2005 Lassen County
Weed Research Report

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This report describes weed control experiments field tested by the Lassen County UCCE office in 2005. 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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Table of Contents

Perennial pepperweed (*Lepidium latifolium*) control with herbicides applied at different growth stages 4

Hoary cress (*Cardaria draba*) control with herbicides applied at the rosette stage 6

Summer pheasant eye (*Adonis aestivalis*) control in non-cropland and pasture 8

Weed control in established alfalfa-orchardgrass 10

Foxtail barley (*Hordeum jubatum*) control in perennial grass pasture 12

Integrated management of medusahead and restoration of degraded grassland..... 16

Native and introduced perennial grass establishment in the Intermountain region of Northern California 18

Integrated management of perennial pepperweed: combining mowing, disking, grazing, or burning with herbicides and perennial grass re-vegetation 25

Perennial Pepperweed (*Lepidium latifolium*) Control with Herbicides Applied at Different Growth Stages (Flower-bud, Post-Flower, & Re-growth Following Mowing)

Introduction: Perennial pepperweed also known as tall whitetop (*Lepidium latifolium*) is rapidly spreading throughout California. The invasive plant spreads via roots and seeds forming monoculture populations within wildlife areas, rangeland, irrigated cropland, and waste areas. This trial examined several herbicides applied at the flower-bud or post-flower growth stage to determine the best application time/herbicide combination for perennial pepperweed control. A portion of the plot area was mowed in early June (at flowering) to examine herbicides applied to re-growth following mowing.

Study Investigators: Rob Wilson and Mark Renz

Cooperator: CDFG Honey Lake Wildlife area

Date and Time of Herbicide Applications:
Flower-bud application- June 02, 2004 at 10:00 am; Temperature 73 degrees F
Post-flower application- August 26, 2004 at 11:00 am; Temperature 76 degrees F
Application to re-growth following mowing- August 26, 2004 at 11:00 am; Temperature 76 degrees F

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.

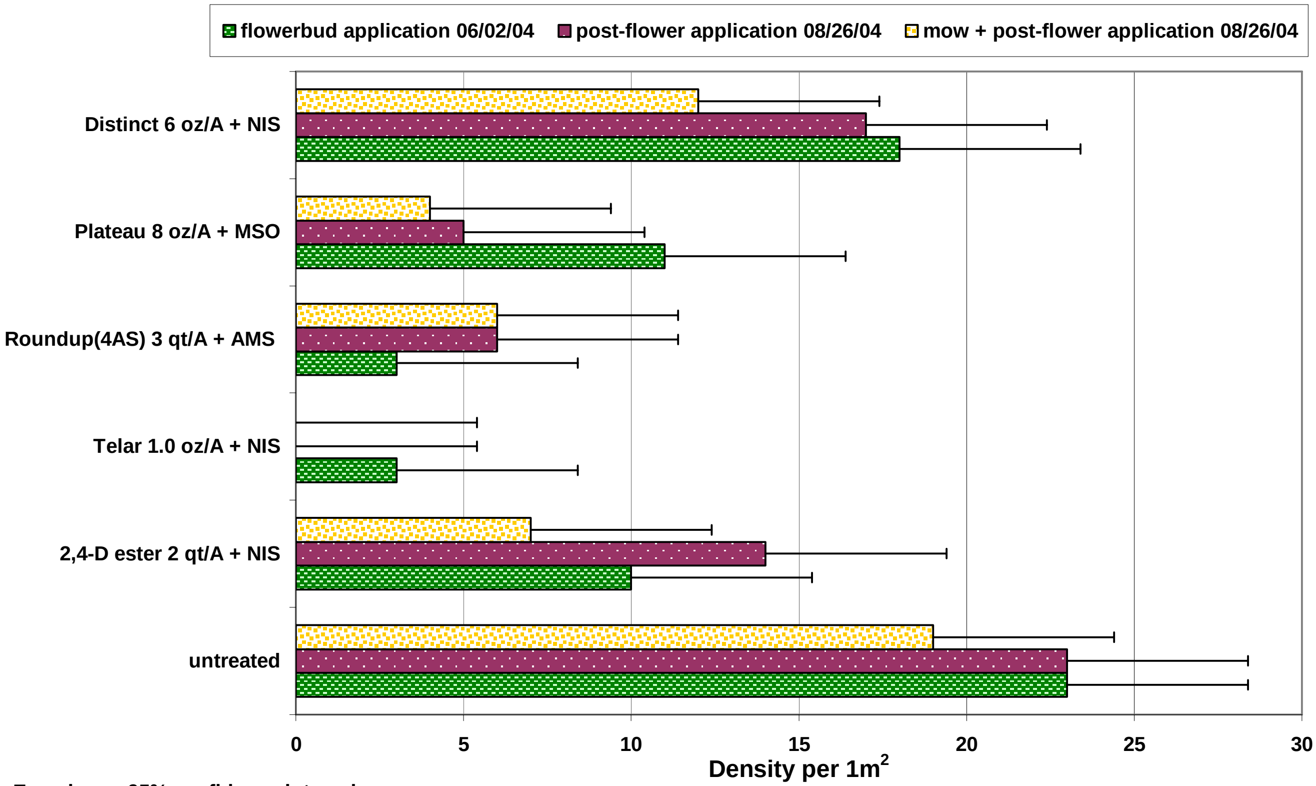
Weather, Precipitation, and Soil Type/Moisture: The study site historically receives around 6 to 8 inches of precipitation a year; the soil is a clay loam. The soil surface was dry and sub-surface was moist at the time of the flower-bud application. The soil surface and sub-surface were dry at the time of the post-flower application.

Plant Community Present at the Time of Application: All replications consisted of solid mono-culture of perennial pepperweed.

Data Collected: Evaluations were made in three 1 m^2 quadrats in each plot to determine herbicide effects on perennial pepperweed. Perennial pepperweed shoot density and cover were measured on June 15, 2005 (1 Year After Treatment- 1YAT).

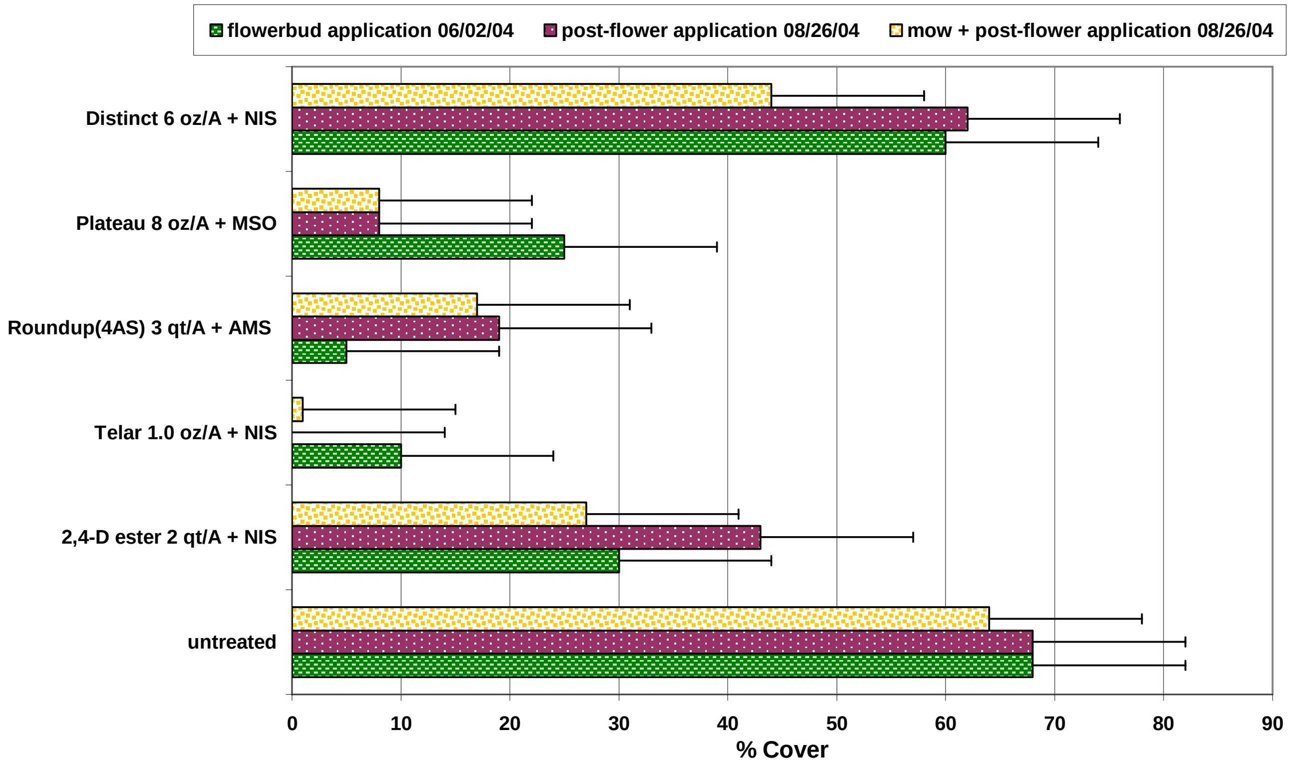
Results: Telar, 2,4-D ester, Roundup, and Plateau applied at all growth stages significantly reduced perennial pepperweed density and cover compared to untreated plots 1 YAT (Figure 1 and Figure 2). Telar at 1.0 oz/A provided the best control of any herbicide tested and reduced perennial pepperweed density and cover by more than 85% compared to untreated plots at all application times. Roundup (4AS) at 3.0 qt/A applied at the flower-bud stage reduced perennial pepperweed density more than 80% compared to untreated plots, whereas 2,4-D ester at 2.0 qt/A at the flower-bud stage reduced density by 57%. 2,4-D ester gave the best control when applied at the flower-bud stage or to re-growth following mowing. Plateau at 8.0 oz/A gave the best control applied in late summer at the post-flower stage or to re-growth following mowing.

Figure 1. The Effect of Herbicides on Perennial Pepperweed Density at Susanville June 2005 (1 year after treatment)



Error bars= 95% confidence interval
NIS = R-11 at 0.25 % v/v; AMS = ammonium sulfate at 10lb/100 gallon; MSO = methylated seed oil at 1 pt/A

Figure 2. The Effect of Herbicides on Perennial Pepperweed Cover at Susanville June 2005 (1 year after treatment)



Error bars= 95% confidence interval
NIS=R-11 at 0.25 % v/v; AMS=ammonium sulfate at 10lb/100 gallon; MSO= methylated seed oil at 1 pt/A

Hoary Cress (*Cardaria draba*) Control in Non-cropland and Pasture

Introduction: Hoary cress or whitetop (*Cardia draba*) is an increasing weed problem in small grains, alfalfa, and non-cropland in Northeast California. The deep-rooted creeping perennial forms dense patches and is difficult to control with herbicides. Populations spread rapidly following cultivation and restrict crop choices in infested fields. This trial examined several herbicides applied at the rosette stage for suppressing hoary cress in small grains, alfalfa, and non-cropland. Herbicide application at flowering is the most effective treatment time, but applications at the rosette stage are common for treating hoary cress in alfalfa and small grains.

Study Investigator: Rob Wilson

Cooperator: Brian Dahle

Date and Time of Herbicide Application: **2004 Rosette application**- March 24, 2004 at 2:00 pm; Temperature 65°F.

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.

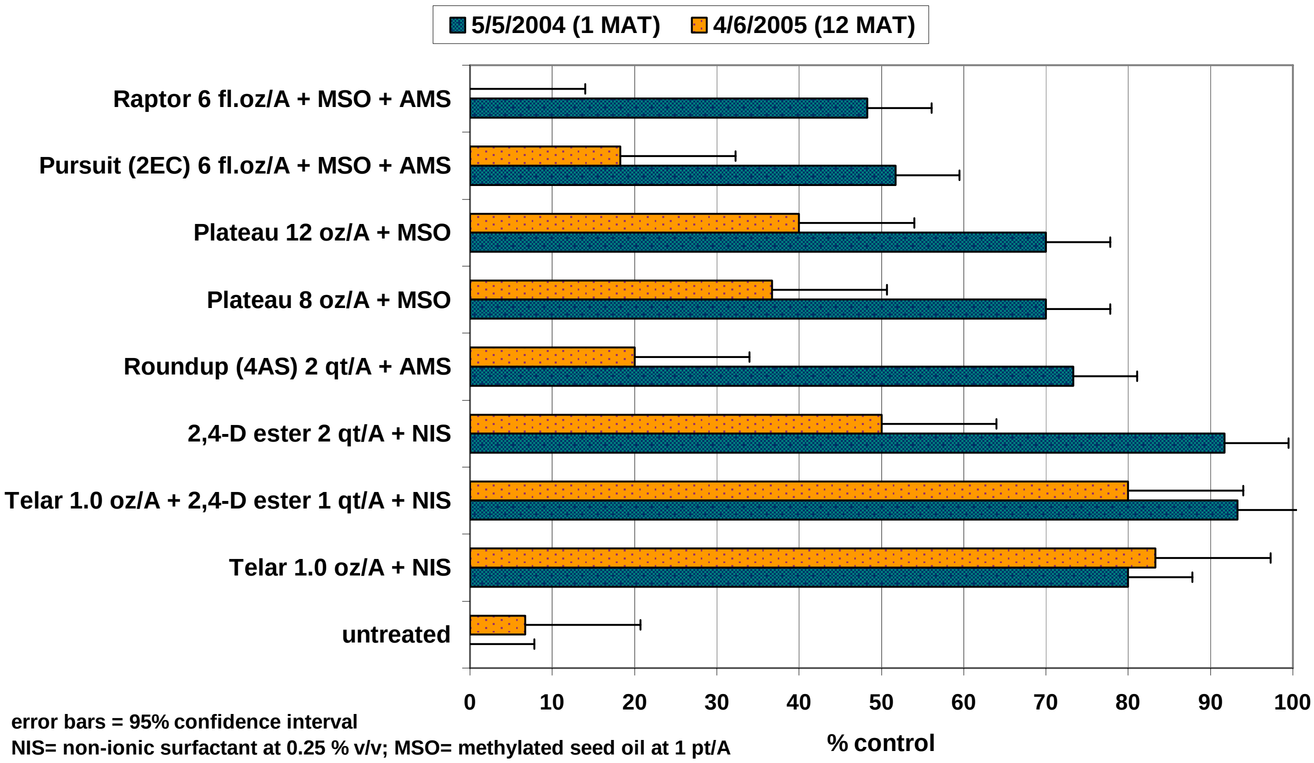
Soil Type and Moisture: clay loam. The soil surface and sub-surface were moist at the time of the application. The site had received fly ash soil amendments for a couple years prior to treatment.

Plant Community Present at the Time of Application: The site was located in non-cropland heavily infested with hoary cress. The site had been disked the year before herbicide treatment. Other vegetation included medusahead, downy brome, and bulbous bluegrass. Hoary cress rosette diameters ranged from 2 to 4 inches at the time of herbicide application.

Data Collected: Percent control evaluations were made on May 5, 2004 and April 6, 2005.

Results: Telar at 1.0 oz/A and Telar at 1.0 oz/A + 2,4-D ester (4SC) at 1.0 qt/A were the best non-crop or grass pasture treatments providing over 80% hoary cress control 12 months after treatment (12 MAT). For control in small grains, 2,4-D ester at 2.0 qt/A appears an effective treatment providing over 90% control 1 MAT and 50% control 1 YAT. For control in alfalfa, pursuit or raptor gave between 40% to 50% control 1 MAT, but hoary cress density rebounded to pre-treatment levels 1 YAT. Roundup Ready alfalfa is the best hope for hoary cress control in alfalfa.

Hoary cress (short whitetop) Control with Herbicides Applied on 03/24/04 at the Rosette Stage



error bars = 95% confidence interval
NIS= non-ionic surfactant at 0.25 % v/v; MSO= methylated seed oil at 1 pt/A
AMS= ammonium sulfate at 10 lb/100 gal

Summer Pheasant Eye (*Adonis aestivalis*) Control

Introduction: Summer pheasant eye (*Adonis aestivalis*) is a poisonous plant that has recently been attributed to livestock poisonings from feeding contaminated hay. The summer annual weed grows primarily in non-crop areas, but it has been found in pasture and small grains. This trial evaluated herbicide efficacy on summer pheasant eye using products commonly used in pasture and non-cropland.

Study Investigators: Rob Wilson, Don Lancaster UCCE Modoc County, and Kate Haas, Modoc County Ag. Department

Date and Time of Herbicide Application: May 25, 2005 at 11:00 pm; Temperature 80°F.

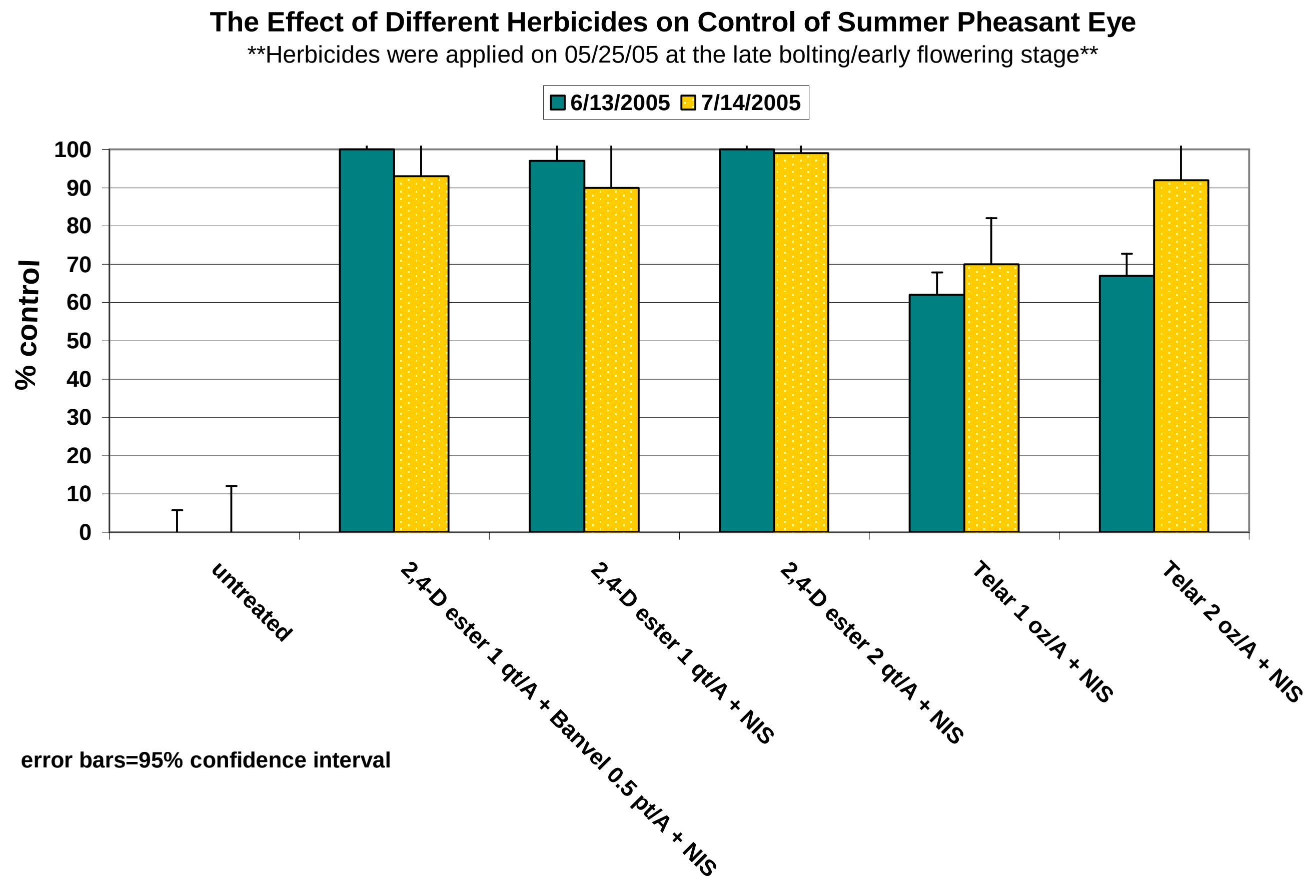
Plot Size and Application Method: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with three replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

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

Plant Community Present at the Time of Application: The site was located along highway 299 near Canby, CA. Roadside vegetation consisted of perennial and annual grasses, poison hemlock, and a heavy infestation of summer pheasant eye. The summer pheasant eye was in the bolting to early flowering stage at the time of the herbicide application.

Data Collected: Percent control evaluations were made on June 13, 2005 and July 13, 2005.

Results: 2,4-D ester at 1.0 or 2.0 qt/A, 2,4-D ester at 1.0 qt/A + Banvel at 0.5 pt/A, and Telar at 2.0 oz/A provided over 90% control of summer pheasant eye one month after treatment. Telar at 1.0 oz/A caused considerable stunting and chlorosis, but several plants outgrew the treatment. Next year, plots will be evaluated to determine if Telar has pre-emergent activity on summer pheasant eye and examine control one year after treatment. Additional herbicide treatments will be applied in 2006 to evaluate herbicide control at the rosette and bolting stage.


The Effect of Different Herbicides on Control of Summer Pheasant Eye
Herbicides were applied on 05/25/05 at the late bolting/early flowering stage
6/13/2005
7/14/2005
% control
100
90
80
70
60
50
40
30
20
10
0
untreated
2,4-D ester 1 qt/A + Banvel 0.5 pt/A + NIS
2,4-D ester 1 qt/A + NIS
2,4-D ester 2 qt/A + NIS
Telar 1 oz/A + NIS
Telar 2 oz/A + NIS
error bars=95% confidence interval

Weed Control in Established Alfalfa-Orchardgrass

Introduction: Alfalfa-grass has become a popular hay crop due to increased demand from horse owners. Although alfalfa-grass mixtures are relatively weed resistant, winter annual and perennial weeds can infest fields causing reduction in forage quality and price. Weeds in alfalfa-grass are difficult to control due to a lack of herbicide choice. This experiment examined potential herbicide options for early spring weed control in alfalfa-orchardgrass. The same experiment was conducted in 2004 at multiple locations in Lassen and Siskiyou counties. Most herbicides used in this experiment are not labeled in California for use in alfalfa-grass forage.

Study Investigators: Rob Wilson and Steve Orloff, UCCE Siskiyou County

Cooperator: Tim and Luke Garrod

Date and Time of Herbicide Application: **Fall treatments**- October 22, 2004 at 10:00 am; Temperature 50°F. **Late Winter treatments**- March 3, 2005 at 9:00 am; Temperature 46°F.

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.

Soil Type/Moisture: Sandy loam. The soil surface was dry and sub-surface was wet at the time of application.

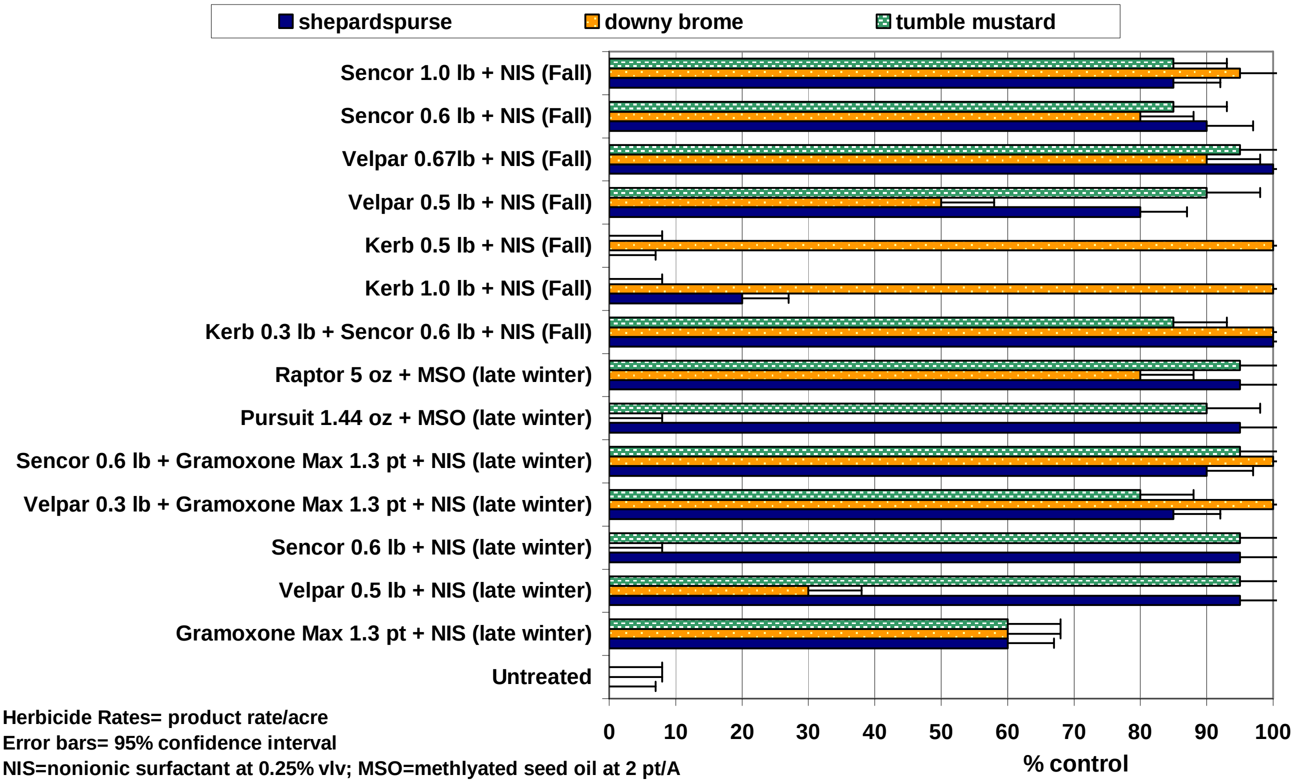
Weed Species Present at Time of Application: **Fall treatments-** downy brome- less than 1 inch tall; dandelion- rosette 1 inch diameter. **Spring treatments-** shepardspurse- rosette 1 inch diameter; downy brome- tillered 1-2 inch tall; tumble mustard- rosette 0.5-1 inch diameter; dandelion- rosette 1-2 inch diameter; prickly lettuce- rosettes 1 inch diameter.

Crop Stage: **Fall treatments-** alfalfa and orchardgrass were dormant; **Spring treatments-** alfalfa- green with 0.5 inch regrowth; orchardgrass- green with 1-2 inch regrowth.

Data Collected: Percent weed control and crop injury was measured on April 1, 2005 and April 27, 2005.

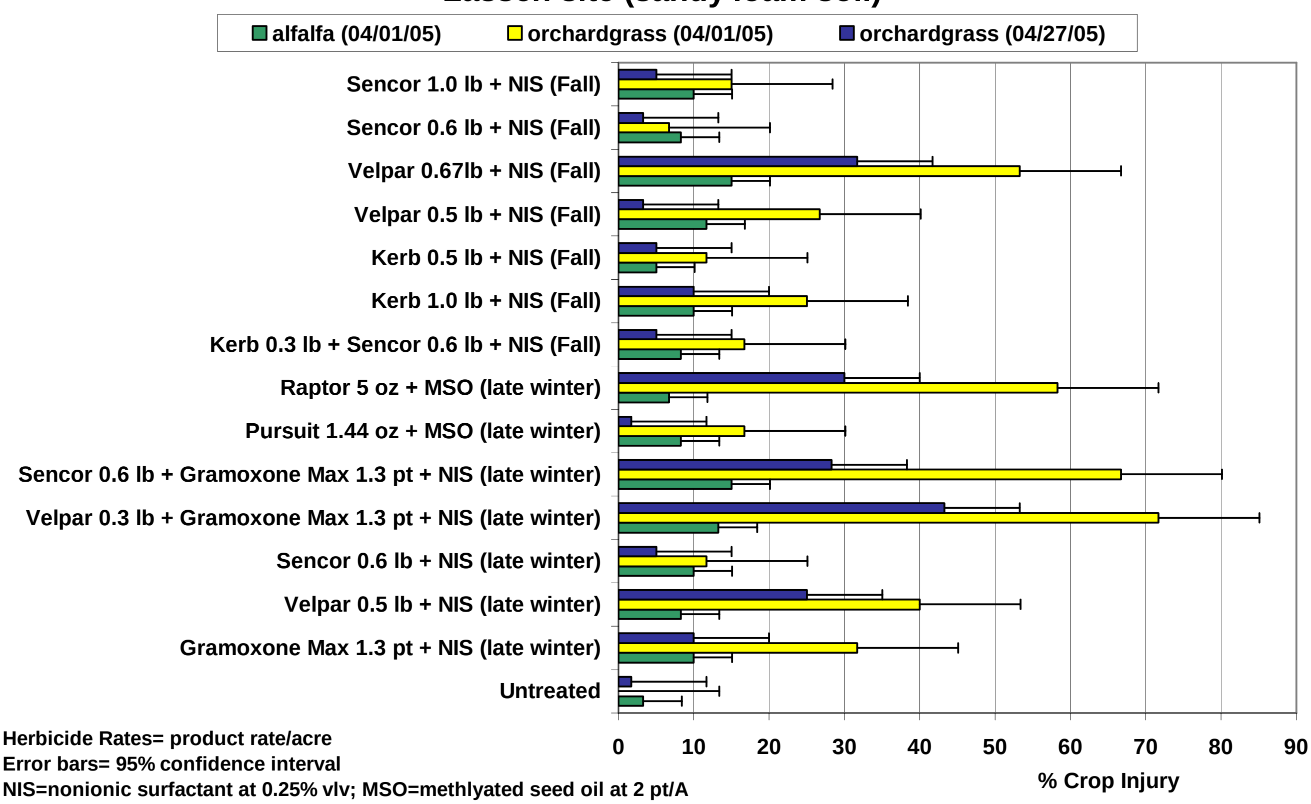
Result Summary: Sencor, Kerb, and Pursuit provided acceptable weed control of certain weed species without reducing alfalfa and orchardgrass height (figures 1 and 2). Of the three herbicides, Sencor is currently the only product with specific label instructions for use in mixed alfalfa-grass. Gramoxone Max provided inconsistent weed control and caused considerable injury to orchardgrass when applied to orchardgrass with spring re-growth. All fall and late winter treatments except Gramoxone and Kerb controlled shepherdspurse and tumble mustard (figure 1). Late fall applications of Sencor at 0.6 to 1.0 lb/A, Velpar DF at rates ≥ 0.67 lb/A, and Kerb at rates ≥ 0.5 lb/A gave acceptable control of downy brome (figure 1).

Figure 1. Weed Control in Alfalfa and Orchardgrass at the Lassen site on April 27, 2005 (sandy loam soil)



Herbicide Rates= product rate/acre
Error bars= 95% confidence interval
NIS=nonionic surfactant at 0.25% vlv; MSO=methlyated seed oil at 2 pt/A
fall herbicide treatments were applied on 10/22/04; late winter herbicide treatments were applied on 03/03/05

Figure 2. Spring Herbicide Injury on Alfalfa and Orchardgrass at the Lassen site (sandy loam soil)



Herbicide Rates= product rate/acre
Error bars= 95% confidence interval
NIS=nonionic surfactant at 0.25% vlv; MSO=methlyated seed oil at 2 pt/A
fall herbicide treatments were applied on 10/22/04; late winter herbicide treatments were applied on 03/03/05

Foxtail Barley (*Hordeum jubatum*) Control in Grass Pasture

Introduction: Foxtail barley is serious weed problem in several pastures throughout Northern California. The perennial grass is palatable to livestock at young stages, but awns on mature plants can cause serious injury to livestock eyes, nose, throat, and ears. Foxtail barley reduces the value of grass hay causing hay producers to cut early before it produces seedheads or cut around patches after seed production. Currently, no herbicides are labeled for foxtail barley control in perennial grass pasture. This trial evaluated the safety and efficacy of several herbicides for foxtail barley control in mixed grass pasture. The predominant grass crop at both sites was tall fescue.

Study Investigator: Rob Wilson

Cooperators: Matt Lavacot and Joe Egan

Herbicide Application: **September treatments**- 09/02/04; **November-December treatments**- 11/02/04; **March treatments**- 03/11/05; **April treatments**- 04/14/05.

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/Moisture: **Willow Creek**- loam. The soil surface and sub-surface were moist at all application times. **Susanville**- clay loam. The soil surface and sub-surface were moist at all applications.

Weed Species Present at the Time of Application: **September treatments**- foxtail barley had 1-3 inches regrowth after cutting; **November-December treatments**- plants were dormant; **March treatments**- foxtail barley had 1 inch spring re-growth; **April treatments**- foxtail barley had 2-5 inches spring re-growth.

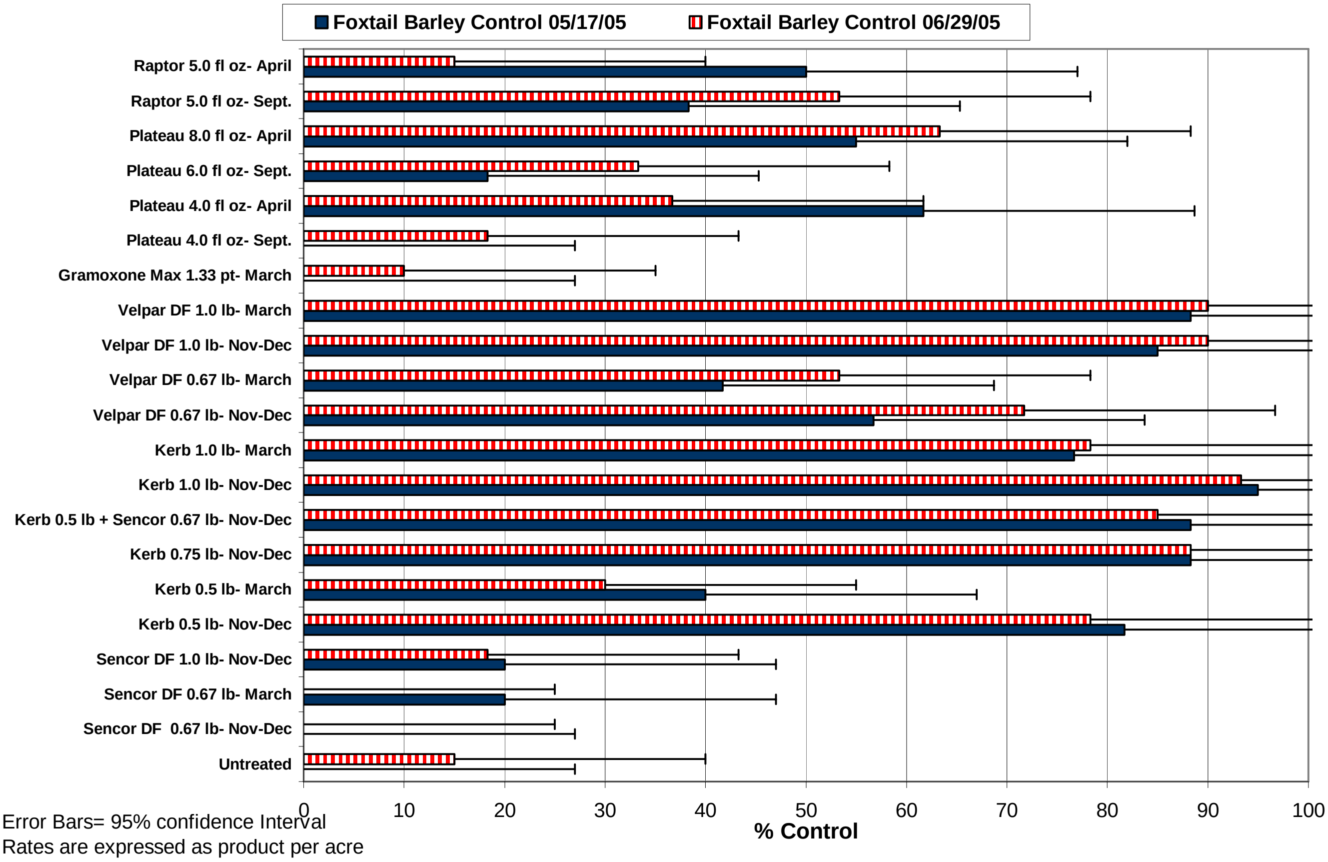
Crop Description at the Time of Application: **Willow Creek**- tall fescue and birdsfoot trefoil; **Susanville**- tall fescue, *juncus* spp(wiregrass), sedges, and birdsfoot trefoil. **September treatments**- grasses had 1-3 inches regrowth after cutting; **November-December treatments**- grasses were dormant; **March treatments**- grasses had 0.5-2 inches re-growth; **April treatments**- grasses had 4-7 inches spring re-growth.

Data Collected: Percent weed control and crop injury was measured on 05/17/05 and 06/29/05 at Willow Creek and 05/17/05, 06/01/05, and 07/15/05 at Susanville. The 06/29/05 evaluation at Willow Creek coincided with the first cutting harvest. The 06/01/05 evaluation at Susanville coincided with the first cutting harvest. The 07/15/05 evaluation at Susanville coincided when foxtail barley headed out after 1st cutting.

Surfactants Added to Herbicides: Non-ionic surfactant (R-11) at 0.25 % v/v was added to all Sencor DF, Velpar DF, Kerb 50-W, and Gramoxone Max treatments. Methylated Seed Oil (Hasten) at 1.0 pt/A was added to Plateau and Raptor treatments.

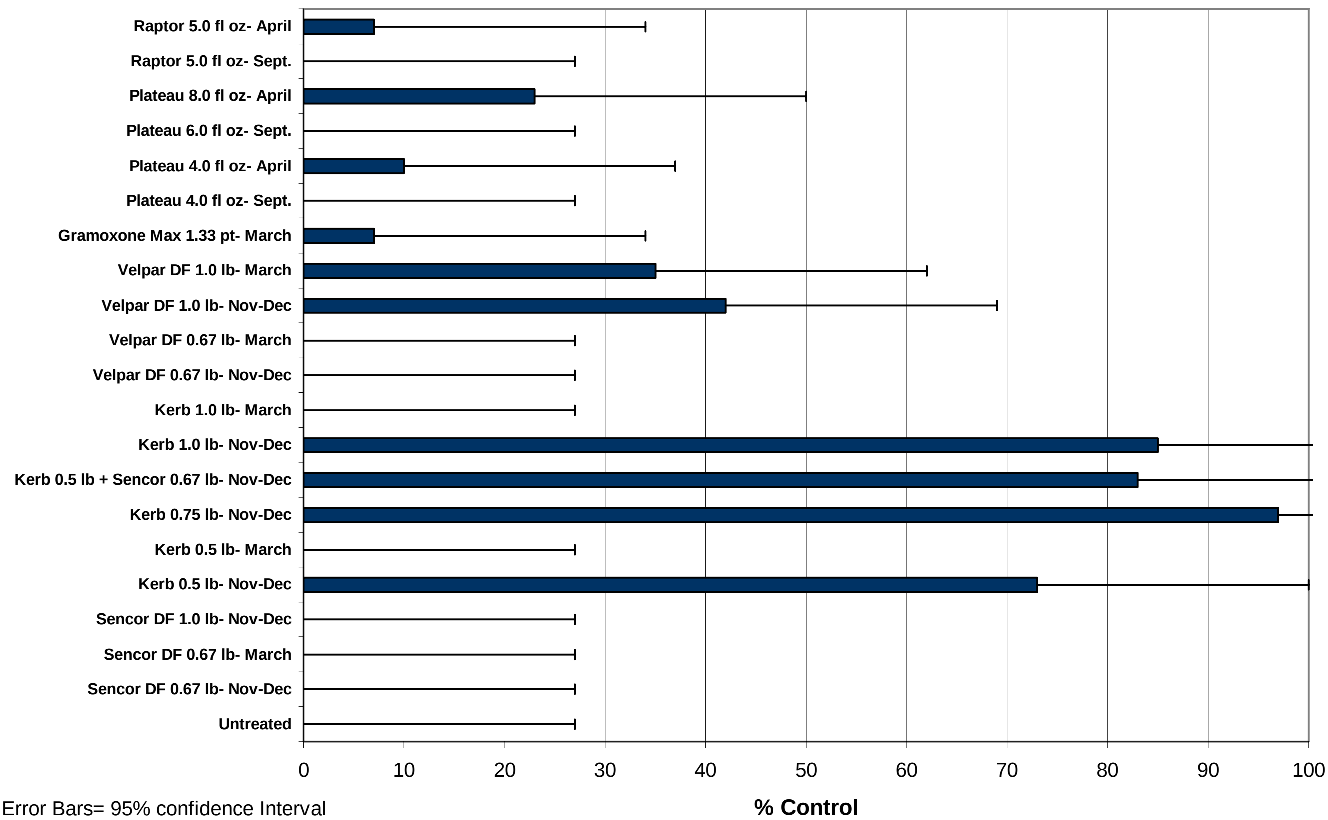
Result Summary: Kerb at rates ≥ 0.75 lb/A and Kerb at 0.5 lb/A + Sencor at 0.67 lb/A applied in November shortly after grasses entered winter dormancy provided over 80% control of foxtail barley at both sites (figures 1 and 2). These treatments caused slight crop injury in the spring, but they didn't reduce crop height or appear to reduce yields at 1st cutting harvest compared to untreated plots (figures 3, 4, and 5). Velpar DF at 1.0 lb provided acceptable foxtail barley control at Willow Creek, but the treatment caused unacceptable injury to tall fescue (figures 3, 4, and 5). Kerb 50-W is not labeled for use in grass pasture.

Figure 1. The Effect of Herbicides and Application Time on Foxtail Barley Control on 05/17/05 and 06/29/05 at Willow Creek



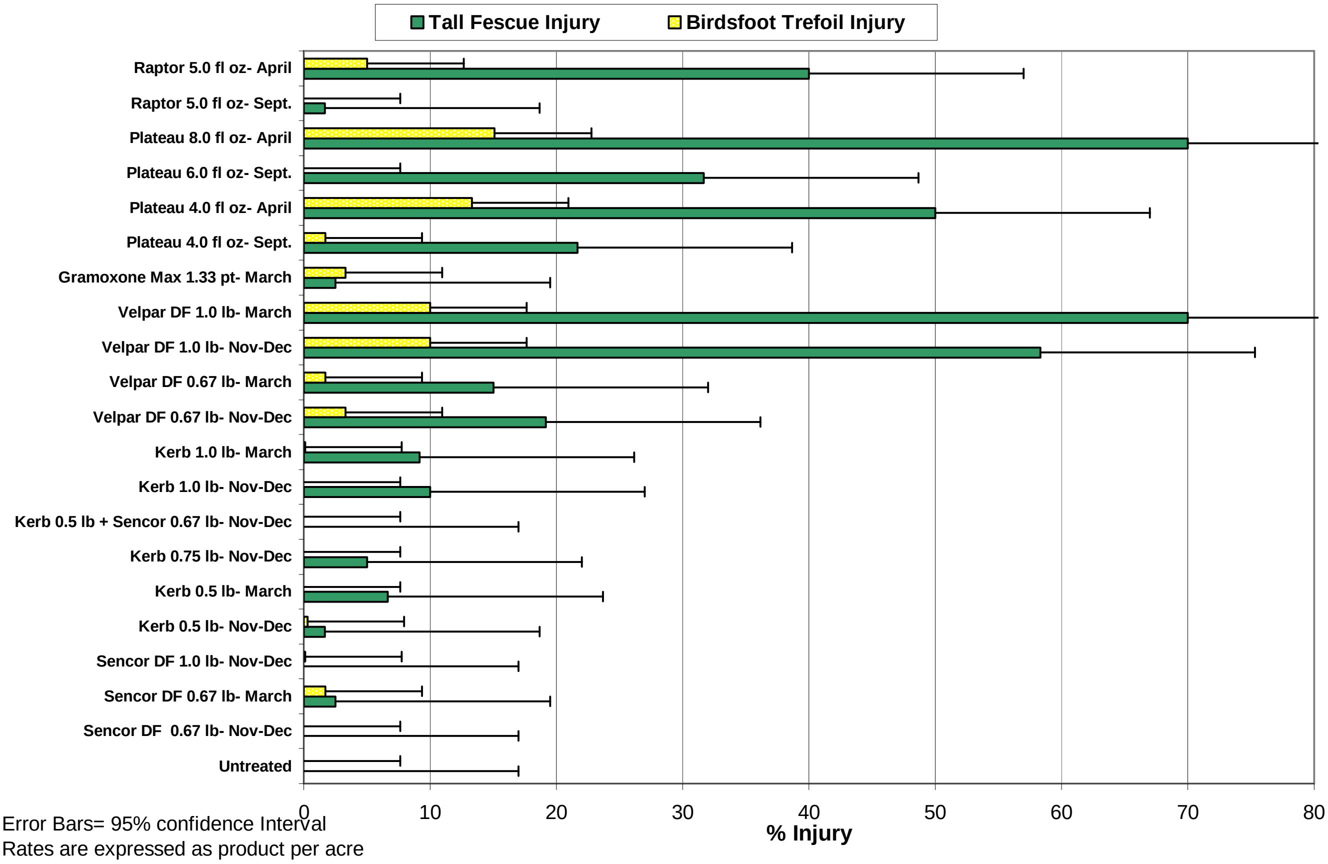
Error Bars= 95% confidence Interval
Rates are expressed as product per acre

Figure 2. The Effect of Herbicides and Application Time on Foxtail Barley Control on 07/15/05 at the Susanville Site



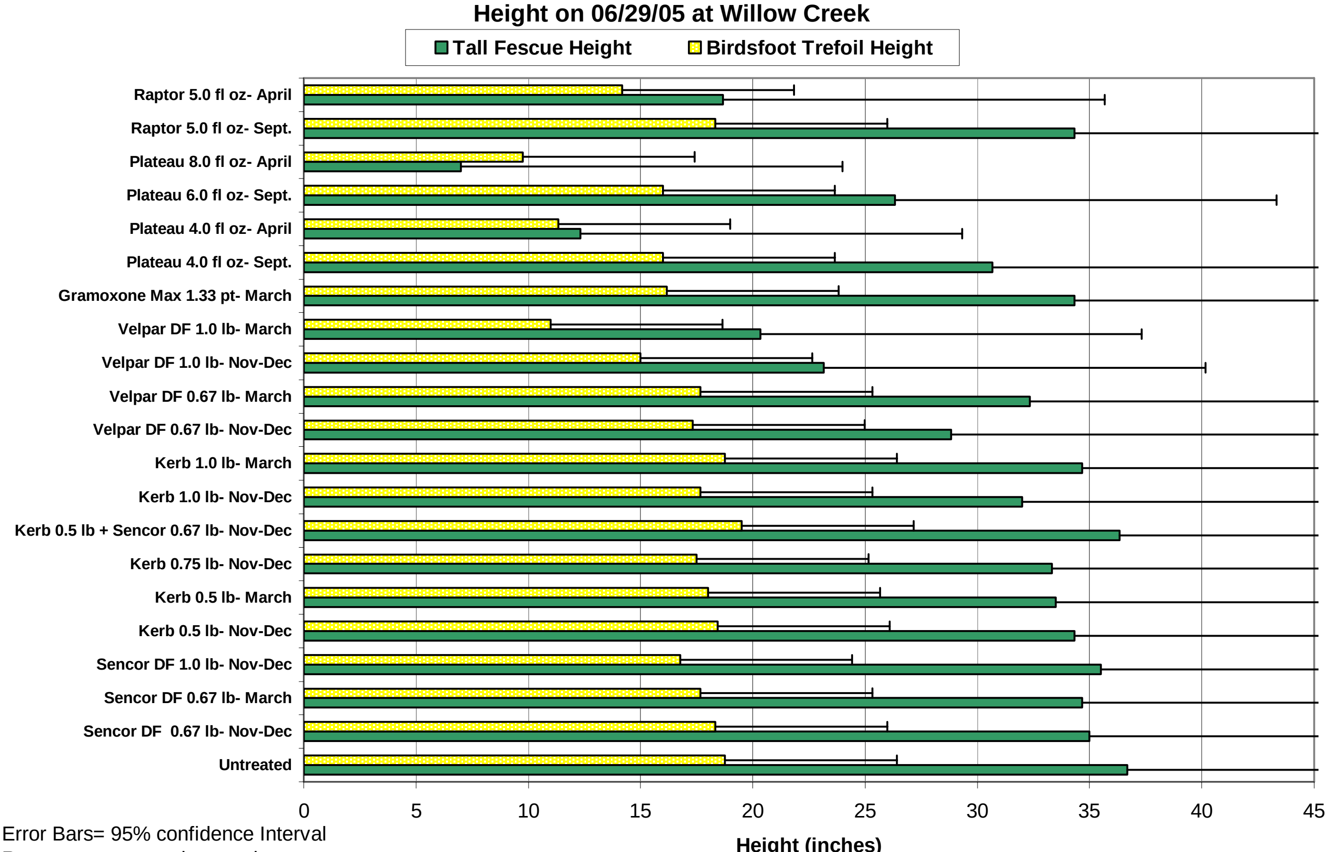
Error Bars= 95% confidence Interval
Rates are expressed as product per acre

Figure 3. The Effect of Herbicides and Application Time on Tall Fescue and Birdsfoot Trefoil Injury on 06/29/05 at Willow Creek



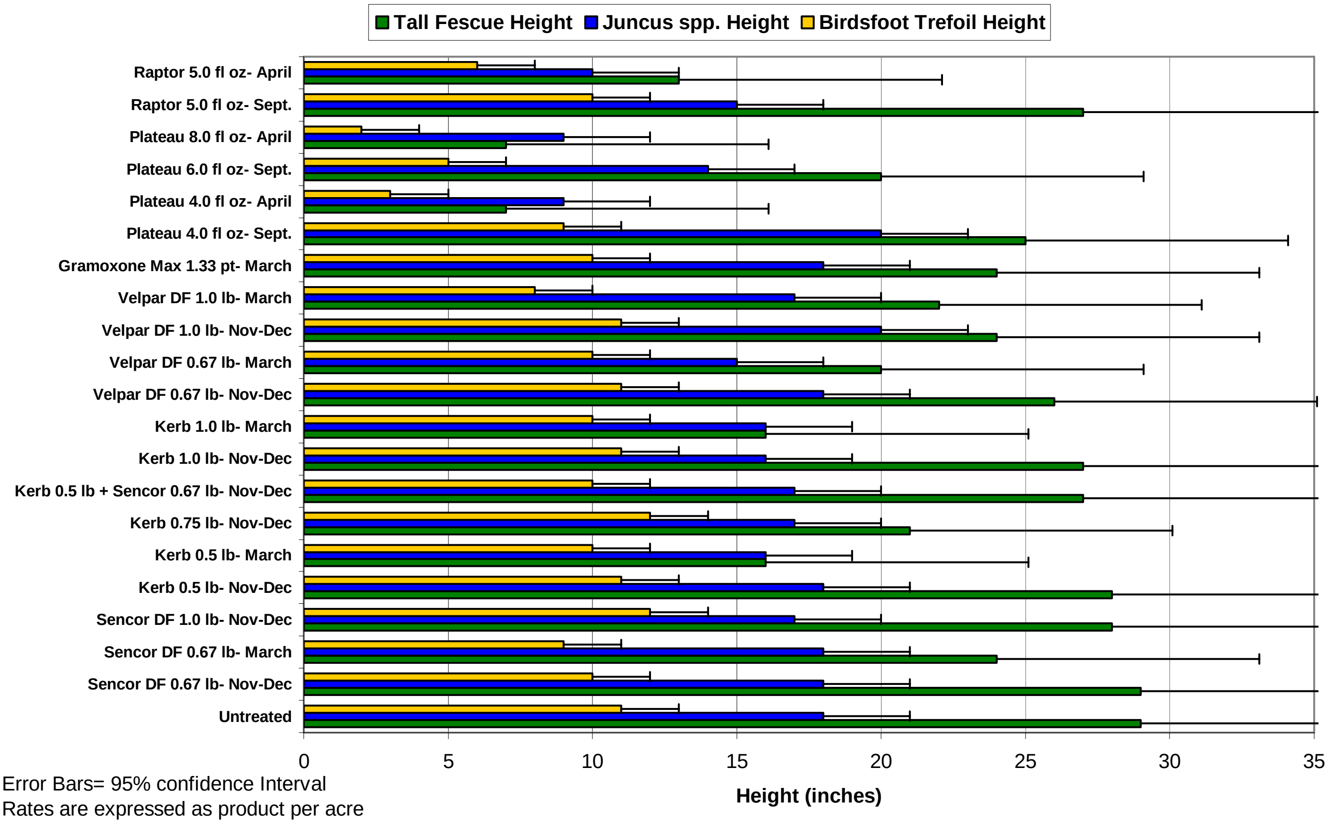
Error Bars= 95% confidence Interval
Rates are expressed as product per acre

Figure 4. The Effect of Herbicides and Application Time on Tall Fescue and Birdsfoot Trefoil Height on 06/29/05 at Willow Creek



Error Bars= 95% confidence Interval
Rates are expressed as product per acre

Figure 5. The Effect of Herbicides and Application Time on Tall Fescue, *Juncus spp.* , and Birdsfoot Trefoil Height on 06/01/05 at Susanville



Error Bars= 95% confidence Interval
Rates are expressed as product per acre

Integrated Management of Medusahead and Restoration of Degraded Grassland

Introduction: Medusahead is a troublesome weed that is well adapted to Northeast California and Southeast Oregon. The winter annual grass typically invades disturbed, big sagebrush communities especially in areas with clay loam soil. After establishment, medusahead spreads rapidly and forms monoculture stands excluding perennial grass and shrub establishment. This experiment evaluated the effectiveness of imazapic (Plateau) herbicide, burning, and burning + imazapic combinations for medusahead control. The experiment also assessed imazapic's effects on other vegetation and the feasibility of re-establishing perennial grasses following treatment. The experiment is part of a state-wide project organized by Joe DiTomaso to examine medusahead management in locations across California. The Lassen trial was conducted in cooperation with the Cedarville BLM office on medusahead-infested rangeland near Snake Lake.

Study Investigators: Joe DiTomaso, UC Davis Weed Specialist, Guy Keyser, UC Davis Research Associate, and Rob Wilson

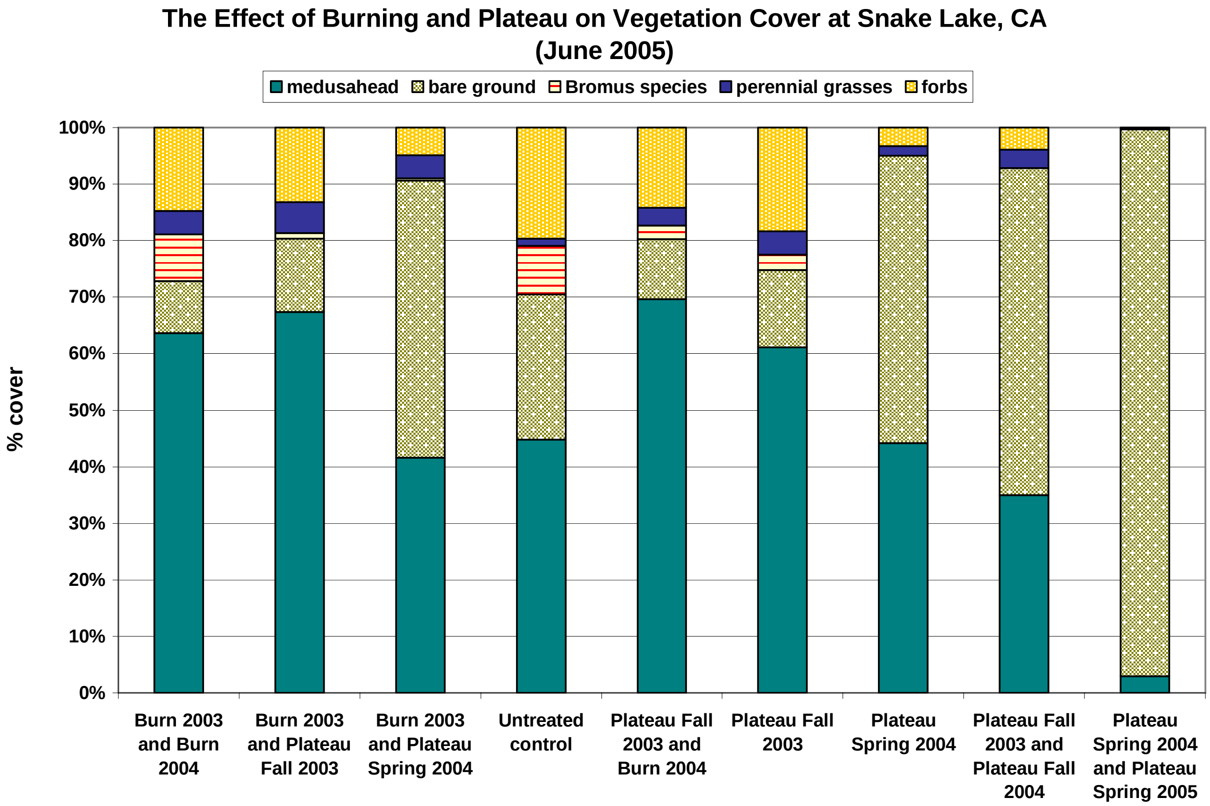
Cooperators: Alan Uchida and Garth Jeffers/ Cedarville BLM office

Materials and Methods:

- The study consisted of 9 treatments arranged in a randomized complete block design with 3 replications (24 plots total).
    - Plot size was 100 ft X 100ft
    - Total experiment size was 5.5 acres
- Imazapic (Plateau) treatments (1 oz ai/A) were be applied to appropriate plots in October or March 2003 and/or 2004 with a boom sprayer attached to ground rig at 20 gallons per acre.
- A summer burn (between May –July) was conducted in appropriate plots in 2003 and/or 2004 before medusahead seed maturation.
- All plots were aerially seeded by the BLM in fall 2004 with a native perennial grass mix.
- Vegetation cover and forage quality were measured in each plot during June 2003, 2004, and 2005 to evaluate treatment effects on the plant community. June measurements occurred when medusahead was in the flowering to soft-dough stage.

Result Summary: Two years of applying Plateau in October and summer burning followed by a March Plateau application decreased medusahead cover compared to untreated plots 1 year after treatment (1 YAT). Unfortunately, medusahead cover was >35 % in these plots 1 YAT suggesting medusahead will likely re-invade the site without further treatments (figure). March applications of Plateau provided superior medusahead control compared to applications in October, but a single treatment at either timing failed to provide acceptable medusahead control 1 YAT. Two consecutive Plateau applications in March provided excellent control three months after treatment, but results 1 YAT will not be available until next spring. A disappointing trend following all Plateau treatments was a striking increase in bare ground 1 YAT. Unfortunately, existing native forbs and perennial grasses did not spread and aerially seeded grasses failed to establish 1 YAT.

Burn treatments were unsuccessful at controlling medusahead, and several burn treatments increased medusahead cover compared to untreated plots. Snake Lake's burn results are opposite of those following burning in the Central Valley in 2003 and 2004. In Valley grasslands, burning provided effective medusahead control 1 YAT. The difference in medusahead control between Snake Lake and the Central Valley is due to differences in vegetation. In Valley grasslands, ample annual grasses such as wild oat and ripgut brome mature earlier than medusahead allowing a hot controlled burn during medushead's soft dough stage. At Snake Lake, other annual grasses are not present to carry the fire causing burn crews to wait to burn after medusahead senesces which is too late to destroy seedheads. Although burning did not control medusahead at Snake Lake, several burn treatments increased perennial grass cover after treatment. Data will be collected in spring 2006 to evaluate treatment effects 1 to 3 YAT.



Native and Introduced Perennial Grass Establishment in the Intermountain Region of Northern California

Introduction: Thousands of acres in Northern California are heavily invaded with weeds. Most of the land has been disturbed by fire, soil movement, or grazing and lacks perennial vegetation to stabilize the site. Currently, millions of dollars are being spent on herbicides to control the weeds, but little work is being done to re-establish desirable perennial vegetation. Although perennial grass establishment does not yield immediate weed and erosion control, it is likely the best hope for long-term weed suppression. Unlike annual crops, dryland perennials persist without irrigation and do not require extensive management after establishment. Perennial grasses provides wildlife habitat, livestock forage, vegetation diversity, and reduce weed invasion and erosion.

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:

The primary goal of this study is to examine the feasibility of establishing native and introduced perennial grasses in Northeast California for the purpose of livestock forage, wildlife habitat, and weed/erosion control.

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 perennial 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 seeding15 to 17 different native and introduced perennial species. A list of the different herbicide and re-vegetation species is listed below.

Herbicide Treatments During Establishment: (Individual treatments differed between sites according to the weeds present)

1. Roundup (4L)- 1.0 qt/A + ammonium sulfate at planting (Spray within 1-5 days before or after planting)
2. 2,4-D ester (4 SC)- 1.0 pt/A + non-ionic surfactant (NIS) after grass emergence when grasses reach the 5 leaf stage
   2,4-D ester or amine (4 SC)- 1.0 qt/A + NIS the year after planting in early spring
3. 2,4-D ester or amine (4 SC)- 1.0 pt/A + Transline- 2/3 pt/A + non-ionic surfactant (NIS) after grass emergence when grasses reach the 5 leaf stage
   2,4-D ester or amine (4 SC)- 1.0 qt/A + Transline- 2/3 pt/A + NIS the year after planting in early spring

4. Weedmaster (2,4-D + dicamba) - 2.0 pt/A + NIS after grass emergence when grasses reach the 5 leaf stage
   Weedmaster (2,4-D + dicamba) - 4.0 pt/A + NIS the year after planting in early spring
5. Plateau (2 SL)- 4.0 oz/A + MSO at planting (Spray within 1-5 days before/after planting)
   Plateau (2 SL)- 8.0 oz/A + MSO applied in late winter the year after planting
6. Plateau (2 SL) - 4.0 oz/A + NIS after grass emergence when grasses reach the 5 leaf stage
   Plateau (2 SL) - 6.0 oz/A + MSO the year after planting in early spring
7. Pursuit DG at 1.44 oz/A + NIS after grass emergence when grasses reach the 5 leaf stage
   Pursuit DG at 1.44 oz/A + NIS + AMS the year after planting in early spring
8. Pursuit DG at 1.44 oz/A + Banvel 0.5 pt/A + NIS after grass emergence when grasses reach the 5 leaf stage
   Pursuit DG at 1.44 oz/A + NIS + AMS the year after planting in early spring
9. Telar (75 DF) - 1.0 oz/A + NIS after grass emergence when grasses reach the 5 leaf stage
   Telar (75 DF) - 1.0 oz/A + NIS the year after planting in early spring

Perennial Re-vegetation Species: (Planted species differed between sites)
1. **'Rosana' Western wheatgrass**- aggressive native sod-grass with low forage production. (7.0 lb/ac)
2. **'Lincoln' Smooth Brome**- sod-grass with good vigor and notable ability to suppress weeds (8.0 lb/ac)
3. **'Magnar' Basin Wildrye-** slightly spreading robust native grass (9.0 lb/ac)
4. **'Secar' bluebunch wheatgrass**- drought tolerant native bunchgrass with good seedling vigor (7.0 lb/ac)
5. **'Bannock' thickspike wheatgrass**- drought tolerant native sod-grass (8.0 lb/ac)
6. **'Revenue' slender wheatgrass**- native bunchgrass with rapid development and salt tolerance (6 lb/ac)
7. **'Hycrest' crested wheatgrass**- drought tolerant introduced grass that consistently establishes on arid range sites (6.0 lb/ac)
8. **'Oahe' intermediate wheatgrass**- mild sod-forming grass suited for use as pasture or hay (12 lb/ac)
9. **'Luna' pubescent wheatgrass**- long lived aggressive sod-former that was the top performing grass selection in a 2001 Siskiyou grass trial (12 lb/ac)
10. **'Newhy' wheatgrass**- cross between quackgrass and bluebunch wheatgrass that tolerates alkaline soils. (8 lb/ac)
11. **'Alkar' Tall Wheatgrass**- tall-growing bunchgrass that is very tolerant to salt, alkali, and drought (12 lb/ac)
12. **'Shoshone' Beardless Wildrye**- sod-forming native grass adapted to saline-alkali conditions (16 lb/ac)
13. **'Paiute' orchardgrass**- dryland orchardgrass variety with good seedling vigor (6.0 lb/ac)
14. **'Sand Hollow' bottlebrush squirreltail-** native bunchgrass with excellent seedling vigor that is often an increaser on rangeland (8.0 lb/ac)
15. **'Blazer XL' alfalfa**- alfalfa variety that persists in dryland situations (5 lb/ac)
16. **forage kochia**- semi-evergreen perennial shrub with good establishment success in desert and semi-desert climates (3 lb/ac)
17. **yellow sweetclover**- tall stemmy, biennial legume suited to a wide range of environments including sagebrush-grass to moist salty lowlands (4 lb/ac)
18. **'Bozoisky-Select' Russian wildrye**- long-lived, drought-tolerant, grazing tolerant introduced bunchgrass (7 lb/ac)
19. **‘Flecha MaxQ’ Tall Fescue-** new tall fescue variety that is said to enter summer dormancy (15 lb/ac)
20. **‘AGRPA 101’ Harding grass-** (7 lb/ac)

Field sites were disked and packed in late fall or winter to control existing weeds and prepare a seedbed. Grass species were seeded around March 1st using the IREC cone planter. Herbicides were applied with a CO_2 backpack sprayer or Tractor mounted sprayer at 20 GPA.

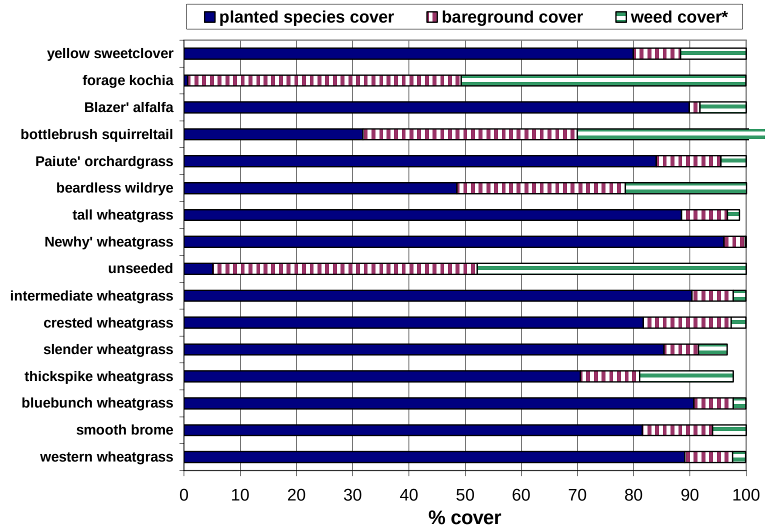
Grass species establishment and vigor was evaluated in June or July during the year of establishment (all sites) and June the year following establishment (for sites seeded in 2004). The percentage of drill row occupied by the seeded species, seeded grass cover, and weed species cover was measured in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

Result Summary: Several native and introduced plant species were capable of successful establishment under dryland conditions on weedy sites in Northern California (figures 1-10). Cover measurements from sites planted in 2004 showed several grass species in combination with herbicides provided superior weed suppression compared to herbicides alone the year after grass establishment (figures 1 & 2). At locations with heavy weed competition, herbicides were critical for successful grass establishment (figures 11-14). Without herbicide treatment during the seedling stage, weed cover equaled 100% at most sites. Telar, 2,4-D ester, Transline + 2,4-D ester, Weedmaster, and Pursuit caused minimal injury to all perennial grasses during establishment. Pursuit was safe on seedling dryland alfalfa.

Species cover and drill row frequency differed between sites in 2005 (figures 3-10) and appeared to be correlated to soil moisture and rainfall. Sites with the highest rainfall during March through June had the highest average grass cover and drill row frequency in herbicide treated plots (figures 3-10 and figure 15). Although rainfall increased grass vigor, weed control was the most important factor affecting grass establishment success. For example at the site with the highest rainfall (Tulelake Wildlife Refuge), average seeded species cover was 0 % in untreated plots whereas it was > 70% in plots treated with Telar.

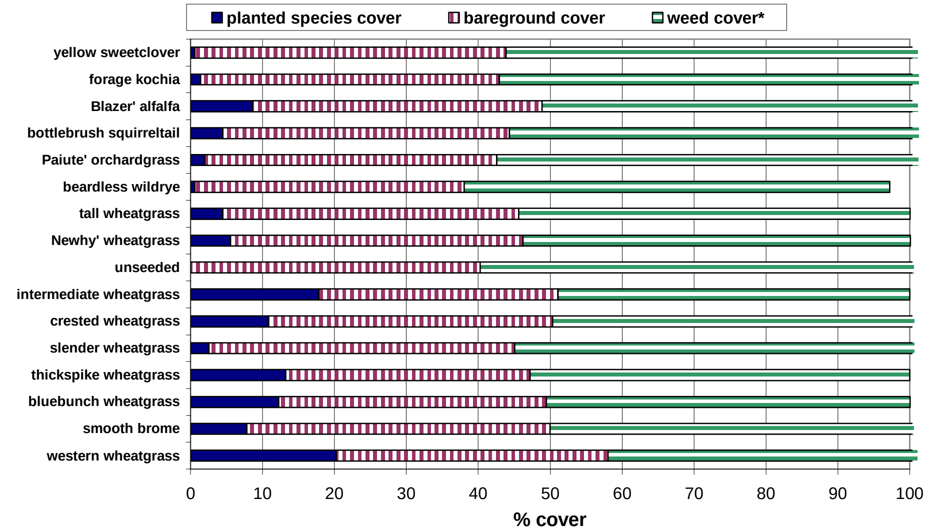
When comparing individual grass species the year of establishment, intermediate wheatgrass, pubescent wheatgrass, and tall wheatgrass exhibited excellent seedling vigor and averaged > 55% drill row occupation and > 30% visual cover three months after seeding (figures 3 & 7). Bottlebrush squirreltail and beardless wildrye consistently had the worst seedling vigor three months after seeding and averaged < 30% drill row occupation and < 8% visual cover at most sites. Results collected next year will provide an indication of each species' long-term establishment success and potential to suppress weeds.

Figure 1. Percent Cover of Planted Species, Bareground, and Weeds Averaged Across Herbicides at the IREC Field Station One Year After Seeding (June 2005)



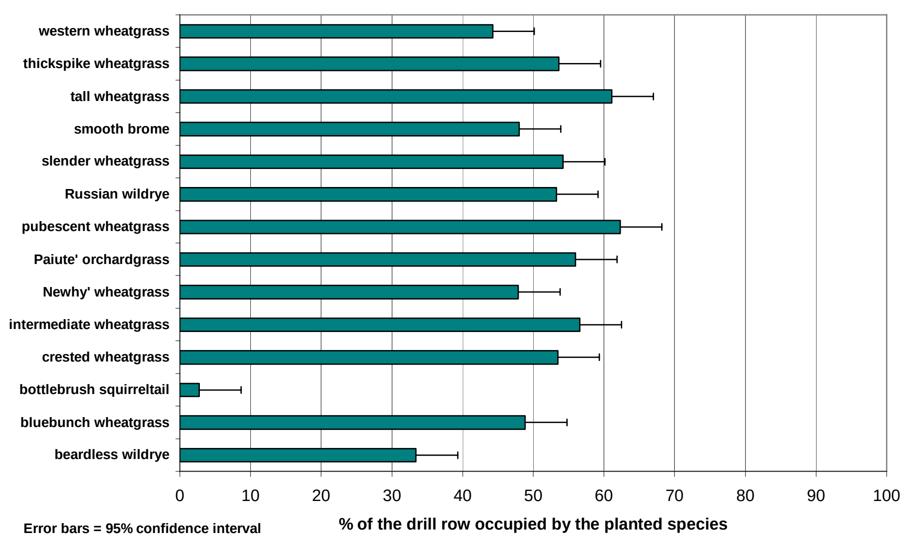
* The primary weed species in the plots were prickly lettuce, kochia, tumble mustard, and downy brome.

Figure 2. Percent Cover of Planted Species, Bareground, and Weeds Averaged Across Herbicides at Doyle One Year After Seeding (June 2005)



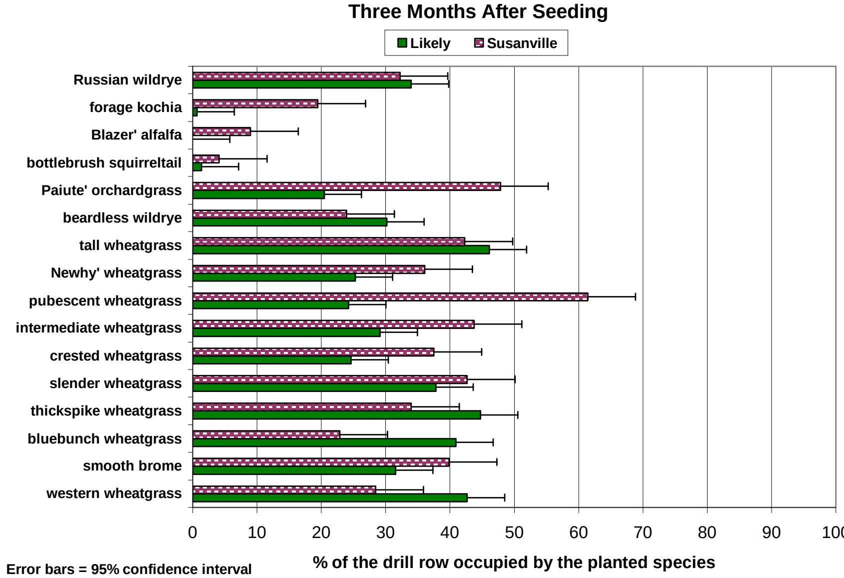
* The primary weed species in the plots were Russian thistle, tumble mustard, common mallow, filaree, prickly lettuce, and kochia.

Figure 3. Drill Row Frequency of Planted Species Averaged Across Herbicide Treatments Three Months After Seeding
(Averaged Across All Sites Planted in 2005)



Error bars = 95% confidence interval

Figure 4. Drill Row Frequency of Planted Species at Susanville and Likely Three Months After Seeding



Error bars = 95% confidence interval

Figure 5. Drill Row Frequency of Planted Species at Yreka Three Months After Seeding

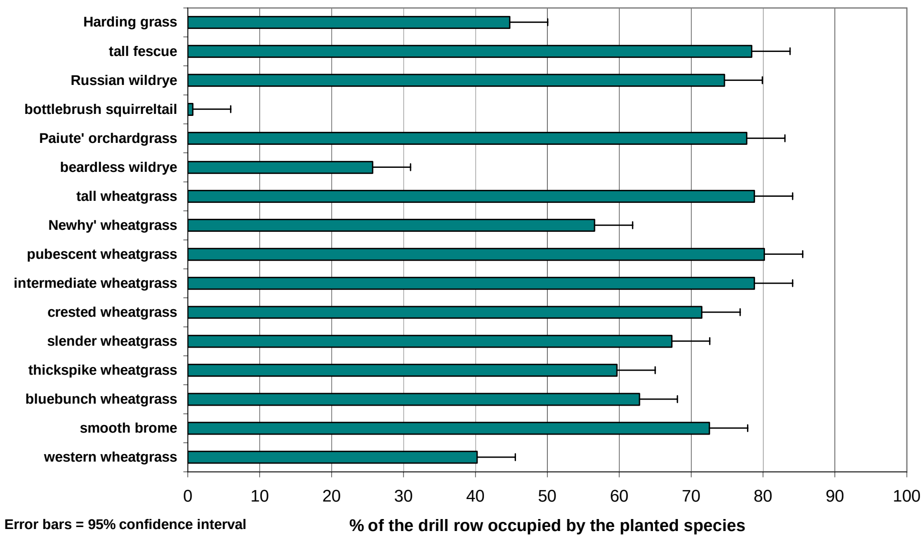


Figure 6. Drill Row Frequency of Planted Species Averaged Across Herbicides at the Tulelake Wildlife Refuge Three Months After Seeding

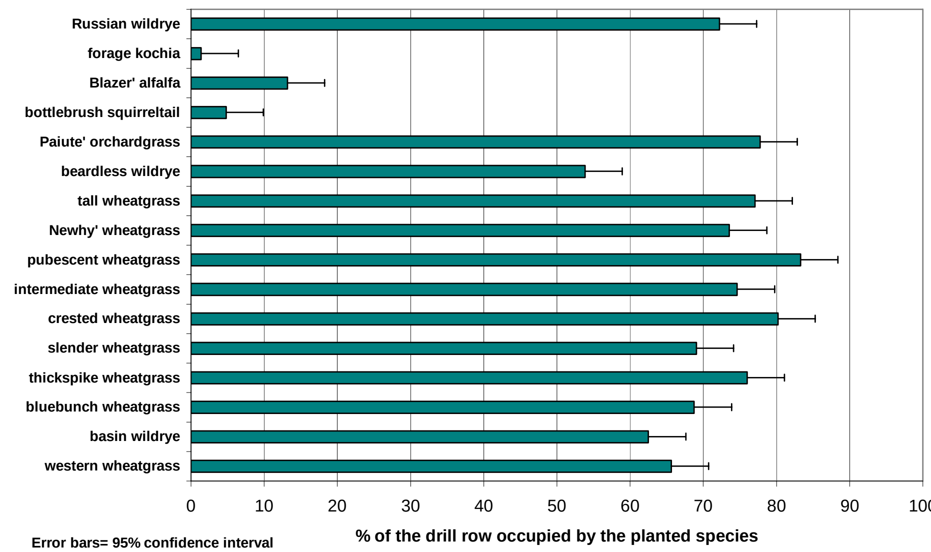


Figure 7. Percent Cover of Planted Species Averaged Across Herbicide Treatments Three Months After Seeding (Averaged Across All Sites Planted in 2005)

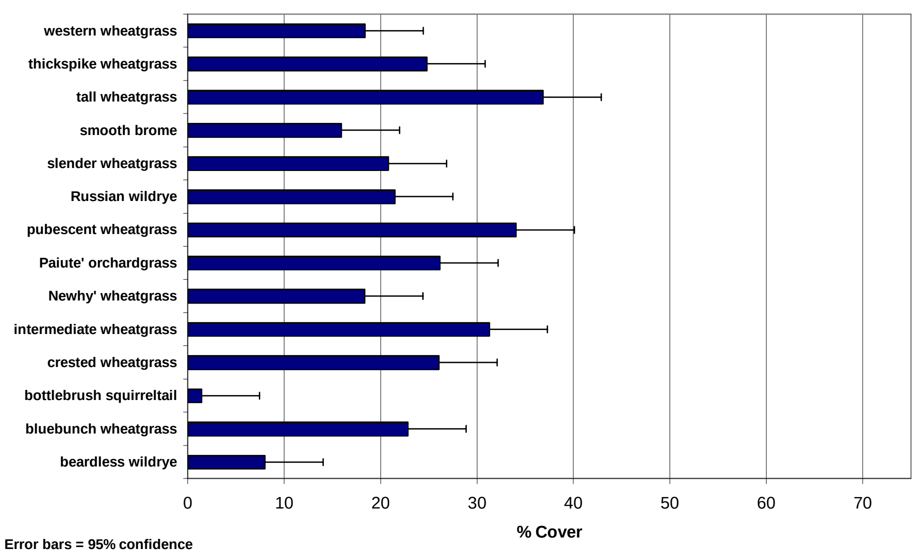


Figure 8. Percent Cover of Planted Species at Likely and Susanville Three Months After Seeding

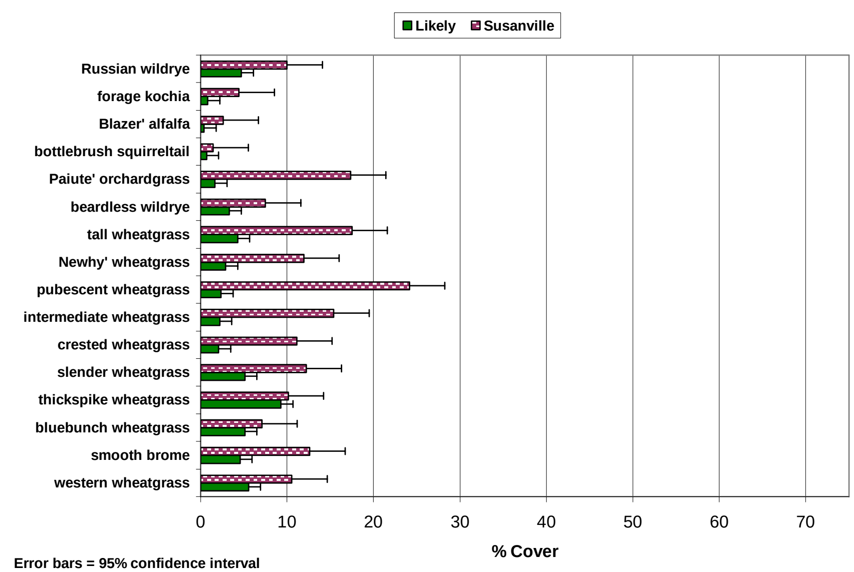


Figure 9. Percent Cover of Planted Species at Yreka Three Months After Seeding

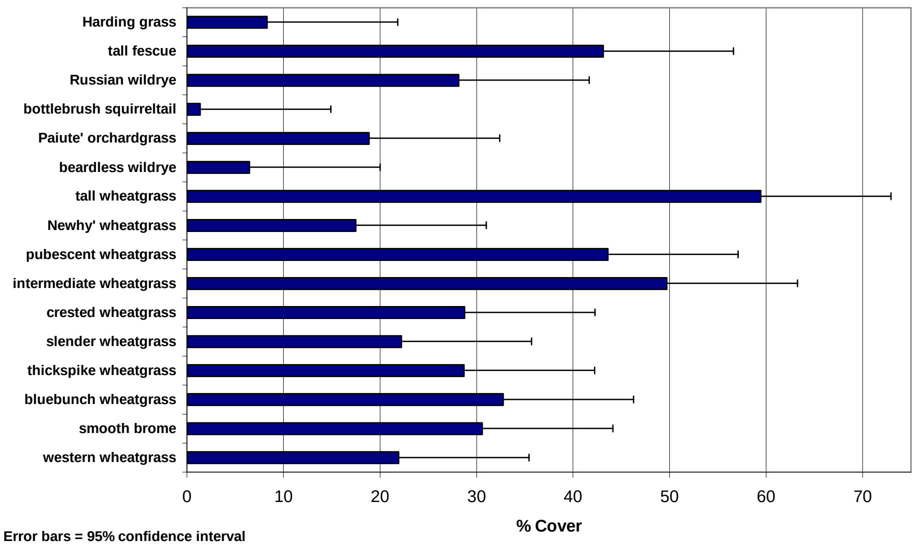


Figure 10. Percent Cover of Planted Species at the Tulelake Wildlife Refuge Three Months After Seeding

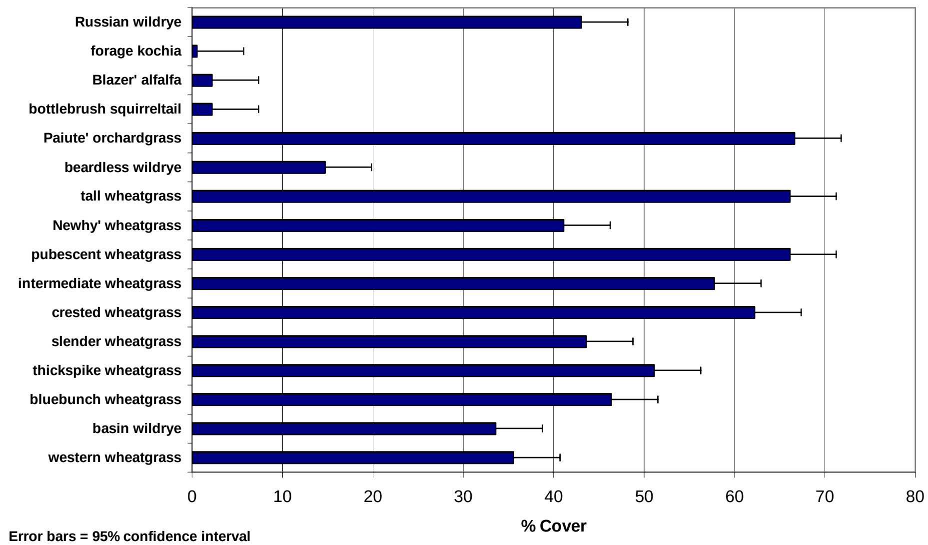
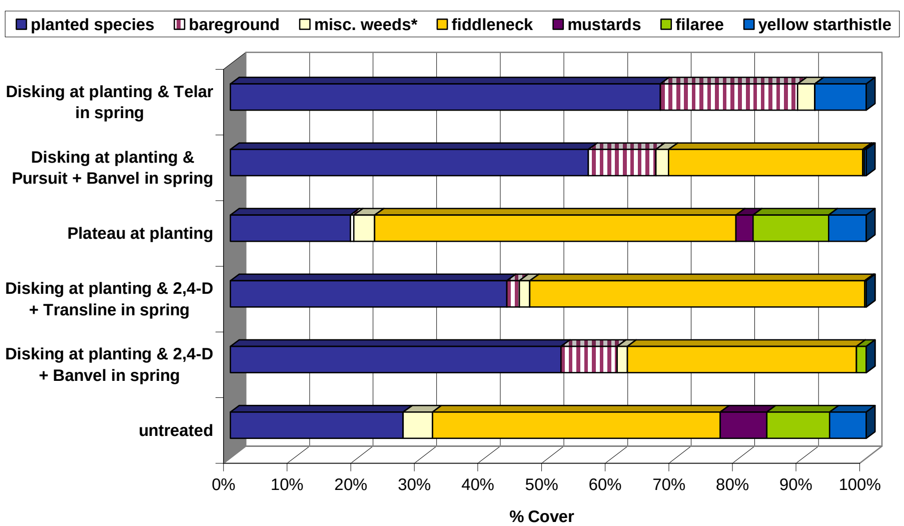
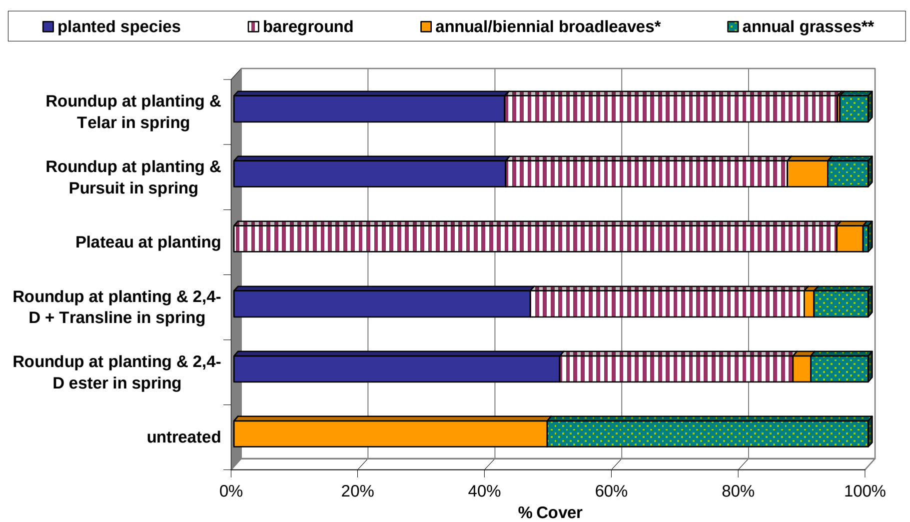


Figure 11. The Effect on Herbicides on the Weeds, Bareground, and Planted Species Cover within the Drill Row at Yreka Three Months After Seeding in 2005



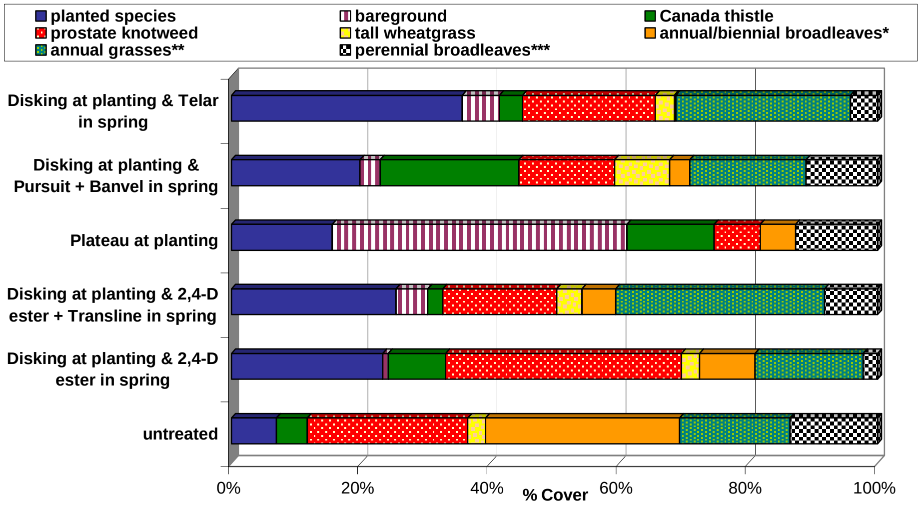
*Misc. weeds at the site included downy brome, lambsquarter, prostate knotweed, japanese brome, ripgut brome, and prickly lettuce.

Figure 12. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover within the Drill Row at Likely Four Months After Seeding in 2005



*Annual/biennial broadleaf weeds at the site included fiddleneck, tumble mustard, filaree, Russian thistle, & Mediterranean sage .
**Annual grass weeds at the site included downy brome and medusahead.

Figure 13. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover within the Drill Row at Susanville Three Months After Seeding in 2005

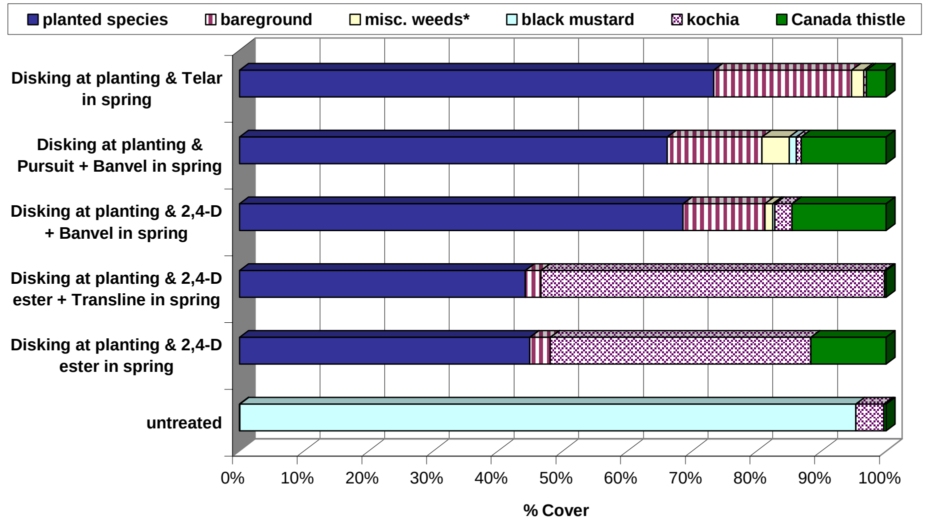


*Annual/biennial broadleaf weeds at the site included lambsquarter, prickly lettuce, filaree, poison hemlock, fiddleneck, sunflower, and tumble mustard .

**Annual grass weeds at the site included downy brome, hare barley, and cereal rye.

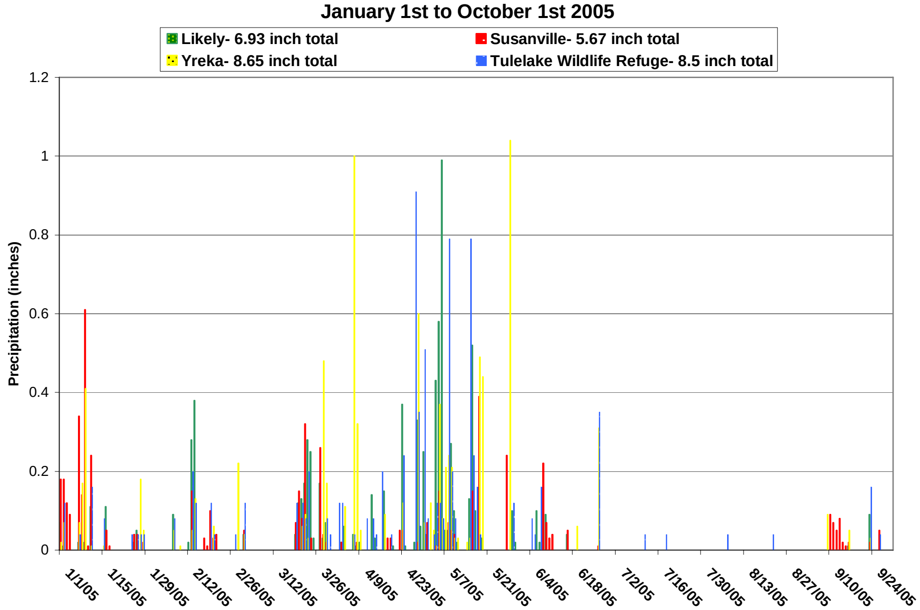
***Perennial broadleaf weeds at the site included field bindweed and chicorv.

Figure 14. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover within the Drill Row at the Tulelake Wildlife Refuge Three Months After Seeding in 2005



*Misc. weeds at the site included downy brome, henbit, and bull thistle .

Figure 15. Precipitation Amounts at the Four Sites Seeded in 2005 from January 1st to October 1st 2005



Integrated Management of Perennial Pepperweed: Combining mowing, disking, grazing, or burning with herbicides and perennial grass re-vegetation

Introduction

Perennial pepperweed or tall whitetop (*Lepidium latifolium*) is an aggressive perennial that infests a vast array of habitats including alkali deserts, pasture, waterways, and wet, riparian areas. Currently, herbicides are the primary method for managing perennial pepperweed. Herbicides are effective at controlling perennial pepperweed, but they require repeat applications for several years to maintain control. This experiment evaluated long-term management techniques for perennial pepperweed without a continued reliance on herbicides. The study examined management strategies that control perennial pepperweed and restore desirable vegetation on the site. The study also set out to find effective management techniques for use in wetlands, rough terrain, and environmentally sensitive areas where few control options currently exist for perennial pepperweed.

Specific objectives include:

1. Determine if integrating burning, mowing, winter grazing, or disking with herbicides and revegetation creates a synergistic effect with regard to perennial pepperweed control.
2. Evaluate burning, mowing, winter grazing, and cultivation's effectiveness at removing perennial pepperweed's litter layer of senesced shoots.
3. Assess the influence different control treatments have on natural vegetation recovery.
4. Determine if re-establishing a competitive, native plant population prevents perennial pepperweed re-invasion.

Study Investigators: Rob Wilson, UCCE Farm Advisor Lassen County; Dr. Joe DiTomaso, UCCE Weed Specialist UC Davis; Debra Boelk, Graduate Student UC Davis

Materials and Methods

The experiment is a split-split plot with four replications. The treatments are listed below.

Site Preparation Treatments- (whole plots)
1. Control (No Alteration to the Site)
2. Winter Burn
3. Spring Mowing
4. Fall/Winter Grazing
5. Cultivation

Re-vegetation Treatments- (split-split-plots)
a. Control
b. Seed native species

Herbicides- (split-plots)
A. Control
B. Spring chlorsulfuron (Telar) at 1.5 oz ai/A
C. Spring 2,4-D ester (4SC) at 1.9 lb ai/A
D. Spring glyphosate (Roundup 4SC) at 3 lb ae/A

The experiment was established at two locations in Lassen County in Fall 2002. Study sites were located in areas heavily infested with perennial pepperweed that lacked competing vegetation. Whole plot size is 120 ft X 60 ft and sub-plot size is 30 ft X 30 ft (5 whole plot treatments * 8 sub-plot treatments * 4 replications) making the entire experiment 3.3 acres per site.

Initial burning, mowing, cattle grazing, and cultivation took place before herbicides were applied. The burn was conducted in the winter between February and April when optimal burn conditions arose. A winter burn was chosen because of the lack of burning restrictions during the winter and the fact that most favorable plants are dormant. The fire's purpose was to burn perennial pepperweed litter and release nutrients back to the soil. Winter grazing consisted of fencing cattle at high stocking rates (100+ cows per whole plot) with supplemental feed (alfalfa and grass hay) for one day. The purpose of grazing was to trample/ break apart perennial pepperweed's litter layer and graze coarse grasses such as tall wheatgrass and basin wildrye. Spring or summer grazing was not used since cattle preferentially graze grass over perennial pepperweed. Spring mowing occurred when perennial pepperweed flowered using a flail mower. The purpose of mowing was to cut and break apart the litter layer and change perennial pepperweed's growth pattern to increase herbicide efficacy. Fall disking was the cultivation treatment which was used to incorporate litter into the soil and severe perennial pepperweed's interconnected roots. Disking alone without herbicides increases perennial pepperweed density and cover.

In spring 2003, Telar, Roundup Ultra (4SC), or 2,4-D ester (4SC) was applied when perennial pepperweed reached the flowerbud stage. In mowed plots, herbicide applications were delayed until September to allow mowed plants to re-grow to the flowerbud stage. Roundup and 2,4-D treatments were repeated in September in disked plots to treat perennial pepperweed shoots that arose after the spring treatment. A non-ionic surfactant at 0.25 % v/v was added to Telar and 2,4-D and ammonium sulfate at 10 lbs/100 gallons of water was added to Roundup. All herbicides were applied using a CO_2 backpack sprayer at 20 gallons per acre.

In spring 2004 and 2005, 2,4-D ester at 1 lb ai/A was applied to all plots treated with 2,4-D and Roundup in 2003 to suppress perennial pepperweed re-growth and control annual broadleaf weeds. In spring 2004, Telar was applied to plots treated with Telar in 2003. Telar was not re-applied in 2005 due to the cost of the treatment and the concern of herbicide build-up in the soil.

In March 2004 and 2005, re-vegetation plots were seeded with a cool season, native perennial grass mix using a no-till drill. In winter grazing plots, re-seeding consisted of broadcasting seed a week before grazing to allow livestock to trample the seed. Western wheatgrass at 6 lbs PLS/acre, beardless wildrye at 9 lbs PLS/acre, reed canarygrass at 2 lbs PLS/acre, and basin wildrye at 4 lbs PLS/acre were seeded in 2004. In 2005, the same mix was re-seeded except slender wheatgrass at 2 lbs PLS/acre was substituted for reed canarygrass.

Percent cover of plant species, bare ground, standing thatch, and ground litter was measured in spring and fall 2003, 2004, and 2005. Seeded perennial grass cover was recorded in spring and fall 2004 and 2005. Data was collected in three, randomly placed 1 m^2 quadrats in each sub-plot. Data was analyzed using a mixed model analysis of variance on each measured factor.

In addition to vegetation data, soil samples were taken in each plot in fall 2002 before treatments were applied and in spring 2005 two years after treatment initiation. The soil was analyzed to determine the level of macro and micro-nutrients, C:N ratio, pH, OM %, soil texture, EC, Na concentration, and SAR.

Results

Burning and tillage were effective at removing accumulated thatch before herbicide treatment (figure 1). Mowing and tillage reduced perennial pepperweed cover compared to untreated plots the year of herbicide application (figure 1). All herbicide treatments reduced perennial pepperweed cover one and two years after treatment, although certain herbicide + site preparation combinations provided better control than others (figures 2 & 3). At the Honeylake Wildlife Area site, Telar or 2,4-D alone, Telar or 2,4-D in combination with burning, mowing, or grazing, and Roundup in combination with mowing provided the best control of perennial pepperweed two years after treatment initiation (figure 3). At the Mapes site, 2,4-D or Roundup alone, 2,4-D in combination with burning, mowing, or grazing, and Roundup in combination with mowing provided the best control of perennial pepperweed (figure 3). Tillage in combination with herbicides often decreased perennial pepperweed control compared to using herbicides alone.

Interestingly, Telar provided excellent perennial pepperweed control at the Honeylake Wildlife Area, but poor control at the Mapes site. The reason for the poor control with Telar at the Mapes site is unknown, but it's likely related to differences in soil properties between sites. Both sites had a clay loam soil, but percent organic matter, electrical conductivity (EC), and total percent carbon were three-fold higher at the Mapes site compared to the Honeylake Wildlife Area. Since Telar has moderate affinity to adsorb to organic matter, the high organic matter at Mapes (10%) likely bound significant amounts of Telar to the soil.

Winter burning and fall tillage provided the best seedbed for re-seeding grasses in 2004 and 2005 (figure 4 & 5). Due to extremely low spring rainfall, perennial grass establishment was terrible in 2004. Plots were re-seeded in March 2005 at both sites to evaluate seeding under average weather conditions.

Spring moisture was slightly above average in 2005 and perennial grass establishment was a success in several treatments. At the Honeylake Wildlife Area, perennial grass cover was highest in the burn + 2,4-D and burn + Roundup treatments (figure 6). At the Mapes site, perennial grass cover was highest in the burn + 2,4-D, burn + Roundup, grazing + 2,4-D, and tillage + Roundup treatments (figure 6). Along with burning, mowing and tillage in combination with 2,4-D and Roundup provided acceptable grass establishment. Grasses in plots treated with Telar were stunted and showed signs of herbicide injury suggesting Telar should be applied after grass establishment. Grass cover was < 4 % in all plots that did not receive herbicide treatment due to excessive competition from perennial pepperweed.

Site preparation and herbicide treatments influenced soil properties in the top 12 inches of soil two years after treatment initiation. Burning lowered soil pH compared to untreated plots at both sites (figure 7), and fall tillage increased soil salinity compared to all other treatments (figures 8 and 9). The increase in soil salinity in tilled plots is likely due to incorporating thatch since perennial pepperweed accumulates salts in vegetative tissue. Soil nitrate levels were also affected by treatments. Soil in plots treated with herbicide had a higher soil nitrate level compared to untreated plots regardless of the site preparation method.

In summary, winter burning in combination with yearly 2,4-D treatments provided the best combination of perennial pepperweed control and native grass establishment. Telar provided excellent perennial pepperweed control at the Honeylake Wildlife Area, but it gave poor control at the Mapes site and stunted grasses during establishment. One way to avoid Telar injury to perennial grasses is to apply 2,4-D or Roundup before seeding and apply Telar after the grasses reach the five leaf stage. In other trials, Telar caused no injury to the seeded grass species when applied after grasses reach the five leaf stage. Combining tillage, mowing, or grazing with yearly 2,4-D treatments could be used for re-vegetating infested areas at locations where burning is not tolerated,. Although trampling seed did not work well, drill-seeding grazed areas should yield similar results to mowed treatments.

Results suggest herbicides are needed for at least two consecutive years to suppress perennial pepperweed and allow for native grass establishment. None of the herbicides provided 100% control of perennial pepperweed after one or two years of treatment suggesting perennial pepperweed populations would rebound quickly if yearly applications were stopped. Without herbicide treatment, none of the site preparation treatments provided satisfactory perennial pepperweed control.

Figure 1. The Influence of Burning, Cattle Grazing, Mowing, and Tillage on Perennial Pepperweed and Ground Litter Cover Immediately Before the 2003 Herbicide Application (averaged between sites)

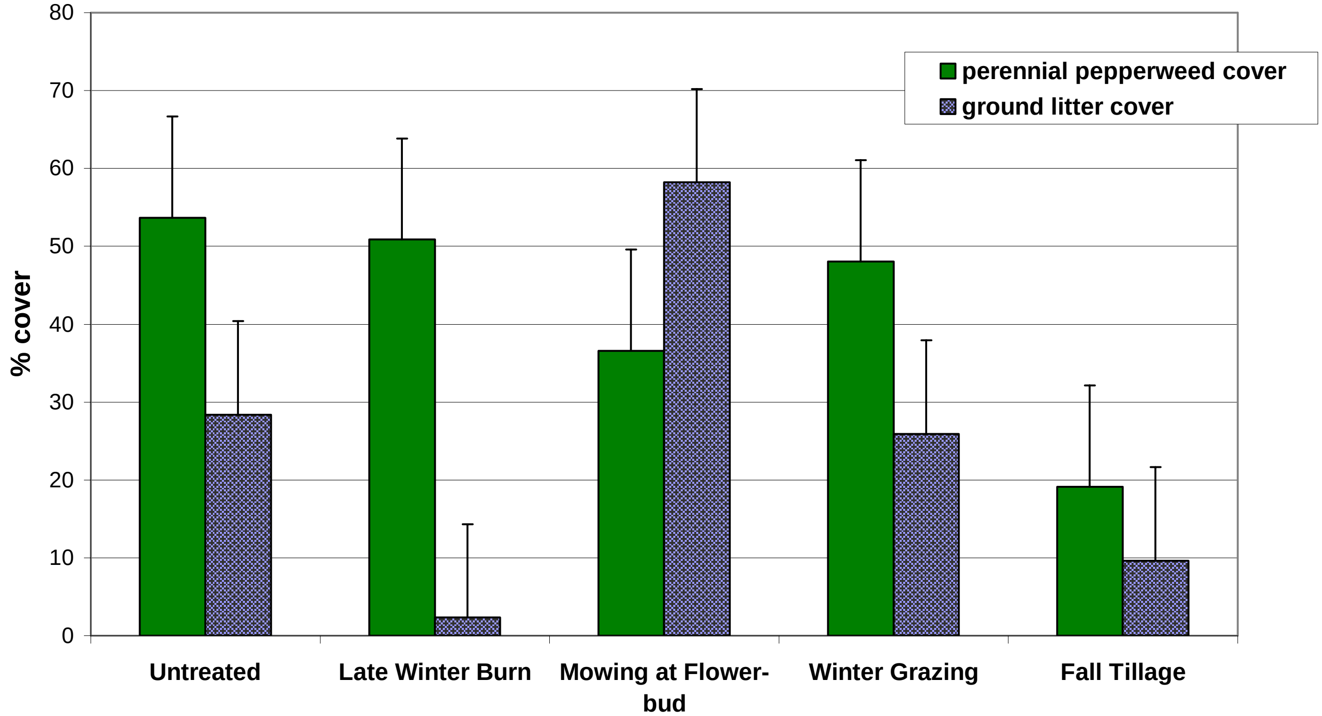
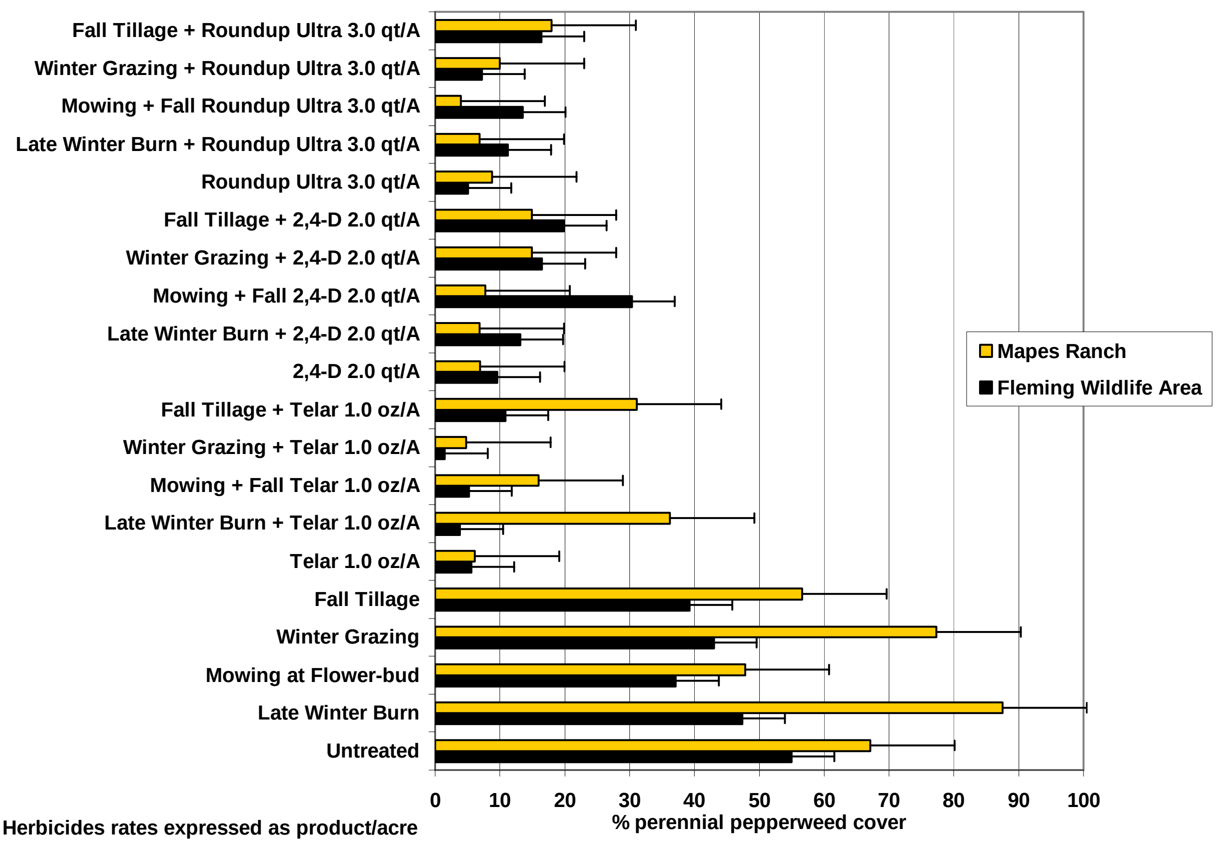


Figure 2. The Effect of Control Methods on Perennial Pepperweed Cover June 2004 (1 Year after Herbicide Treatment)



Herbicides rates expressed as product/acre

Figure 3. The Effect of Control Methods on Perennial Pepperweed Cover June 2005 (2 years after treatment initiation)

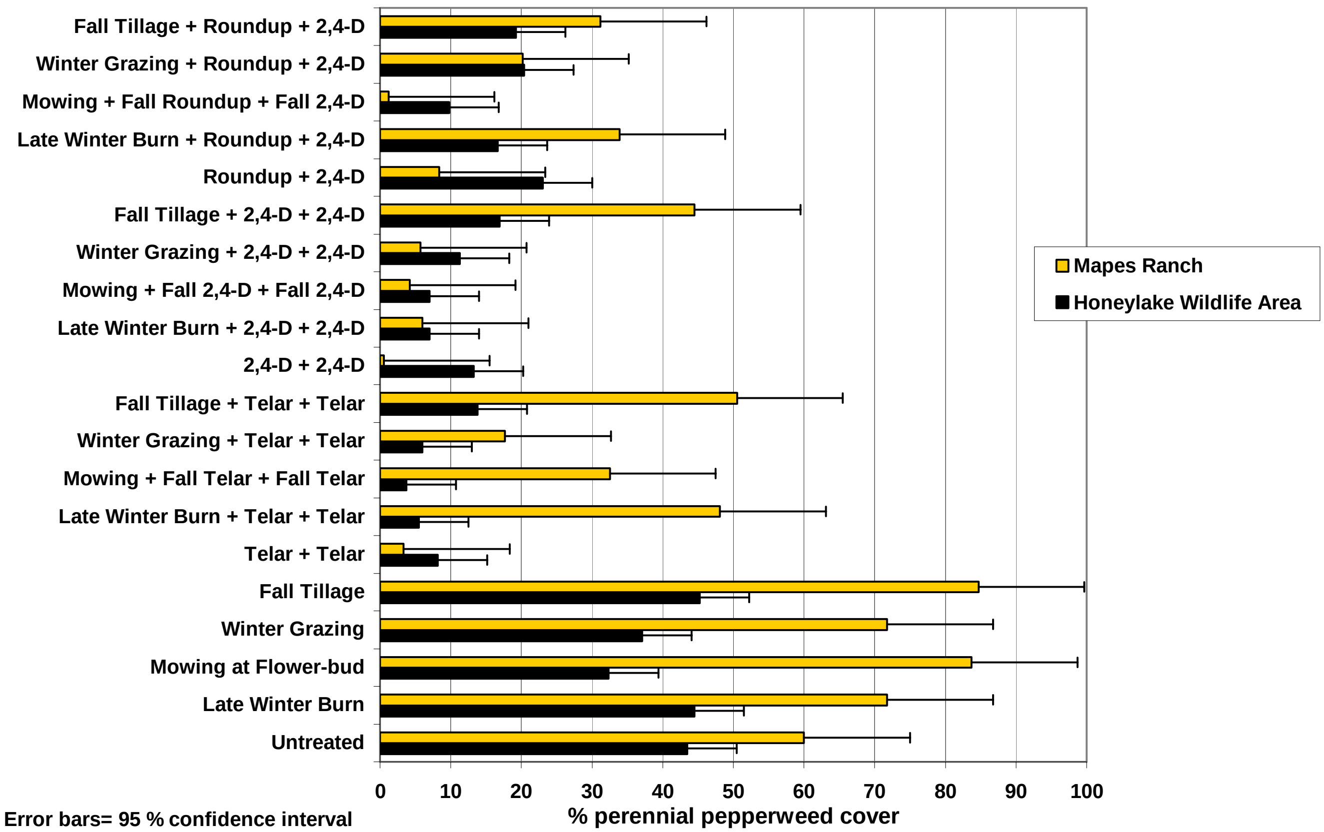


Figure 4. The Influence of Site Preparation Treatments on Vegetation, Bareground, and Litter Cover in June 2005 at Mapes Ranch
(Data was averaged across herbicide treatments)

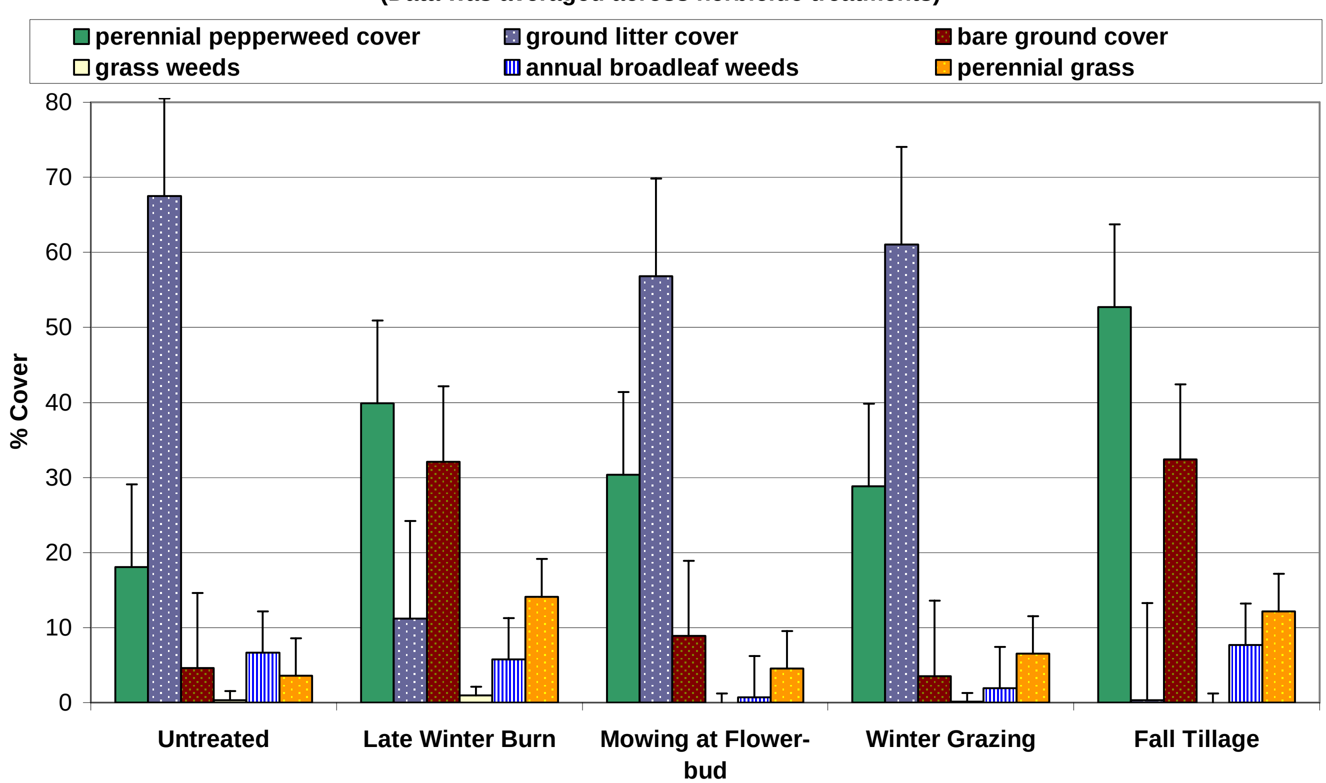


Figure 5. The Influence of Site Preparation Treatments on Vegetation, Bareground, and Litter Cover in June 2005 at Honeylake Wildlife Area
(Data was averaged across herbicide treatments)

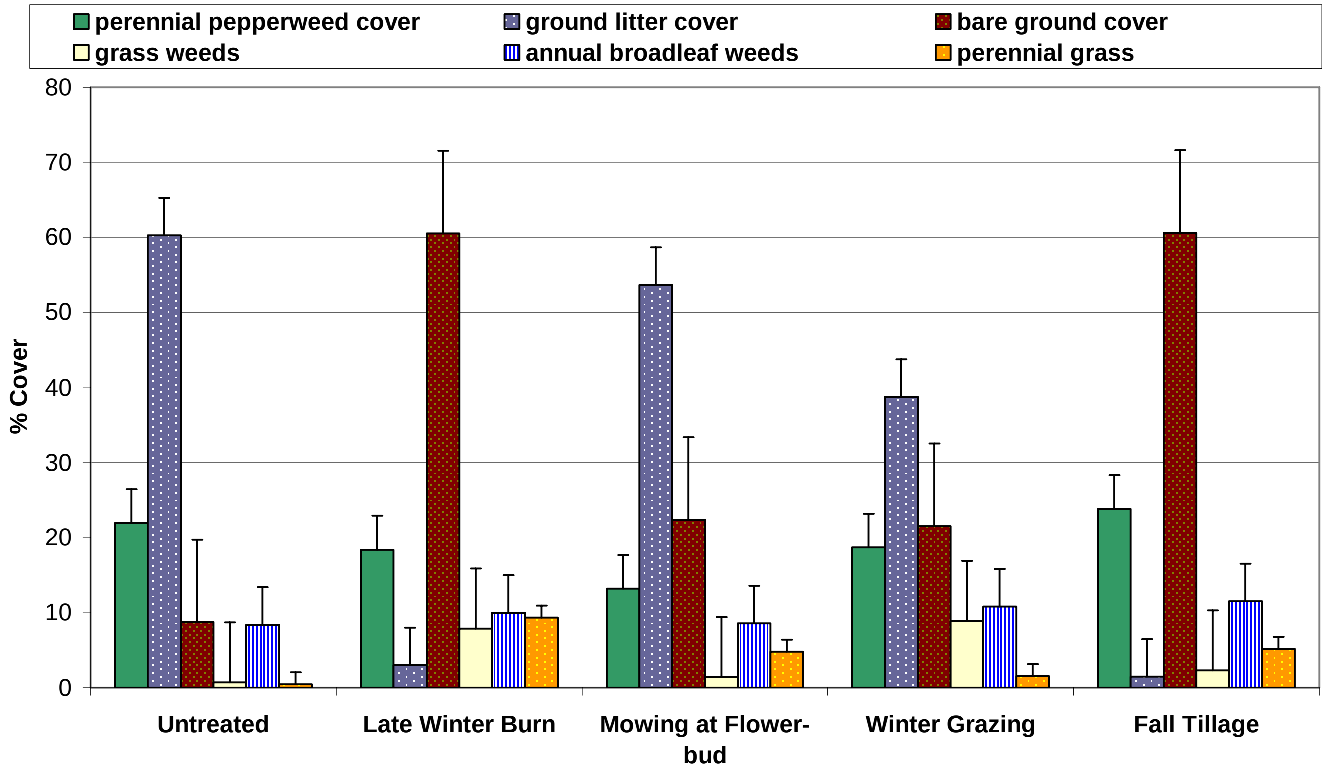
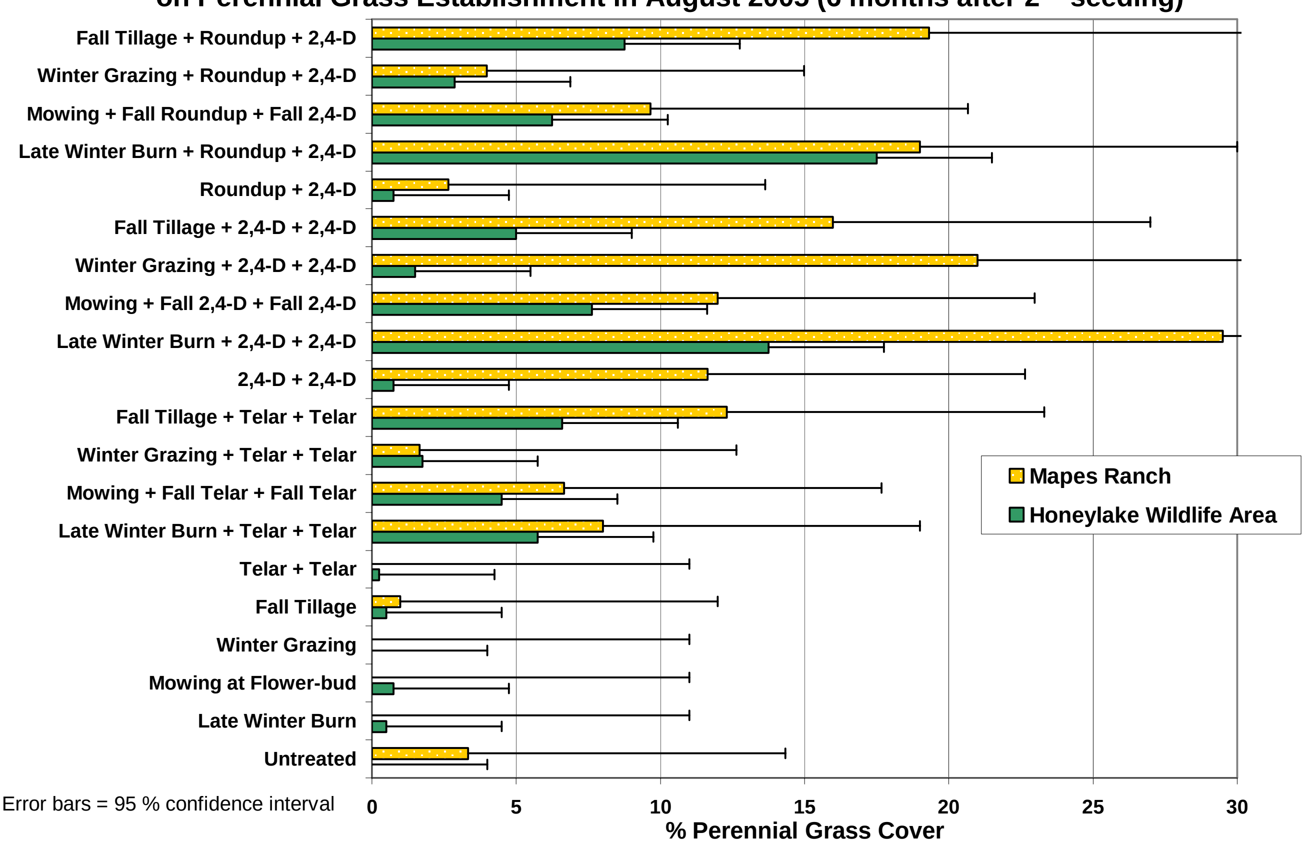


Figure 6. The Influence Integrating Site Preparation Treatments and Herbicides on Perennial Grass Establishment in August 2005 (6 months after 2nd seeding)



Error bars = 95 % confidence interval

Figure 7. The Effect of Site Prep Treatments on Soil pH (2 years after treatment initiation)

Data was averaged across herbicide treatment

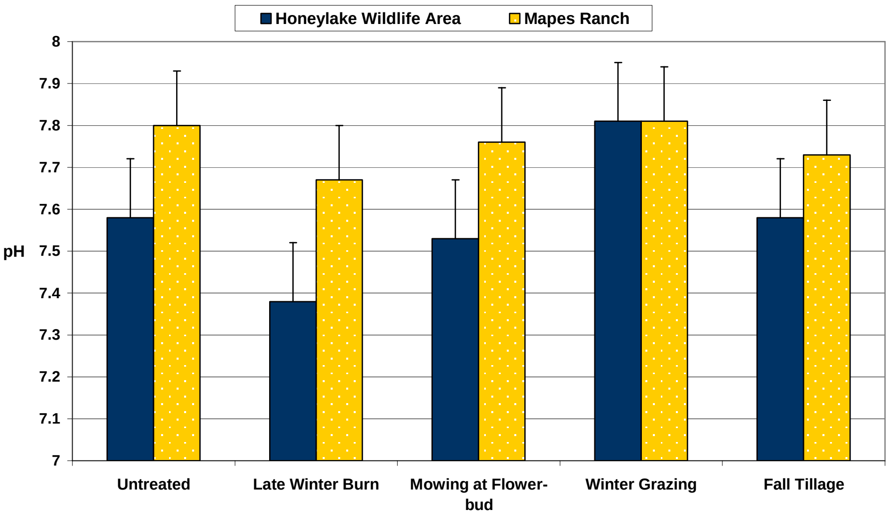


Figure 8. The Effect of Site Prep Treatments on Soil Electrical Conductivity- EC (2 years after treatment initiation)

Data was averaged across herbicide treatment

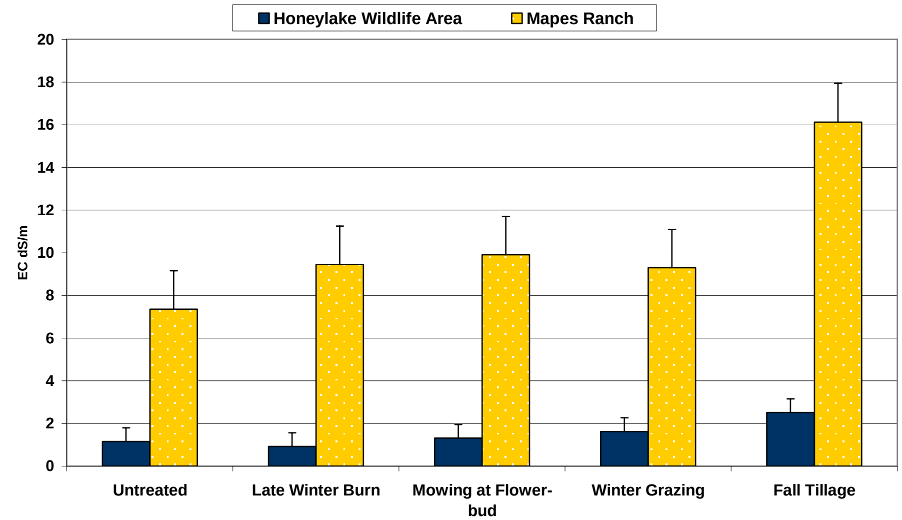


Figure 9. The Effect of Site Prep Treatments on the Soil Sodium Adsorption Ratio-SAR (2 years after treatment initiation)

Data was averaged across herbicide treatment

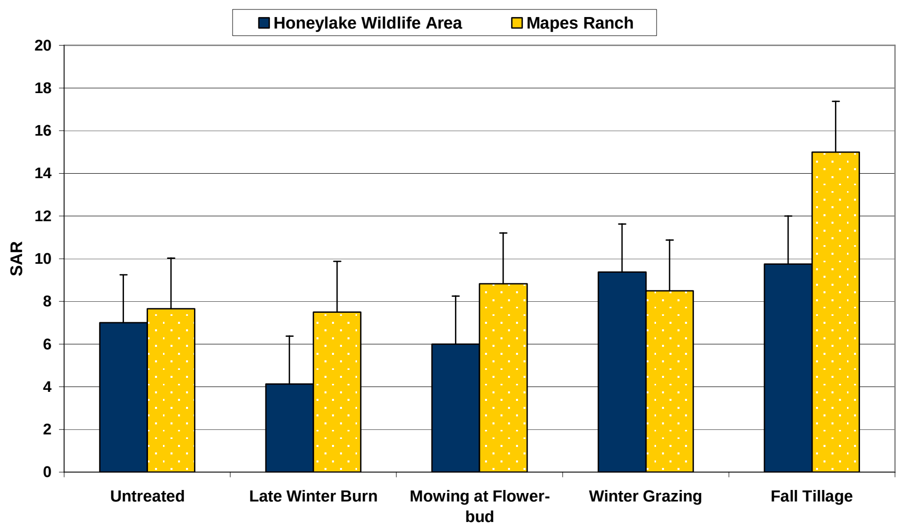


Figure 10. The Effect of Site Prep and Herbicide Treatment on Soil Nitrate Nitrogen (NO_3) in the top 12 inches of soil at the Honeylake Wildlife Area (2 years after treatment initiation)

Data was averaged across herbicide treatment