Research Reports

Weed Control in Dune Sedge Transplants

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ADDITIONAL INDEX WORDS. *Carex pansa*, groundcover, herbicides, mulch, phytotoxicity, postemergent, preemergent, reduced risk, sand dune sedge

SUMMARY. Dune sedge (*Carex pansa*) can be used as either a groundcover or mowed turf. It is planted as plugs or small pots, but at 9-inch spacing, it may take over 1 year to completely fill in as turf, allowing weeds to grow between plants. This research was conducted to evaluate control of annual weeds and crop phytotoxicity with several conventional and reduced-risk herbicides in newly transplanted dune sedge. Three experiments were conducted on the same planting over a 5-month period, with dune sedge plants and weeds recovering well to permit subsequent evaluations. In Expt. 1, four preemergent and four reduced-risk postemergent herbicides and shredded fir bark mulch were compared shortly after planting. The use of oryzalin, dithiopyr, an experimental fatty acid herbicide (experimental FA), and mulch led to good control of the young weeds; all others resulted in less than 50% control. The experimental FA and ammoniated soap of fatty acids caused phytotoxicity to the dune sedge. In Expt. 2, four postemergent conventional herbicides, the same four reduced-risk postemergent herbicides (including two at increased rates) and the continued mulch treatment were tested. Most reduced-risk herbicides severely burned back the weeds initially, but regrowth ensued. In Expt. 3, a grass herbicide, a broadleaf herbicide combination, and a mix of the two were compared on the remaining plots with healthy dune sedge and actively growing weeds. Fluazifop provided good control of wild oat, carfentrazone + 2,4-D + mecoprop + dicamba largely controlled broadleaf weeds, and the combination controlled most weeds; no phytotoxicity occurred to the dune sedge. The results of the three experiments suggest that an application of dithiopyr, oryzalin, or a 2-inch layer of mulch shortly after planting, followed if necessary by hand weeding or treating weeds with carfentrazone + 2,4-D + mecoprop + dicamba tank-mixed with fluazifop would be an ideal strategy for management of annual weeds during the establishment of dune sedge. For organic or reduced-risk management, bark or wood chip mulch followed by hand weeding would be the best approach.

Dune sedge is a perennial, creeping sedge with slow-growing rhizomes, which forms a dense leafy cover 20–25 cm tall if not mowed. It tolerates moderate

traffic and a variety of soil types and climates, including the hot summers in the Central Valley of California.

Like most sedges (*Carex* sp.), it grows well in partial shade, but with sufficient water will perform well in full sun (Greenlee, 2000). It can be mowed regularly as a turf or mowed one to several times per year at height of 8–10 cm. Unmowed, it makes an attractive natural deep green meadow and remains green year-round, performing similar to fine-leaf fescues (*Festuca* sp.).

Broadcast seeding of dune sedge is not practical because the seed is difficult to collect in large enough amounts, it is slow to emerge in field conditions, and establishment is sporadic due to weed competition (Amme, 2008). Therefore, it is typically established by transplanting plugs or plants grown in small pots 6–12 inches apart (Greenlee, 2000), and plants spread by rhizomes. Closer spacing of transplants is cost-prohibitive for larger plantings, and wider spacing exacerbates weed competition for 1 year or more.

Weed control is essential in weedy sites for 1 year to reduce the weed seed bank (Anderson, 2001). Weeds should be controlled in the fall or winter before planting using broad-spectrum herbicides, and/or preemergent herbicides can be used immediately following planting. Nonchemical preplant strategies include weed flaming, sheet mulching, or soil solarization. Although susceptible to weed competition during establishment, dune sedge is very competitive once established and subsequent weed control is often minimal.

A turf demonstration trial was established in Sacramento County in 2010, in which four turf species were each compared at irrigation regimes of 40%, 60%, and 80% reference evapotranspiration [ET_0 (Ingels, 2011)]. Dune sedge was fairly drought tolerant, performing well at 60% ET_0 , whereas clustered field sedge (*Carex praegracilis*) exhibited browning and severe stunting at this level. The sedges and several other species were planted as plugs or from small pots. All weeds were controlled in the year

We thank Jeff Chandler and Taylor Lewis of Cornflower Farms (Elk Grove, CA) for their support on this project.

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
9.3540	gal/acre	L·ha ⁻¹	0.1069
2.54	inch(es)	cm	0.3937
70.0532	oz/acre	g·ha ⁻¹	0.0143
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

before planting, but where transplants were used weed seedling growth was substantial, requiring three to four periods of extensive hand weeding until full establishment of the turf.

In a New Zealand study, eight postemergent herbicides were evaluated for weed control and plant phytotoxicity after spraying over forest plants, including weeping brown sedge [*Carex flagellifera* (Harrington and Schmitz, 2007)]. Only glyphosate, a nonselective herbicide, and amitrole, which controls annual grasses and broadleaf and aquatic weeds, caused substantial phytotoxicity to the weeping brown sedge. Aminopyralid, clopyralid, fluazifop, haloxyfop, metsulfuron, and terbutylazine caused little or no phytotoxicity. In another New Zealand study, clethodim, clopyralid, dicamba, fluazifop, haloxyfop, and triclopyr were not phytotoxic to the weed species oval sedge (*Carex ovalis*) or the native species (*Carex gaudichaudiana*), but glyphosate killed 100% of these plants (Champion, 1998).

In a study conducted in Illinois, the postemergent herbicide sethoxydim was used for treatment of canary grass (*Phalaris arundinacea*) without interfering with the growth of a native sedge/meadow seed mix (Simpson, 2009).

Interest in alternative turf species such as dune sedge is increasing, but little information is available on the efficacy and crop safety of common weed control tactics during the critical establishment period. Therefore, three trials were conducted in newly transplanted dune sedge to evaluate weed control efficacy and crop response. The purpose of this project was to test several weed control methods in a dune sedge planting and evaluate the phytotoxicity of herbicides on the transplants. We had a special interest in testing reduced-risk postemergent herbicides because of local interest in reducing the use of synthetic herbicides.

Materials and methods

Three experiments were conducted over a period of 5 months on the same planting at Cornflower Farms (Elk Grove, CA) in 2012. The field was fallow and not irrigated for many years, with annual weeds growing densely each winter and reseeding each spring. The most prevalent weed seedlings were wild oat (*Avena fatua*),

white clover (*Trifolium repens*), broadleaf filaree (*Erodium botrys*), and woollypod vetch (*Vicia villosa*). A few plants of field bindweed (*Convolvulus arvensis*) persisted. The site was rototilled twice in mid-May 2012 and raked smooth before planting. A randomized complete block design was used, composed of 10 treatments and four replications. On 22 May 2012, 35 dune sedge plants grown in 2-inch-diameter pots were planted 12 inches apart in each of forty 5 × 7-ft plots.

Overhead sprinkler irrigation was used on all plots. Irrigation timing and amount were used in such a way as to maintain the plants at or slightly below 100% ET_o through each of the experiments. Temperature and rainfall information were retrieved from a nearby weather station. Average high temperatures from the day of planting to the final evaluation in Expt. 3 were as follows: 28 °C (May), 30 °C (June), 33 °C (July), 35 °C (Aug.), 33 °C (Sept.), and 28 °C (Oct.). The only rainfall events occurred 26 May and 4 June (0.4 inch each).

In Expt. 1, pre- and postemergent herbicides and wood chip mulch were compared for efficacy and damage to the dune sedge plants (Table 1). The preemergent herbicides, applied 24 May (2 d after planting), were prodiamine (Barricade 65 WG; Syngenta Crop Protection, Greensboro, NC), pendimethalin (Pendulum AquaCap; BASF, Research Park Triangle, NC), oryzalin (Surflan AS; United Phosphorus, King of Prussia, PA), and dithiopyr (Dimension 2EW; Dow AgroSciences; Indianapolis). Postemergent herbicides,

applied 7 June (14 d after planting), were ammoniated soap of fatty acids (Final-San-O; Certis USA, Columbia, MD), experimental FA (Westbridge Agricultural Products, Vista, CA), acetic acid (Weed Pharm; Pharm Solutions, Port Townsend, WA), and iron hydroxyethylene-diaminetriacetic acid [HEDTA (Fiesta; Engage Agro USA, Prescott, AZ)]. The mulch treatment, which consisted of a 2-inch layer of shredded fir bark containing pieces that were ≈1/2 to 2 inches long by 1/4 to 3/4 inch wide, was also applied 24 May; no weeds had yet germinated at the time of application. On 26 June, injury or phytotoxicity to weeds and dune sedge was visually rated, as was vigor of the dune sedge.

Herbicides were applied using a pressurized carbon dioxide backpack sprayer with three fan nozzles (8004 TeeJet EX; Spraying Systems, Wheaton, IL). Each nozzle delivered 0.28 gal/min and one pass of the wand was used. Preemergent herbicides were applied at 50 gal/acre final volume and postemergent herbicides were applied at 100 gal/acre final volume.

Weeds were allowed to grow in all plots through July. In early August, all plots were hand weeded and then new weeds were allowed to grow. Expt. 2 was conducted using these existing plots. This time, four postemergent herbicides were applied in plots where preemergent herbicides (prodiamine, pendimethalin, oryzalin, and dithiopyr, respectively) were used in Expt. 1 (Table 2). The new postemergent herbicides used were clethodim

Table 1. Treatments and rates used in Expt. 1 for weed control in a dune sedge planting. Dune sedge planted 22 May 2012. Preemergent herbicides sprayed 24 May 2012 and postemergent herbicides sprayed 7 June 2012.

Treatment	Rate (a.i.) ^z
Prodiamine ^y	15.6 oz/acre
Pendimethalin ^y	23.5 oz/acre
Oryzalin ^y	25.9 oz/acre
Dithiopyr ^y	3.8 oz/acre
Ammoniated soap of fatty acids ^{x,w}	2.2 gal/acre
Experimental FA ^{x,w,v}	4.7 gal/acre
20% acetic acid ^{x,w}	20.0 gal/acre
Iron HEDTA ^{x,w,u}	0.8 gal/acre
Fir bark mulch	2-inches deep
Untreated	—

^z1 oz/acre = 70.0532 g·ha⁻¹, 1 gal/acre = 9.3540 L·ha⁻¹, 1 inch = 2.54 cm.

^yPreemergent herbicide applied in 50 gal/acre water solution.

^xPostemergent herbicide applied in 100 gal/acre water solution.

^wReduced-risk products.

^vExperimental fatty acid herbicide (Westbridge Agricultural Products, Vista, CA).

^uIron hydroxyethylene-diaminetriacetic acid.

(Envoy Plus; Valent USA, Walnut Creek, CA), carfentrazone (Shark EW; FMC, Philadelphia, PA), halosulfuron (Sedgehammer; Gowen, Yuma, AZ), and clove leaf oil (Matran; Eco-smart Technologies, Franklin, TN). On all other plots, the same products were again used, but the rate of ammoniated soap of fatty acids was doubled and the rate of iron HEDTA was applied at just over three times the rate of that used in Expt. 1. The fir bark mulch was not reapplied. All herbicides in Expt. 2 were applied 29 Aug. 2012, and plots were evaluated on 2 and 18 d after treatment (DAT). Control of the four most prevalent weed species listed above was based on percent weed damage. Plots were also visually rated for crop damage to dune sedge plants.

In the Expt. 3, all plots were mowed to 6-inch height on 20 Sept. New plots were established over the existing trial, with each new plot

consisting of three randomly chosen consecutive plots from the previous trial. The new trial consisted of three treatments with four replications and the treatments used are listed in Table 3. The herbicides used were carfentrazone + 2,4-D + mecoprop + dicamba (SpeedZone Southern; PBI/Gordon, KS City, MO), fluazifop (Fusilade II, Syngenta Crop Protection), and a combination of the two herbicides. One previously used 5 × 7-ft plot per replicate with large numbers of healthy weeds and dune sedge was evaluated after treatment. Carfentrazone + 2,4-D + mecoprop + dicamba is a broadleaf postemergent herbicide and fluazifop is a grass herbicide. Plots were sprayed on 3 Oct. and weed control and dune sedge injury were rated on 18 Oct.

The nature of the herbicides determined the type of evaluations made. Four of the treatments in Expt. 1 were preemergent herbicides and four were postemergent. In Expts. 2 and 3, all

herbicides were postemergent treatments. For preemergent treatments in Expt. 1, weed control was determined by the absence of weeds, and for all experiments, postemergence weed damage was assessed. All visual evaluations in the initial trial were made on a 0–10 basis (0 = no weed control or damage, 10 = full control and no damage). Evaluations were “blind” and not based on the untreated plots. Several evaluations were conducted for each experiment, but only data from the last evaluation date are provided (as well as 2 DAT for Expt. 2 to show the quick burn down of reduced-risk herbicides) since effects were at their maximum at that time. All dune sedge plants except those on plot edges were evaluated for phytotoxicity. In addition, dune sedge vigor was evaluated in Expt. 1 because the effect of the preemergent treatments may restrict growth of the dune sedge and may not be reflected in phytotoxicity, but in smaller, less vigorous plants. Assessed weed control and damage ratings less than 7 and dune sedge damage of more than 5 would likely be deemed economically unacceptable in all but the most remote landscape situations.

Because of the limited amount of area available for research of herbicides on dune sedge and the need to develop data on several compounds, plots from Expt. 1 were used again for Expt. 2. Sufficient weeds had grown over the 3-month period between applications, even in the preemergent herbicide plots, to allow visual damage ratings in Expt. 2. At least three healthy plants per plot of each of the four weed species documented were present; other species not documented had fewer than three plants. Expt. 3 evaluations were made on plots with healthy weed and dune sedge populations.

DATA ANALYSIS. All data on weed control, weed damage, and dune sedge damage and vigor were analyzed using analysis of variance and mean separation was conducted using Duncan's multiple range test at $P \leq 0.05$, 0.01, or 0.001.

Results

EXPT. 1. On 26 June, 33 d after applying preemergent herbicides and mulch and 19 d after postemergent herbicide applications, oryzalin, dithiopyr, experimental FA, and mulch treatments had significantly better overall

Table 2. Postemergent herbicides and rates used in Expt. 2 for weed control in a dune sedge planting. Plots were sprayed 29 Aug. 2012 after hand weeding in early Aug. 2012.

Treatment	Rate (a.i.) ^z
Clethodim ^y	0.18 oz/acre
Carfentrazone ^y	0.05 oz/acre
Halosulfuron ^y	0.75 oz/acre
Clove leaf oil ^{x,v}	10.0 gal/acre
Ammoniated soap of fatty acids ^{x,w}	4.4 gal/acre
Experimental FA ^{x,w,v}	4.7 gal/acre
20% acetic acid ^{x,w}	20.0 gal/acre
Iron HEDTA ^{x,u}	2.6 gal/acre
Wood chip mulch	2 inches deep (not reapplied)
Untreated	—

^z1 oz/acre = 70.0532 g·ha⁻¹, 1 gal/acre = 9.3540 L·ha⁻¹, 1 inch = 2.54 cm.

^yApplied in 50 gal/acre water solution; surfactant/adjuvant petroleum hydrocarbons + alkylphenol ethoxylate (Herbimax; Loveland Products, Greeley, CO) was added at 0.25 gal/acre a.i.

^xReduced-risk product applied in 100 gal/acre water solution.

^wSaponin organic wetting agent (Natural Wet; JH Biotech, Ventura, CA) was added at 0.10 gal/acre a.i.

^vExperimental fatty acid herbicide (Westbridge Agricultural Products, Vista, CA).

^uIron hydroxyethylene-diaminetriacetic acid.

Table 3. Postemergent herbicides and rates used in Expt. 3 for weed control in a dune sedge planting. Plots were sprayed 3 Oct. 2012 after mowing to 6-inch (15.2 cm) height on 20 Sept. 2012.

Treatment ^z	Rate (oz/acre a.i.) ^y
Carfentrazone + 2,4-D + mecoprop + dicamba	
Carfentrazone-ethyl	0.31
2,4-D, 2-ethylexyl ester	4.14
Mecoprop-p acid	1.60
Dicamba acid	0.40
Fluazifop-p-butyl ^x	1.2
Tank mix of the above two treatments ^y	—

^zAll products applied in 100 gal/acre water solution; 1 gal/acre = 9.3540 L·ha⁻¹.

^y1 oz/acre = 70.0532 g·ha⁻¹.

^xSurfactant/adjuvant petroleum hydrocarbons + alkylphenol ethoxylate (Herbimax; Loveland Products, Greeley, CO) was added at 0.25 gal/acre a.i.

weed control than all other treatments (Table 4). All other treatments provided economically unacceptable control. The iron HEDTA treatment had the poorest weed control, which was no different from untreated plots.

Experimental FA caused the most phytotoxicity to the dune sedge plants followed by ammoniated soap of fatty acid, with little to no damage from the other products. Experimental FA also resulted in somewhat reduced dune sedge vigor compared with other treatments.

EXPT. 2. Weed control was evaluated two times after the 29 Aug.

application date. At 2 DAT, the reduced-risk herbicides clove leaf oil, ammoniated soap of fatty acid, and experimental FA resulted in the highest damage ratings to the four weeds evaluated in this trial (Table 5). Acetic acid resulted in good control of white clover at 2 DAT, but acetic acid and iron HEDTA were less effective in controlling other weeds; iron HEDTA had almost no effect on wild oat. Clethodim and halosulfuron had little or no effect, while carfentrazone largely controlled white clover.

By 18 Sept. (20 DAT), all weeds in the reduced-risk treatments had

recovered from herbicide treatment except for vetch in the ammoniated soap of fatty acids treatment (Table 6). Other herbicides were partially to mostly effective: Clethodim on wild oat, carfentrazone on clover, and halosulfuron on filaree and vetch. All of the reduced-risk products had phytotoxic effects on the dune sedge, both at 2 and 20 DAT, except iron HEDTA.

EXPT. 3. Fluazifop-p-butyl largely controlled wild oat and carfentrazone + 2,4-D + mecoprop + dicamba provided partial control of clover and filaree and near complete control of vetch (Table 7). Combining the two products resulted in control of wild oat and broadleaf weeds similar to control of broadleaf weeds by carfentrazone + 2,4-D + mecoprop + dicamba (broadleaf herbicide) and wild oat by fluazifop (grass herbicide) alone. No phytotoxicity to the dune sedge was observed from any treatment in this experiment.

Discussion

The preemergent herbicides oryzalin and dithiopyr provided reasonably good control of most annual weeds and did not injure the dune sedge, whereas proflam and pendimethalin provided moderate to poor control. Fir bark mulch also provided relatively good control; weed growth most likely occurred because many of the bark pieces were fairly long and thin, allowing some light to reach the soil. For the postemergent reduced-risk herbicides, only experimental FA controlled most young weeds in Expt. 1, but this herbicide also damaged the dune sedge.

Weeds were somewhat larger in Expt. 2 than in Expt. 1. Reduced-risk herbicide treatments generally caused only temporary damage, as nearly all weeds began regrowing within 1–2 weeks after application, and most of these herbicides damaged the dune sedge, at least temporarily. Clethodim and carfentrazone provided partial control of wild oat and clover, respectively, and did not damage the dune sedge. Halosulfuron largely controlled filaree and vetch, and did not cause visible injury to dune sedge. Doubling the rate of ammoniated soap of fatty acids resulted in greater damage to dune sedge and no better control of weeds, and tripling the rate of iron HEDTA led to no damage to dune sedge and marginal (but temporary) improvement in weed control. The fir bark mulch, which was applied

Table 4. Overall weed control and dune sedge damage (phytotoxicity) by different herbicides and dune sedge vigor on 26 June 2012, 33 d after applying preemergent herbicides and fir bark mulch and 19 d after postemergent herbicide applications in Expt. 1.

Treatment	Weed control (0–10 scale) ^z	Dune sedge damage (0–10 scale) ^y	Dune sedge vigor (0–10 scale) ^x
Proflam	2.6 bc ^w	0.4 c	4.6 bc
Pendimethalin	4.2 b	0.1 c	6.0 ab
Oryzalin	7.6 a	0.2 c	6.4 a
Dithiopyr	8.9 a	0.4 c	5.8 bc
Ammoniated soap of fatty acids	3.5 bc	4.9 b	5.2 bc
Experimental FA ^v	7.7 a	6.2 a	3.4 c
20% acetic acid	2.2 bc	0.6 c	5.9 bc
Iron HEDTA ^u	0.0 c	0.2 c	5.3 bc
Fir bark mulch	7.1 a	0.0 c	5.3 bc
Untreated	0.0 c	0.0 c	4.9 bc
Significance level ^w	***	***	*

^z0 = no weed control or damage, 10 = complete weed control or plant death.

^y0 = no damage, 10 = plant death.

^x0 = dead, 10 = very vigorous and spreading fast.

^wMean separation (in columns) by Duncan's multiple range test; *, *** significant at $P \leq 0.05$ or 0.001, respectively.

^vExperimental fatty acid herbicide (Westbridge Agricultural Products, Vista, CA).

^uIron hydroxyethylene-diaminetriacetic acid.

Table 5. Damage to predominant weed species and dune sedge by different herbicides on 31 Aug. 2012, 2 d after treatment in Expt. 2. All plots were hand weeded in early Aug. 2012.

Treatment	Herbicide damage (0–10 scale) ^z				
	Wild oat	White clover	Broadleaf filaree	Woollypod vetch	Dune sedge
Clethodim	0.0 c ^y	0.0 c	0.0 c	0.0 c	0.1 d
Carfentrazone	0.0 c	8.4 a	3.5 b	0.2 c	0.5 d
Halosulfuron	0.0 c	0.1 c	0.1 c	0.2 c	0.1 d
Clove leaf oil	7.3 a	9.6 a	9.9 a	9.9 a	4.5 bc
Ammoniated soap of fatty acids	7.6 a	9.3 a	9.2 a	10.0 a	7.6 a
Experimental FA ^x	7.1 a	9.2 a	8.3 a	9.5 a	5.7 b
20% acetic acid	4.5 b	8.5 a	4.0 b	5.2 b	3.6 c
Iron HEDTA ^w	0.7 c	6.4 b	4.8 b	6.2 b	0.6 d
Significance level ^y	*	*	*	*	*

^z0 = no damage, 10 = plant death.

^yMean separation (in columns) by Duncan's multiple range test; *significant at $P \leq 0.05$.

^xExperimental fatty acid herbicide (Westbridge Agricultural Products, Vista, CA).

^wIron hydroxyethylene-diaminetriacetic acid.

Table 6. Damage to predominant weed species and dune sedge by different herbicides on 18 Sept. 2012, 20 d after treatment in Expt. 2. All plots were hand weeded in early Aug. 2012.

Treatment	Herbicide damage (0–10 scale) ^z				
	Wild oat	White clover	Broadleaf filaree	Woollypod vetch	Dune sedge
Clethodim	5.9 a ^y	0.0 b	0.2 c	0.0 c	0.2 d
Carfentrazone	0.0 c	6.7 a	0.0 c	0.1 c	1.5 d
Halosulfuron	0.0 c	0.1 b	7.9 a	8.1 a	0.7 d
Clove leaf oil	0.7 c	0.9 b	2.0 b	1.0 c	6.2 ab
Ammoniated soap of fatty acids	2.7 b	1.0 b	1.0 bc	10.0 a	7.5 a
Experimental FA ^x	1.0 bc	0.5 b	0.2 c	3.0 b	5.6 b
20% acetic acid	1.2 bc	0.9 b	0.5 c	0.1 c	3.9 c
Iron HEDTA ^w	0.1 c	1.1 b	0.2 c	2.7 bc	0.5 d
Significance level ^y	***	**	***	***	***

^z0 = no damage, 10 = plant death.

^yMean separation (in columns) by Duncan's multiple range test; **, *** significant at $P \leq 0.01$ or 0.001, respectively.

^xExperimental fatty acid herbicide (Westbridge Agricultural Products, Vista, CA).

^wIron hydroxyethylene-diaminetriacetic acid.

Table 7. Damage to predominant weed species by different herbicides on 18 Oct. 2012, 15 d after treatment in Expt. 3. Plots were mowed to 6-inch (15.2 cm) height on 20 Sept. 2012. No damage occurred to the dune sedge.

Treatment	Herbicide damage (0–10 scale) ^z			
	Wild oat	White clover	Broadleaf filaree	Woollypod vetch
Carfentrazone + 2,4-D + mecoprop + dicamba ^y	0.5 b ^x	6.7 a	6.5 a	9.7 a
Fluazifop-p-butyl ^w	8.0 a	0.0 b	2.0 b	0.0 b
Combination	8.0 a	6.5 a	7.2 a	9.2 a
Significance level ^x	***	***	**	***

^z0 = no damage, 10 = plant death.

^yBroadleaf herbicide with no grass activity.

^xMean separation (in columns) by Duncan's multiple range test; **, *** significant at $P \leq 0.01$ or 0.001, respectively.

^wGrass herbicide with no broadleaf activity.

only in Expt. 1, continued to provide a level of control through Expt. 2.

In Expt. 3, the postemergent herbicides fluazifop and carfentrazone + 2,4-D + mecoprop + dicamba provided moderate control of wild oat and broadleaves, respectively, and a tank mix of the two products likewise provided moderate control.

Reduced-risk herbicides, and post-emergent contact herbicides in general,

work best on broadleaf weeds and are weaker on grasses because the growing point of the grasses is at or below ground level. In some cases, the grass is small enough where the entire plant was killed. Fluazifop-p-butyl is a postemergent systemic grass-only herbicide and is not intended to control broadleaf plants. It is used to control annual and perennial grasses and there are several reports that fluazifop may suppress the growth of

filaree. Halosulfuron is intended to control yellow and purple nutsedge. It was included in this study to determine if it would cause unacceptable phytotoxicity on dune sedge. None of the herbicides used in this experiment were expected to control the regrowth of broadleaf perennial weeds such as bindweed.

The results of this series of experiments suggest that an integrated strategy might include dithiopyr, oryzalin, or a 2-inch layer of fir bark mulch shortly after planting, followed by hand weeding or treatment of weeds with carfentrazone + 2,4-D + mecoprop + dicamba tank-mixed with fluazifop.

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