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Evaluation of Dinitroaniline Herbicides for Weed Control in Container Landscape Plant Production[1]

Robert H. Stamps[2] and Catherine A. Neal[3]
Central Florida Research and Education Center—Apopka
Institute of Food and Agricultural Sciences
University of Florida
2807 Binion Road, Apopka, FL 32703

Abstract

Five formulations of three dinitroaniline (DNA) herbicides [Surflan (oryzalin); Pre-M, Southern Weedgrass Control (pendimethalin); and Barricade (prodiamine)] were applied at 4.48 kg ai/ha (4.0 lb ai/A) every four months to container-grown landscape plants. These treatments were compared with untreated and weed-free controls, as well as the combination herbicides Rout and Ornamental Herbicide 2 composed of oryzalin or pendimethalin, respectively, [1.12 kg ai/ha (1.0 lb ai/A)] with Goal (oxyfluorfen) [2.24 kg ai/ha (2.0 lb ai/A)]. The combination herbicides caused the greatest amount of acute phytotoxicity, severely damaging *Hemerocallis* hybrid 'Aztec Gold' and *Liriope muscari* 'Big Blue'. Water dispersable granular formulations of Pre-M (pendimethalin) and Barricade (prodiamine) were phytotoxic to *Photinia* × *fraseri* while the granular formulations were not. Surflan (oryzalin) caused the greatest reduction in crop growth and was the only treatment that reduced survival. Surflan (oryzalin) and Ornamental Herbicide 2 (pendimethalin + oxyfluorfen) inhibited daylily flowering 98% and 65%, respectively. *Hairy* bittercress (*Cardamine hirsuta*), spotted spurge (*Chamaesyce maculata*), and yerba-de-tago (*Eclipta alba*) control generally was best with Barricade (prodiamine) and treatments containing Goal (oxyfluorfen). All herbicides, except Surflan (oryzalin), reduced weed biomass after two herbicide applications. All herbicides provided significant weed control after three applications.

Index words: Weed control, growth, phytotoxicity, flowering

Species used in this study: sprengeri fern [*Asparagus densiflorus* (Kunth) Jessop 'Sprengeri']; Aztec Gold daylily [*Hemerocallis* hybrid 'Aztec Gold']; Chinese holly [*Ilex cornuta* Lindl. & Paxt.]; shore juniper [*Juniperus conferta* Parl.]; dwarf white crape myrtle [*Lagerstroemia indica* L.]; Big Blue lilyturf [*Liriope muscari* (Decne.) L.H. Bailey 'Big Blue']; giant lilyturf [*Liriope muscari* (Decne.) L.H. Bailey 'Evergreen Giant']; mondo grass [*Ophiopogon japonicus* (Thunb.) Ker-Gawl]; red top [*Photinia* × *fraseri* Dress]; variegated pittosporum [*Pittosporum tobira* (Thunb.) Ait. 'Variegata']; live oak [*Quercus virginiana* Mill.]; and Southern Charm azalea [*Rhododendron indicum* (L.) Sweet. 'Southern Charm'].

Herbicides used in this study: Surflan (oryzalin) 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Pre-M, Southern Weedgrass Control (pendimethalin) N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzene; Barricade (prodiamine) N^3,N^3,-Di-*n*-propyl-2,4-dinitro-6-(trifluoromethyl)-*m*-phenylenediamine; Goal (oxyfluorfen) 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene.

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[2]Associate Professor of Environmental Horticulture.

[3]Extension Agent III (Commercial Horticulture). Lake County Cooperative Extension Service, 1220 Duncan Drive, Tavares, FL 32778

Significance to the Nursery Industry

The results of this study indicate that the landscape plants tested were generally more tolerant of Pre-M, Southern Weedgrass Control (pendimethalin) and Barricade (prodiamine) than the other herbicides. This may have been due in part to the lower solubility of these products which may have reduced their movement down into the nursery crop root zone. Additionally, weed control was generally good for the least soluble herbicides, thereby making them good candidates for possible inclusion in environmentally sound crop management systems.

Introduction

Weed control is an important aspect in the production of container-grown landscape plants (2, 5). Mechanical (hand) weeding is expensive and can cause crop injury (1, 4), while chemical control can lead to crop phytotoxicity (3, 7). Dinitroaniline (DNA) herbicides control a fairly wide spectrum of weeds and, due to the low solubility of some DNA herbicides (8), they have the potential for providing persistent weed control while reducing the chances for contamination

of both surface and ground water. However, the phytotoxic effects of repeated applications of these herbicides have not been evaluated on a wide variety of crops. Additionally, efficacy of these chemicals has not been adequately determined for some troublesome weeds.

Objectives of this study were to evaluate several DNA herbicides for weed control and crop safety.

Materials and Methods

Liners of plants from eleven genera of landscape plants were planted in 3.8 l (#1) black plastic containers during the first week of June, 1986. Container medium consisted of milled pine bark:Florida sedge peat:builders' sand (4:2:1 by vol) amended with 8.9 kg/m^3 (15 lbs/yd^3) 17N-2.6P-9.9K (17-6-12) slow-release fertilizer (Osmocote, Sierra Chemical), 0.9 kg/m^3 (1.5 lbs/yd^3) minor element mix (Micromax, Sierra Chemical), 3.0 kg/m^3 (5 lbs/yd^3) dolomite and 4.7 kg/m^3 (8 lbs/yd^3) sewage sludge. Supplemental liquid fertilization was applied as needed at a rate of 100 ppm N obtained using an 8N-0P-5K-2Mg (8-0-6-2) fertilizer. Herbicides were first applied on June 13, 1986 and then at 4-month intervals for a total of three applications. Treatments consisted of an untreated control; a "weed-free" control (weeded bimonthly); Surflan (oryzalin) A.S. formulation—solubility in water at 25°C (77°F) of 2,600 ppb; Pre-M 60 WDG and Southern Weedgrass Control 1.7 G (pendimethalin)—solubility in water at 23°C (73°F) of 275 ppb; and Barricade (prodiamine)—solubility in water at 25°C of 13 ppb, 65 WDG and 1.25 G formulations—at 4.48 kg ai/ha (4 lbs ai/A); and two 3G combination treatments of Ornamental Herbicide 2 or Rout [containing either pendimethalin or oryzalin, respectively, at 1.12 kg ai/ha (1.0 lb ai/A) and oxyfluorfen—solubility in water at 25°C of 100 ppb at 2.24 kg ai/ha (2.0 lb ai/A)]. These latter two combination treatments are commonly used in commercial practice. Granular formulations were broadcast over plots containing plants with dry foliage. Liquid drenches were applied from overhead as dilute solutions/suspensions equivalent to applying about 22,000 liters/ha (2,800 gal/A) to simulate commercial chemigation practices. Immediately after all treatments had been applied, 1.3 centimeters (0.5 in) of water were applied to all plots using solid-set overhead irrigation. This same irrigation system was used to water and fertilize the plants as needed during the production cycle. One month after herbicides were applied, aliquots containing about 240 spotted spurge [*Chamaesyce maculata* (L.) Small] and 120 yerba-de-tago [*Eclipta alba* (L.) Hassk.] seeds were distributed over each plot. Additionally, three 10 cm (4 in) pots of hairy bittercress (*Cardamine hirsuta* L.) were placed in each plot one week after the second herbicide treatment. Plot size was 1.5 m^2 (15.8 ft^2) for the first 4 months (containers pot to pot), 1.7 m^2 (18 ft^2) for the second 4 months (plants spaced), and 0.7 m^2 (8 ft^2) for the species remaining for the final 4 months. At the end of each 4-month interval all plots were weeded and the weeds dried at 70°C (158°F). The experimental design was randomized complete block with 4 replications. The experimental unit for phytotoxicity and crop growth consisted of 4 plants of each species in each plot (16 plants/treatment).

Acute phytotoxicity was rated 1 and 4 weeks after the first and 3 weeks after the 2nd herbicide application (1 = no damage, 2 = slight damage but salable, 3 = moderate damage and unsalable, 4 = severe damage and 5 = dead). Crop growth (chronic phytotoxicity) was measured 8 or 12 months after experiment initiation depending on when each species reached salable size. Plant height and/or width (depending on growth habit), root grade (3 = healthy, fibrous, white roots covering 100% of root ball surface; 2 = healthy, fibrous, white roots covering > 75% of the root ball; and 1 = roots exhibiting reduced whiteness and fibrousness and covering < 75% of the root ball), and survival data were taken when the plants reached salable size 8 or 12 months after experiment initiation. Flowering data (number of peduncles, i.e. flower stalks, and open flowers per plant) for *Hemerocallis* 'Aztec Gold' were recorded on May 4, 1987.

Control of each weed species was evaluated monthly by counting the number of weeds and/or visually estimating weed coverage percentages. Dry weight of weeds was determined after each 4-month weeding. Weed counts and percentage data were transformed using arcsine and square root transformations where applicable (6) prior to analysis of variance and means separation using Duncan's new multiple range test.

Results and Discussion

Acute phytotoxicity. Ornamental Herbicide 2 and Rout (the combination treatments containing oxyfluorfen) caused visible damage to sprengeri fern, daylily, 'Big Blue' lilyturf, and red top; and Rout (combination of oxyfluorfen + oryzalin) also damaged dwarf lilyturf (Table 1). Damage consisted mainly of tissue bleaching. Surflan (oryzalin) and the WDG formulations of pendimethalin and Barricade (prodiamine) were phytotoxic to red top, causing leaf distortion and chlorotic/necrotic spotting. Surflan (oryzalin) and Barricade 1.25 G (prodiamine) damaged dwarf lilyturf.

Chronic phytotoxicity (crop growth). A single application of Surflan (oryzalin) reduced the growth of sprengeri fern, daylily, 'Big Blue' lilyturf, dwarf lilyturf, red top and live oak 23–56% compared to the controls (data not shown). The initial application of either formulation of Barricade (prodiamine) or Ornamental Herbicide 2 and Rout (the treatments containing oxyfluorfen) reduced growth of sprengeri fern about 31%. A single application of Barricade WDG (prodiamine) or Ornamental Herbicide 2 (oxyfluorfen + pendimethalin) reduced daylily growth by 21% and 25%, respectively (data not shown). Live oaks outgrew the initial Surflan (oryzalin) stunting (24%) as did the daylilies stunted by the Ornamental Herbicide 2 (oxyfluorfen + pendimethalin) treatment. By the time the crops reached salable size, Surflan (oryzalin) had reduced the growth of sprengeri fern, daylily, holly, both cultivars of lilyturf, dwarf lilyturf, red top and azalea by 13–64% (Table 2). Surflan (oryzalin) stunting of the sprengeri fern, holly, lilyturfs and azalea was accompanied by reductions of the root systems (Table 2). Rout (oxyfluorfen + oryzalin) also decreased the root grade of dwarf lilyturf and Barricade (prodiamine) treatments reduced the root grade of 'Southern Charm' azalea. The granular formulation of Barricade (prodiamine) and Rout (oryzalin + oxyfluorfen) reduced sprengeri fern growth.

Survival. None of the treatments reduced plant survival except Surflan (oryzalin) which reduced sprengeri fern and holly survival by 14% and 25%, respectively (data not shown).

Daylily flowering. Surflan (oryzalin) reduced peduncle (flowerstalk) production by 79% and Surflan (oryzalin) and

Table 1. Acute phytotoxicity[z] observed 1 and 4 weeks (June 19 and July 10, 1986, respectively) after the first and 2 weeks (October 29, 1986) after the second herbicide applications.

Herbicide	Formulation	Rate (kg/ha)	Date	*Asparagus densiflorus* 'Sprengeri'	*Hemerocallis* 'Aztec Gold'	*Liriope muscari* 'Big Blue'	*Ophiopogon japonicus*	*Photinia* X *fraseri*
Controls (untreated and weed-free)	—	—	6/19/86	1.00[y]	1.00	1.00	1.00	1.00
			7/10/86	1.00	1.00	1.00	1.00	1.00
			10/29/86	1.50	1.00	1.00	1.25	1.00
Surflan (oryzalin)	40 AS	4.48	6/19/86	1.00	1.00	1.00	1.00	1.50*
			7/10/86	1.50	1.00	1.00	1.50	1.50
			10/29/86	2.00	1.00	1.00	3.50*	1.00
Pre-M (pendimethalin)	60 WDG	4.48	6/19/86	1.50	1.00	1.00	1.00	1.50*
			7/10/86	1.25	1.00	1.25	1.00	1.75*
			10/29/86	2.00	1.00	1.25	1.75	2.88*
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	6/19/86	1.25	1.00	1.00	1.00	1.00
			7/10/86	1.50	1.00	1.00	1.00	1.50
			10/29/86	1.50	1.00	1.00	1.50	1.50
Barricade (prodiamine)	65 WDG	4.48	6/19/86	1.50	1.00	1.00	1.00	1.00
			7/10/86	1.50	1.00	1.00	1.25	1.75*
			10/29/86	2.25	1.25	1.00	1.75	2.75*
Barricade (prodiamine)	1.25 G	4.48	6/19/86	1.25	1.00	1.00	1.00	1.00
			7/10/86	1.25	1.00	1.00	1.00	1.50
			10/29/86	2.5	1.50	1.00	2.25*	1.00
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	6/19/86	2.0*[x]	1.00	1.00	1.00	1.00
			7/10/86	2.0*	1.00	1.25	1.75	2.25*
			10/29/86	1.5	4.00*	4.00*	2.75*	1.25
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	6/19/86	1.75*	1.00	1.00	1.00	1.00
			7/10/86	1.75	1.00	1.00	1.00	2.00*
			10/29/86	2.25	4.00*	4.25*	2.13	1.75*

[z]No visible phytotoxicity was observed on *Ilex cornuta, Juniperus conferta, Lagerstroemia indica, Liriope muscari* 'Evergreen Giant', *Pittosporum tobira* 'Variegata', *Quercus virginiana* or *Rhododendron* 'Southern Charm'.

[y]Rating scale: 1 = no damage, 2 = slight damage but still salable, 3 = moderate damage and unsalable, 4 = severe damage, 5 = dead.

[x]* indicates means significantly different from controls using LSD comparisons, 5% level.

Ornamental Herbicide 2 (oxyfluorfen + pendimethalin) inhibited flowering 98% and 65%, respectively, compared to the controls (data not shown).

Weed control. Ornamental Herbicide 2 and Rout (treatments containing oxyfluorfen) were the only ones that inhibited bittercress seed germination after 2 treatments (Table 3); however, other herbicides suppressed bittercress growth. At 4 months after the second herbicide application, the granular formulation of Barricade (prodiamine) and Ornamental Herbicide 2 and Rout (the oxyfluorfen combination treatments) gave excellent bittercress control. Barricade WDG

Table 2. Effects of herbicide treatments on crop growth[z] (height or plant index[y]) and root grade[x].

			Asparagus densiflorus 'Sprengeri'		*Hemerocallis* 'Aztec Gold'		*Ilex cornuta*		*Liriope muscari* 'Big Blue'	
Herbicide	Formulation	Rate (kg/ha)	Plant index	Root grade	Plant height (cm)	Root grade	Plant index	Root grade	Plant height (cm)	Root grade
Untreated control	—	—	49 ab[w]	3.0 a	43 a	3.0 a	24 a	2.9 a	33 a	2.9 a
Weed-free control	—	—	51 a	2.9 ab	40 a	2.9 a	25 a	2.9 a	30 a	2.9 a
Surflan (oryzalin)	40 AS	4.48	18 d	2.1 c	32 b	2.8 a	18 b	2.2 b	23 b	2.2 b
Pre-M (pendimethalin)	60 WDG	4.48	49 ab	2.9 ab	42 a	3.0 a	23 a	2.9 a	30 a	2.7 a
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	49 ab	2.9 ab	42 a	3.0 a	26 a	2.9 a	33 a	2.9 a
Barricade (prodiamine)	65 WDG	4.48	43 abc	2.8 ab	41 a	2.9 a	25 a	2.8 a	30 a	2.7 a
Barricade (prodiamine)	1.25 G	4.48	34 c	2.8 ab	46 a	3.0 a	26 a	2.9 a	29 a	2.8 a
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	36 c	2.7 b	41 a	3.0 a	24 a	2.9 a	31 a	2.5 ab
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	40 bc	3.0 a	42 a	2.8 a	26 a	2.9 a	31 a	2.7 a

[z]Growth of *Juniperus conferta* and *Lagerstroemia indica* was not affected by treatments.

[y]Plant index = (height + width)/2.

[x]Root grades: 3 = fibrous white roots covering 100% of root ball surface; 2 = fibrous white roots covering > 75% of root ball; 1 = roots exhibiting reduced whiteness, fibrousness and covering < 75% of root ball.

[w]Means in a column followed by the same letter or letters are not significantly different at the 5% level using Duncan's multiple range test.

Table 2 (Cont'd). Effects of herbicide treatments on crop growth[z] (height or plant index[y]) and root grade[x].

Herbicide	Formulation	Rate (kg/ha)	*Liriope muscari* 'Evergreen Giant' Plant height (cm)	*Liriope muscari* 'Evergreen Giant' Root grade	*Ophiopogon japonicus* Plant height (cm)	*Ophiopogon japonicus* Root grade	*Photinia* X *fraseri* Plant index	*Photinia* X *fraseri* Root grade	*Pittosporum tobira* 'Variegata' Plant index	*Pittosporum tobira* 'Variegata' Root grade
Untreated control	—	—	48 a	2.9 a	20 a	2.6 a	60 ab	2.9 a	35 a	3.0 a
Weed-free control	—	—	44 ab	2.9 a	17 bc	2.6 a	58 abc	3.0 a	34 a	2.9 a
Surflan (oryzalin)	40 AS	4.48	38 c	2.5 b	9 d	2.0 b	52 c	2.9 a	31 a	3.0 a
Pre-M (pendimethalin)	60 WDG	4.48	47 a	2.9 a	16 c	2.3 ab	53 bc	2.9 a	36 a	3.0 a
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	46 ab	2.9 a	19 ab	2.6 a	61 a	3.0 a	37 a	2.9 a
Barricade (prodiamine)	65 WDG	4.48	45 ab	2.9 a	16 c	2.2 ab	53 bc	3.0 a	32 a	2.9 a
Barricade (prodiamine)	1.25 G	4.48	42 bc	2.9 a	14 c	2.3 ab	59 ab	3.0 a	31 a	2.9 a
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	47 a	2.9 a	16 c	2.0 b	54 bc	3.0 a	29 a	2.8 a
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	44 ab	2.9 a	15 c	2.4 ab	58 abc	3.0 a	33 a	2.8 a

Herbicide	Formulation	Rate (kg/ha)	*Quercus virginiana* Plant height (cm)	*Quercus virginiana* Root grade	*Rhododendron* 'Southern Charm' Plant index	*Rhododendron* 'Southern Charm' Root grade
Untreated control	—	—	62 a	3.0 a	41 ab	3.0 a
Weed-free control	—	—	62 a	2.8 ab	37 abc	2.9 a
Surflan (oryzalin)	40 AS	4.48	51 a	2.5 b	31 c	2.0 c
Pre-M (pendimethalin)	60 WDG	4.48	60 a	2.7 ab	44 a	2.9 a
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	60 a	2.5 b	42 ab	2.9 a
Barricade (prodiamine)	65 WDG	4.48	59 a	2.8 ab	36 bc	2.1 b
Barricade (prodiamine)	1.25 G	4.48	59 a	2.8 ab	35 bc	2.4 bc
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	64 a	2.8 ab	42 ab	3.0 a
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	64 a	2.7 ab	42 ab	2.8 a

[z]Growth of *Juniperus conferta* and *Lagerstroemia indica* was not affected by treatments.

[y]Plant index = (height + width)/2.

[x]Root grades: 3 = fibrous white roots covering 100% of root ball surface; 2 = fibrous white roots covering > 75% of root ball; 1 = roots exhibiting reduced whiteness, fibrousness and covering < 75% of root ball.

[w]Means in a column followed by the same letter or letters are not significantly different at the 5% level using Duncan's multiple range test.

Table 3. Bittercress control following 2nd and 3rd herbicide applications applied October 16, 1986 and February 13, 1987, respectively.

Herbicide	Formulation	Rate (kg/ha)	Months after 2nd herbicide application: 2 Plants/plot	3 Plants/plot	4 Plants/plot	4 Control (%)[z]	Months after 3rd herbicide application: 2 Plants/plot	3 Plants/plot	4 Plants/plot	4 Control (%)
Untreated control	—	—	100+ a[y]	100+ a	100+ a	0 d	100+ a	100+ a	100+ a	0 c
Surflan (oryzalin)	40 AS	4.48	100+ a	100+ a	100+ a	−84 e	65 b	57.5 b	88.8 a	85.0 b
Pre-M (pendimethalin)	60 WDG	4.48	100+ a	100+ a	100+ a	44 c	38 c	1.2 c	13.2 b	99.9 a
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	100+ a	100+ a	100+ a	73 b	8 d	1.8 c	3.8 b	99.8 a
Barricade (prodiamine)	65 WDG	4.48	100+ a	100+ a	100+ a	70 b	9 d	4.5 c	10.8 b	99.9 a
Barricade (prodiamine)	1.25 G	4.48	100+ a	100+ a	100+ a	95 a	12 d	0.0 c	0.5 b	99.9 a
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	6 b	46 b	31 b	93 a	1 d	0.2 c	0.2 b	99.9 a
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	16 b	34 b	16 b	98 a	0 d	0.2 c	0.2 b	99.9 a

[z]Percentages were based on visual estimates of weed coverage and transformed to the arcsine of the square root of the percentage before statistical analysis.

[y]Means in a column followed by the same letter or letters are not significantly different at the 5% level using Duncan's multiple range test. 100+ indicates that there were over 100 bittercress plants per plot.

(prodiamine) and Southern Weedgrass Control (pendimethalin G) provided fair bittercress control, followed by Pre-M (pendimethalin WDG) which gave poor control. Surflan (oryzalin) appeared to enhance bittercress growth, probably by reducing competition from many of the crop species due to its inhibition of their growth (Table 2). After 3 applications, all herbicide treatments suppressed bittercress seed germination for 3 months; however, after 4 months Surflan (oryzalin) did not control germination. After a year, all herbicides provided excellent control of bittercress growth except Surflan (oryzalin).

After one application, Barricade G (prodiamine) and Rout (oryzalin + oxyfluorfen) suppressed yerba-de-tago seed germination for 3 months; but, none of the treatments were still effective after 4 months (Table 4). After two herbicide applications, Barricade (prodiamine) and Ornamental Herbicide 2 and Rout (treatments containing oxyfluorfen) suppressed germination for 3 months. All of the herbicide treatments except Pre-M and Southern Weedgrass Control (pendimethalin) suppressed yerba-de-tago growth for 4 months. After 3 applications, all herbicide treatments suppressed yerba-de-tago growth.

Spurge seed germination was suppressed by all treatments; Pre-M and Southern Weedgrass Control (pendimethalin) and Ornamental Herbicide 2 (pendimethalin + oxyfluorfen) treatments gave excellent control for 2 months while Barricade (prodiamine) and Rout (oxyfluorfen + oryzalin) treatments provided 100% control for 3 months (data not shown).

Weed biomass production was reduced by Barricade G (prodiamine) and Rout (oryzalin + oxyfluorfen) at 4 months, by all herbicides except Surflan (oryzalin) at 8 months, and by all herbicides at 12 months (Figure 1). Over the year of testing, best weed suppression was given by Barricade (prodiamine) and Ornamental Herbicide 2 and Rout (the treatments containing oxyfluorfen).

(*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 4. Control of yerba-de-tago following herbicide applications on June 13 and October 16, 1986, and February 13, 1987.

			Months after 1st application			Months after 2nd application			
Herbicide	Formulation	Rate (kg/ha)	2 Plants/ plot	3 Plants/ plot[y]	4 Plants/ plot[y]	1 Plants/ plot	2 Plants/ plot	3[z] Plants/ plot	3 Control (%)[x]
Untreated control	—	—	0	10 a[w]	6 a	0	46.5 a	50 a	0 b
Surflan (oryzalin)	40 AS	4.48	0	5 abc	6 a	0	51.0 a	23 ab	96 a
Pre-M (pendimethalin)	60 WDG	4.48	0	4 abc	5 a	0	39.2 ab	52 a	−10 b
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	0	7 ab	6 a	0	28.2 ab	35 ab	−2 b
Barricade (prodiamine)	65 WDG	4.48	0	5 abc	5 a	0	15.5 ab	7 a	99 a
Barricade (prodiamine)	1.25 G	4.48	0	2 bc	2 a	0	9.5 ab	4 b	83 a
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	0	1 c	1 a	0	0.0 b	0 b	100 a
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	0	5 abc	4 a	0	0.2 b	3 b	93 a

			Months after 3rd application				
Herbicide	Formulation	Rate (kg/ha)	1 Plants/ plot	2 Plants/ plot	3 Plants/ plot	4 Plants/ plot	4 Control (%)[x]
Untreated control	—	—	0	67 a	67 a	48 a	0 c
Surflan (oryzalin)	40 AS	4.48	0	69 a	20 bc	28 ab	70 ab
Pre-M (pendimethalin)	60 WDG	4.48	0	8 b	21 bc	17 ab	44 b
Southern Weedgrass Control (pendimethalin)	1.7 G	4.48	0	62 a	50 ab	37 ab	70 ab
Barricade (prodiamine)	65 WDG	4.48	0	4 b	3 c	10 b	87 ab
Barricade (prodiamine)	1.25 G	4.48	0	13 b	0 c	1 b	99a
Rout (oryzalin + oxyfluorfen)	3 G	1.12 + 2.24	0	3 b	1 c	1 b	99 a
Ornamental Herbicide 2 (pendimethalin + oxyfluorfen)	3 G	1.12 + 2.24	0	0 b	2 c	2 b	73 ab

[z]Cold damaged the yerba-de-tago after this rating, so 4 month data not reported.

[y]Square root transformations of plant counts were made prior to statistical analysis.

[w]Means in a column followed by the same letter or letters are not significantly different at the 5% level using Duncan's multiple range test.

[x]Percentages were based on visual estimates of weed coverage and transformed to the arcsine of the square root of the percentage before statistical analysis.

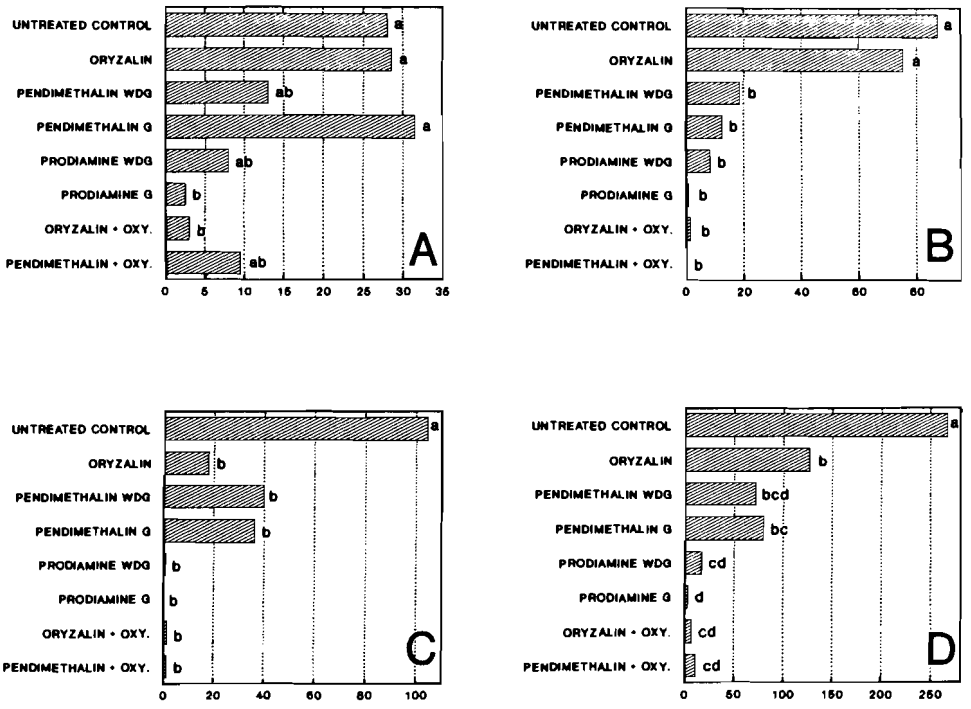

Fig. 1. Dry weights of weeds, in grams, after 4 (A), 8 (B) and 12 (C) months, and total weed dry weight for 1 year (D). Bars in a graph followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test. Combination treatments contained 1.12 kg ai/ha (1 lb ai/A) of oryzalin or pendimethalin plus 2.24 kg ai/ha (2 lb ai/A) of oxyfluorfen (oxy.). All other herbicides were applied at 4.48 kg ai/ha (4 lb ai/A).

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