2006 Lassen County Weed Research Report

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This report describes weed control experiments field tested by the Lassen County UCCE office in 2006. 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.

Commercial companies and products are mentioned in this publication solely for the purpose of providing specific information. Mention of a company or product does not constitute a guarantee by the University of California or an endorsement over products of other companies not mentioned.

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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 Spring Planted Roundup Ready Alfalfa

Introduction: Roundup Ready alfalfa is new technology that recently became available to alfalfa growers. Roundup Ready alfalfa varieties have genetic resistance to glyphosate enabling Roundup UltraMax or Roundup WeatherMax to be applied directly over the crop for weed control (see Roundup UltraMax label for full details). This experiment evaluated different Roundup rates and Roundup tank-mixes for weed control in spring planted alfalfa. The trial also measured alfalfa yield, stand count, and forage quality at the first harvest.

Study Investigators: Rob Wilson

Cooperators: Richard Egan and Fred Wemple

Date and Crop Stage of Herbicide Applications:
Standish Site: 06/30/06; alfalfa at 3 to 4 leaf stage; sequential trt was applied one month after 1st trt.
Milford Site: 06/08/2006; alfalfa at 3 leaf stage; sequential trt was applied one month after 1st trt.

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:
Standish Site: planted: 06/05/06 at 17lbs/acre; flood irrigated; sandy loam soil
Milford Site: planted: 05/07/06 at 20 lbs/acre; pivot irrigated; sandy loam soil

Weeds Present at the Time of Application:
Standish Site: purslane, stinkgrass, lovegrass, redroot pigweed, common mallow, lambsquarter, puncturevine
Milford Site: sunflower, lovegrass, lambsquarter, redroot pigweed

Data Collected: % weed control was measured one month after treatment and at first cutting. Alfalfa and weed yield, alfalfa stand count, and forage quality were measured at first cutting.

Results: At both sites, Roundup at all rates provided acceptable weed control of all weed species in the trial (figures 1 & 2). At the Standish site, a small percentage of lovegrass, stinkgrass, and lambsquarter germinated and/or re-grew after the first Roundup treatment (figure 2), but these weeds were controlled if the plots were re-treated with Roundup one month after the first application (figure 2). Tank-mixes of Pursuit or Prism with Roundup did not improve weed control compared to using Roundup alone, and none of the tank-mixes caused significant crop injury or yield loss. These tank-mixes may be useful if fields have weeds that are tolerant or resistant to Roundup. When comparing Roundup to conventional seedling herbicide treatments (Raptor or Pursuit + Prism), Roundup provided better weed control at both sites (figures 1 & 2). Raptor and Pursuit + Prism gave good control of most broadleaf weeds, but they gave mediocre control of lovegrass and stinkgrass.

Total yield (weeds + alfalfa) and alfalfa yield for all the Roundup treatments were not significantly different (figures 3 & 4). At both sites, the untreated plots had the highest total yield (weeds + alfalfa), but the lowest alfalfa yield. At the Standish site, alfalfa yield in untreated plots was more than 85 % lower compared to Roundup plots. The alfalfa stand in untreated plots decreased by more than 30% compared to Roundup and Raptor treatments. At both sites, weeds made up less than 4% of the total yield in plots treated with Roundup. At the Milford site, weeds accounted for a small percentage of total yield in the Raptor and Pursuit + Prism treatments, but at Standish, weeds (lovegrass & stinkgrass) accounted for more than 40% of the total yield in Raptor and Pursuit + Prism treatments. At both sites, alfalfa yield in plots treated with Raptor was 0.2 tons/acre lower than the average yield in Roundup treated plots. Weeds affected forage quality at both sites. In weedy plots, crude protein and TDN were significantly lower compared to weed-free plots (figures 6 & 7).

In summary, Roundup Ready alfalfa looks be a valuable tool for alfalfa producers. The flexibility to treat alfalfa with Roundup anytime during the stand's life makes weed control during seedling establishment, spring green-up, and between cuttings simple and effective. Roundup also provides growers with the ability to effectively control weed species that conventional alfalfa herbicides cannot control such as dandelion, field bindweed, whitetop, quackgrass, bluegrass, lovegrass, and curly dock. As with other Roundup Ready crops, weed shifts and resistance are possible in Roundup Ready alfalfa if fields are continually treated with Roundup.

Treatment Comparison at First Cutting at the Standish Site

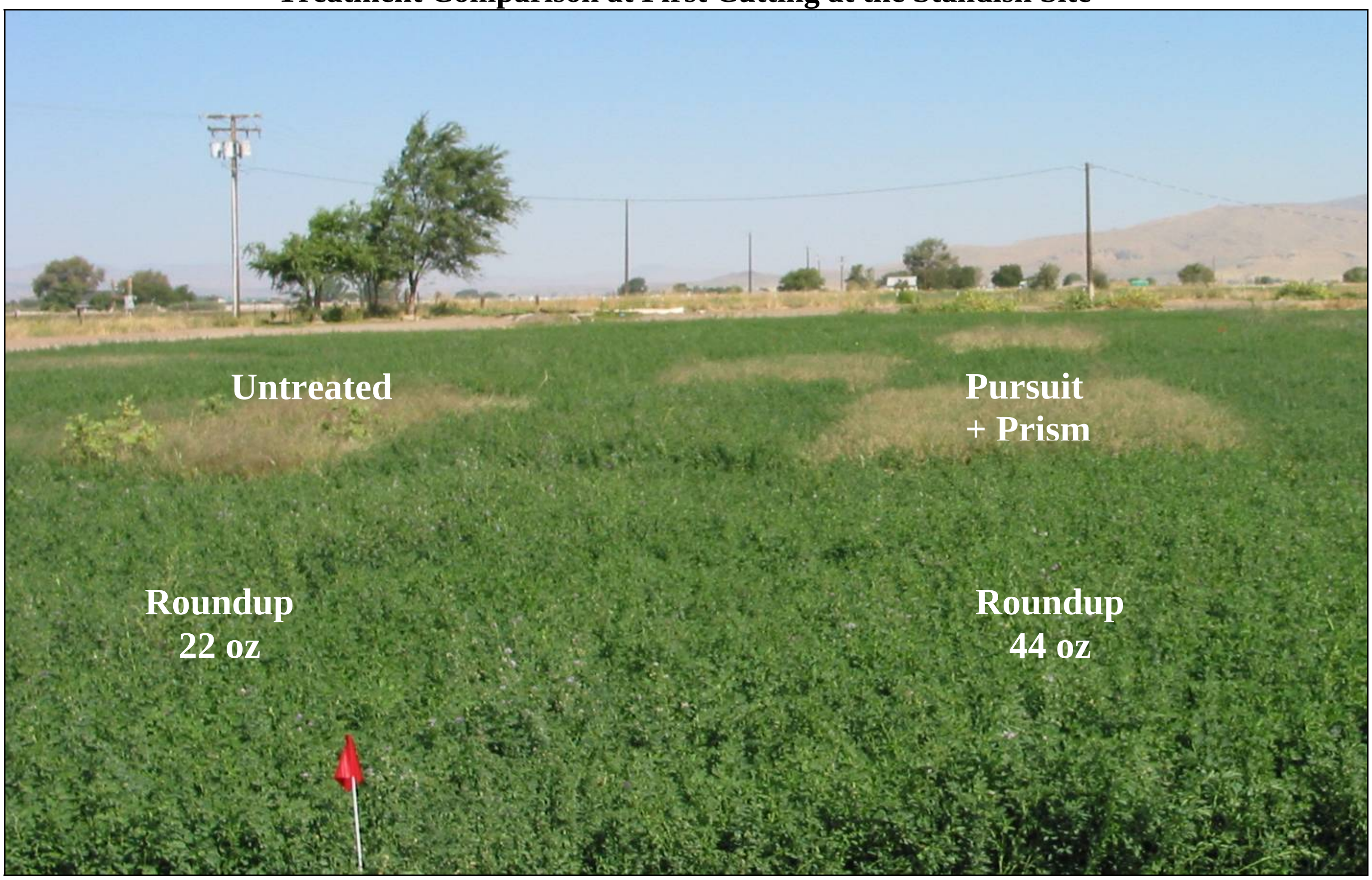
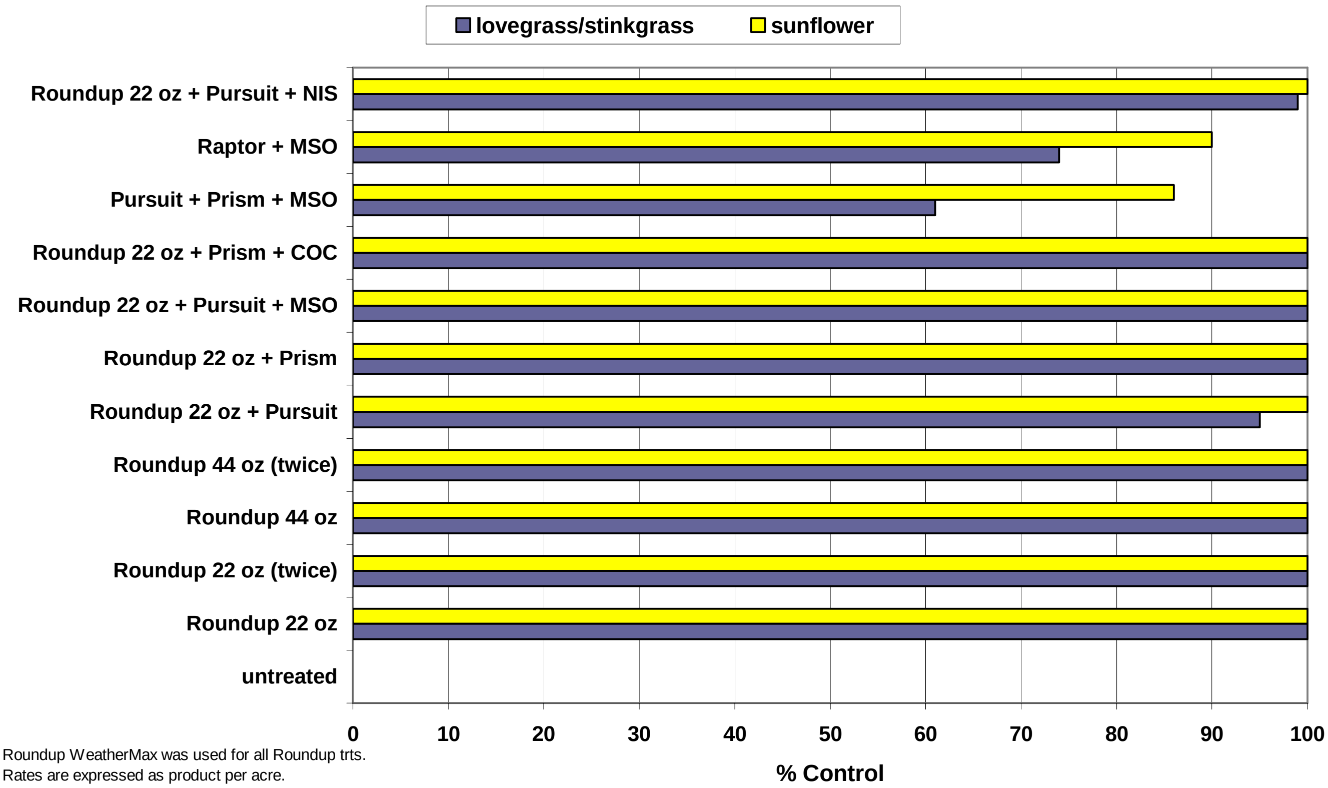
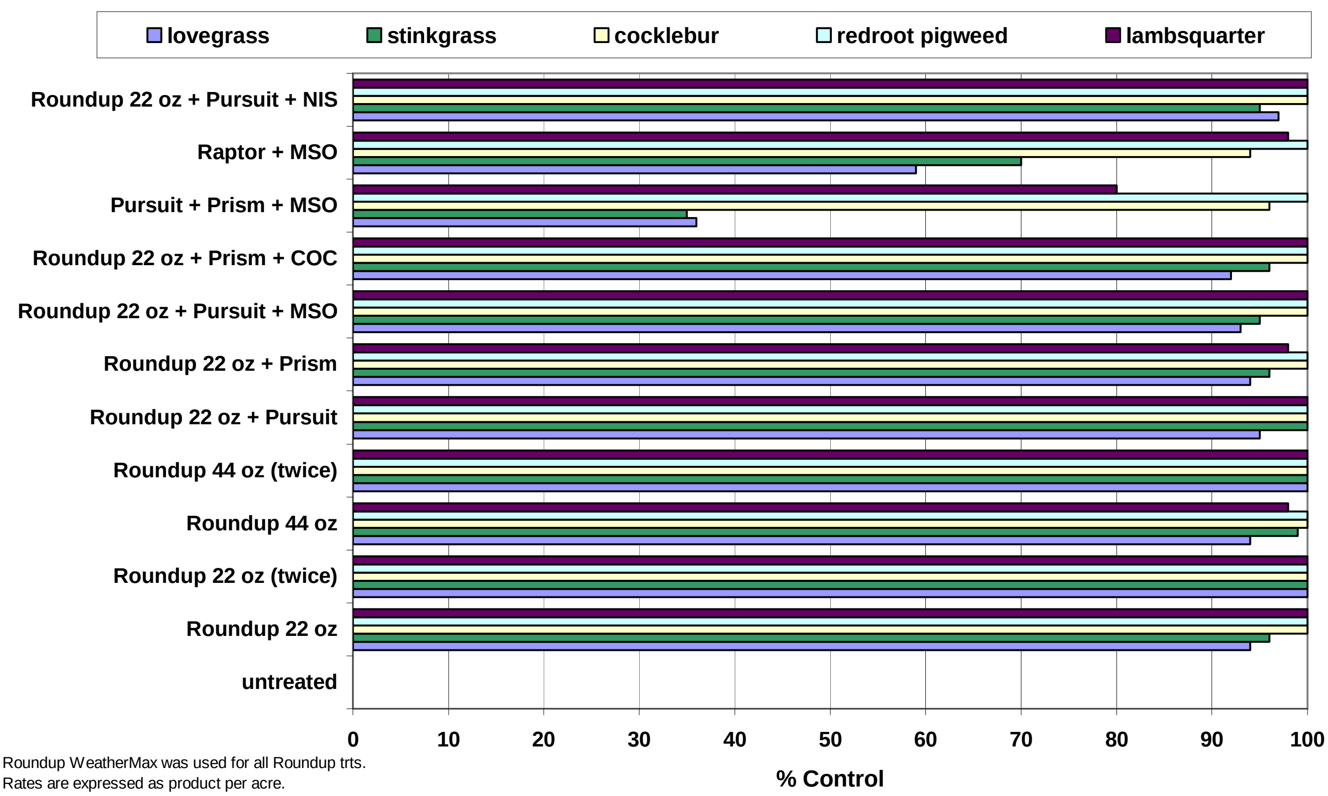


Figure 1. The Effect of Seedling Herbicide Treatments on Weed Control at 1st Cutting in Milford



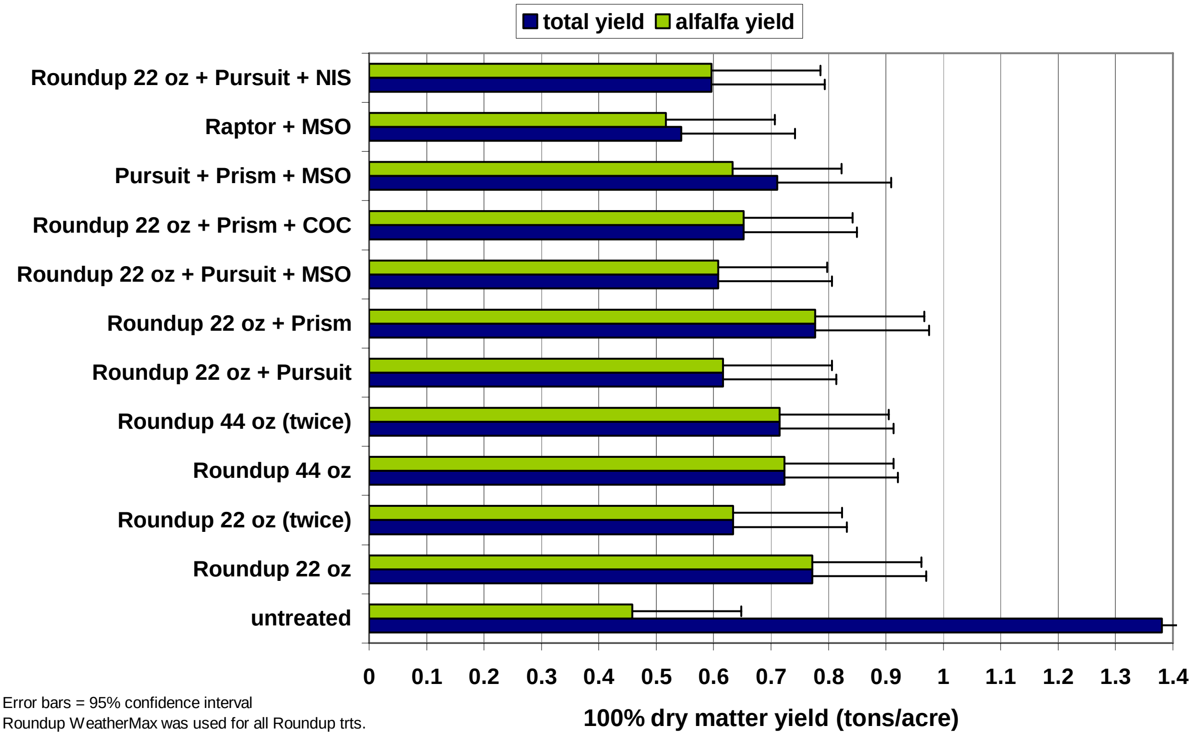
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 2. The Effect of Seedling Herbicide Treatments on Weed Control at 1st Cutting in Standish



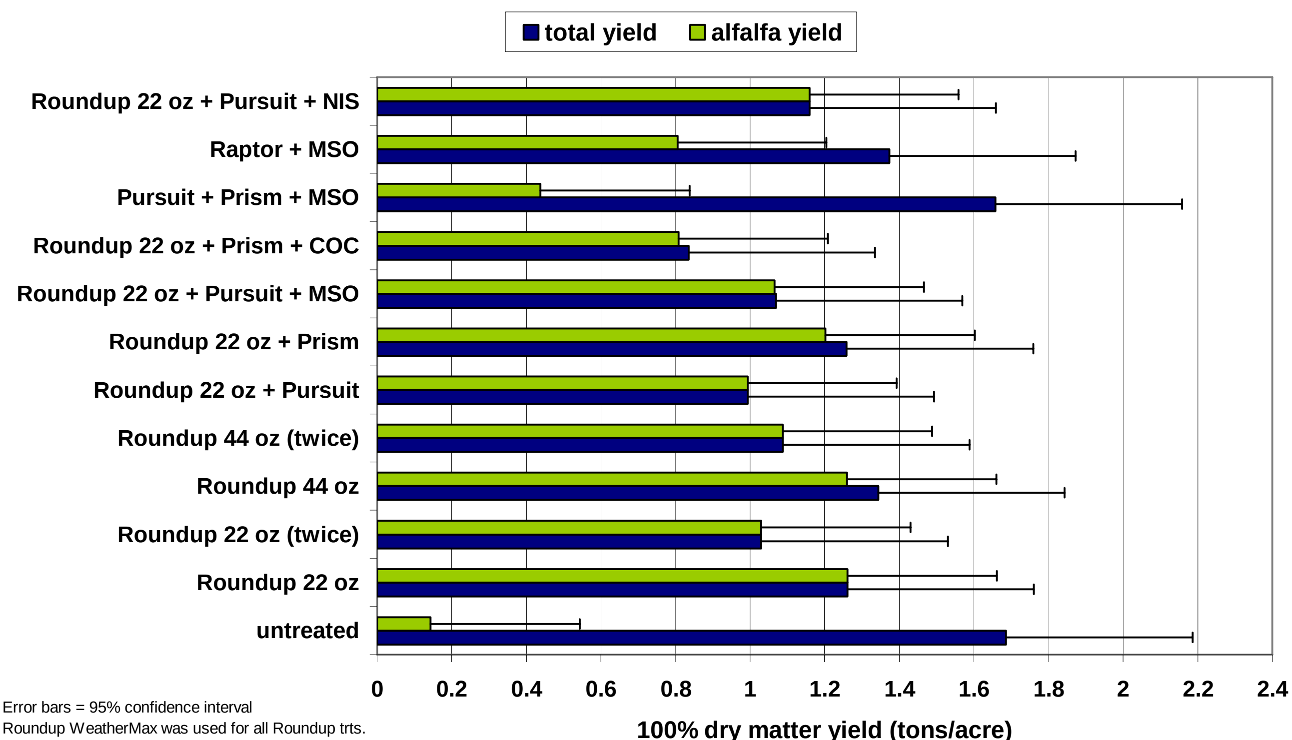
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 3. The Effect of Seedling Herbicide Treatments on Total Yield (alfalfa & weeds) and Alfalfa Yield at 1st Cutting in Milford



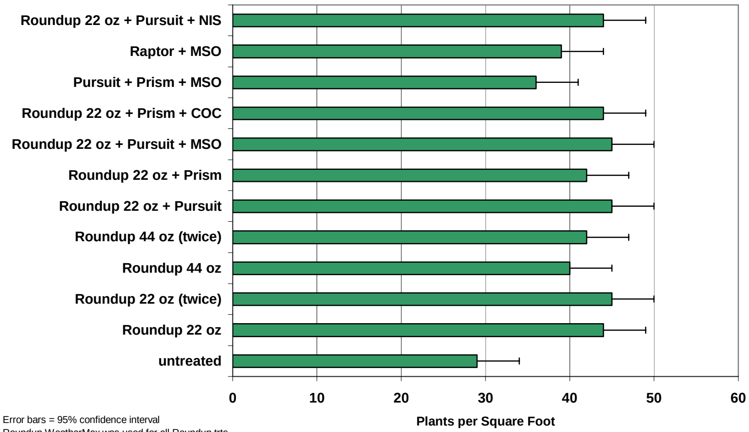
Error bars = 95% confidence interval
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 4. The Effect of Seedling Herbicide Treatments on Total Yield (alfalfa & weeds) and Alfalfa Yield at 1st Cutting in Standish



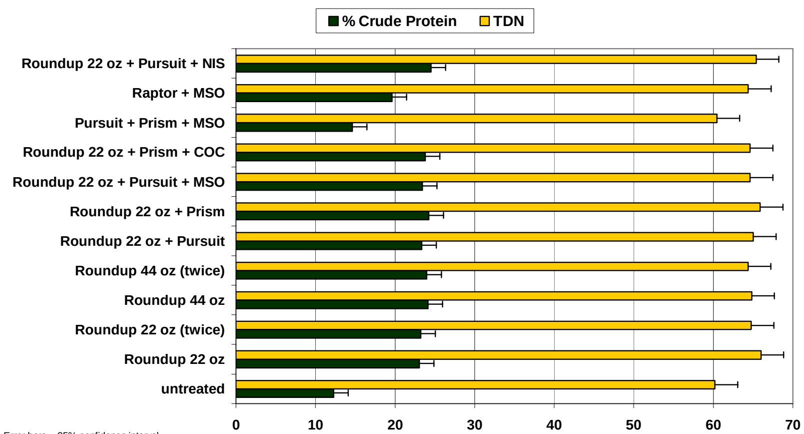
Error bars = 95% confidence interval
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 5. The Effect of Seedling Herbicide Treatments on Alfalfa Stand Count after 1st Cutting at Standish



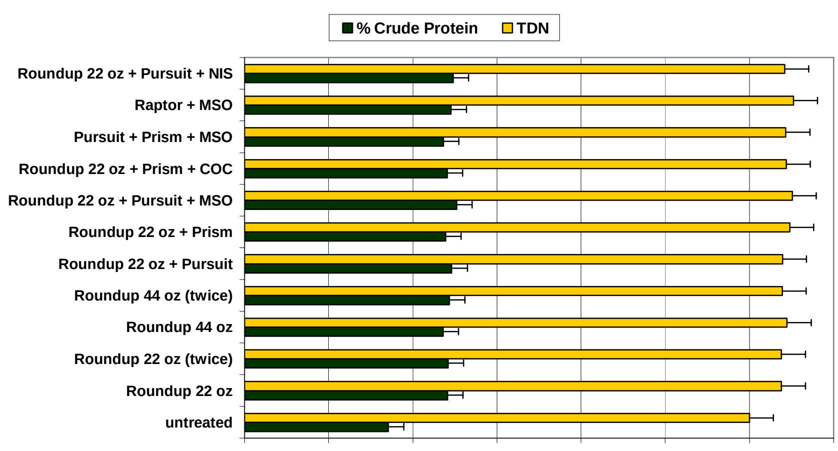
Error bars = 95% confidence interval
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 6. The Effect of Seedling Herbicide Treatments on 1st Cutting Forage Quality (alfalfa & weeds) in Standish



Error bars = 95% confidence interval
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

Figure 7. The Effect of Seedling Herbicide Treatments on 1st Cutting Forage Quality (alfalfa & weeds) in Milford



Error bars = 95% confidence interval
Roundup WeatherMax was used for all Roundup trts.
Rates are expressed as product per acre.
Pursuit, Raptor, and Prism were applied at the middle rate on the label.
All treatments included ammonium sulfate at 1.5% v/v; MSO= methylated seed oil; COC= crop oil concentrate

The Effect of Herbicides including Milestone on Bolting Scotch Thistle

<u>Introduction:</u> Milestone (aminopyralid) was recently registered in California in fall 2006. Milestone is a selective herbicide that effectively controls most thistles and knapweeds. Milestone is safe to use on most grasses. This trial evaluated the efficacy of Milestone and other herbicides on large Scotch thistle in the bolting to early bud stage. Other trials have shown Milestone to be effective at controlling Scotch thistle rosettes, but land managers often treat Scotch thistle patches after bolting since plants are visible above other vegetation.

<u>Study Investigator</u>: Rob Wilson, Don Lancaster UCCE Modoc County, and Kate Haas, Modoc County Ag. Department

<u>Cooperator</u>: Modoc Ag. Department

<u>Date of Herbicide Application</u>: June 20, 2006; 11:00 am; Air temperature 75°F.

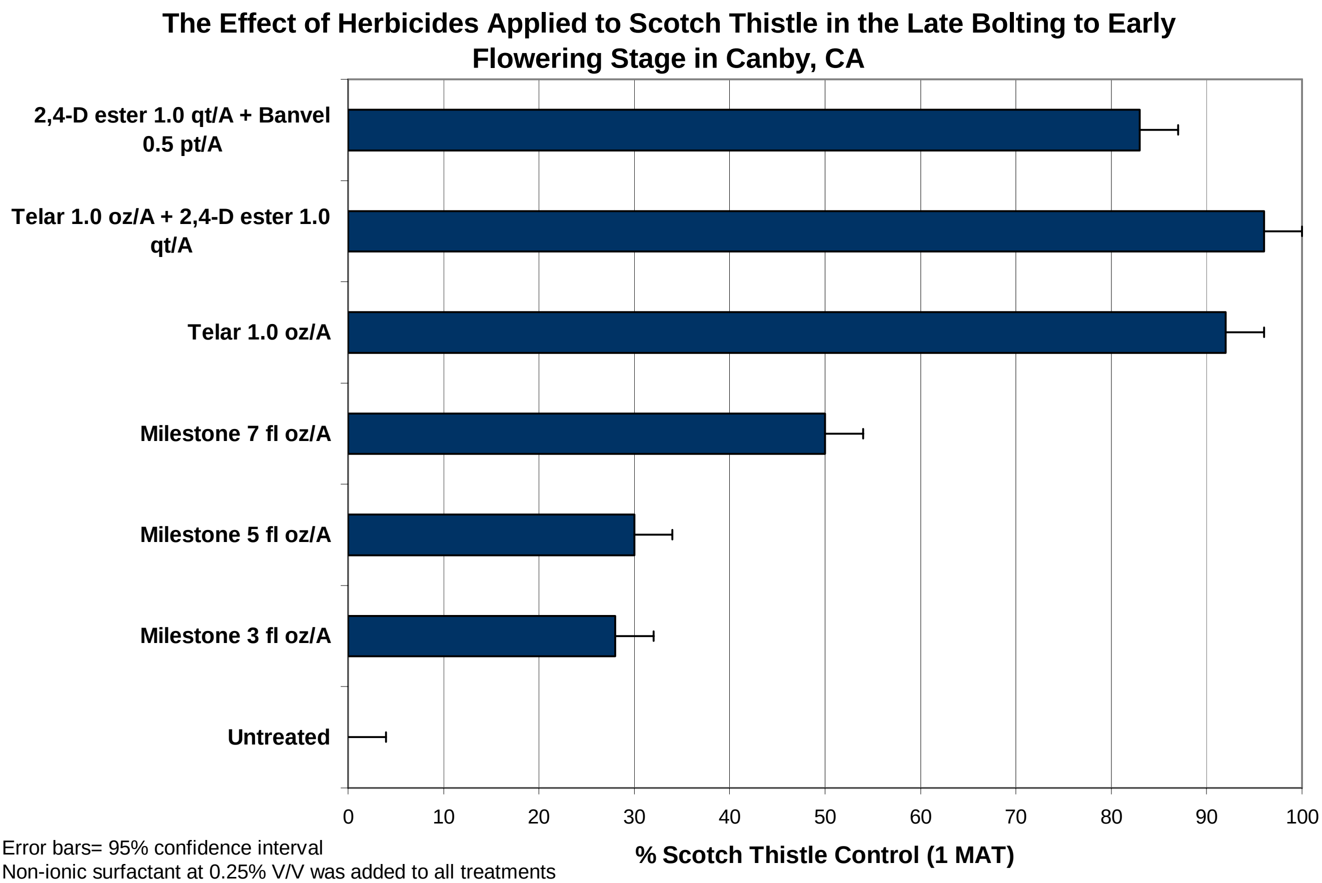
<u>Plot Size and Application Method</u>: Plot size was 10 X 30 ft. The experiment was arranged in a randomized complete block with three replications. Herbicides were applied at 20 gallons per acre using a 10 ft boom CO_2 backpack sprayer.

<u>Soil Type and Moisture</u>: sandy loam. The soil surface and sub-surface were dry at the time of the application.

<u>Plant Community Present at the Time of Application</u>: The site was located in non-cropland heavily infested with scotch thistle. Bolting Scotch thistle was 3 to 6 feet tall. Most plants in each plot were in the early flower-bud stage. Other vegetation included medusahead, downy brome, and bulbous bluegrass.

<u>Data Collected</u>: Percent control of Scotch thistle was measured one month after treatment.

<u>Results</u>: Milestone was not effective at controlling Scotch thistle in the flower-bud stage. Plants in Milestone treated plots re-grew treatment at every rate. The best herbicide treatments for controlling large Scotch thistle and preventing seed production were Telar and Telar + 2,4-D. Both Telar treatments stop Scotch thistle growth immediately and prevented seeds from forming in the seedheads. 2,4-D + Banvel was effective at controlling large Scotch thistle plants, but plump seed was present in a few of the seedheads one month after treatment. Plump seed was present in all seedheads in Milestone treated plots.



Error bars= 95% confidence interval
Non-ionic surfactant at 0.25% V/V was added to all treatments
Rates are listed as product rate per Acre

Evaluations of Matrix and Matrix Tank-mixes for Selective Annual Grass Control in Big Sagebrush rangeland

Introduction: Matrix (rimsulfuron) is a herbicide currently labeled for use in potatoes and tomatoes. This experiment evaluated the effectiveness of Matrix and Matrix tank-mixes for downy brome and medusahead control in big sagebrush rangeland. The experiment evaluated weed control and Matrix safety on perennial grasses and sagebrush.

Study Investigators: Rob Wilson

Cooperator: Lassen Ag. Department and Richard Egan

Date of Herbicide Application: December 06, 2006; 10:00 am; Air Temperature 40°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.

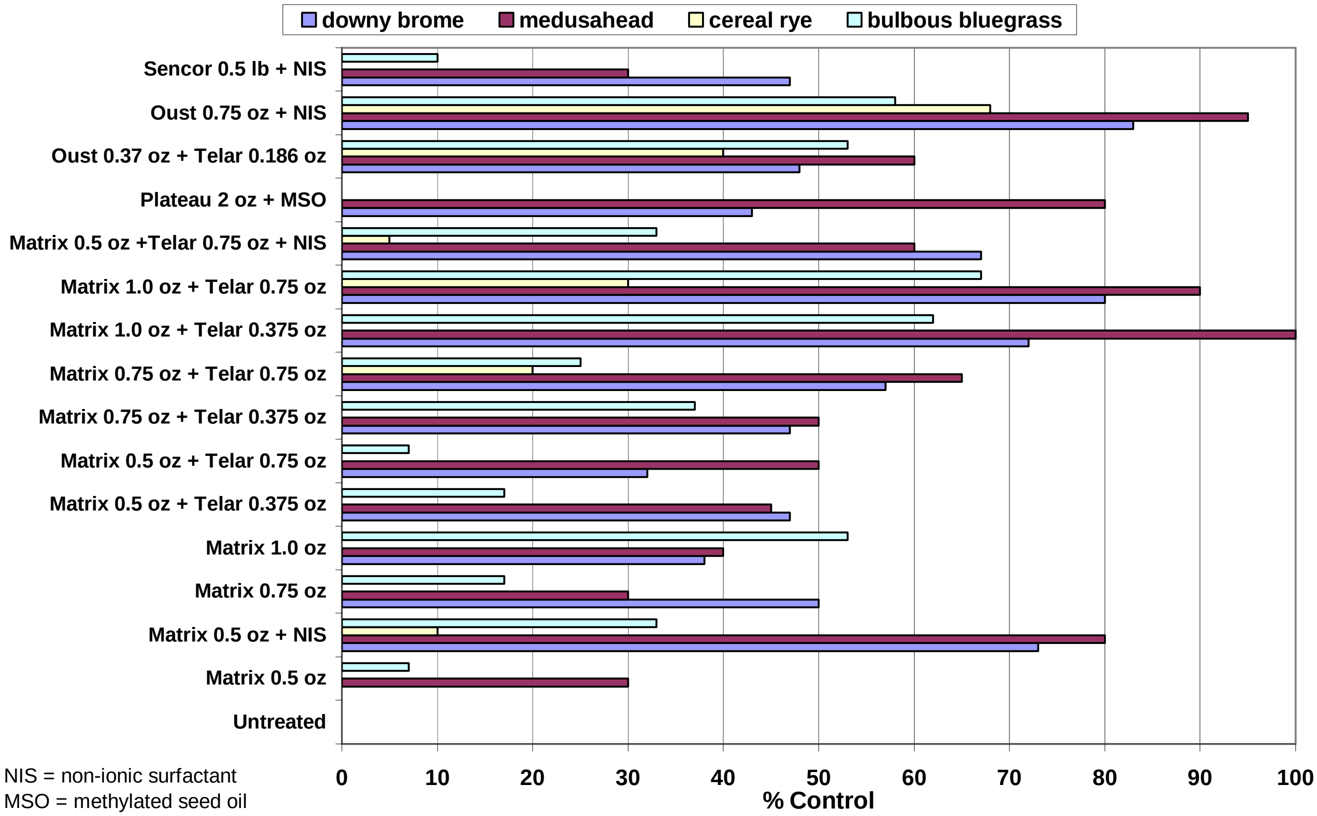
Soil Type and Moisture: loam. The soil surface and sub-surface were moist at the time of the application. Both sites received over 15 inches of precipitation between December and April after the December application. The winter of 2006 was extremely wet; average precipitation at the sites is around 8 inches between December and April.

Plant Community Present at the Time of Application: The sites were located in non-cropland heavily infested with medusahead and/or downy brome. Vegetation at the Egan site was primarily medusahead with scattered squirreltail, downy brome, big sagebrush, and bitterbrush. Vegetation at the Susanville site was primarily downy brome with scattered medusahead and cereal rye. Downy brome and medusahead were starting to emerge to 1 inch tall at the time of herbicide application. Perennial grasses were dormant at herbicide application.

Data Collected: Percent control evaluations were made when annual and perennial grasses were flowering approximately 6 months after treatment.

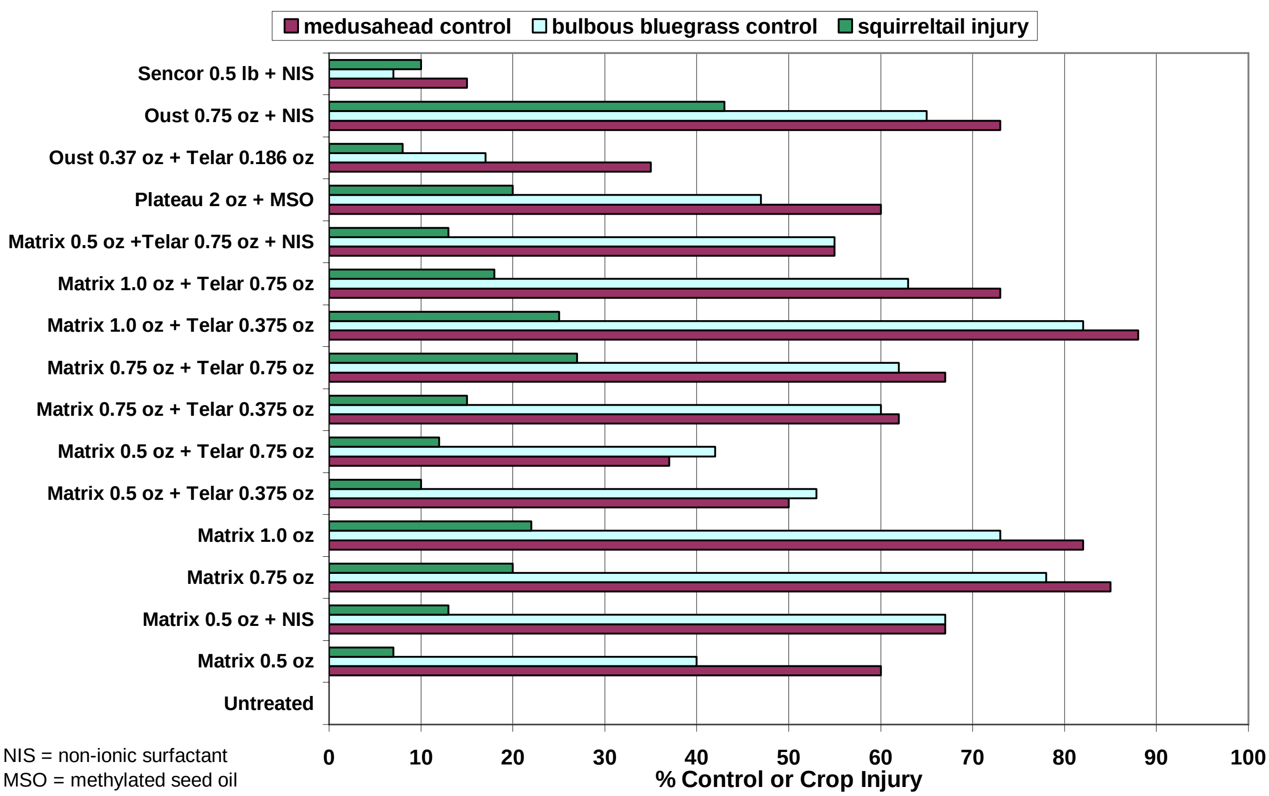
Results: Results suggest Matrix has a potential fit for selective medusahead and downy brome control in Northern California, but more research is needed examining rates and application timing. At both sites, excessive precipitation shortly after application increased data variability and affected results. Several Matrix treatments provided similar control of downy brome and medusahead compared to Plateau and Oust (two herbicides currently used for selective annual grass control in perennial grass rangeland). At rates at or above 0.75 oz ai/A, Matrix provided over 75% control of medusahead at the Egan site. Downy brome control with Matrix was not acceptable at the Susanville site, but Matrix rates at or above 0.75 oz ai/A caused considerable downy brome stunting and seedhead reduction. Matrix showed acceptable selectivity on squirreltail, intermediate wheatgrass, and big sagebrush. Matrix caused less injury to these desirable plants compared to Plateau and Oust.

The Effect of Matrix and Other Herbicides Applied in Early December on Weed Control in June 2006 at the Susanville Site



NIS = non-ionic surfactant
MSO = methylated seed oil

The Effect of Matrix and Other Herbicides Applied in Early December on Weed Control and Grass Injury in June 2006 at the Egan Site



NIS = non-ionic surfactant
MSO = methylated seed oil

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.

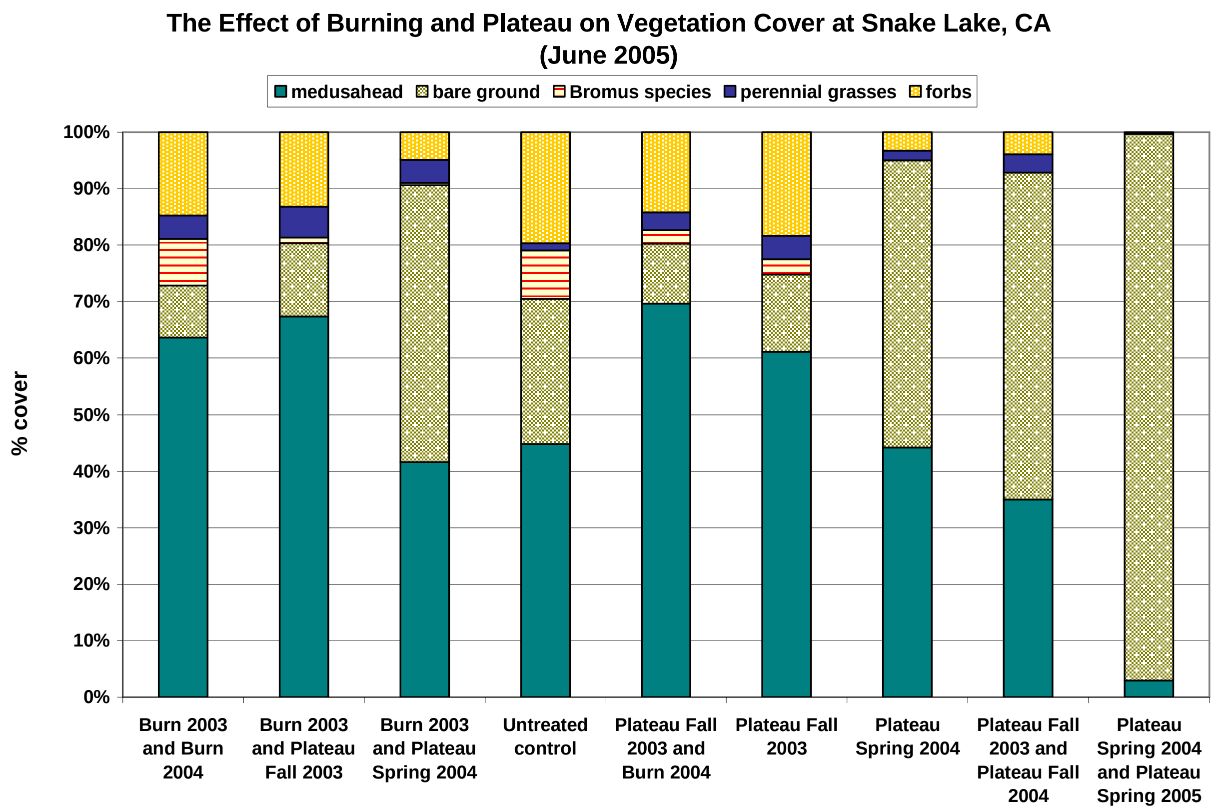
Study Investigators: Joe DiTomaso, UC Davis Weed Specialist, Guy Keyser, UC Davis Research Associate, and Rob Wilson

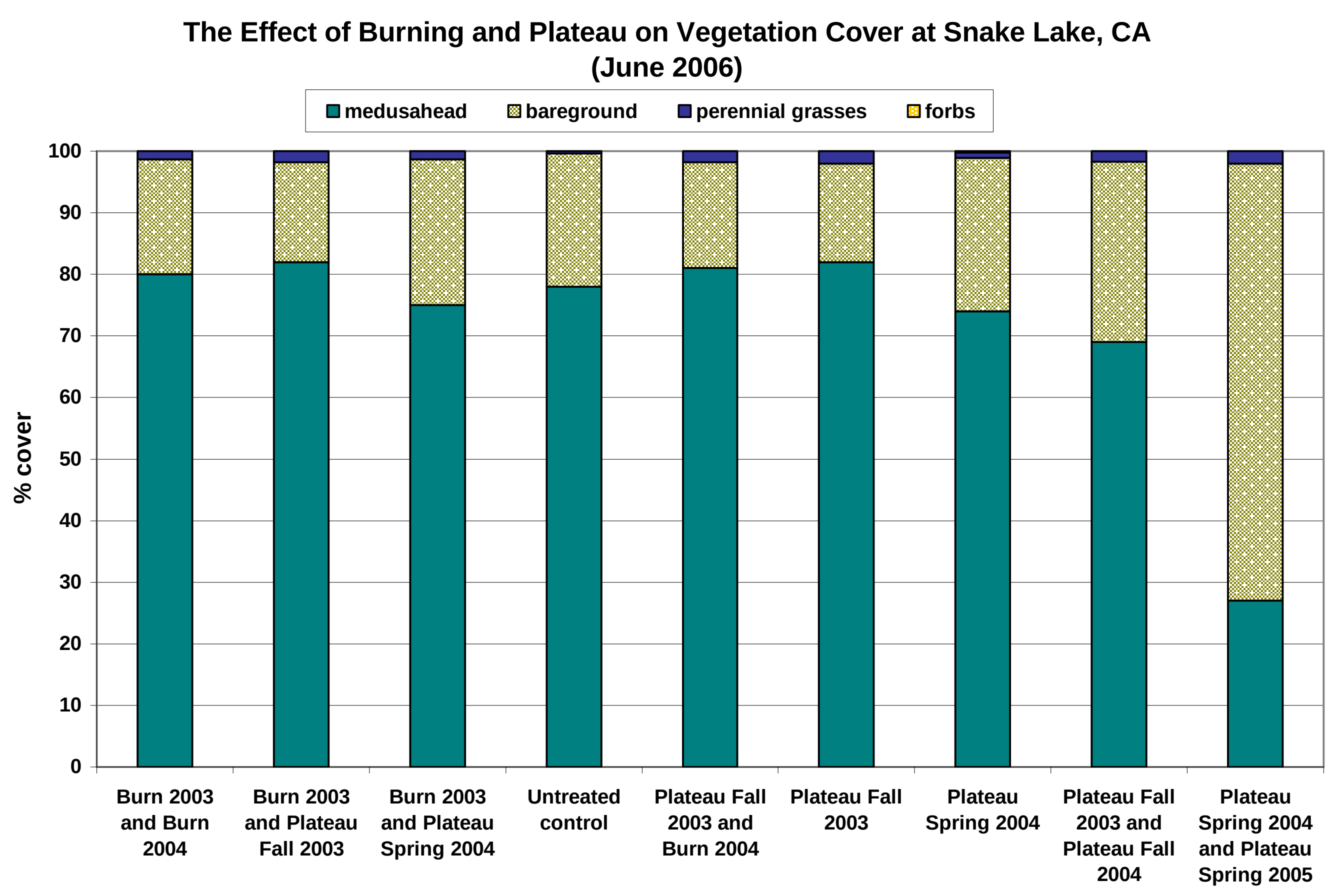
Cooperators: Alan Uchida and Garth Jeffers/ Cedarville BLM office

Materials and Methods:

- The study consisted of 9 treatments arranged in a randomized complete block with 3 replications (24 plots total).
    - Plot size was 100 ft X 100 ft
    - 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, 2004, and/or 2005 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, 2005, and 2006 to evaluate treatment effects on the plant community. June measurements occurred when medusahead was in the flowering to soft-dough stage.

Result Summary: Several treatments provided over 80% control of medusahead the year of treatment, but medusahead populations rebounded to pre-treatment levels 1year after treatment (1 YAT) in most plots. Two consecutive Plateau applications in March provided the best control of medusahead 1 YAT, but control was only 65% suggesting long-term suppression is unlikely. Two years of applying Plateau in October or summer burning followed by a March Plateau application decreased medusahead cover compared to untreated plots 1 YAT, but medusahead cover rebounded to pre-treatment levels 2 years after treatment (figure 2). March applications of Plateau provided superior medusahead control compared to applications in October. A disappointing trend following all Plateau treatments was a striking increase in bare ground 1 YAT. Unfortunately, existing and aerially seeded native forb and perennial grasses did not increase 1 and 2 YAT. Burn treatments were unsuccessful at controlling medusahead, and several burn treatments increased medusahead cover compared to untreated plots.


The Effect of Burning and Plateau on Vegetation Cover at Snake Lake, CA
(June 2005)
medusahead
bare ground
Bromus species
perennial grasses
forbs
% cover
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Burn 2003 and Burn 2004
Burn 2003 and Plateau Fall 2003
Burn 2003 and Plateau Spring 2004
Untreated control
Plateau Fall 2003 and Burn 2004
Plateau Fall 2003
Plateau Spring 2004
Plateau Fall 2003 and Plateau Fall 2004
Plateau Spring 2004 and Plateau Spring 2005


The Effect of Burning and Plateau on Vegetation Cover at Snake Lake, CA
(June 2006)
medusahead
bareground
perennial grasses
forbs
% cover
100
90
80
70
60
50
40
30
20
10
0
Burn 2003 and Burn 2004
Burn 2003 and Plateau Fall 2003
Burn 2003 and Plateau Spring 2004
Untreated control
Plateau Fall 2003 and Burn 2004
Plateau Fall 2003
Plateau Spring 2004
Plateau Fall 2003 and Plateau Fall 2004
Plateau Spring 2004 and Plateau Spring 2005

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.

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 in a 1 m^2 quadrat.

Result Summary: Several native and introduced plant species successfully established under dryland conditions on weedy sites in Northern California. Cover measurements showed several grass species in combination with herbicides provided superior weed suppression compared to using herbicides alone the year after grass establishment (figures 1-5). At locations with heavy weed competition, herbicide treatment the year of seeding and year after seeding was critical for successful grass establishment (figures 7-9). Without herbicide treatment, weed cover was greater than 70 % and seeded grass cover was less than 5 % at all sites one year after planting. Telar, 2,4-D ester, Transline + 2,4-D ester, Weedmaster, and Pursuit caused minimal injury to perennial grasses during establishment. Pursuit was safe on seedling alfalfa.

Average species cover differed between sites in 2006 (figures 1-6) and appeared to be correlated to soil moisture. Sites with the highest soil moisture during the year of seeding had the highest average grass cover. Although soil moisture increased grass cover, weed control was the most important factor affecting grass establishment success. At the site with the highest soil moisture (Tulelake Wildlife Refuge), average seeded species cover was 5 % in untreated plots whereas it was > 50% in plots treated with Telar one year after seeding.

When comparing individual grass species, their establishment success differed between sites one year after seeding (figures 1-5). The differences were related to soil type and soil moisture during the year of establishment. The Tulelake sites had clay loam soil with 9 to 12 inches of precipitation during the establishment year. The Yreka site had gravelly loam soil with 8.5 inches of precipitation during the establishment year. The Doyle site had sandy loam soil with 2.9 inches of precipitation during the establishment year. The Likely site had loam soil with 6.9 inches of precipitation during the establishment year. Averaged across sites, crested wheatgrass, tall wheatgrass, western wheatgrass (native), and bluebunch wheatgrass (native) had the highest cover 1 year after seeding (figure 6). Bottlebrush squirreltail and Paiute orchardgrass had the lowest cover 1 year after seeding (figure 6). 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 in Herbicide Treated Plots at the Tulelake National Wildlife Refuge One Year After Seeding (July 2006)

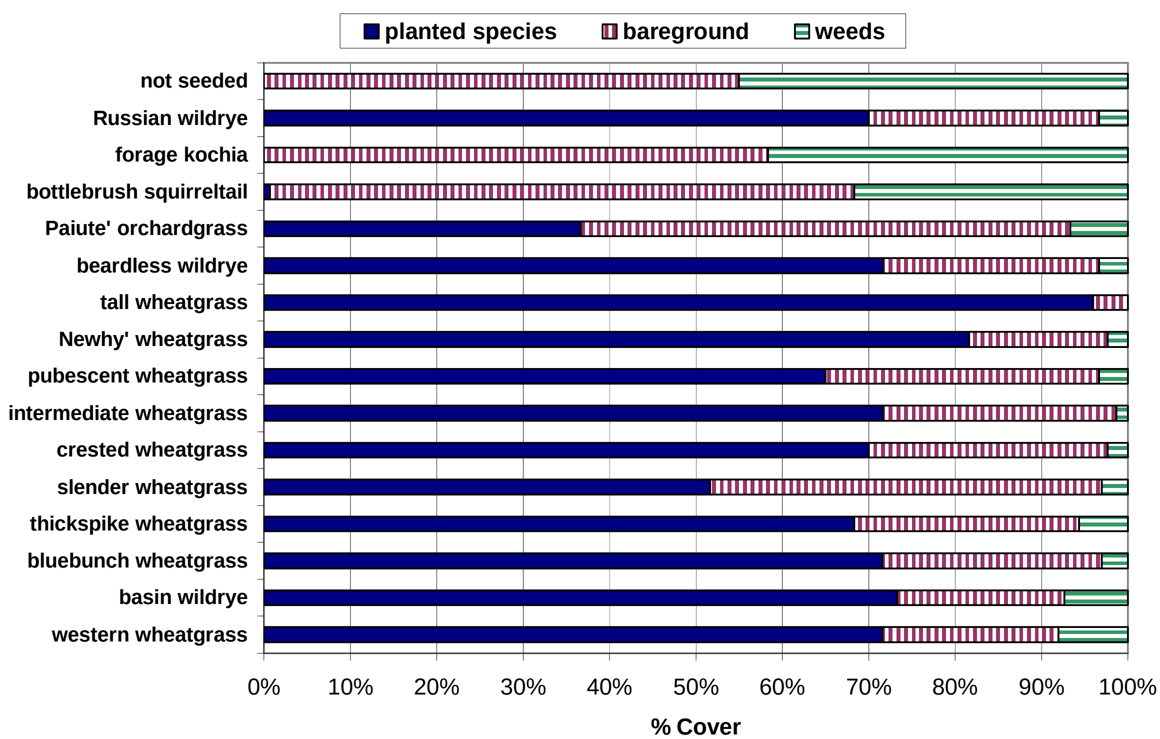


Figure 2. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide Treated Plots at Yreka One Year After Seeding (July 2006)

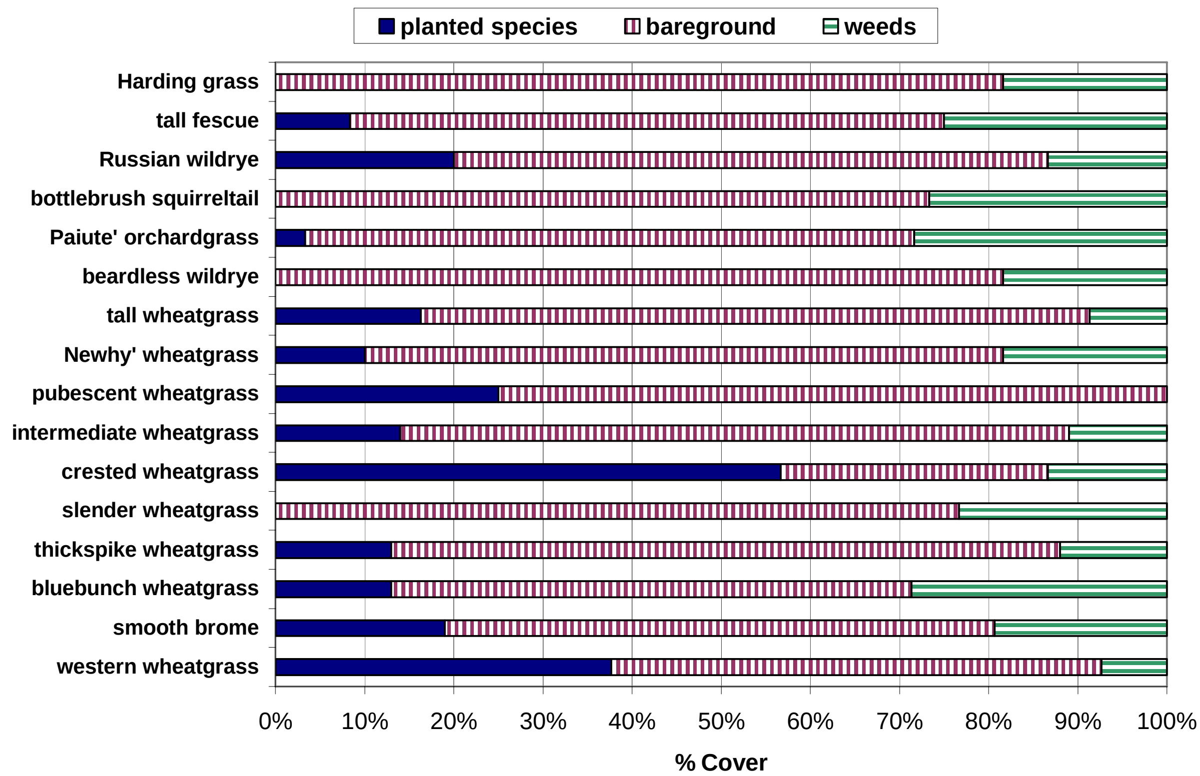


Figure 3. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide Treated Plots at Likely One Year After Seeding (June 2006)

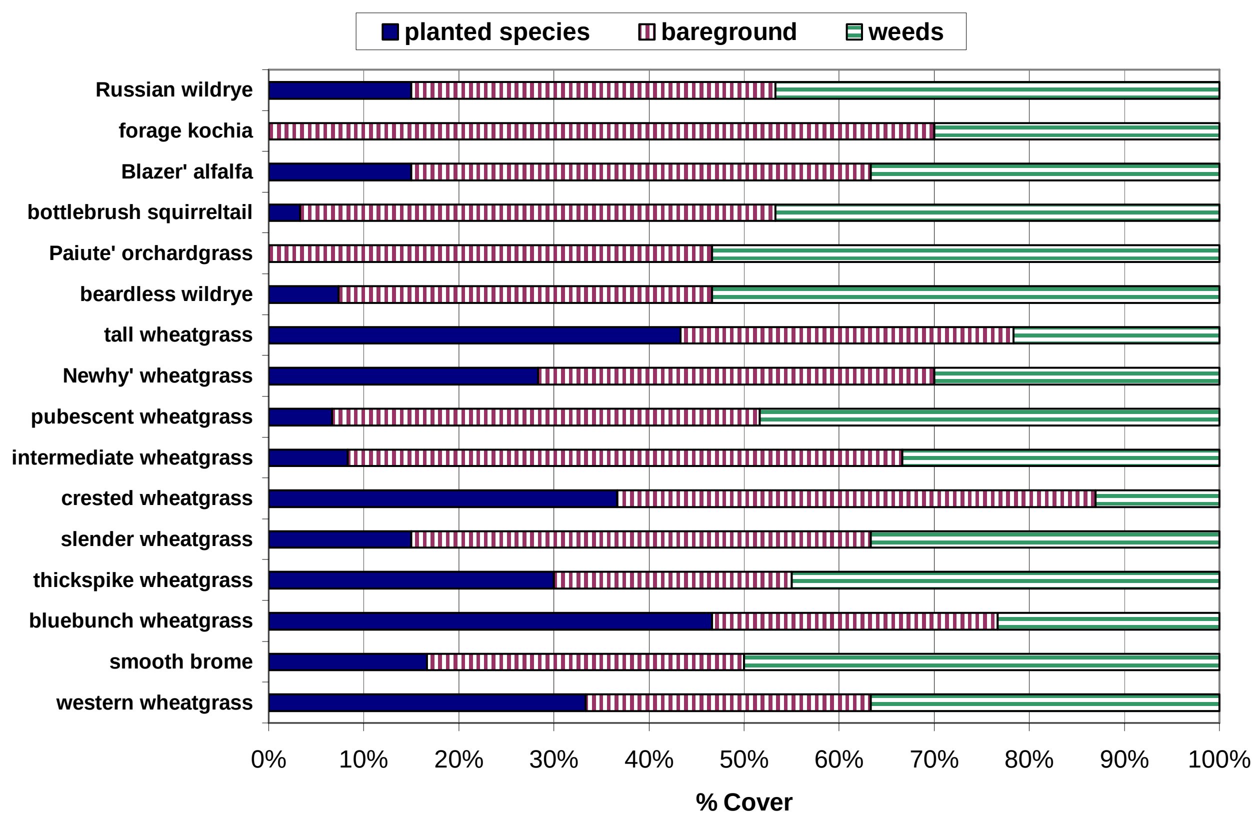


Figure 4. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide Treated Plots at the IREC Field Station Two Years After Seeding (July 2006)

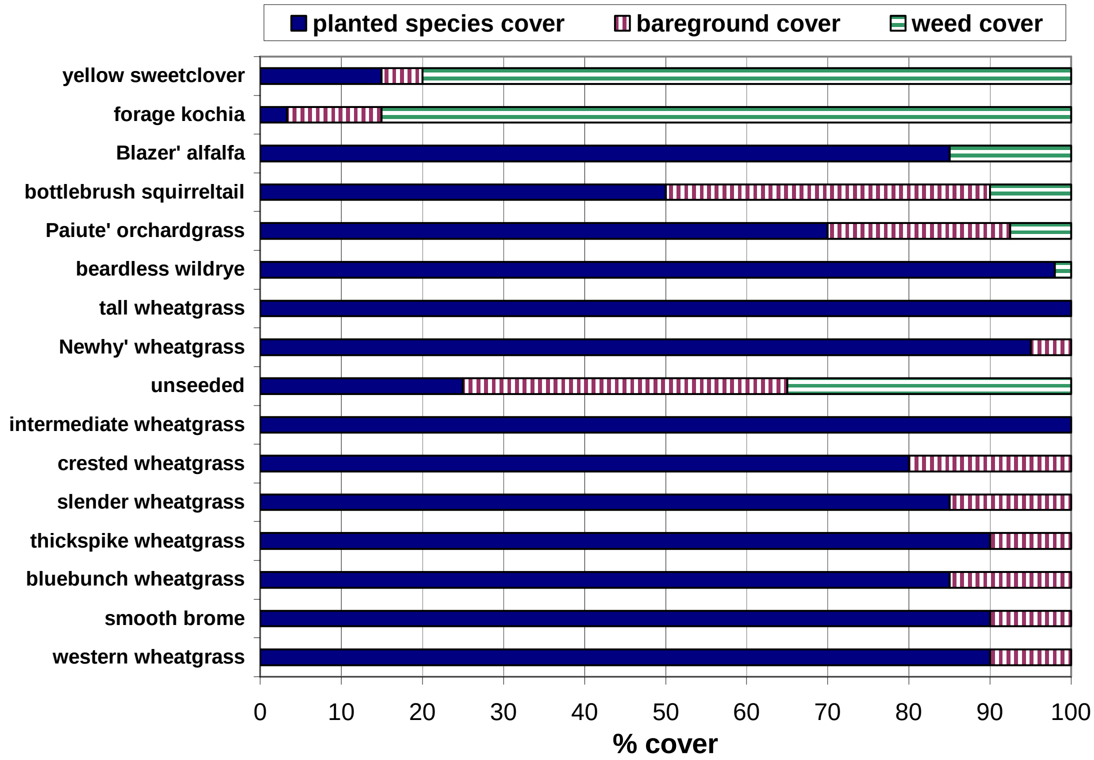


Figure 5. Percent Cover of Planted Species, Bareground, and Weeds in Herbicide Treated Plots at Doyle, CA Two Years After Seeding (June 2006)

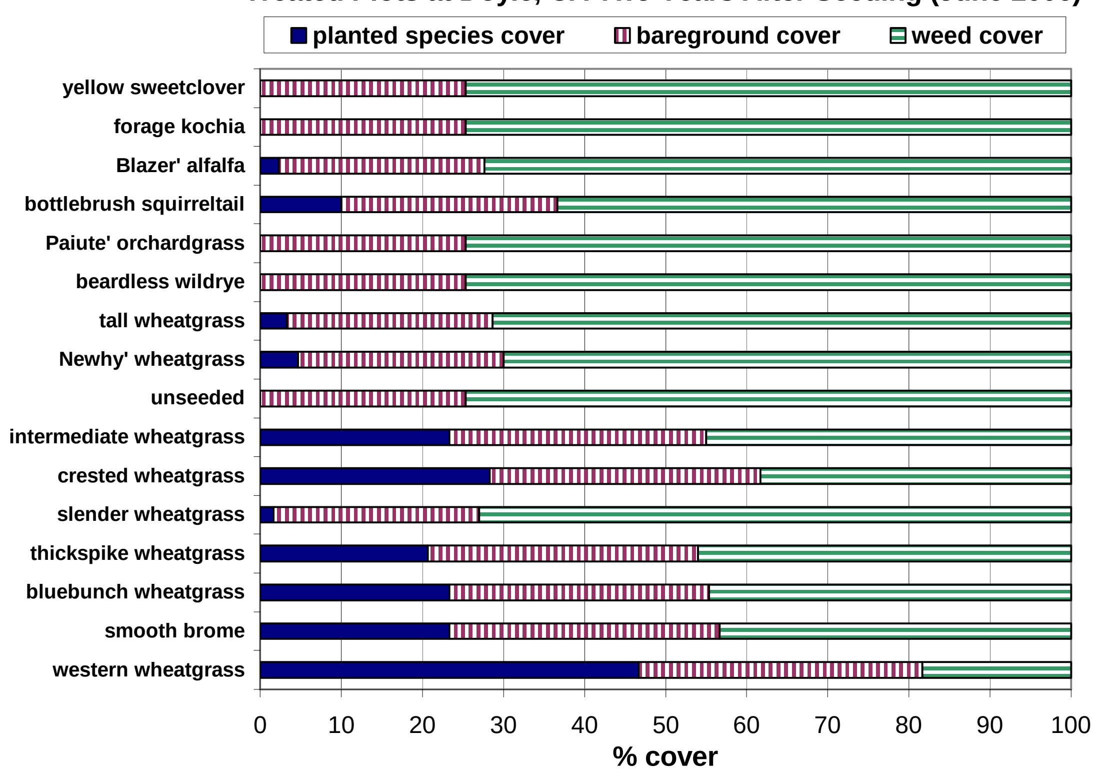


Figure 6. Percent Cover of Planted Species in Herbicide Treated Plots Averaged Across All Sites One Year After Seeding

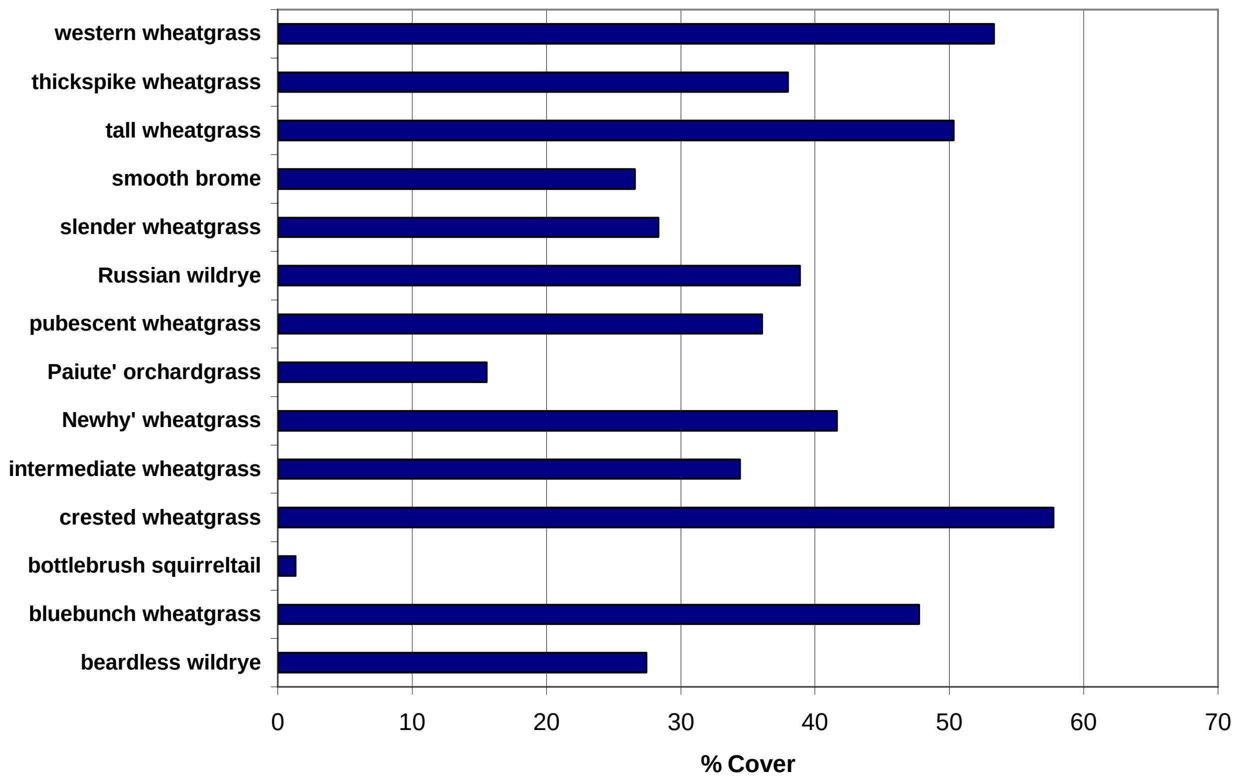
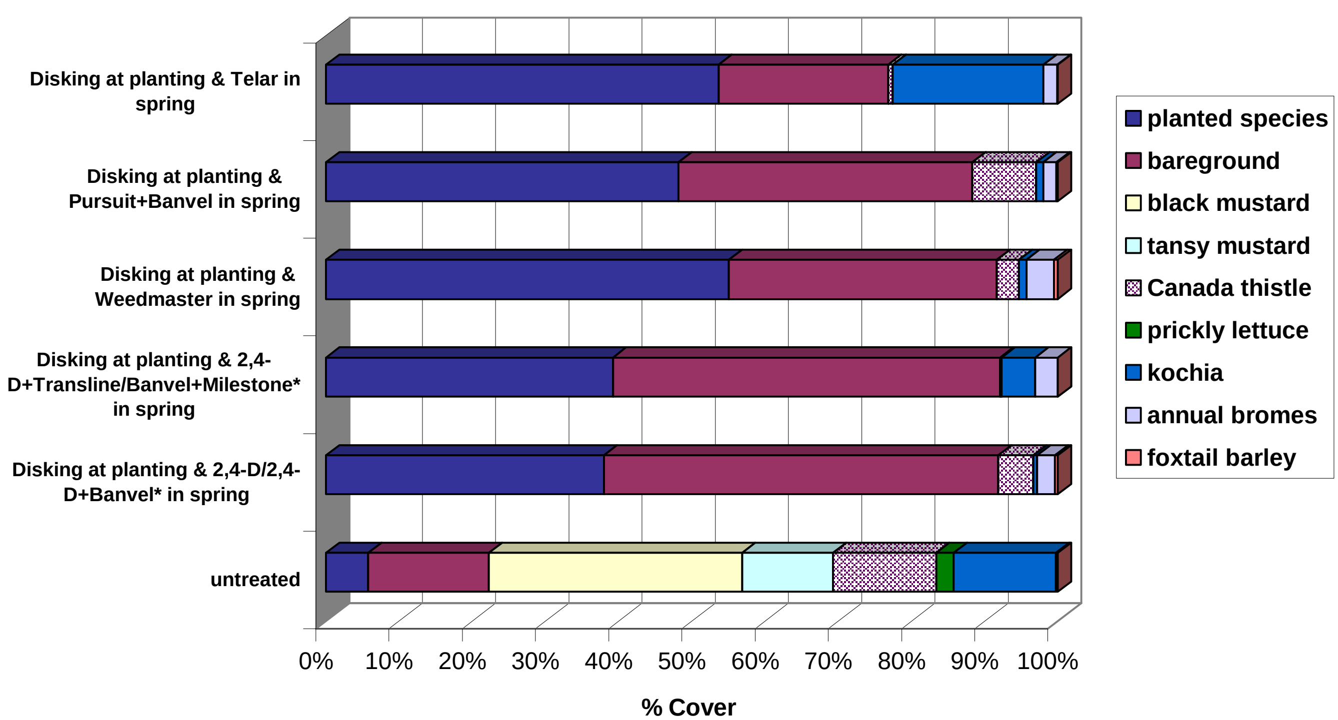
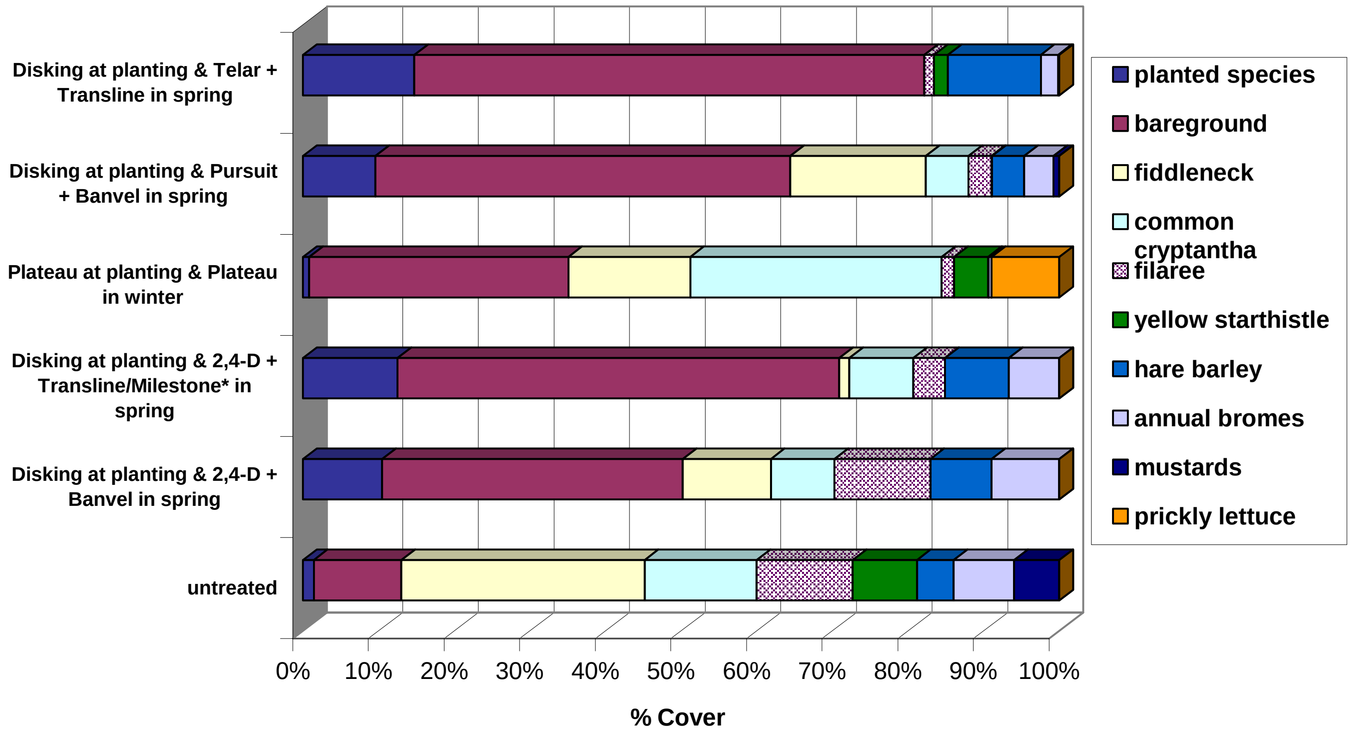


Figure 7. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover at the Tulelake Wildlife Refuge One Year After Seeding (June 2006)



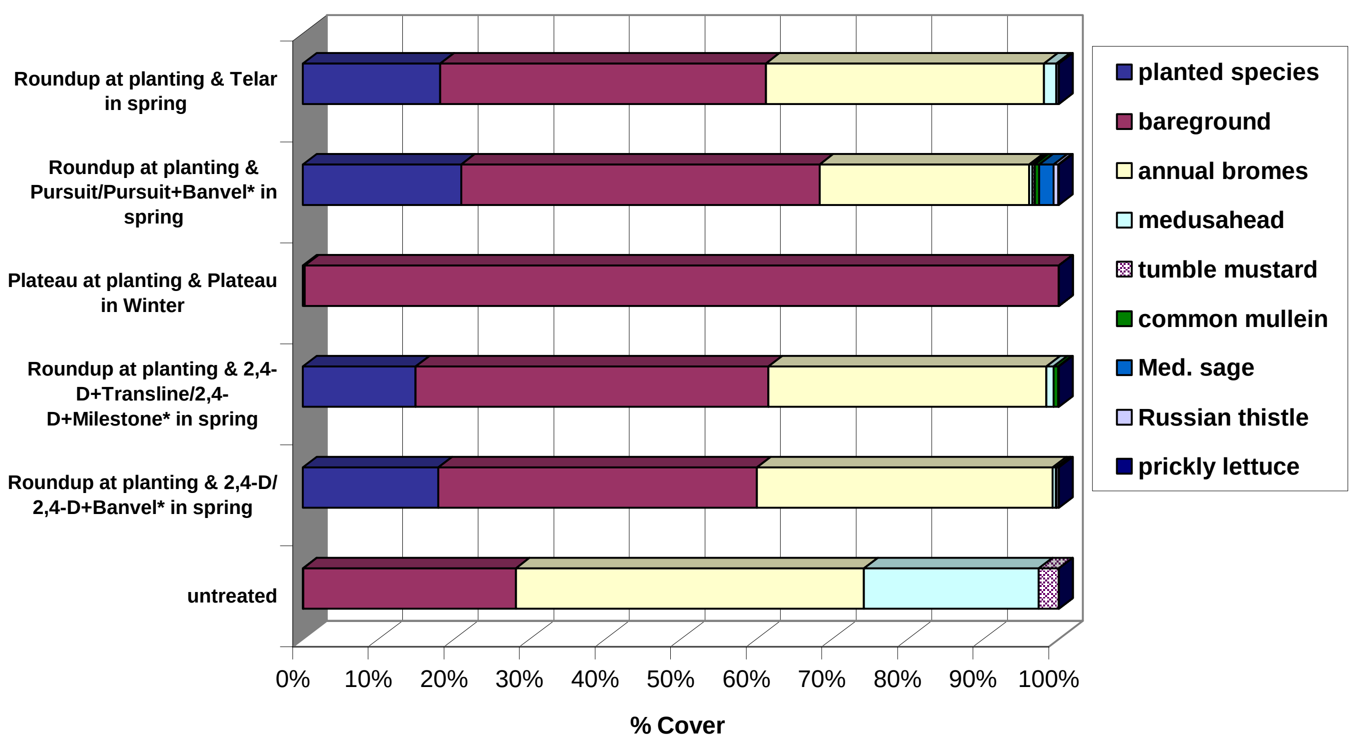
*= herbicide treatment applied the year of seeding/herbicide treatment applied the year following seeding .

Figure 8. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover at Yreka One Year After Seeding (June 2006)



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

Figure 9. The Effect on Herbicides on Weeds, Bareground, and Planted Species Cover at Likely One Year After Seeding (June 2006)



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

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, 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.

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Materials and Methods

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. 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 incorporated litter into the soil and severe perennial pepperweed's interconnected roots. Previous research has shown 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, 2005, and 2006. Seeded perennial grass cover was recorded in spring and fall 2004, 2005, and 2006. Data was collected in three, randomly placed 1 m^2 quadrats in each sub-plot.

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, mowing, tillage, and grazing were effective at knocking down old thatch to facilitate herbicide treatment. Burning and tillage were also effective at removing thatch and exposing bare soil. All herbicide treatments reduced perennial pepperweed cover one, two, and three years after treatment, although certain herbicide + site preparation combinations provided better control than others (see graphs). 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 mediocre control at the Mapes site. The reason for the poor control with Telar 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.

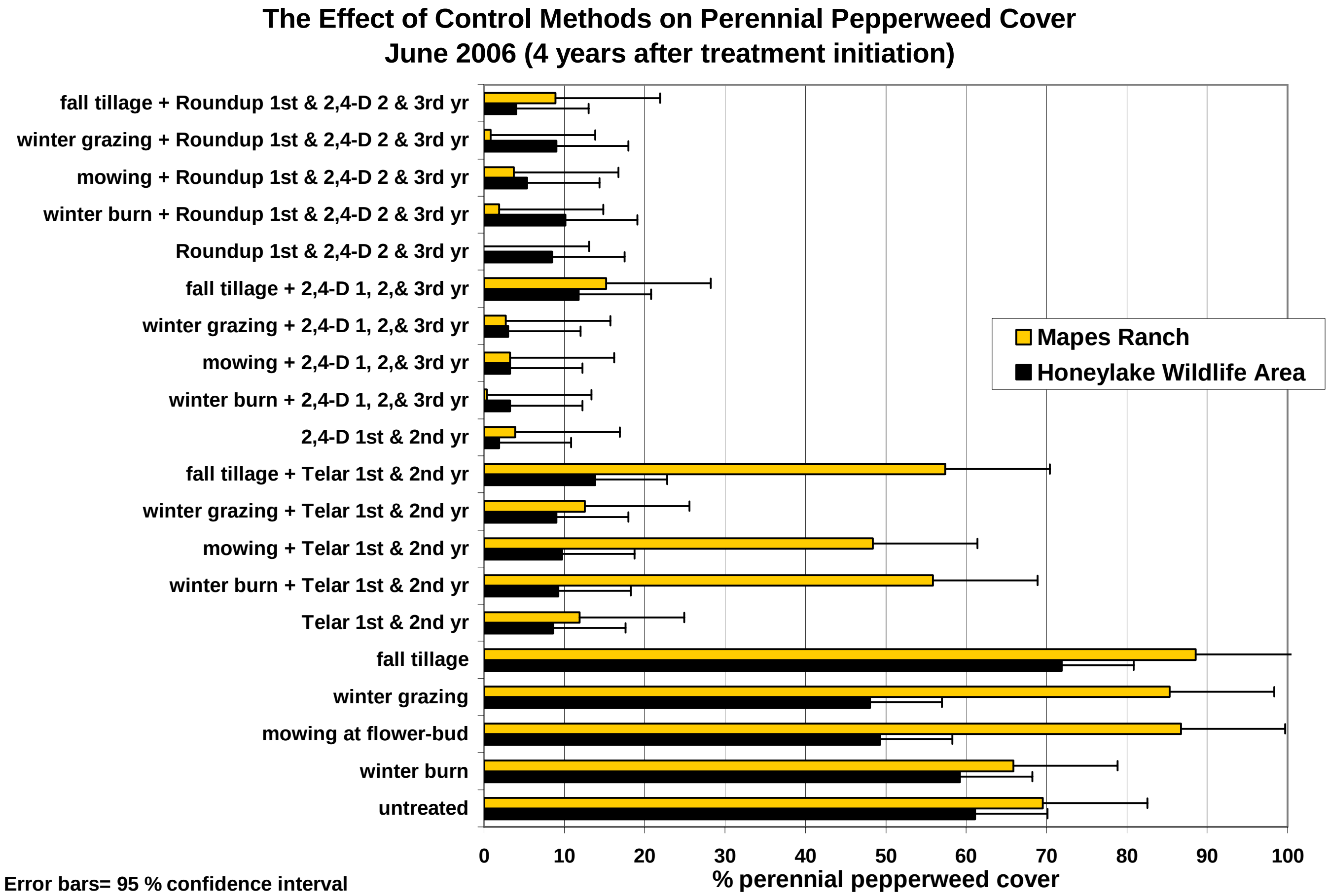
Winter burning and fall tillage provided the best seedbed for re-seeding grasses. Due to extremely low spring rainfall, perennial grass establishment was terrible in 2004. Plots were re-seeded in March 2005 at both sites to evaluate seeding under average weather conditions. Precipitation was average in 2005 and above average in 2006.

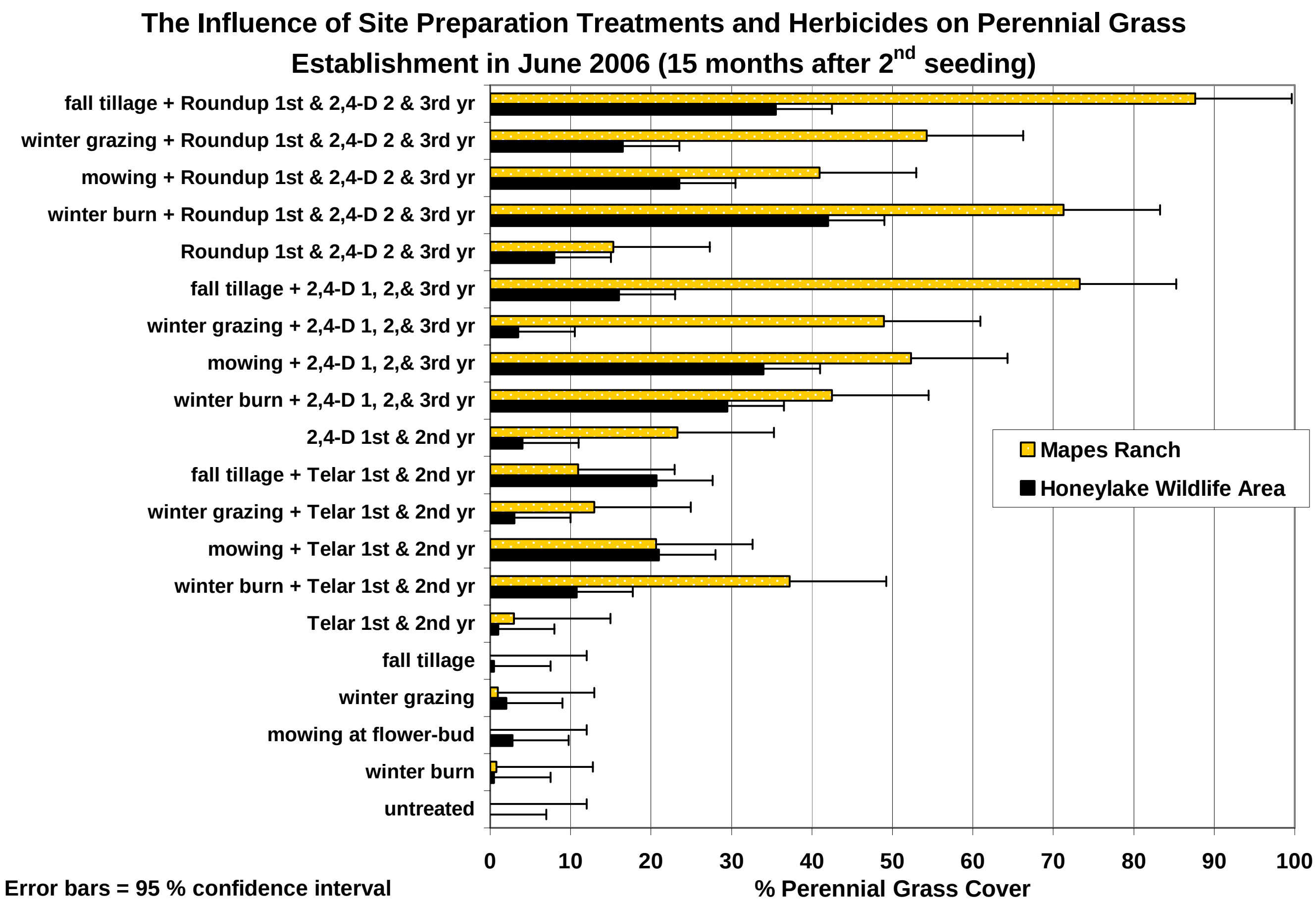
Perennial grass establishment after the 2005 seeding was a success in several treatments (see graphs). The treatments that provided the best grass establishment were burning mowing, or tilling before seeding in combination with herbicide treatment before and after seeding. Applying Roundup or 2,4-D before seeding and 2,4-D after seeding were the best herbicide treatments for maximizing grass establishment. Grass cover was **<** 4 % in plots that did not receive herbicide treatment due to excessive competition from perennial pepperweed. Grasses in plots treated with Telar were stunted and showed signs of herbicide injury suggesting Telar should be applied after grass establishment.

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, and fall tillage increased soil salinity compared to all other treatments. 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 affected by treatments. Soil in herbicide-treated plots had higher soil nitrate compared to untreated plots regardless of the site preparation method.

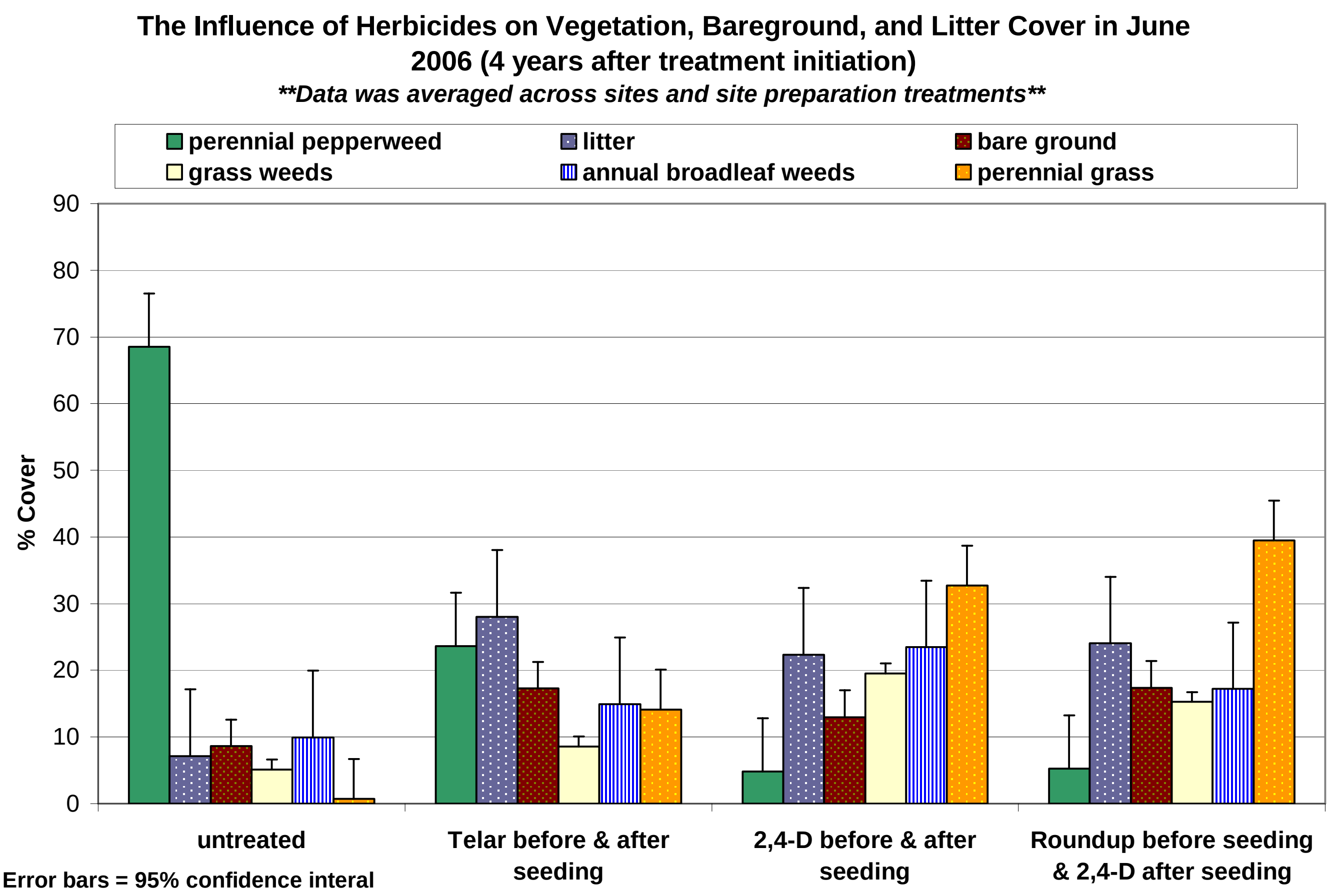
In summary, winter burning or spring mowing in combination with yearly 2,4-D treatments provided the best combination of perennial pepperweed control and native grass establishment. Telar provided excellent perennial pepperweed control at the Honeylake Wildlife Area, but Telar gave poor control at the 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 seeded grass species when applied after grasses reach the five leaf stage. Combining tillage with yearly 2,4-D treatments provided excellent grass establishment, but perennial pepperweed control was worse compared to burn and mow plots. Trampling seed resulted in more variable grass establishment compared to drill seeding, but trampling appears to be a viable re-seeding option for rough terrain.

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 three years of treatment suggesting perennial pepperweed populations will rebound if yearly applications are stopped. Without herbicide treatment, none of the site preparation treatments provided satisfactory perennial pepperweed control.





Error bars = 95 % confidence interval



Error bars = 95% confidence interal

Burn + 2,4-D + Re-seeding in June 2006 (one year after second seeding)

Fall Disking + 2,4-D + Re-seeding (Left) vs. Fall Disking + Re-seeding (Right)

Notice the lack of perennial grass in re-seeded fall disking plots without herbicide treatment (right) due to heavy competition from perennial pepperweed re-sprouts