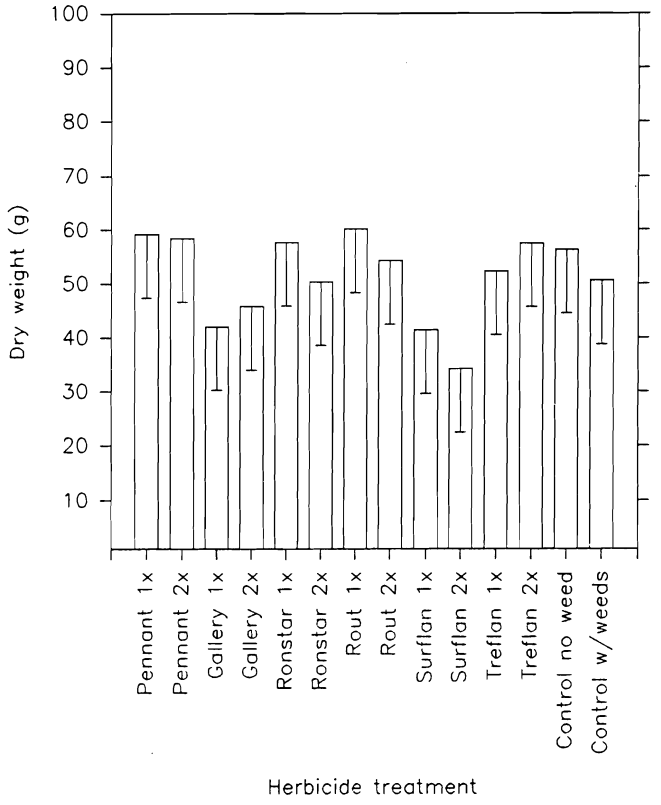

Fig. 1 Growth as measured by dry weights (g) for *Gypsophila pacifica* as influenced by herbicide treatments. (Fishers protected $LSD_{0.05}$ = 11.78)

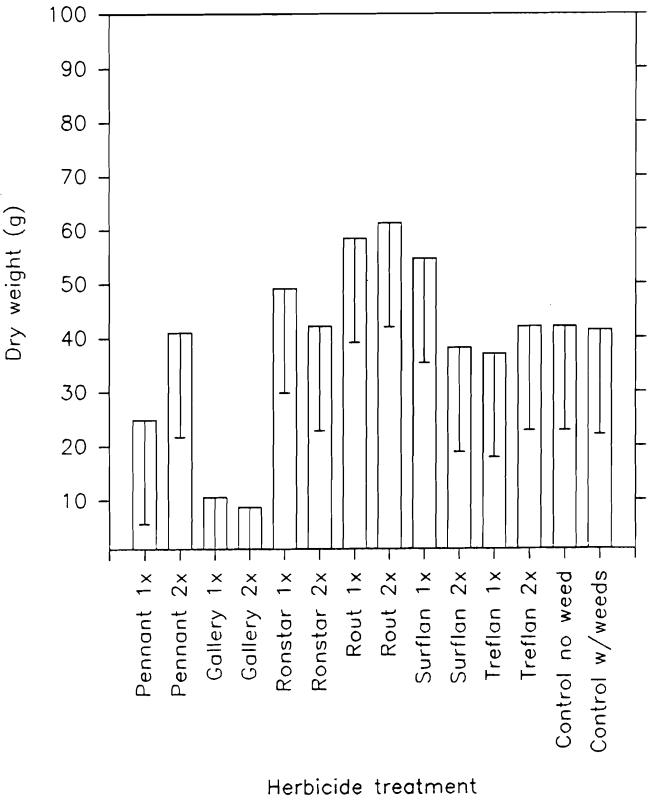

Fig. 2. Growth as measured by dry weights (g) for *Stachys byzantina* as influenced by herbicide treatments. (Fishers protected $LSD_{0.05}$ = 19.30)

(*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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