2007 Lassen County Weed Research Report

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This report describes weed control experiments field tested by the Lassen County UCCE office in 2007. The report includes research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed herein have been registered. Pesticides must be registered by appropriate federal and state agencies before they can be recommended.

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The author would like to specially thank all landowners who cooperated on experiments. These cooperators donated valuable land, time, and equipment to make this research possible.

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Weed Control with Roundup and Roundup Tank-mixes in Established Roundup Ready Alfalfa

Introduction: Roundup Ready alfalfa is new technology that is currently on hold. Roundup Ready alfalfa became available to alfalfa growers in 2005, but a US District Court issued an injunction to prevent any new sales or planting of Roundup Ready alfalfa until an EIS is completed. Roundup Ready alfalfa varieties have genetic resistance to glyphosate enabling labeled glyphosate products to be applied directly over the crop for weed control. This experiment evaluated herbicide application times, glyphosate rates, and glyphosate tank-mixes for weed control in established alfalfa. We measured weed control, crop injury, and alfalfa yield at the first harvest.

Study Investigators: Rob Wilson and Wayne Edwards

Cooperator: Fred Wemple

Date and Crop Stage of Herbicide Applications: **November application**: 11/09/06, alfalfa dormant; **March application**: 3/10/07, alfalfa had 0.5 to 1.5 inch regrowth; **April application:** 4/5/07, alfalfa had 3 to 5 inch regrowth.

Plot Size and Application Method: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with four replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

Cropping Practices:
Milford Site: planted: 05/07/06 at 20 lbs/acre; pivot irrigated; sandy loam soil

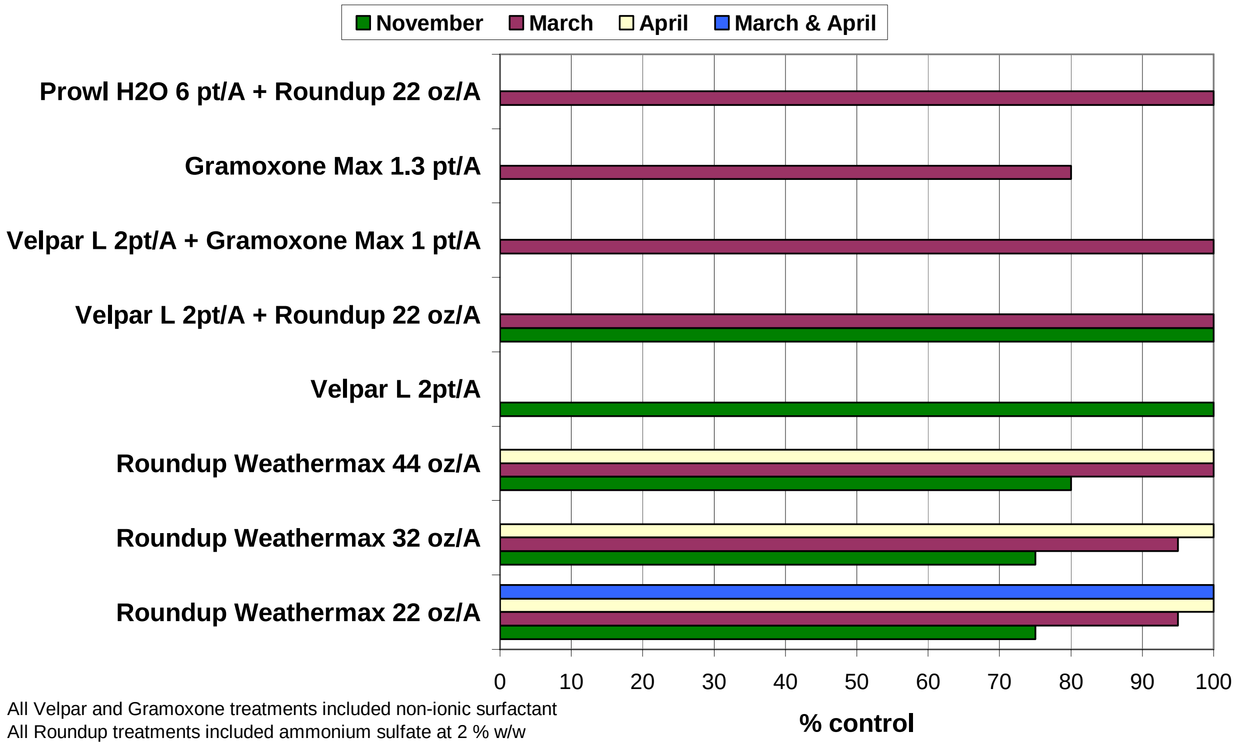
Weeds on site: lambsquarter, downy brome, and sporadic Russian thistle

Data Collected: % weed control, % alfalfa injury, and alfalfa and weed yield at first-cutting

Results: Weed control ratings showed March and April applications of Roundup Weathermax provided better downy brome control compared to November application (figure 1). Velpar and Prowl H20 + Roundup Weathermax also gave 100% downy brome control (figure 1). For early season lambsquarter control, the 44 oz/ac rate of Roundup Weathermax applied in April was the best Roundup rate and application time combination with 91% control (figure 2). The March application of Velpar + Roundup Weathermax, Velpar + Gramoxone, and Prowl H2O + Roundup Weathermax also gave over 90% control of lambsquarter (figure 2).

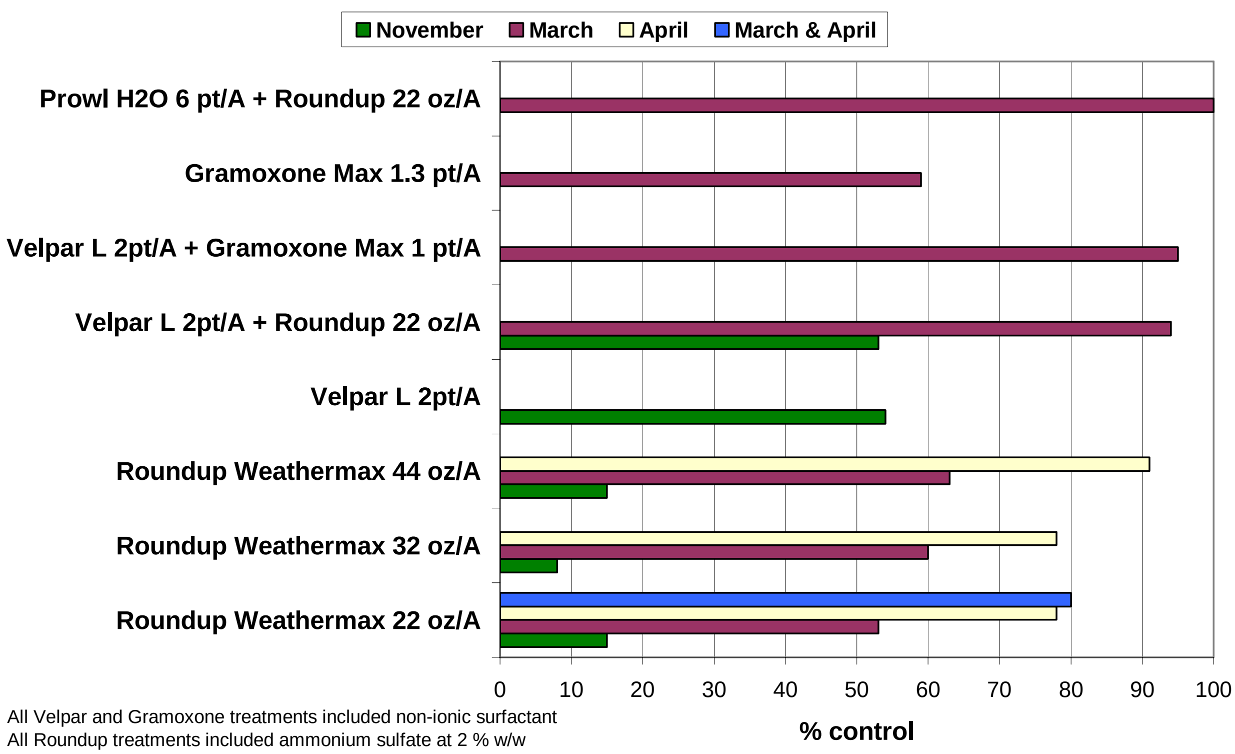
Weeds had a minimal impact on first-cutting yield in this study. The downy brome population was low throughout the study site, and downy brome biomass was only significant in untreated plots (0.12 tons per acre). The lambsquarter population was high in all plots, but lambsquarter emerged in early April and remained small and stunted through first-cutting from alfalfa competition. Although lambsquarter was suppressed by the alfalfa, several lambsquarter plants survived through first cutting and were visible above the alfalfa canopy by third cutting especially in areas with gopher activity (personal observation). Gramoxone treatments caused visual injury to the alfalfa one month after treatment, but alfalfa yield did not differ between treatments including untreated plots (figure 3). The only treatments with significant weed yield were the untreated control (0.12 tons per acre) and Gramoxone treatment (0.09 tons per acre).

Figure 1. Downy Brome Control from Herbicides Applied in November, March, and/or April in RR Alfalfa



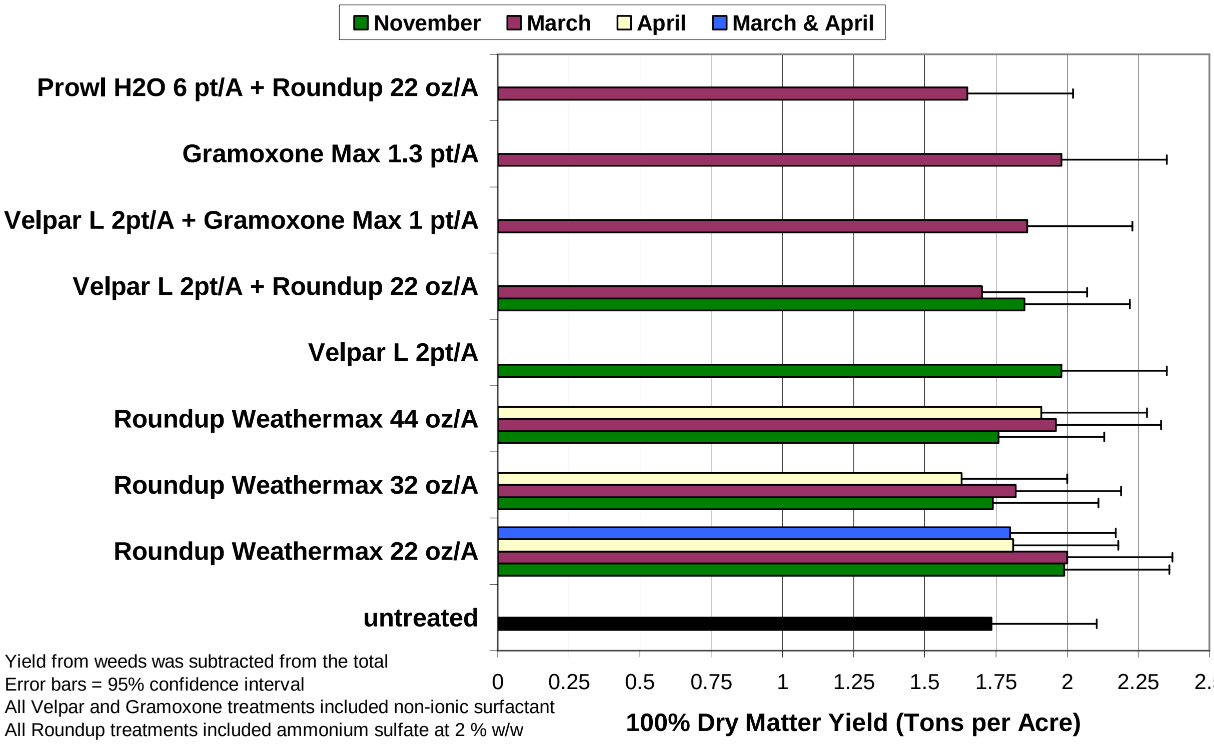
All Velpar and Gramoxone treatments included non-ionic surfactant
All Roundup treatments included ammonium sulfate at 2 % w/w

Figure 2. Lambsquarter Control from Herbicides Applied in November, March, and/or April in RR Alfalfa



All Velpar and Gramoxone treatments included non-ionic surfactant
All Roundup treatments included ammonium sulfate at 2 % w/w

Figure 3. Alfalfa Yield from Herbicides Applied in November, March, and/or April in RR Alfalfa



Yield from weeds was subtracted from the total
Error bars = 95% confidence interval
All Velpar and Gramoxone treatments included non-ionic surfactant
All Roundup treatments included ammonium sulfate at 2 % w/w

Herbicides for Selective Annual Grass Control in Big Sagebrush rangeland

Introduction: This experiment evaluated the effectiveness of herbicides for downy brome and medusahead control in big sagebrush rangeland. Matrix (rimsulfuron) is a new herbicide currently labeled for use in potatoes and tomatoes, and it is likely to be labeled in tree fruit and non-cropland shortly. The experiment evaluated weed control and herbicide safety on perennial grasses within the plots.

Study Investigators: Rob Wilson

Date of Herbicide Applications: **November (fall) application**: 11/01/06; **March (spring) application**: 3/22/07.

Plot Size and Application Method: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with three replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

Soil Type and Moisture: loam. The soil surface was dry and sub-surface was moist at the time of the fall and spring application. The site received at least 0.5 inches of precipitation within 15 days of the fall and spring application.

Plant Community Present at the Time of Application: The site was located in non-cropland heavily infested with medusahead. Vegetation was primarily medusahead and Japanese brome with scattered squirreltail, California brome, and downy brome. Medusahead was starting to emerge to 1 inch tall at the time of fall herbicide application and was 1 to 3 inches tall at the spring application. Perennial grasses were dormant at fall herbicide application and were 2 to 4 inches tall at the spring application.

Data Collected: Percent control evaluations were made when annual and perennial grasses were flowering in mid-June.

Results: Matrix has a potential fit for selective medusahead and downy brome control in Northern California. Fall applications of Matrix at rates ≥ 4 oz/A gave 100% control of medusahead and Japanese brome (figure 1). Fall applications of Landmark, Plateau, and Oust also gave near perfect control of medusahead and Japanese brome (figure 1). Fall application of Matrix gave better control than early spring applications (figure 1). Low rates of glyphosate (Roundup) ≤ 16 oz/A applied in early spring did not provide over 80% control medusahead (figure 1), but in other trials, 1 qt/A of Roundup applied in early spring gave 100% medusahead control. Matrix and Plateau showed good safety on established squirreltail and California brome (figure 2). Landmark, Oust, and Roundup at 16 oz/A caused > 50% injury to perennial grasses (figure 2).

Figure 1. The Effect of Herbicides and Application Timing on Winter Annual Grass Control on June 4, 2007 at Likely, CA

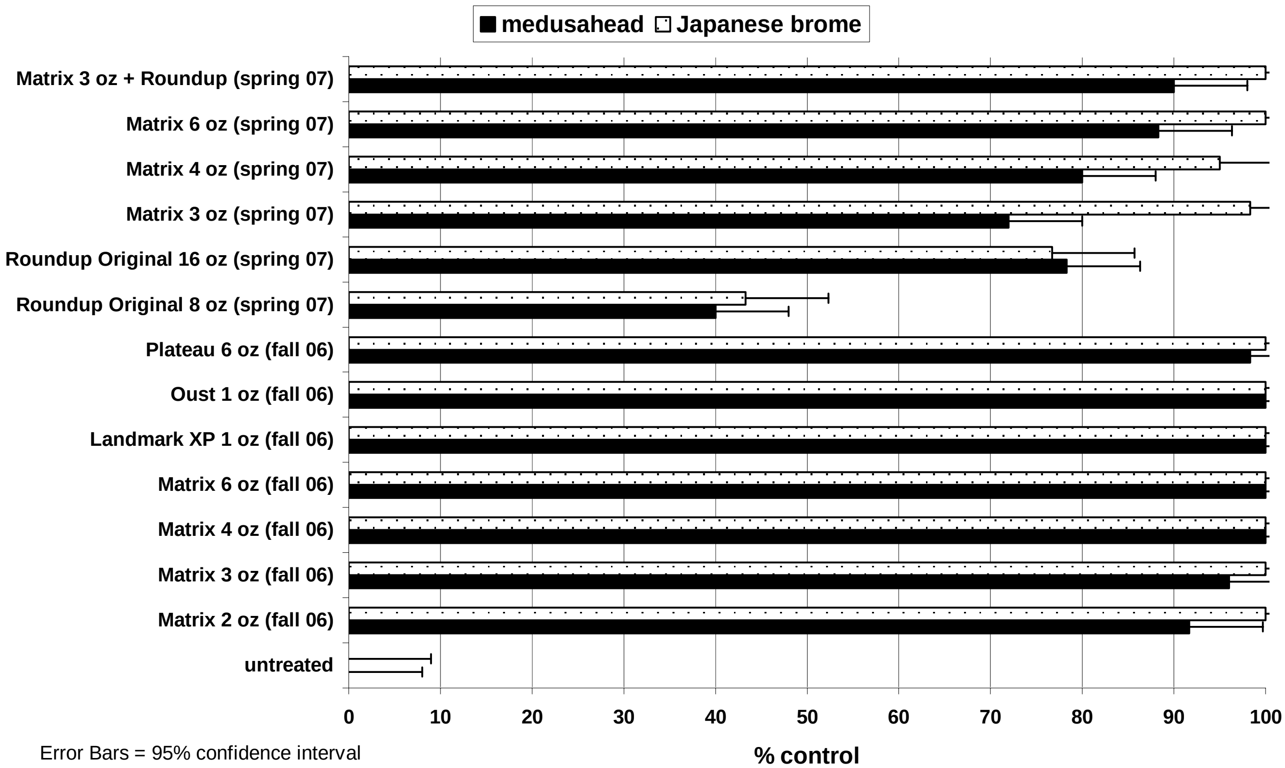
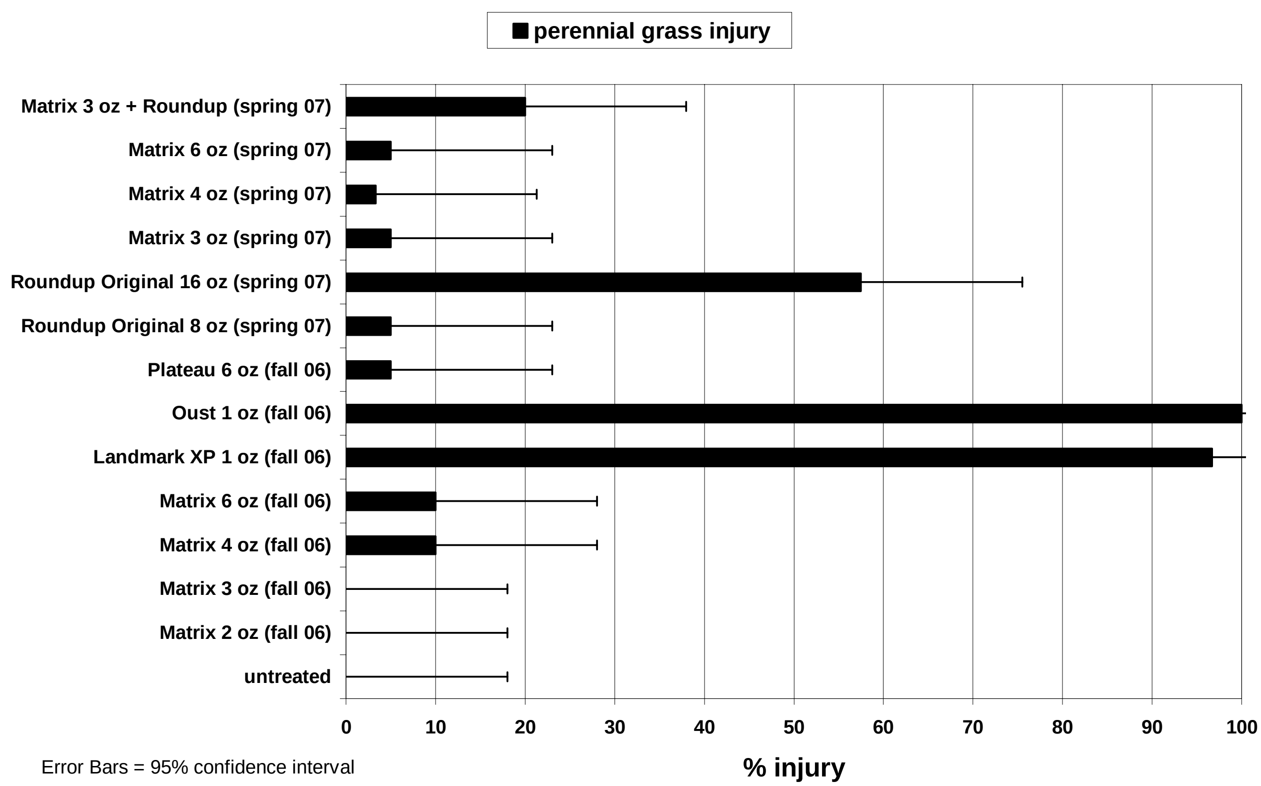


Figure 2. Perennial Grass Injury from Herbicides on June 4, 2007 at Likely, CA



The Influence of Rimsulfuron, Imazapic, and Sulfometuron + Chlorsulfuron on Perennial Grass Re-vegetation

Introduction: Recent research has demonstrated rimsulfuron (Matrix), imazapic (Plateau), and sulfometuron + chlorsulfuron (Landmark) have a potential fit for cheatgrass and medusahead control in Northeast California rangelands. Fall applications of these herbicides selectively control several winter annual grass weeds in sagebrush rangeland. Although rimsulfuron and imazapic are safe on several established perennial grasses, research is needed to determine when perennial grasses can be reseeded after herbicide application. This research study examined when native and introduced perennial grasses commonly grown in Northeast California can be re-seeded following herbicide application.

Study Investigators: Rob Wilson

Date of Herbicide Application: 01/24/07

Cooperator: IREC field station in Tulelake, CA.

Plot Design and Herbicide Application Method: The experiment was arranged in split-block with four replications. Herbicide blocks were 20 X 40 ft. Grass blocks were 5 X 20 ft. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

Soil Type and Moisture: mucky silty clay loam with high organic matter. The soil surface and sub-surface were moist at the time of herbicide application. The site received at least 0.5 inches of precipitation within 15 days of the herbicide application.

Experiment Procedures: The perennial grasses were seeded using the IREC cone-planter drill in mid-April (spring seeding) or mid-August (fall seeding). The trial was irrigated during grass establishment to assure uniform grass emergence and seedling growth. Plots were hand-weeded to prevent weed competition.

Data Collected: Visual herbicide injury on perennial grass seedlings was estimated 2, 3, and 6 months after emergence. Grass stand, grass cover, and grass height were measured 3 and 6 months after seeding. Grass yield for the spring seeding was measured in September 2007.

Results: All herbicides reduced grass cover and yield compared to the untreated control for spring seeded grasses (figures 1 and 2). Matrix at 4 oz/A and Plateau at 6 oz/A caused the least amount of injury and stunting to the spring seeded grasses (figures 1 and 2). Spring seeded grasses did not establish in the Landmark treated plots (figures 1 and 2).

Fall-seeded grasses established in several herbicide treated plots (figure 3) suggesting waiting a full growing season after herbicide application increased safety. Matrix at 4 oz/A did not cause grass injury or reduction in grass cover compared to the untreated control for all grass species (figure 3). Plateau and Matrix at 8 oz/A also did not reduce grass cover compared the untreated control for several fall-seeded grasses. Landmark at 1.5 oz/A caused significant reduction in grass cover compared to the untreated control for most fall-seeded grass species. Results collected in spring 2008 will provide an indication of the herbicides' influence on grass over-wintering success and spring yield.

Figure 1. Percent Cover of Spring-Seeded Grasses at Tulelake, CA (3 months after planting)

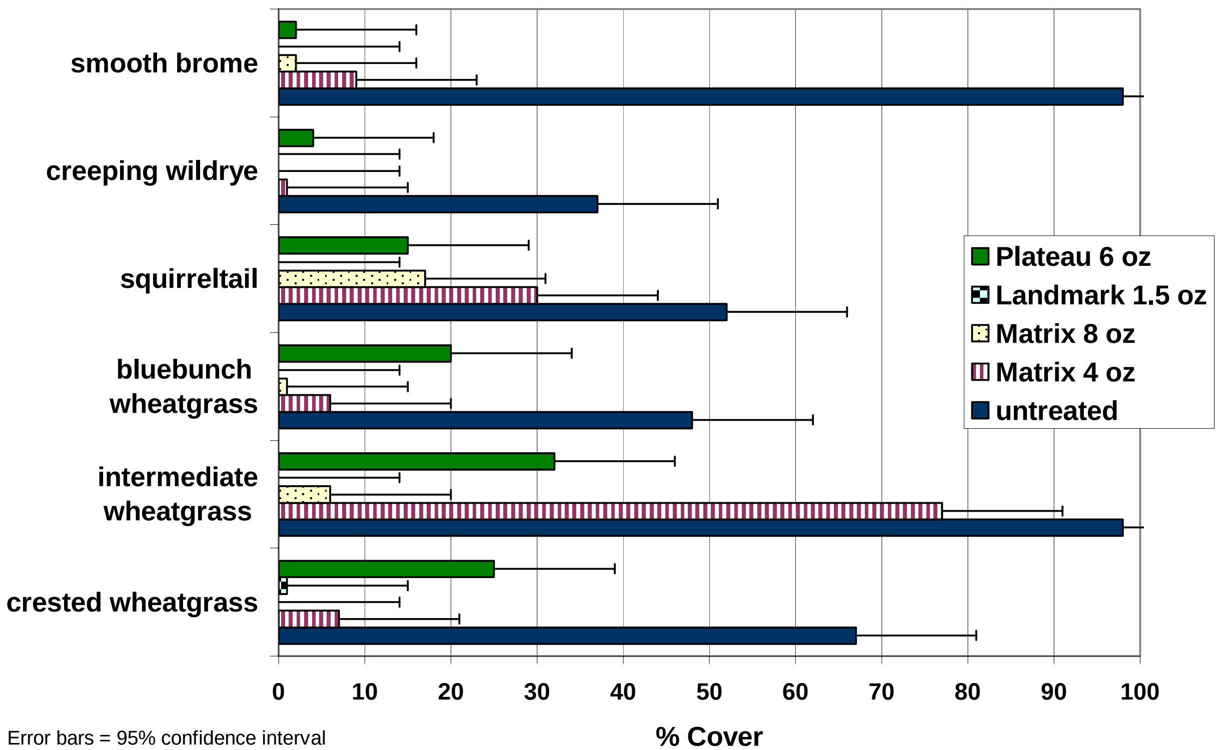


Figure 2. 100% Dry Matter Forage Yield of Spring-seeded Grasses at Tulelake, CA on 9/25/07 (1 full growing season after April planting)

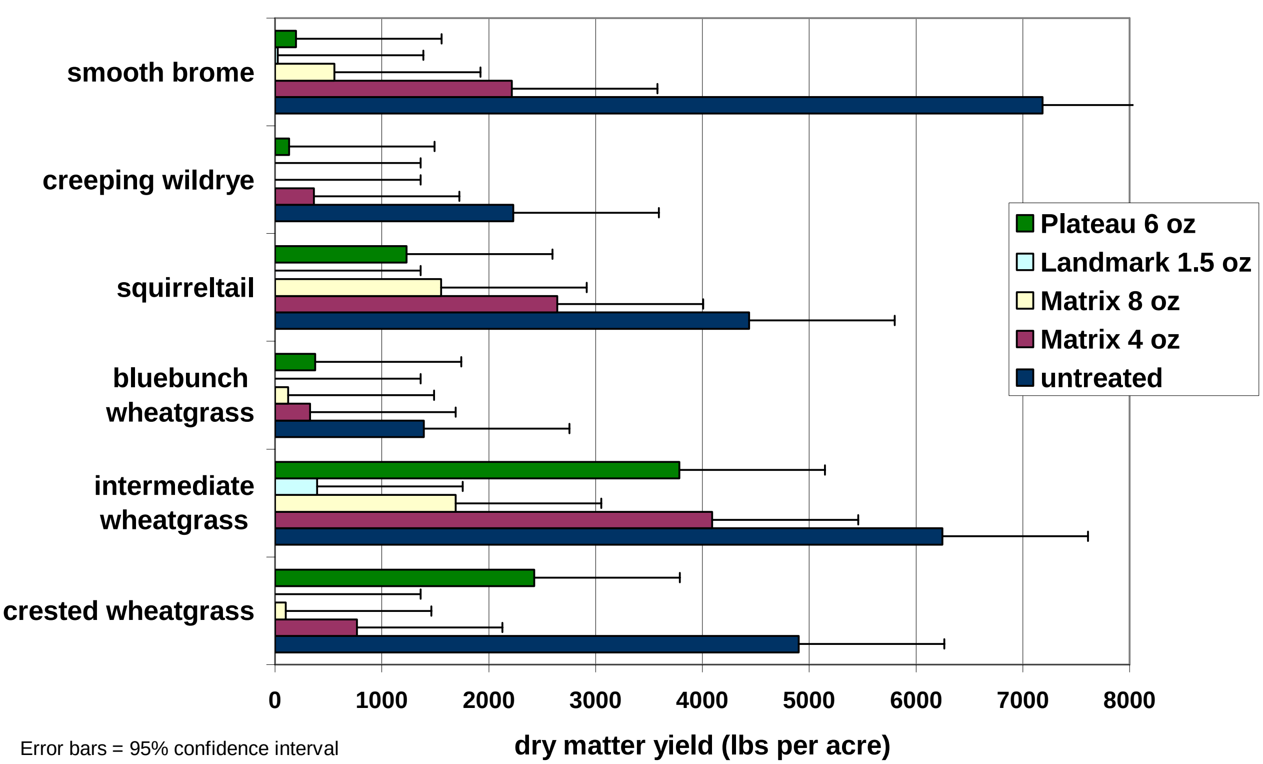
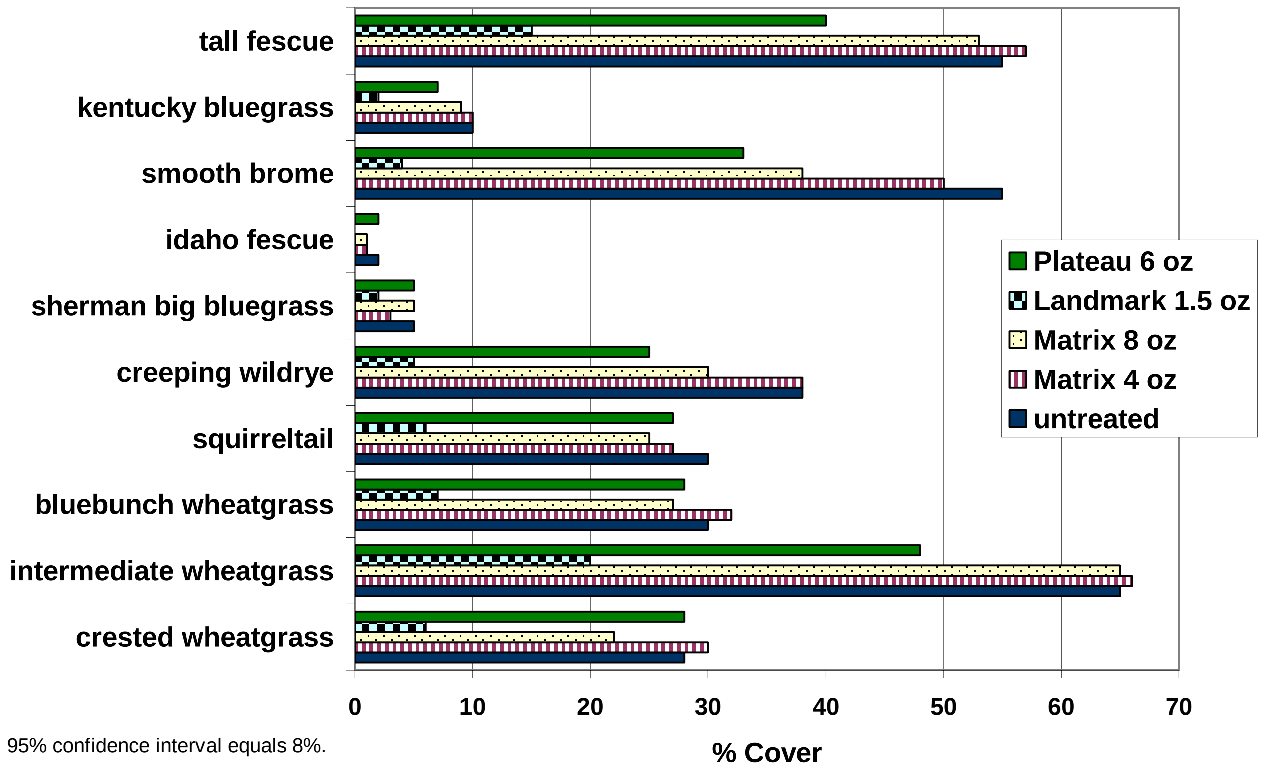


Figure 3. Percent Cover of Fall-Seeded Grasses at Tulelake, CA (2 months after planting)



95% confidence interval equals 8%.

Scotch Thistle Control with Herbicides Applied at the Rosette and Bolting Stage

Joseph DiTomaso, Guy Kyser, and Rob Wilson

In spring 2007 we established an experiment on Scotch thistle control in a dense patch in Modoc County, California. The site was located approximately 4 miles north of Canby at 41^{o} 25' 35" N, 120^{o} 47' 39" W, at 1315 m elevation on a shallow east-facing slope.

We applied 25 herbicide treatments: 15 at the rosette stage (8 May) and 10 at bolting (19 June) plus an untreated control. The main target chemical was *Milestone* (aminopyralid), a selective herbicide from Dow AgroSciences recently registered in California. This compound was compared with standards such as *Banvel* (dicamba) + 2,4-D (a tank mix recommended for Scotch thistle control in this area), *Transline* (clopyralid; the most common selective treatment for thistle control prior to registration of Milestone), and *Tordon* (picloram; an effective herbicide which is not registered in California). Another compound included was *Forefront*, a mixture of aminopyralid + 2,4-D which is not currently registered in California.

Plots were 10 by 30 ft in three replications. Applications were made with a CO_2 backpack sprayer with six 8002 nozzles, delivering a total spray solution of 20 gallons per acre. Weather at both application times was fair, high 70s to mid 80s F, with relative humidity approximately 20% and light north winds (~ 5 mph). Plants at the rosette stage were 6 to 12 inches in height and 6 to 18 inches in diameter; bolting plants were up to 4 ft tall, with young seedheads in the spiny (unopened) stage.

Visual evaluations were taken three times, 19 June (rosette treatments only), 12 July, and 21 August. In the first evaluation after treatment, plots were rated for foliage burndown. In later evaluations, plots were rated for control, both of foliage and of seedhead production. Data were analyzed using analysis of variance (ANOVA) followed by means separation with the Student-Newman-Keuls test ($\alpha = 0.05$). Data were arcsine transformed for analysis.

In rosette-stage applications, *Milestone* treatments tended to take 2 to 3 months to achieve full control. *Milestone* gave foliage control of 95% at the highest rate, 7 oz/ac. *Telar* (chlorsulfuron) alone, and all mixes with 2,4-D, gave excellent control of 95% or higher. All treatments except for low rates of Milestone gave >95% suppression of seedheads. See Table 1 on page 13 for all rosette treatment results.

None of the bolting-stage treatments gave outstanding results, although *Telar* + 2,4-D, *Banvel* + 2,4-D, and *Tordon* + 2,4-D produced control of 85 to 90%. These tank mixes also were the most effective at preventing seedhead production (90 to 95% control); however, *Telar* alone gave 88% control of seedheads. See Table 1 on page 13 for all bolting treatment results.

Table 1. Treatments and evaluation results. Values followed by the same letter are not different at the 95% confidence level. Treatments with included 0.25% Activator-90.

Treatment			Product rate, oz/acre	Active ingredient	Rate, a.i. or a.e. oz/acre	Control ratings (100% = complete control)				
						6/19	7/12		8/21	
						foliage	foliage	heads	foliage	heads
1	rosette	*Milestone*	3	aminopyralid	0.75	* 50 bc	72 abc	67 abcd	82 ab	80 ab
2	rosette	*Milestone*	5	aminopyralid	1.25	* 42 c	72 abc	75 abc	72 abc	62 bc
3	rosette	*Milestone*	7	aminopyralid	1.75	* 75 abc	91 ab	93 ab	95 a	97 a
4	rosette	*Forefront*	42	aminopyralid + 2,4-D	1.75 + 14	* 58 bc	91 a	90 ab	95 a	95 a
5	rosette	*Telar*	1	chlorsulfuron	0.75	* 48 bc	63 bc	97 ab	95 a	98 a
6	rosette	*Telar* + 2,4-D	1 + 32	chlorsulfuron + 2,4-D	0.75 + 15.2	* 83 ab	100 a	100 a	100 a	100 a
7	rosette	*Banvel* + 2,4-D	8 + 32	dicamba + 2,4-D	4 + 15.2	* 85 ab	90 a	93 ab	97 a	97 a
8	rosette	*Tordon* + 2,4-D	16 + 32	picloram + 2,4-D	2 + 15.2	* 85 ab	100 a	100 a	100 a	100 a
9	rosette	*Transline*	8	clopyralid	3	* 52 bc	91 ab	93 ab	100 a	100 a
10	bolting	*Milestone*	3	aminopyralid	0.75		* 37 a	30 cd	17 ef	0 d
11	bolting	*Milestone*	5	aminopyralid	1.25		* 40 a	30 cd	30 de	15 d
12	bolting	*Milestone*	7	aminopyralid	1.75		* 43 a	20 d	50 cd	12 d
13	bolting	*Milestone*	14	aminopyralid	3.5		* 52 a	53 bcd	73 abc	68 abc
14	bolting	*Forefront*	42	aminopyralid + 2,4-D	1.75 + 14		* 62 a	30 cd	67 ab	47 c
15	bolting	*Telar*	1	chlorsulfuron	0.75		* 32 a	67 abcd	65 ab	88 ab
16	bolting	*Telar* + 2,4-D	1 + 32	chlorsulfuron + 2,4-D	0.75 + 15.2		* 72 a	77 abc	90 a	95 a
17	bolting	*Banvel* + 2,4-D	8 + 32	dicamba + 2,4-D	4 + 15.2		* 63 a	83 ab	87 ab	90 ab
18	bolting	*Tordon* + 2,4-D	16 + 32	picloram + 2,4-D	2 + 15.2		* 72 a	67 abcd	85 ab	90 a
19	bolting	*Transline*	8	clopyralid	3		* 40 a	23 de	57 bc	27 d
20		untreated				* 0 e	0	0 e	0 f	0 d

* Rating indicates initial burndown rather than control. In the 7/12 evaluation, rosette and bolting treatments are rated and analyzed separately.

Squarrose Knapweed Control with Herbicides Applied at Rosette and Bolting Stage

Introduction: Squarrose knapweed is a common rangeland weed in Big Valley in Northeast California. This trial evaluated the efficacy of Milestone and other herbicides applied at the rosette and late bolting stage on squarrose knapweed. Land managers in Big Valley are currently using 2,4-D, Banvel, Transline, and Transline + 2,4-D to control squarrose knapweed.

Study Investigator: Rob Wilson

Cooperator: Carri Pirosko

Date of Herbicide Application: Rosette trts: 04/23/07; Bolting trts: 06/06/07

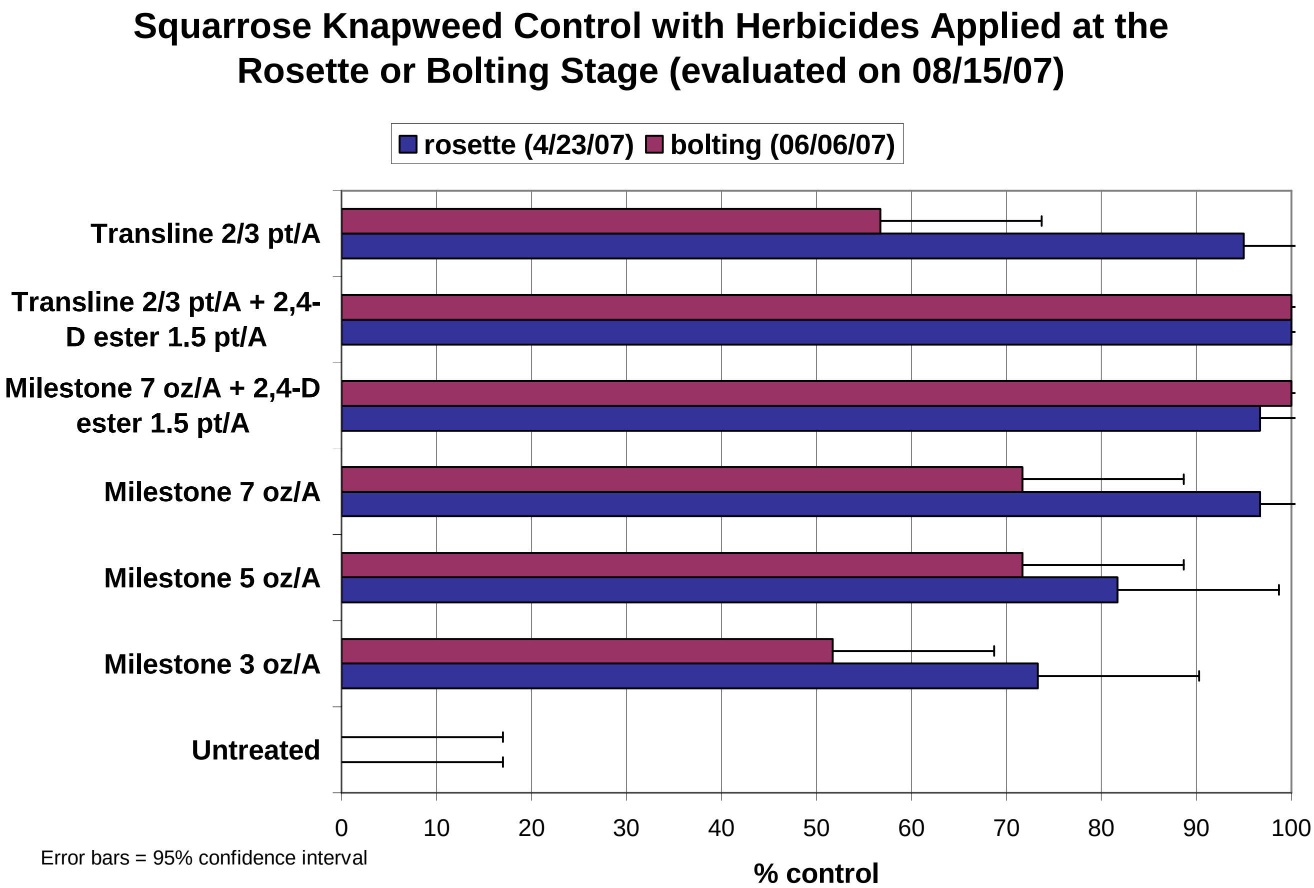
Plot Size and Application Method: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with three replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

Soil Type and Moisture: loam. The soil surface and sub-surface was moist at the time of the rosette application. The soil surface was moist and sub-surface was dry at the time of bolting application.

Plant Community Present at the Time of Application: The site was located in a horse pasture heavily infested with squarrose knapweed. Rosettes were 3 to 5 inches diameter and bolting plants were 1 to 2 ft tall with most bolting plants showing small flowerbuds. Other vegetation included downy brome, bulbous bluegrass, and sporadic sagebrush and rabbitbrush.

Data Collected: Squarrose knapweed burndown from herbicides was measured on 6/6/07 and 7/11/07, and percent control was measured on 8/14/07.

Results: The year of herbicide application Transline and Milestone applied at the rosette stage provided better control compared to applications at the bolting stage. The highest labeled rate of Transline and Milestone with or without 2,4-D provided over 90% control of squarrose knapweed when applied at the rosette stage. For treatments at bolting, 2,4-D tank-mixed with the high rate of Transline or Milestone was needed for 100% control. Transline and Milestone applied alone at bolting gave less than 75% control. Complete results are shown in the figure on page 15. Results will be collected next year to determine herbicide control one year after treatment.


Squarrose Knapweed Control with Herbicides Applied at the Rosette or Bolting Stage (evaluated on 08/15/07)
rosette (4/23/07)
bolting (06/06/07)
Transline 2/3 pt/A
Transline 2/3 pt/A + 2,4-D ester 1.5 pt/A
Milestone 7 oz/A + 2,4-D ester 1.5 pt/A
Milestone 7 oz/A
Milestone 5 oz/A
Milestone 3 oz/A
Untreated
0
10
20
30
40
50
60
70
80
90
100
% control
Error bars = 95% confidence interval

Puncturevine Control with Herbicides Applied in Early April before Weed Emergence

Introduction: Puncturevine is an increasing problem around roads, farmsteads, equipment yards, and public recreation areas. This trial investigated herbicides for providing pre-emergent season-long control of puncturevine.

Study Investigator: Rob Wilson and Steve Orloff

Cooperator: Fred Wemple

Date of Herbicide Application: Pre-emergent treatments: 4/13/07; Post-emergent treatments: 07/03/07

Plot Size and Application Method: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with three replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

Soil Type and Moisture: loamy sand. The soil surface was dry and sub-surface was moist at the time of the April application. The soil surface and sub-surface was dry at the time of post-emergent application in July. The site received less than 0.5 inches of rain two months after treatment.

Plant Community Present at the Time of Application: The site was located in a center-pivot corner currently being fallowed by the cooperator. The site was not irrigated. Puncturevine and annual bursage were the predominant weeds growing on site.

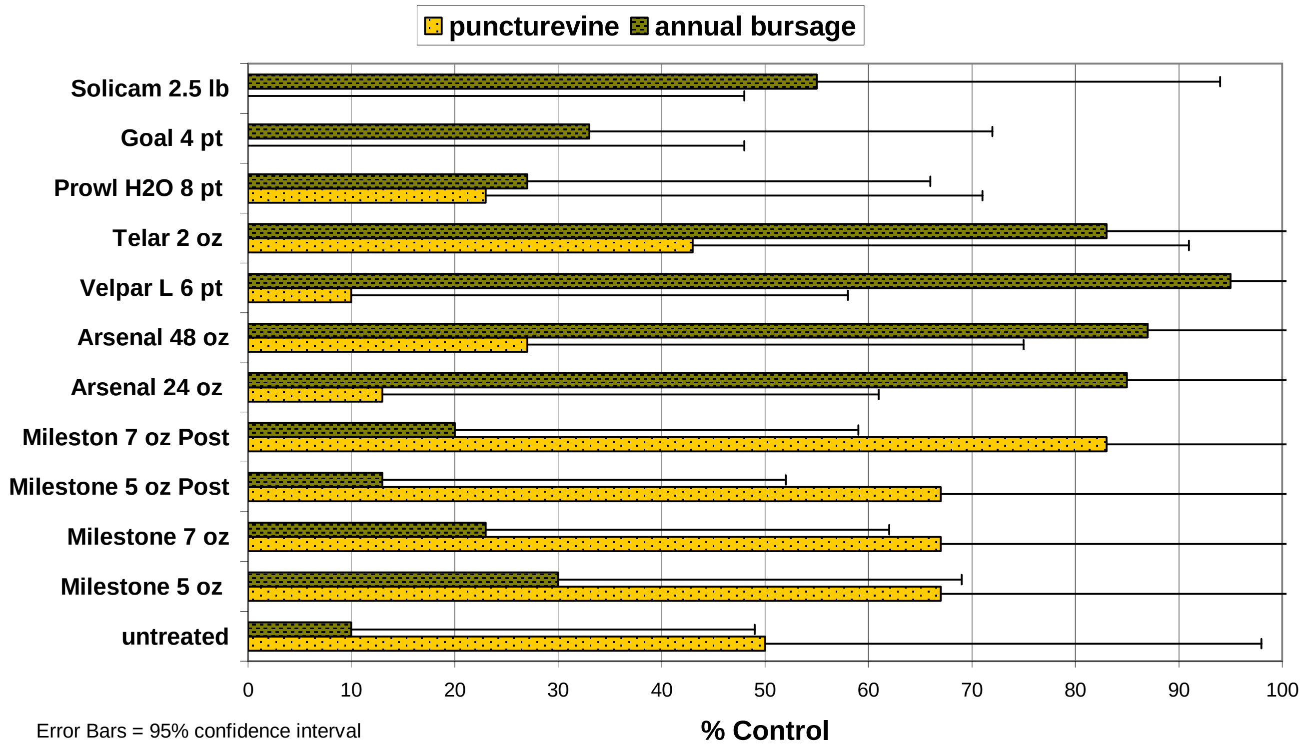
Data Collected: Visual estimates of puncturevine and annual bursage % control were made on June 12, 2007, July 3, 2007, and August 24, 2007.

Results: At the Lassen site, herbicide control of puncturevine was variable between plots, and none of the pre-emergent treatments provided over 70% control of puncturevine at the August evaluation (see figure on page 17). This variability may be due to lack of rainfall after herbicide application (less than 0.5 inch for two months after treatment) and/or the sandy soil type. Milestone at 7 oz/A applied post-emergent provided over 80% control of puncturevine, but large puncturevine plants escaped the treatment. Interestingly, puncturevine density was lower in untreated plots compared to several of the herbicide-treated plots at the August evaluation. The lower puncturevine density in untreated plots is likely due to competition from other weeds. Arsenal, Velpar, and Telar provided over 80% control of annual bursage at the Lassen site.

In the same trial conducted in Siskiyou County this year, Arsenal at 24 oz/A and Velpar L at 6 pt/A applied pre-emergent provided over 90% season-long puncturevine control, and Milestone at 7 oz/A applied pre-emergent provided over 80% season-long control (see figure on page 17).

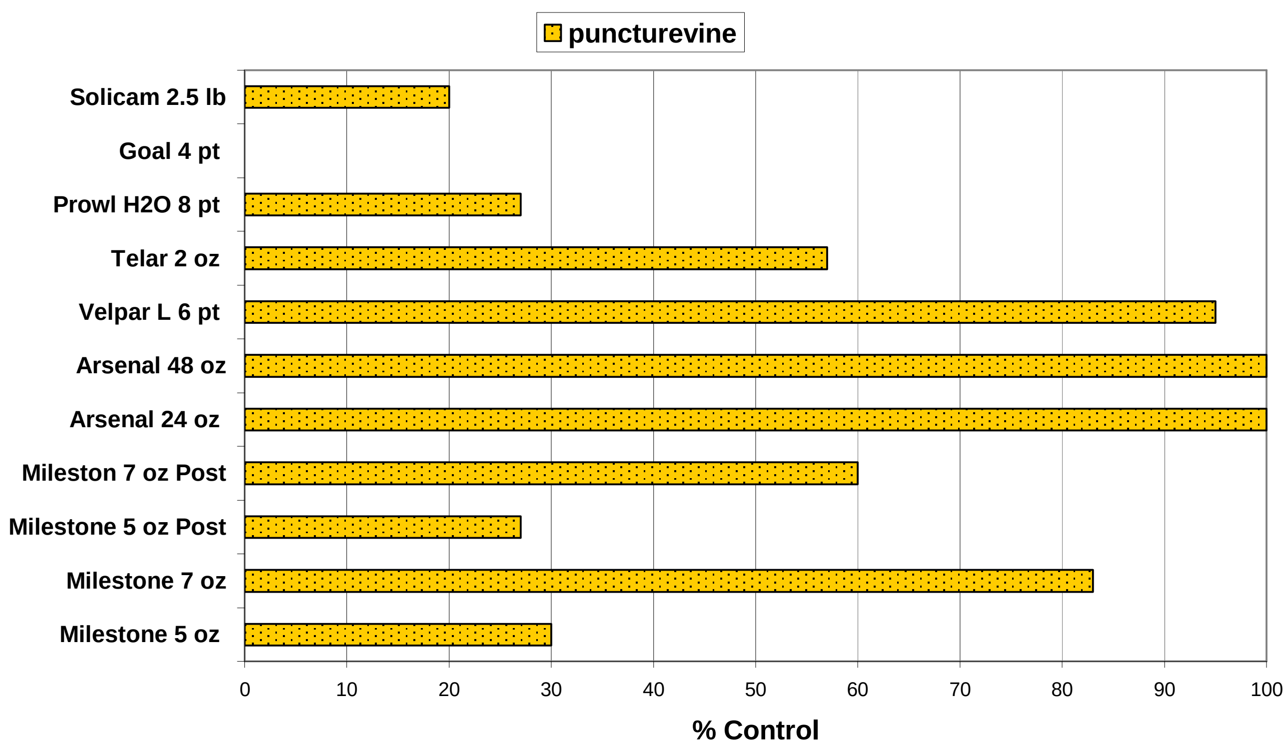
Control of Puncturevine and Annual Bursage From Herbicides Applied in Early April before Weed Emergence in Lassen County

(Milestone at 5 and 7 oz/A was also applied post-emergent in early July)



Control of Puncturevine From Herbicides Applied in Early April before Weed Emergence in Siskiyou County

(Milestone at 5 and 7 oz/A was also applied post-emergent in early July)



Integrating Herbicides and Perennial Grass Revegetation for Weed Suppression in Pasture and Non-Crop Areas

Introduction: Thousands of non-crop acres in California are infested with invasive weeds. The weeds destroy wildlife habitat, alter soil and water resources, invade cropland, decrease grazing productivity, and decrease recreation value. Weeds also commonly spread into suburban areas costing landowners thousands of dollars in management and land value loss. California managers spend millions of dollars on non-crop weed control each year, but unfortunately, most weed control efforts do not produce long-term weed suppression or increases in land productivity.

Range and wildland ecology experts suggest artificial revegetation is critical to restoring vegetation health and land-use productivity on weedy sites. Research has also demonstrated revegetation of disturbed land can greatly improve long-term weed suppression. This research project addressed the importance of revegetation in an integrated weed management program and tested re-seeding strategies for non-crop areas and pastures within Northeast California. The re-vegetation treatments were designed to maximized establishment success, minimized noxious weeds, and restored productivity of weedy sites to meet the needs of wildlife, recreation, and agriculture.

Study Investigators: Rob Wilson, UCCE Lassen County; Don Lancaster UCCE Modoc County; Steve Orloff, UCCE Siskiyou County; Harry Carlson and Don Kirby, Tulelake IREC Field Station; Joe DiTomaso, UC Davis; and Ceci Dale Cesmat & Dave Dyer, USDA-NRCS

Materials and Methods:

Specific objectives include:

- Evaluate different native and introduced perennial grass species on the basis of establishment success, vigor, and ability to prevent weed invasion.
- Determine perennial grass species' tolerance to pre and post-emergent herbicides commonly used for grass establishment.
- Assess different herbicide + grass species combinations on their ability to suppress weeds during and after grass establishment.

The experiment is being conducted at six sites. Sites in Doyle and Tulelake (IREC) were established in fall 2003. Four additional sites were established in fall 2004 at the Tulelake National Wildlife Refuge, Yreka, Likely, and Susanville. The experiment at all sites is arranged in a split block with 3 replications. Whole block treatments consist of five or six different herbicide treatments (depending on the site) applied to control weeds during establishment. The goal of herbicide treatment is to limit weed competition, prevent weed seed production, and slow vegetative spread of creeping-root perennials. The sub-block treatments consist of seeding 15 to 17 different native and introduced perennial species.

Field sites were disked and packed in late fall to control existing weeds and prepare a seedbed. Grass species were seeded around March 1st using a drill. Herbicides were applied with a CO_2 backpack sprayer or tractor-mounted sprayer at 20 GPA. Herbicide treatments were applied the year of grass seeding and one year after grass seeding.

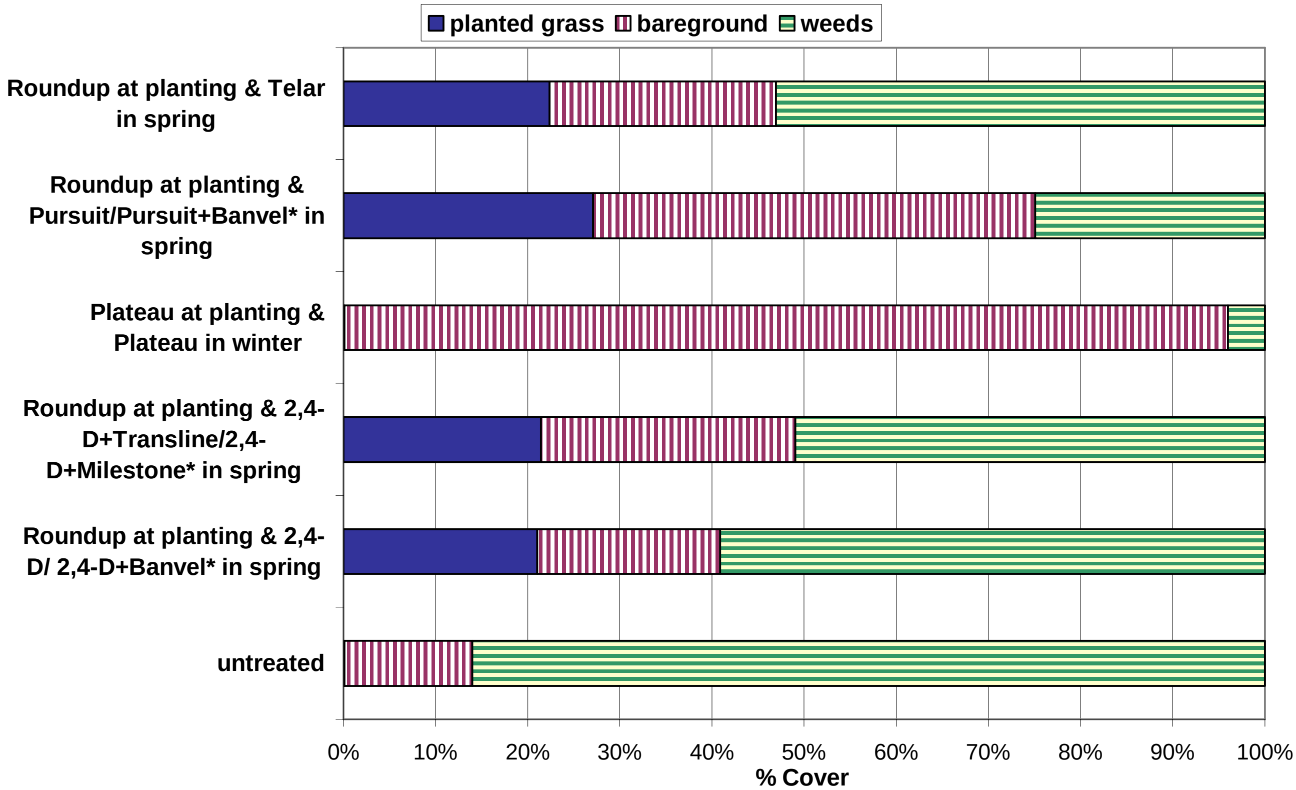
Grass species establishment and vigor was evaluated in June or July during the year of establishment (all sites) and June and August the year following establishment (for sites seeded in 2004). The percentage of drill row occupied by the seeded species, seeded grass cover, and weed species cover was measured in each plot. Data was collected using point-intercept counts and visual estimation of percent cover in 1 m^2 quadrats.

Result Summary: Several native and introduced plant species successfully established under dryland conditions on weedy sites in Northern California. At locations with heavy weed competition, herbicide treatment the year of seeding and year after seeding was critical for successful establishment. Without herbicide treatment (untreated plots), weed cover was greater than 50 % and seeded grass cover was less than 6 % at weedy sites two year after planting (figures 1, 2, and 3). In plots where herbicides gave effective weed control and grass safety, seeded grass cover was 10 to 20 fold greater than untreated plots (figures 1, 2, and 3). Telar, 2,4-D ester, Transline + 2,4-D ester, Banvel + 2,4-D ester, and Pursuit caused minimal injury to perennial grasses when applied at the 3 to 5 leaf stage during establishment. Pursuit was safe on seedling alfalfa.

Seeded grass cover differed between sites and was correlated to soil moisture. Sites with the highest soil moisture the year of seeding had the highest average grass cover. Although soil moisture increased grass cover, weed control remained the most important factor affecting species establishment success. At the site with the highest soil moisture (Tulelake Wildlife Refuge), average seeded grass cover was 5 % in untreated plots whereas it was > 50% in herbicide treated plots one year after seeding (data not shown) and 5% and > 27% respectively two year after seeding (figure 3).

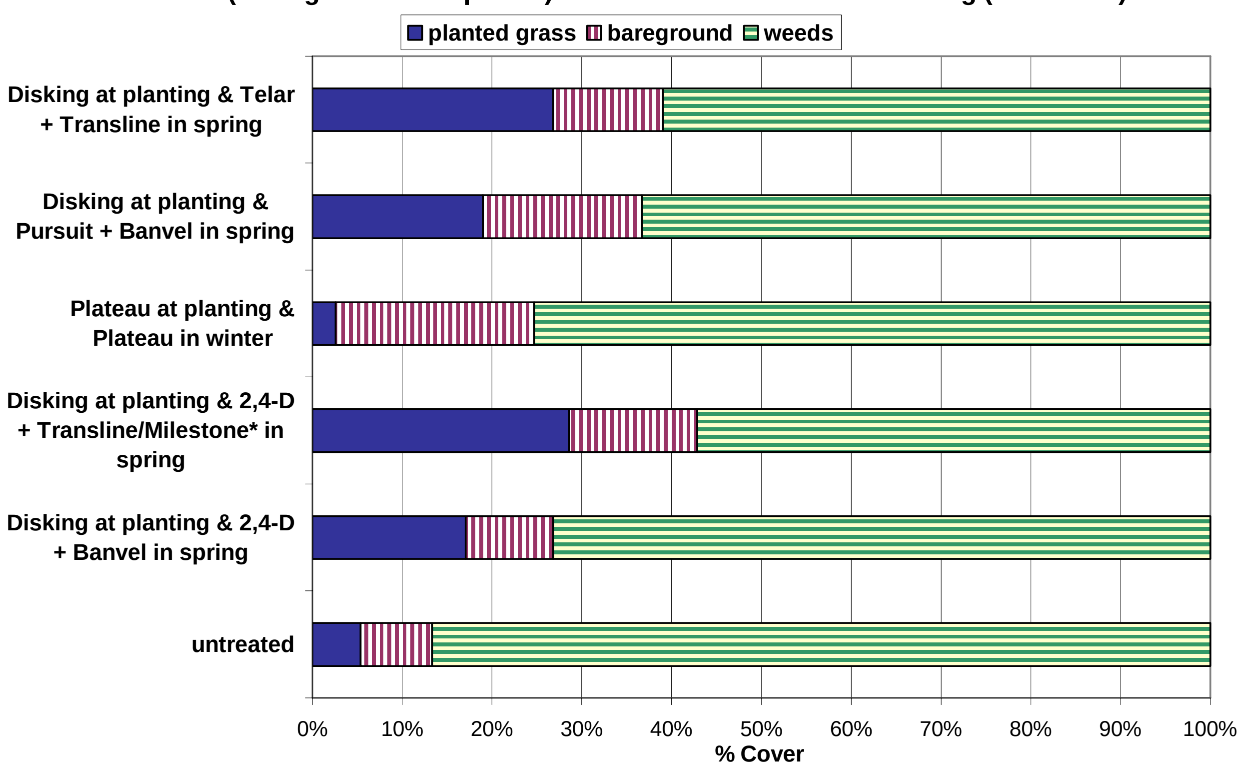
Cover measurements showed dense, perennial grass stands in combination with herbicides provided superior weed suppression compared to using herbicides alone two years after grass establishment (figures 4, 5, and 6). When comparing individual species, their establishment and persistence differed between sites (figures 4, 5, and 6). The differences were related to soil type and soil moisture trends the year of establishment and years after establishment. Likely, California was the driest site and the Tulelake Wildlife Refuge was the wettest site. Averaged across sites, crested wheatgrass, tall wheatgrass, Russian wildrye, western wheatgrass (native), bluebunch wheatgrass (native), and thickspike wheatgrass (native) had grass cover over 30% two years after seeding, and squirreltail, orchardgrass, beardless wildrye, and slender wheatgrass had grass cover below 10% two years after seeding (figure 7).

Figure 1. The Effect of Herbicides on Weeds, Bareground, and Planted Grass Cover (averaged across species) at Likely Two Years After Seeding (June 2007)



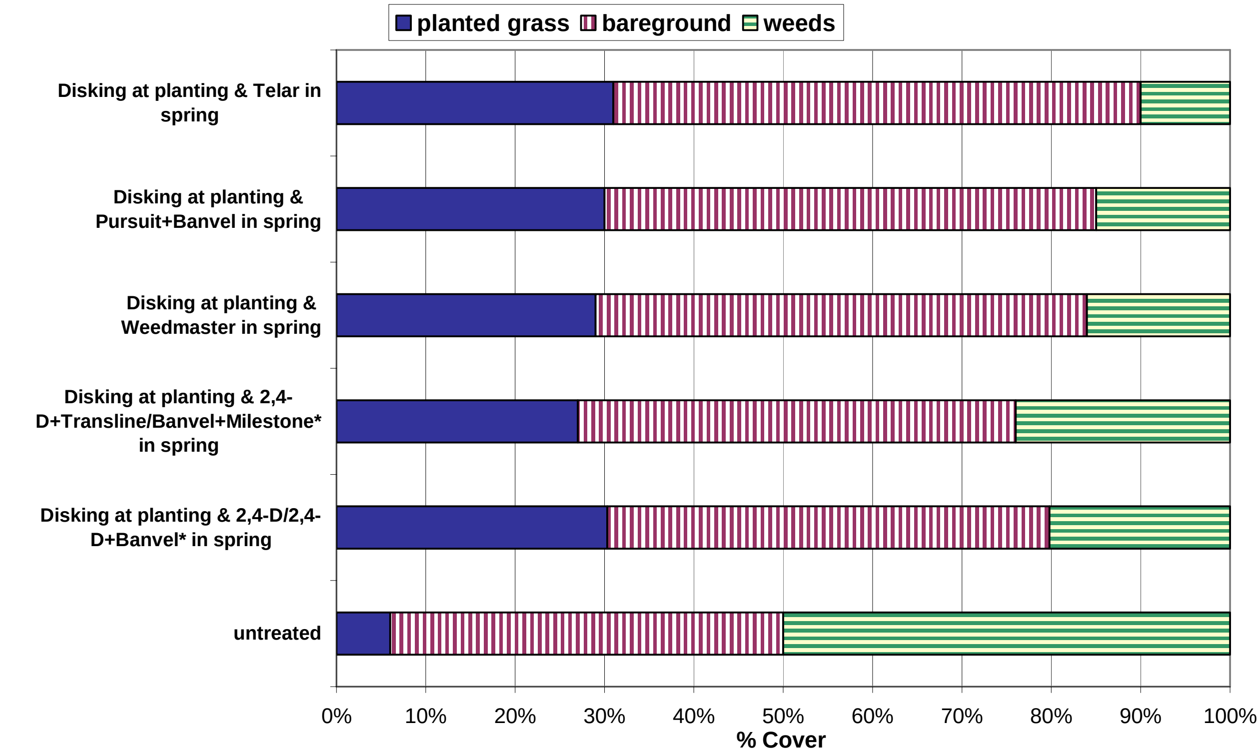
*= herbicide treatment applied the year of seeding / herbicide treatment applied the year following seeding

Figure 2. The Effect of Herbicides on Weeds, Bareground, and Planted Grass Cover (averaged across species) at Yreka Two Years After Seeding (June 2007)



*= herbicide treatment applied the year of seeding / herbicide treatment applied the year following seeding

Figure 3. The Effect of Herbicides on Weeds, Bareground, and Planted Grass Cover (averaged across species) at Tulelake Wildlife Refuge Two Years After Seeding (June 2007)



*= herbicide treatment applied the year of seeding / herbicide treatment applied the year following seeding

Figure 4. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide-treated Plots at Likely Two Years After Seeding and One Year After the Final Herbicide Application (June 2007)

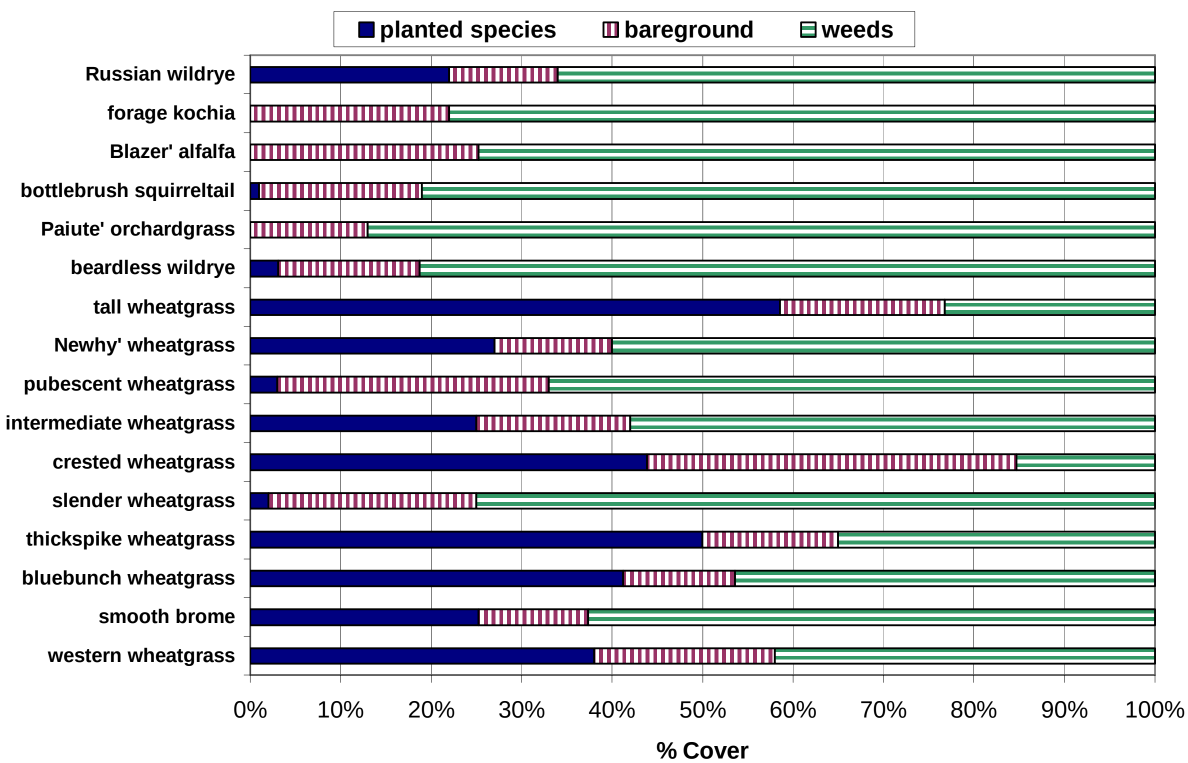


Figure 5. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide-treated Plots at Yreka Two Years After Seeding and One Year After the Final Herbicide Application (June 2007)

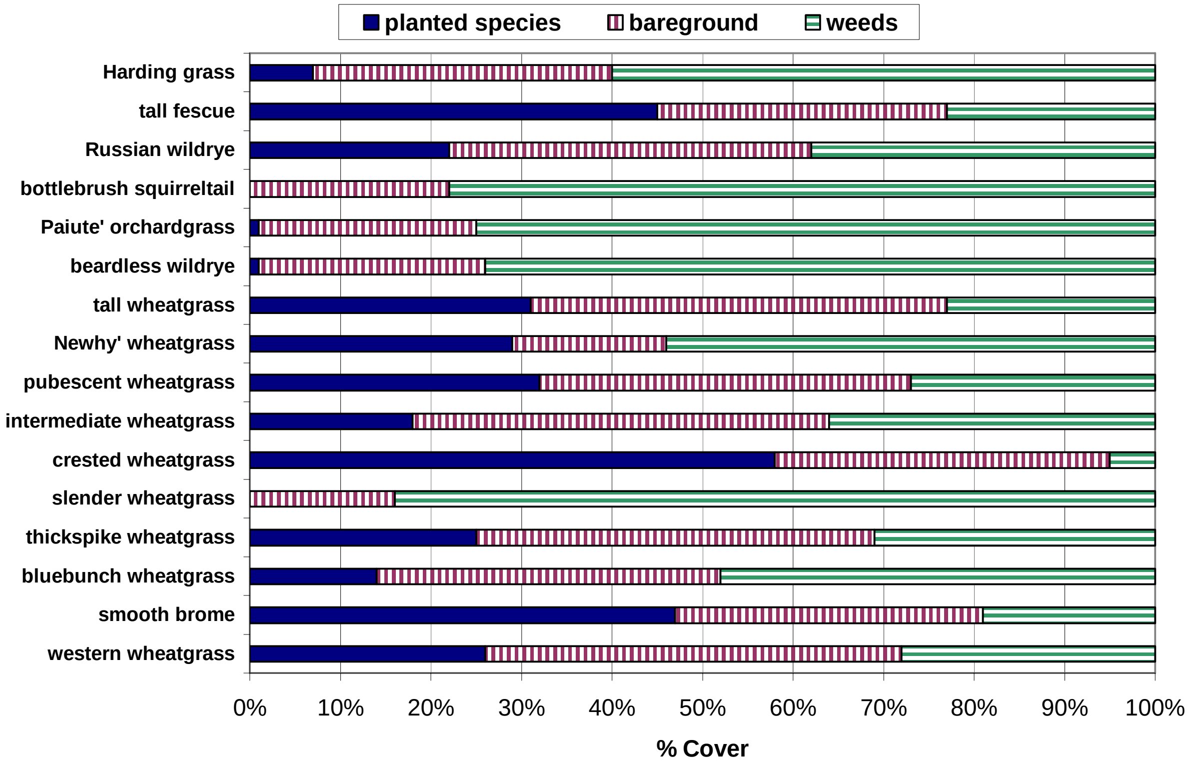


Figure 6. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide-treated Plots at Tulelake Wildlife Refuge Two Years After Seeding and One Year After the Final Herbicide Application (June 2007)

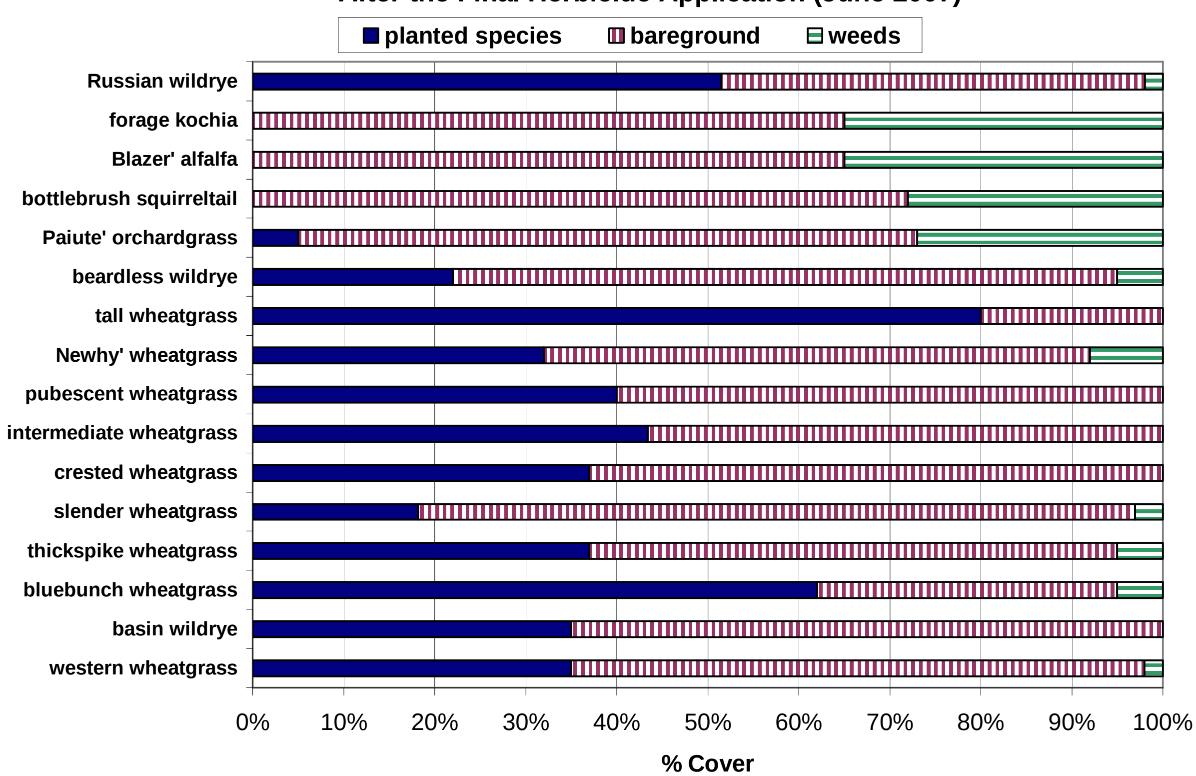
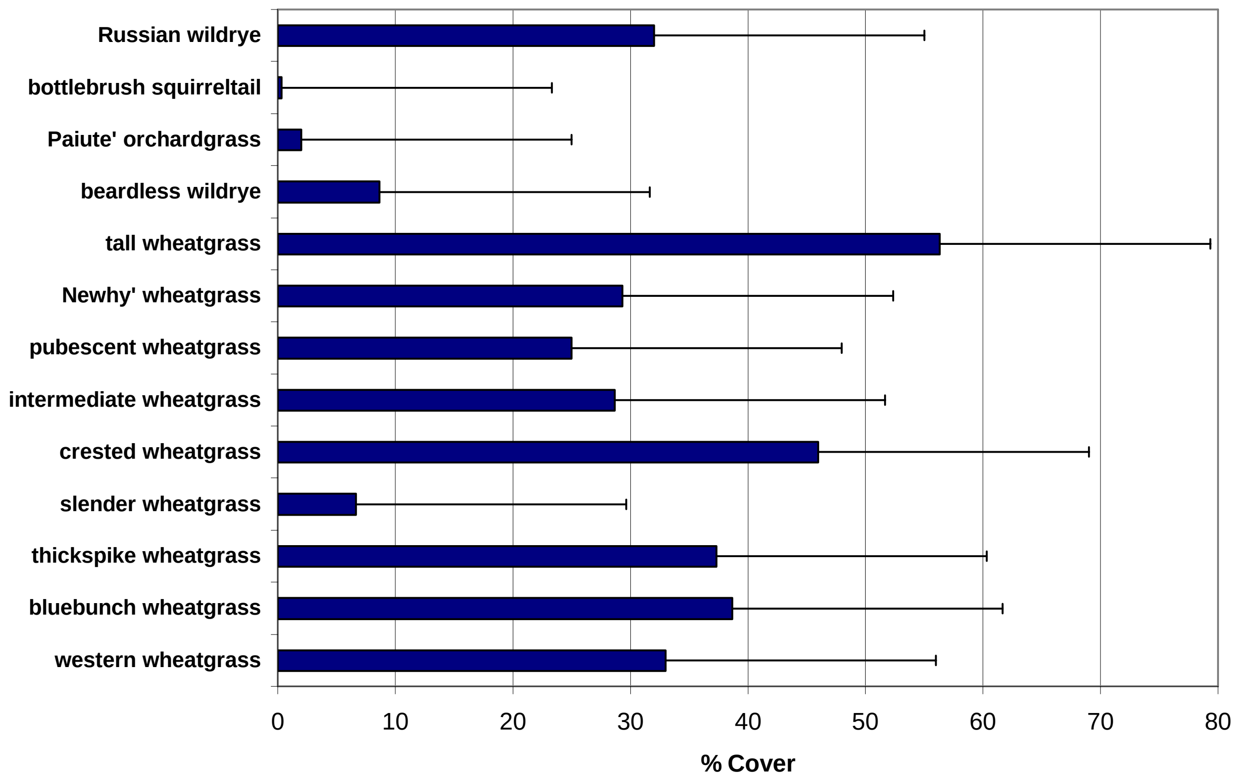


Figure 7. Percent Cover of Planted Species in Herbicide Treated Plots Averaged Across All Sites Two Years After Seeding



Error bars = 95% confidence interval

Grass Seeding in Combination with Banvel + Milestone (left) vs. Grass Seeding Without Herbicides (right) Two Years after Seeding