2017- Weed and Agriculture Research Report
Lassen, Modoc, Sierra and Plumas Counties

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I would like to sincerely thank all the cooperators, who allowed my colleagues and I to conduct these field trials on their land. I really appreciate the alterations of your management practices, donations of time, equipment, and labor to accommodate this work. Without your generosity, and help none of this work would have been completed.

In no specific order, cooperators included in this report are: Buck Parks, Jay Dow, Herb Jasper, John Flournoy, Billy Flournoy, Tim Garrod, Luke Garrod, Craig Hemphill, Steven Martin, Marty Svendsen, Ed Svendsen, Pam Cherney, Jack Hanson, Wyatt Hanson, Ron Lavor, Bob Sitika, and Einen Grandi

Additionally, I would like to thank Eric Rubio for help finding sites, and donation of product which allowed these trials to be completed.

For more information about any of the trials described, please do not hesitate to contact me.

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Roundup Ready Alfalfa: Avoiding Injury While Maximizing Weed Control

Introduction: Roundup Ready Alfalfa is one of many GMO crops that allow the use of Roundup *(glyphosate)*, to be used over the top of the crop to control weeds. Conventional crop varieties would be killed by these applications. Roundup Ready (RR) technology has been a boon for producers allowing them to effectively control difficult-to-control weeds. In 2014, late Farm Advisor Steve Orloff became aware of a situation where applications of Roundup to Roundup Ready Alfalfa appeared to cause injury which had not been seen before. Through rigorous testing over 2015 and 2016, it was determined that applications of Roundup followed by frost could cause injury and yield reductions to the alfalfa during first cutting. Injury appeared as individual stems dying and curling over into a shepherd's crook, typically a week or two after application. Stems continued to curl over and die in the understory of the alfalfa stand for weeks. In certain instances, height reductions and chlorosis were noted on treated plants. Injury from application was not noted when frost did not occur after application. This study was set up to confirm the agronomic practices that reduced the chance of injury to alfalfa after roundup applications, from field trials in 2016. Data from 2016 field trials can be found here.

In previous studies it had been observed that, at the time of application, the taller the alfalfa was, the more injury was noted. Additionally, it had also been observed that higher rates of glyphosate caused more injury. Previous trials had shown that applications of 22 oz. Roundup Powermax per acre to alfalfa plants shorter than two inches did not result in injury. This trial was set up to replicate alfalfa injury with applications at various heights, and two rates of Roundup.

Study Investigators: Steve Orloff, Brad Hanson, Rob Wilson and Tom Getts

Cooperator: Jay Dow

Date of Herbicide Applications: Dormant season applications were made at 10:00 am on March 3, 2017, it was 60 degrees, and 43% RH, most alfalfa plants were not showing any spring growth. Applications were made to the two-inch growth stage of alfalfa at 9:00 am on March 20, it was 55 degrees and 43% RH. Applications to the four-inch growth stage were made at 9:00 am on March 31, it was 42 degrees, and 57% RH. Applications to the six-inch growth stage were made at 9 am on April 14th, it was 48 degrees, and 50% RH. Applications were made to the eight-inch growth stage and mowed plots at 9:00 am on April 25, it was 51 degrees, and 47% RH.

Mowing: Was conducted on March 31 using a rotary lawnmower. Alfalfa was 4 inches tall, and it was mowed down to 2 inches. Mowing was conducted to test if alfalfa height/coverage was important. The goal was to create conditions where the alfalfa was significantly shorter. At time of application on April 25, the mowed treatments were approximately two inches shorter than unmowed treatments.

Study Design: Four replications of 10 x 20 ft. plots were laid out in a randomized complete block.

Data Collected: Average alfalfa heights were taken in May 16. On May 26, two 0.5 meter ^2 quadrats were utilized to take injured stem counts. First cutting biomass was harvest on May 30, 2017. Second cutting biomass was harvested on June 30, 2017. Biomass was harvested with a carter forage harvester. Sub samples were taken and dried in an oven to convert wet biomass harvest to dry tons/acre.

Results: Significant differences in the average height of plots was not observed in this study as it has been in previous trials. However, significant differences in injured stem counts were apparent (Figure 1). Dying shepherds crook alfalfa stems averaged four stems per meter squared, in both the untreated and dormant season Sencor (*metribuzin*) treatments. Similar numbers were observed in the plots where the alfalfa was treated at two inches. At the four-inch application, there was a slight numerical increase, but no statistical difference. Treatments made to later growth stages had significantly more injured stems, with 38 injured stems per meter squared observed in the 44 oz. treatment applied to eight-inch tall alfalfa.

Yield differences were apparent and significant in the first cutting. Compared to the untreated check, there was a 0.8-ton yield reduction for the 44 oz. six-inch alfalfa treatment. Other treatments with significant yield reductions included the 44 oz. eight-inch alfalfa treatment and, not surprisingly, both mowed treatments. Smaller numerical yield reductions were reported for other treatments, but statistical differences were not observed. Only two treatments had significantly lower yields than the untreated check in the second cutting, the 44 oz. mowed treatment, and the 44 oz. eight-inch treatment (Figure 3).

This amount of injury especially during first cutting, which is often the most profitable cutting in alfalfa production, can cause major economic impacts. **Current best management practices are to apply early in the season before two inches of growth occurs to avoid injury. Frost occurring after an application to alfalfa at a larger growth stage growth can result in injury and yield reductions. Most trials conducted have not observed any yield reductions during the second cutting.**

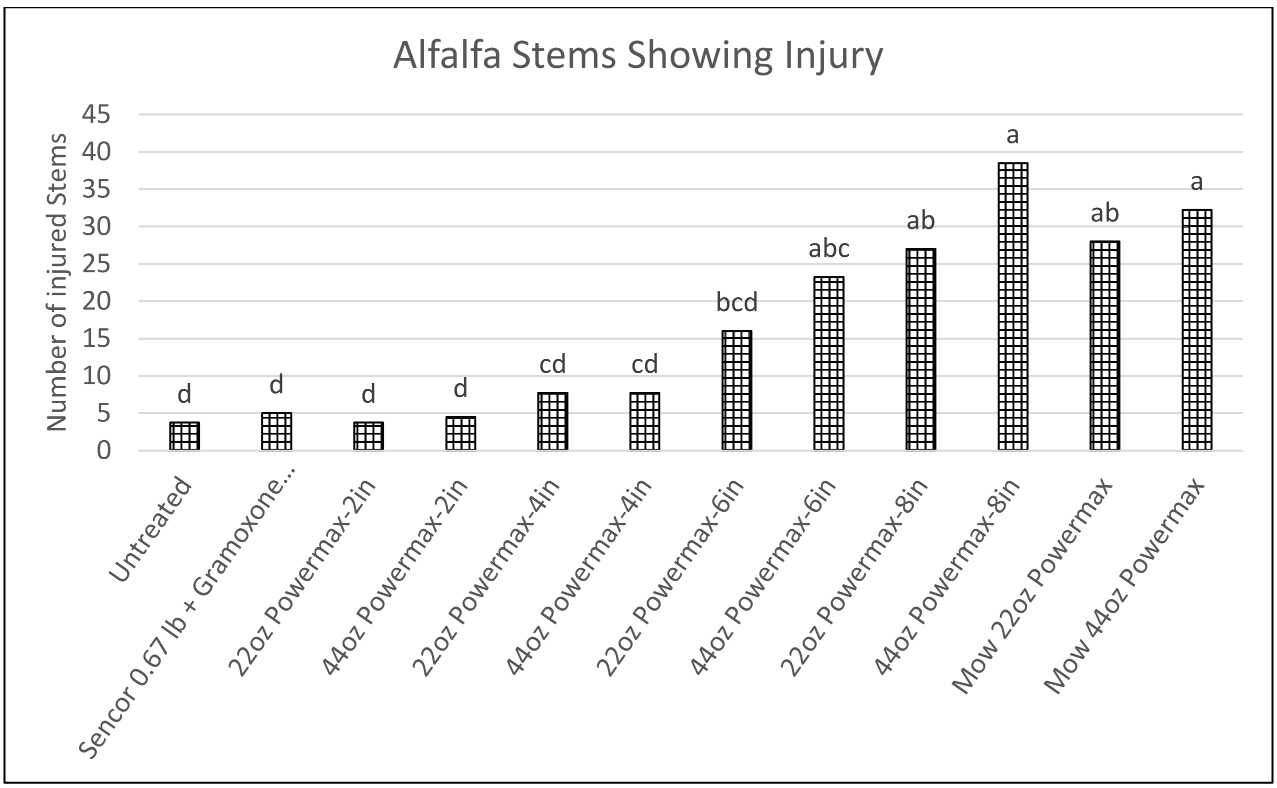


Figure 1: Number of injured alfalfa stems counted in two 0.5 meter^2 quadrats. *Gramoxone was applied at 32 oz/acre

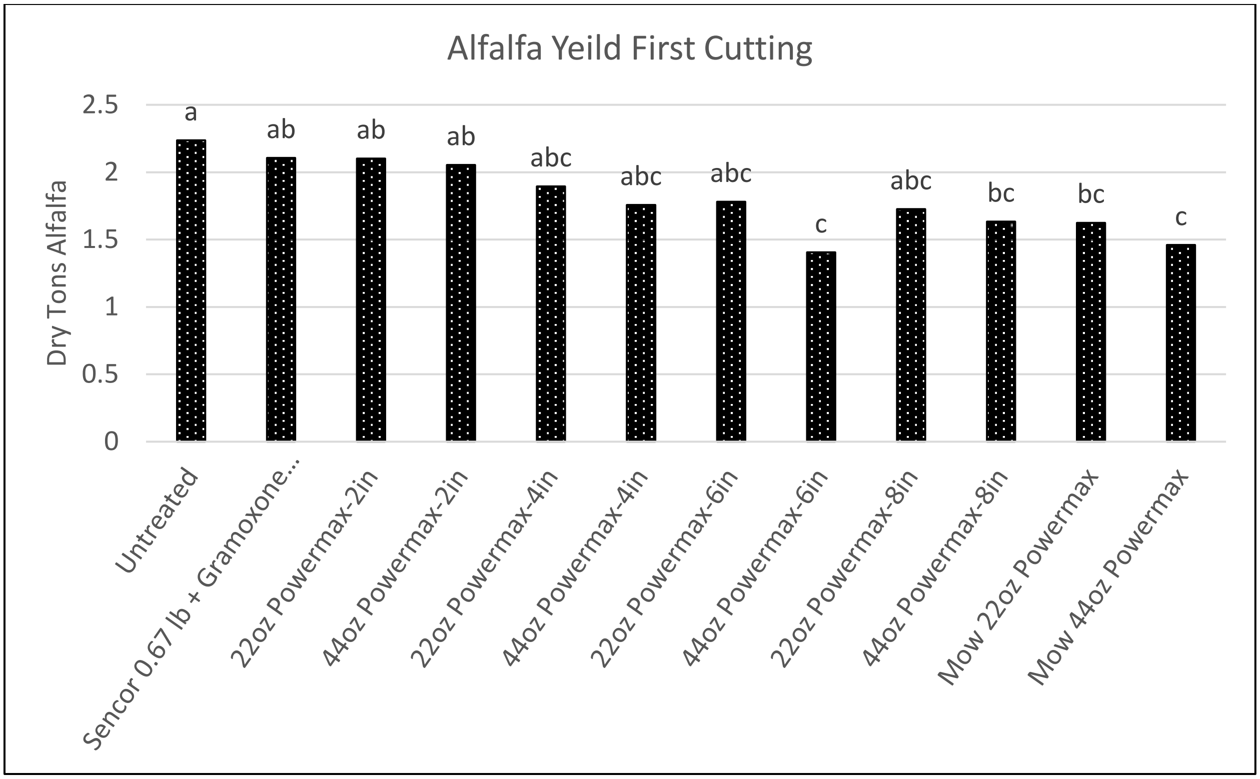


Figure 2: Yield in tons per acre for the first cutting harvest. *Gramoxone was applied at 32 oz/acre

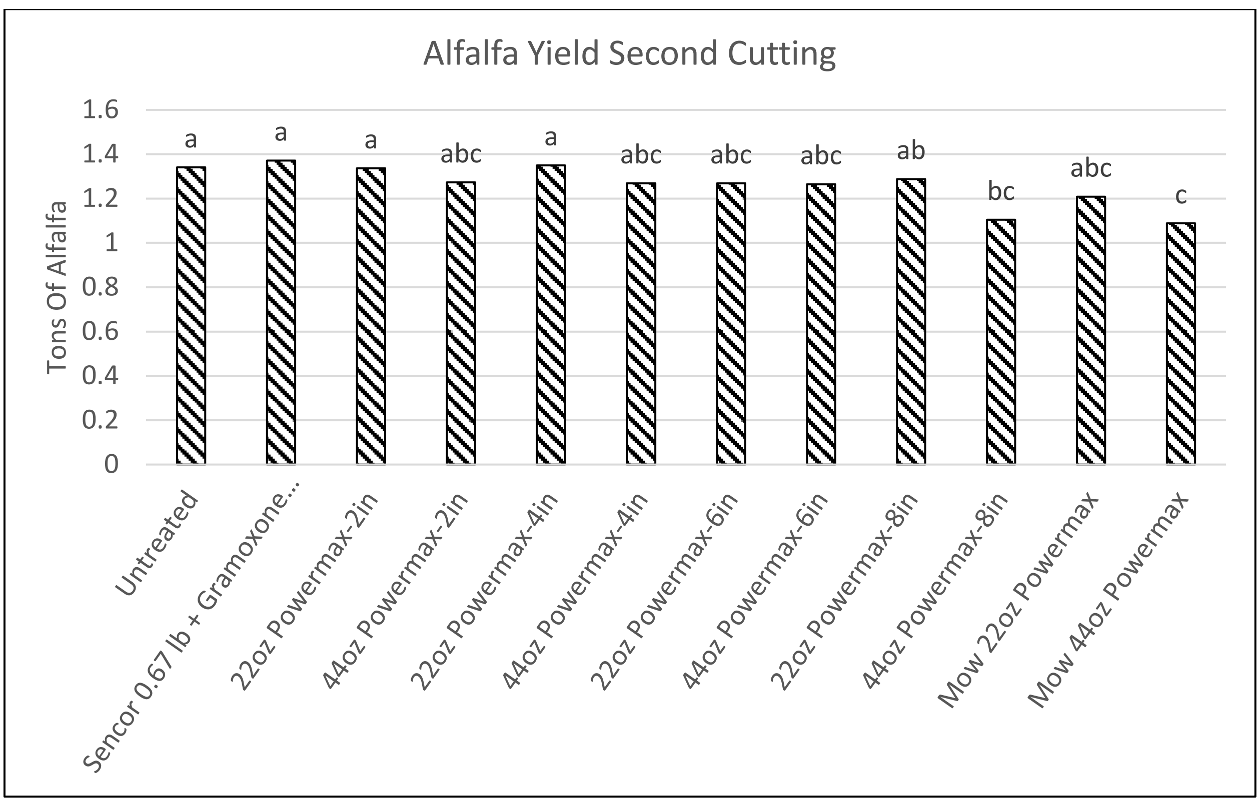


Figure 3: Yield of alfalfa in tons per acre for the second cutting. *Gramoxone was applied at 32 oz/acre

Photo one: Shepherds crook stem after Roundup application.

Photo two: Understory of 8 inch 44oz Roundup application before harvest. Chlorosis and nercortic stems in the understory.

Photo three: Untreated plot before harvest, much less chlorosis and fewer necrotic stems in understory.

Weed Control in Mixed Alfalfa Orchardgrass Stand

Introduction: Alfalfa production for the dairy and export market drives production in the Intermountain Region. However, alfalfa establishment is expensive, so producers will often interseed grasses into old alfalfa stands which are thinning to prolong stand life. Mixed grass alfalfa hay is a desirable high value product for the horse hay market. Weed control in these mixed systems becomes difficult, as there are desirable grasses and desirable broadleaf plants. Few herbicides provide effective weed control while maintaining crop safety in mixed stands. This study was part of a two-year trial to test Sharpen (saflufenacil), and Shark (carfentrazone) for crop safety and weed control in mixed stands.

Study Investigators: Steve Orloff, Darin Culp, and Tom Getts

Cooperators: Luke Garrod, Tim Garrod, and Steven Martin

Date of herbicide applications: Applications were made at the Standish site March 11, 2017, at 9:30 am, it was 56 degrees F, clear, with a 2 mph wind from the south. Applications were made at the Doyle site March 11, 2017, at 4:30 pm, it was 68 degrees F, with a 5 mph wind.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block at two locations.

Plant growth stage at application: At the Standish site, alfalfa was 1 inch and the orchardgrass was 1-5 inches. Major weeds were: 1-2 inch cheatgrass, 1-2 inch Jim hill mustard, 1-2 inch annual polonium, with sparse populations of flixweed, prickly lettuce, and red stem filaree. At the Doyle site, alfalfa and orchardgrass were just breaking dormancy. The major weed was cheatgrass, with sparse populations of dandelions, flixweed and tumble mustard.

Data collected: Plots were visually evaluated for crop injury and weed control one, two, four, and eight weeks after treatment.

Crop injury results:

Standish: Initially both Shark and Sharpen burned back the alfalfa, sharpen especially turned all foliage alive necrotic. Much of this injury subsided by four weeks, with little injury noticeable at eight weeks (figure one). Orchardgrass injury was less substantial than alfalfa injury. More injury was noted in the Sharpen treatments than the Shark treatments, however, most injury was not noticeable eight weeks after treatment (figure two).

Doyle: Alfalfa was initially burned back by Sharpen and Shark treatments, with more burn back in the Sharpen treatments. Injury seemed to subside, and most injury was gone by eight weeks after treatment (figure three). Orchardgrass initially showed lots of leaf spotting, and tip burn in Sharpen plots. One oz. of Shark did not cause as much burn back on the orchardgrass as two oz. of Shark. Injury subsided for most treatments by eight weeks, with little noticeable difference between treatments and untreated plots. (figure four).

*Off label rates of 4 oz. and 9 oz. of Sharpen caused crop injury, but not much more crop injury than the two oz. rate.

Weed control results:

Standish: Cheatgrass was not effectively controlled with Shark or Sharpen treatments. Treatments which included Dimetric offered the best control of treatments tested, however, the Dimetric's effectiveness was not apparent until four weeks after application (figure five). Annual polemonium (annual Jacobs ladder) was prolific following the wet winter. Shark offered less control of annual polemonium compared to other treatments tested, which offered excellent control (figure six). Likewise, Shark offered less control of Jim hill mustard than other treatments tested (figure seven). Prickly lettuce was effectively controlled on all treatments (figure eight).

Doyle: Broadleaf weeds were not in sufficient quantities to assess control. Anecdotally, neither Shark nor Sharpen offered effective control of established dandelions. Cheatgrass pressure was intense with numerous seedlings per square inch. Initial application appeared to cause injury, but cheatgrass grew out of this injury in all treatments which did not include Dimetric (figure nine). Dimetric did not offer commercially acceptable control with cheatgrass plants still persisting within treated plots.

**In all plots below error bars indicate standard error of the mean.

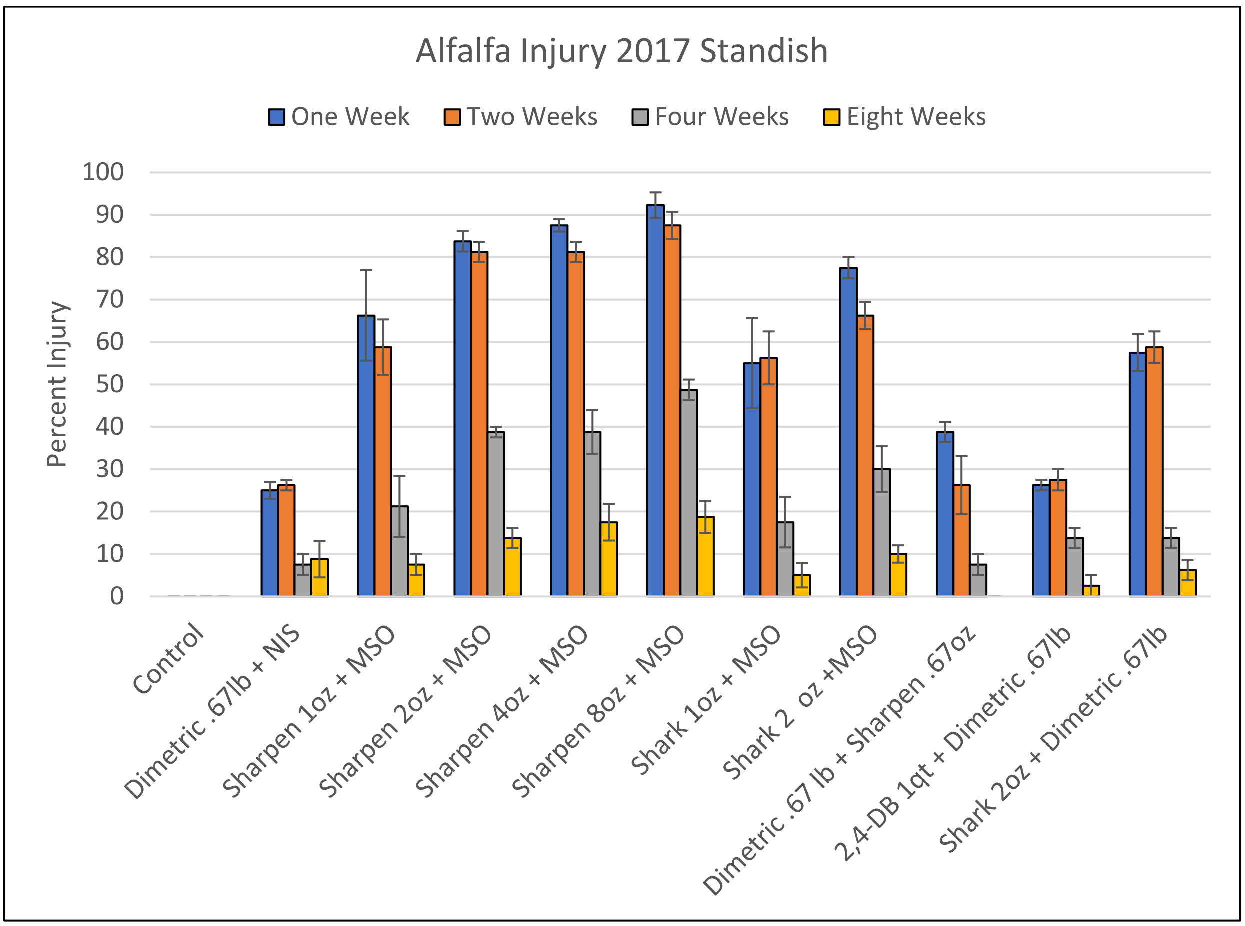


Figure one: Alfalfa injury from the Standish site one, two, four and eight weeks after treatments.

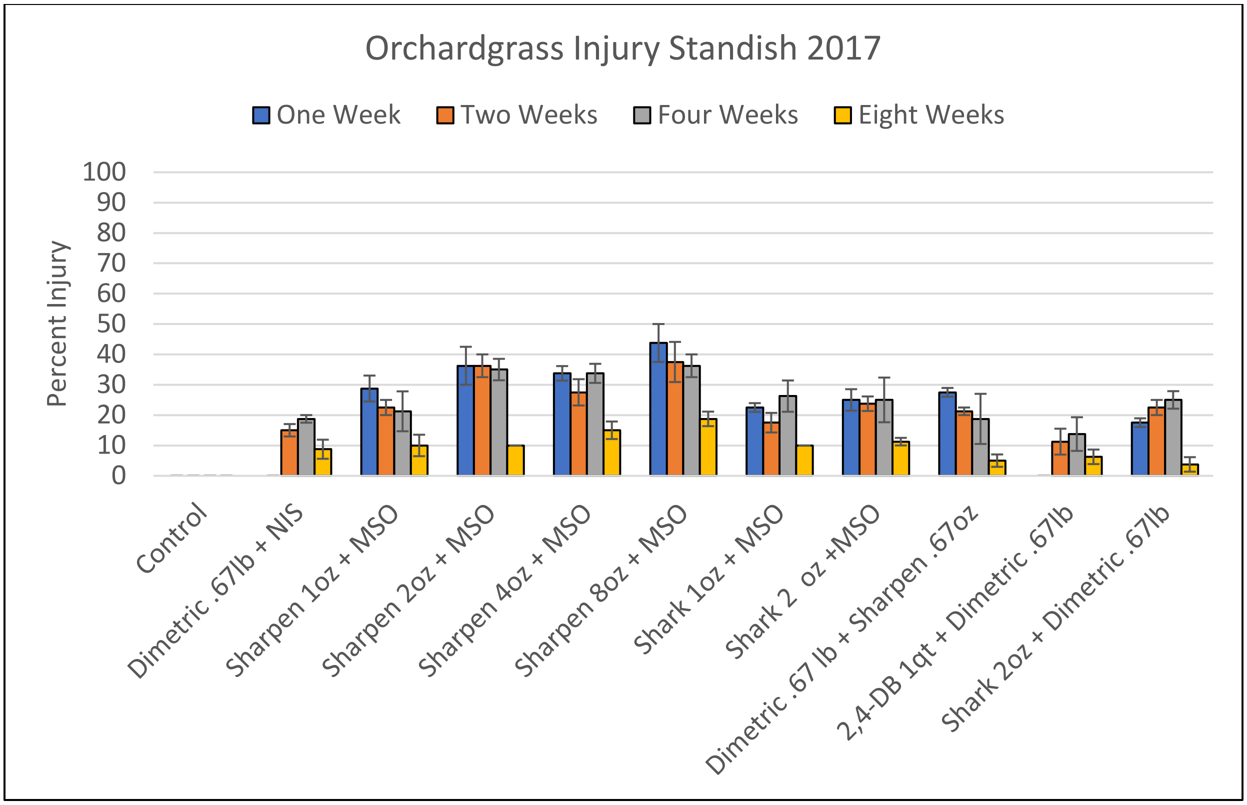


Figure two: Orchardgrass injury from the Standish site one, two, four and eight weeks after treatments.

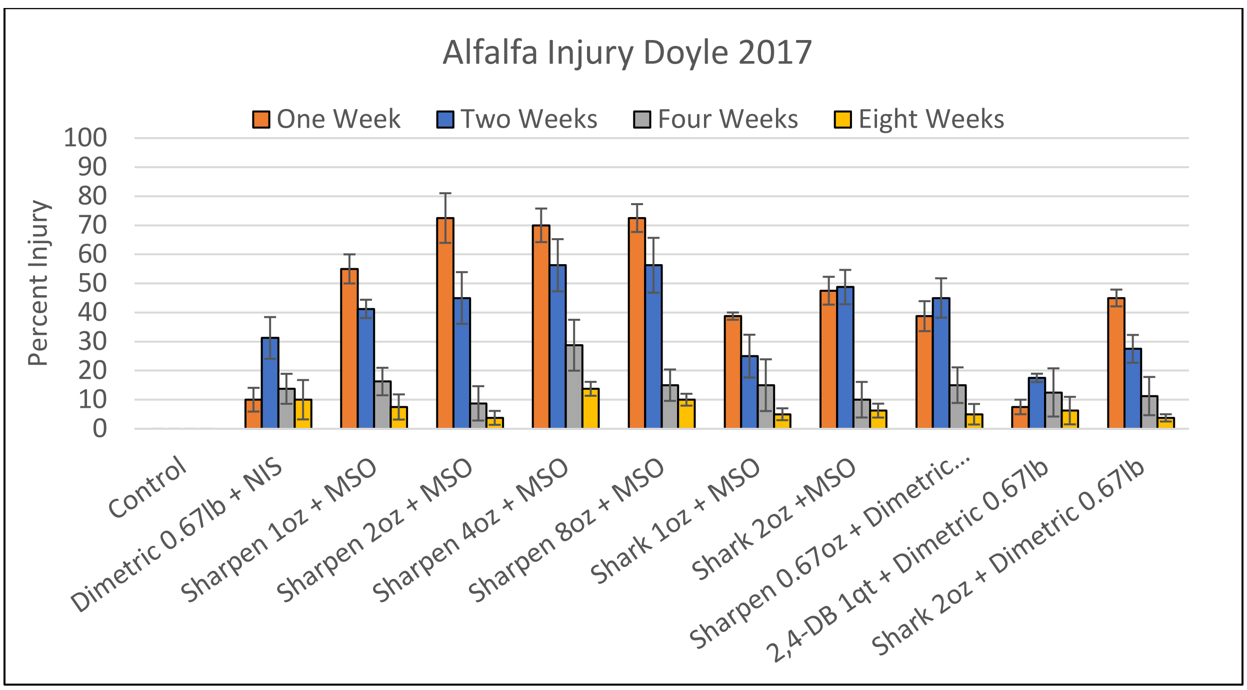


Figure three: Alfalfa injury from the Doyle site one, two, four and eight weeks after treatments.

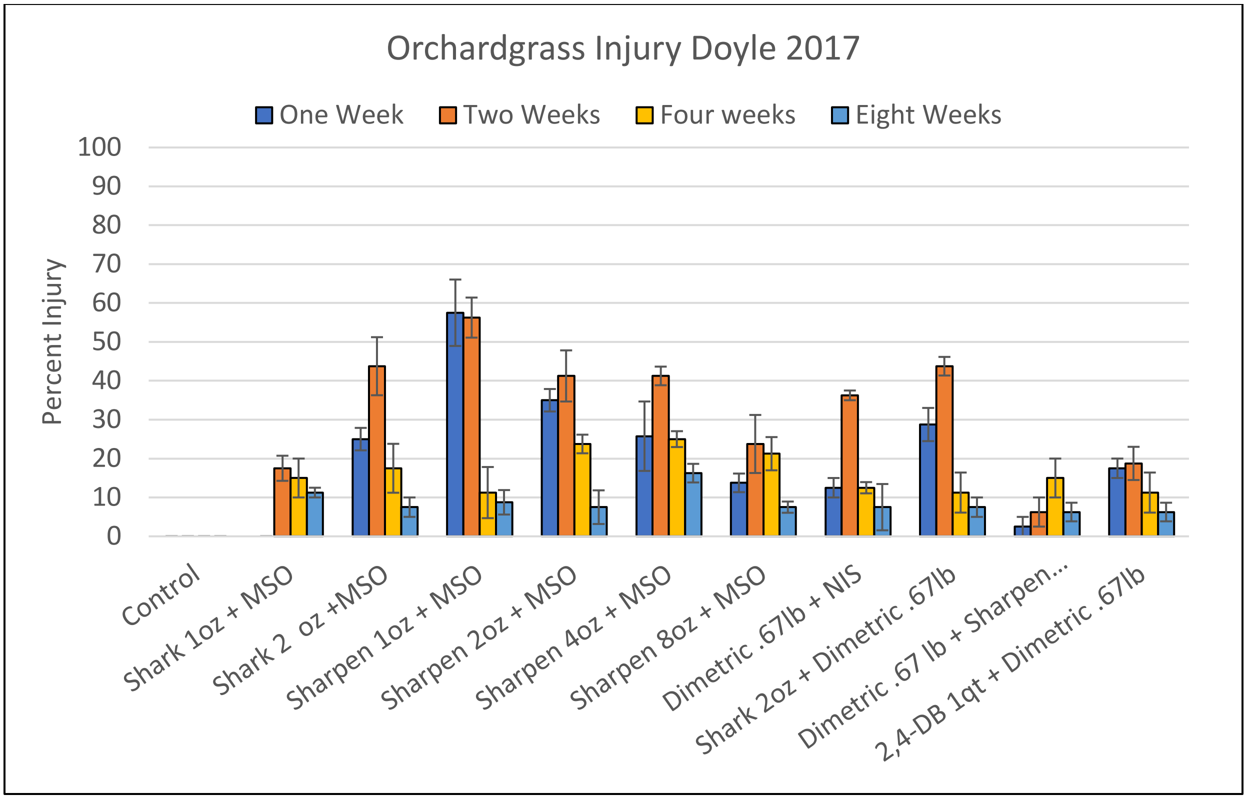


Figure four: Orchardgrass injury from the Doyle site one, two, four and eight weeks after treatments.

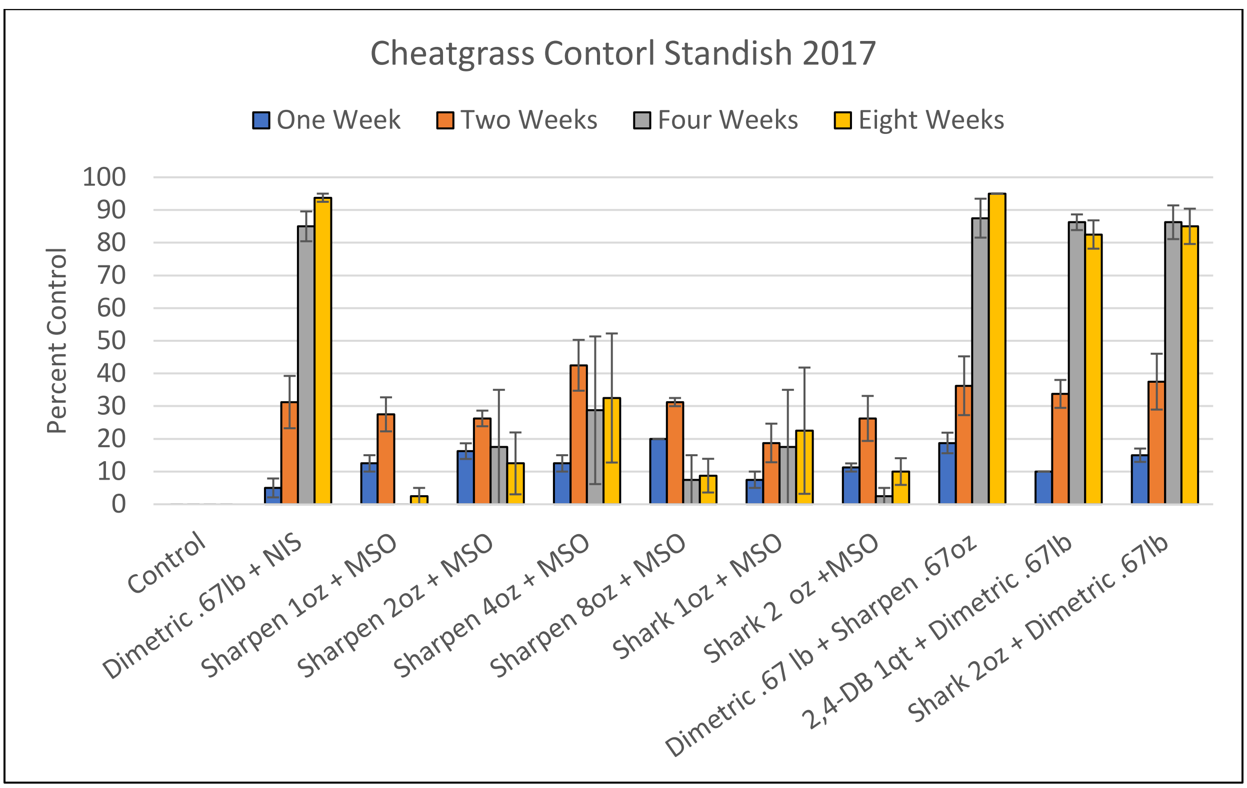


Figure five: Cheatgrass control at the Doyle site, one, two, four and eight weeks after treatment.

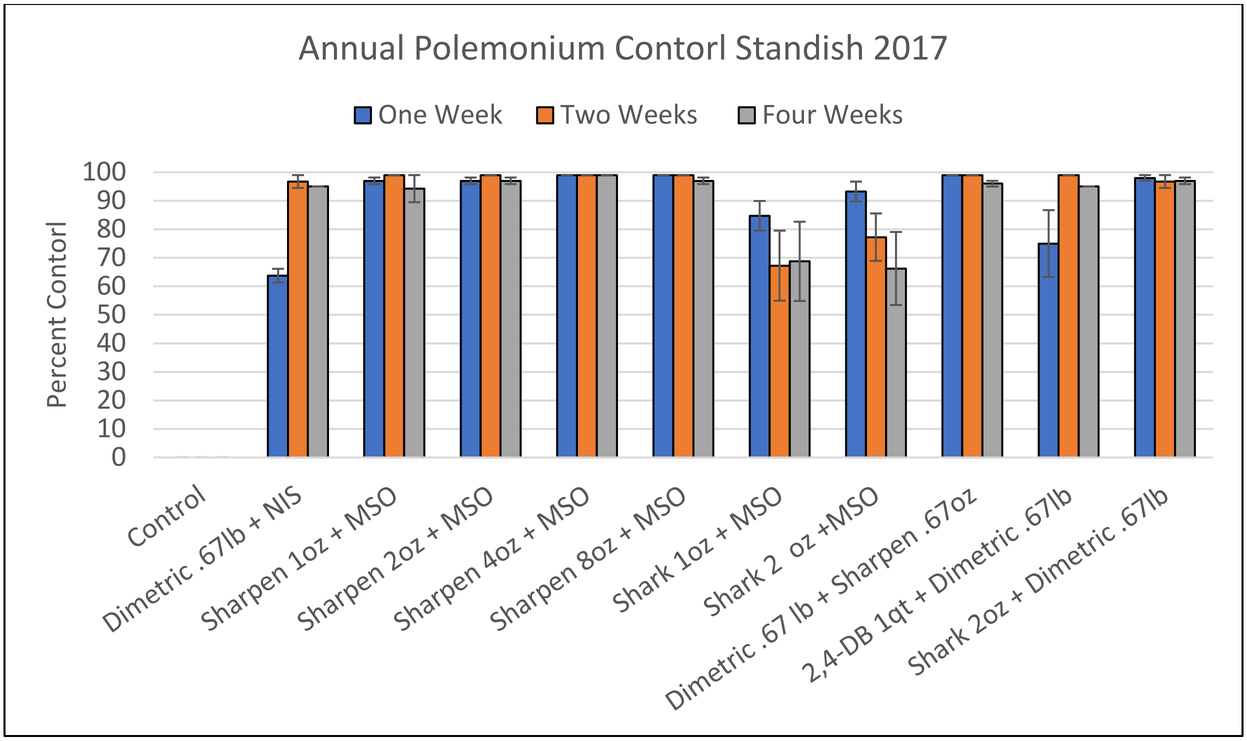


Figure six: Annual polemonium control at the Standish site, one, two, and four weeks after treatment.

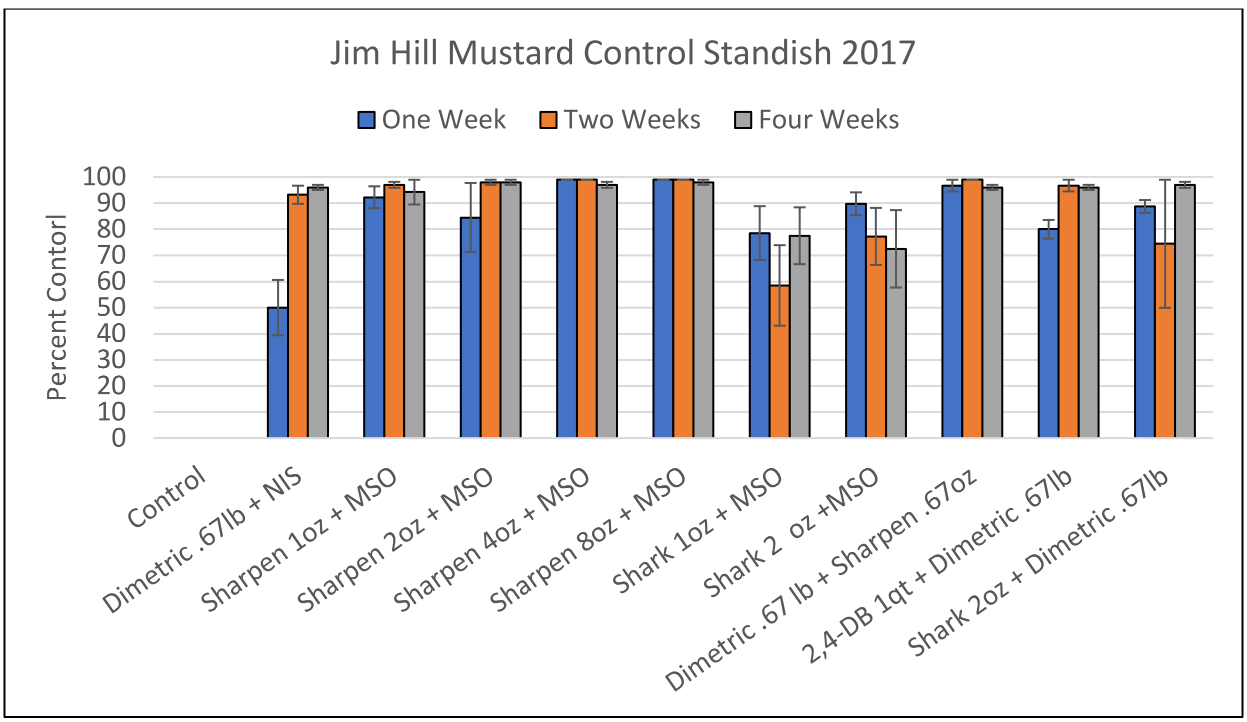


Figure seven: Jim Hill mustard control at the Standish site one, two and four weeks after treatment.

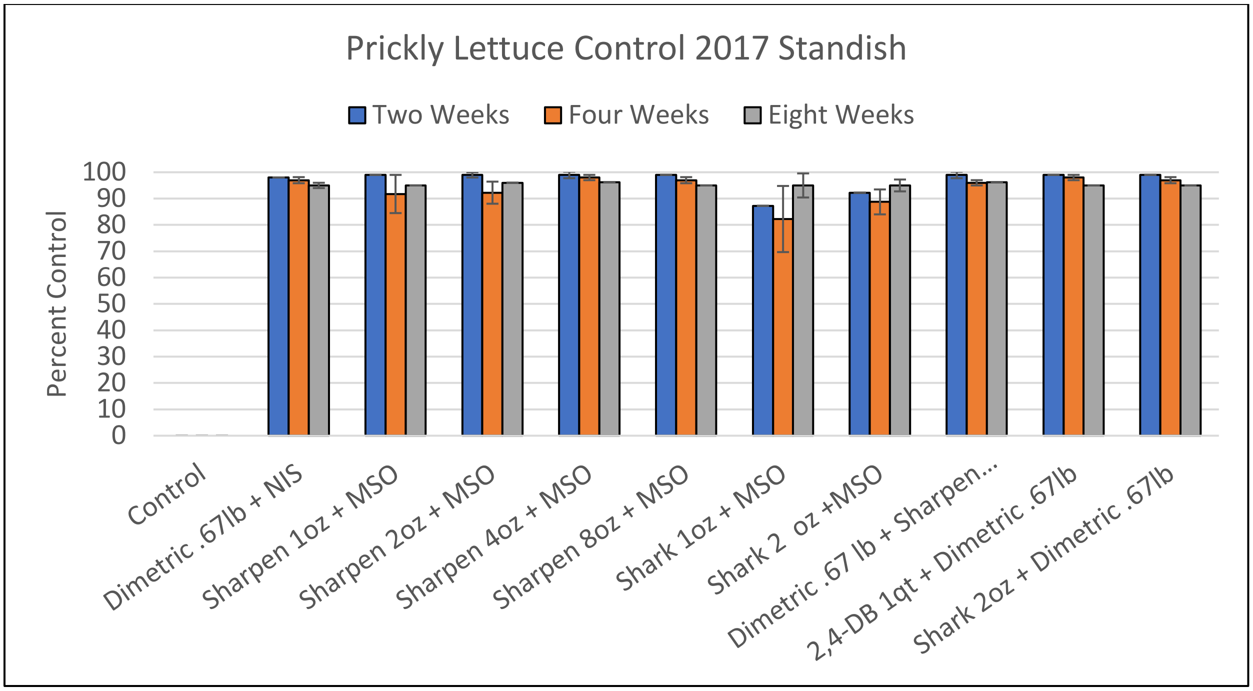


Figure eight: Prickly lettuce control at the Standish site two, four and eight weeks after treatment. (*One weeks after treatment values were not sufficient to report.)

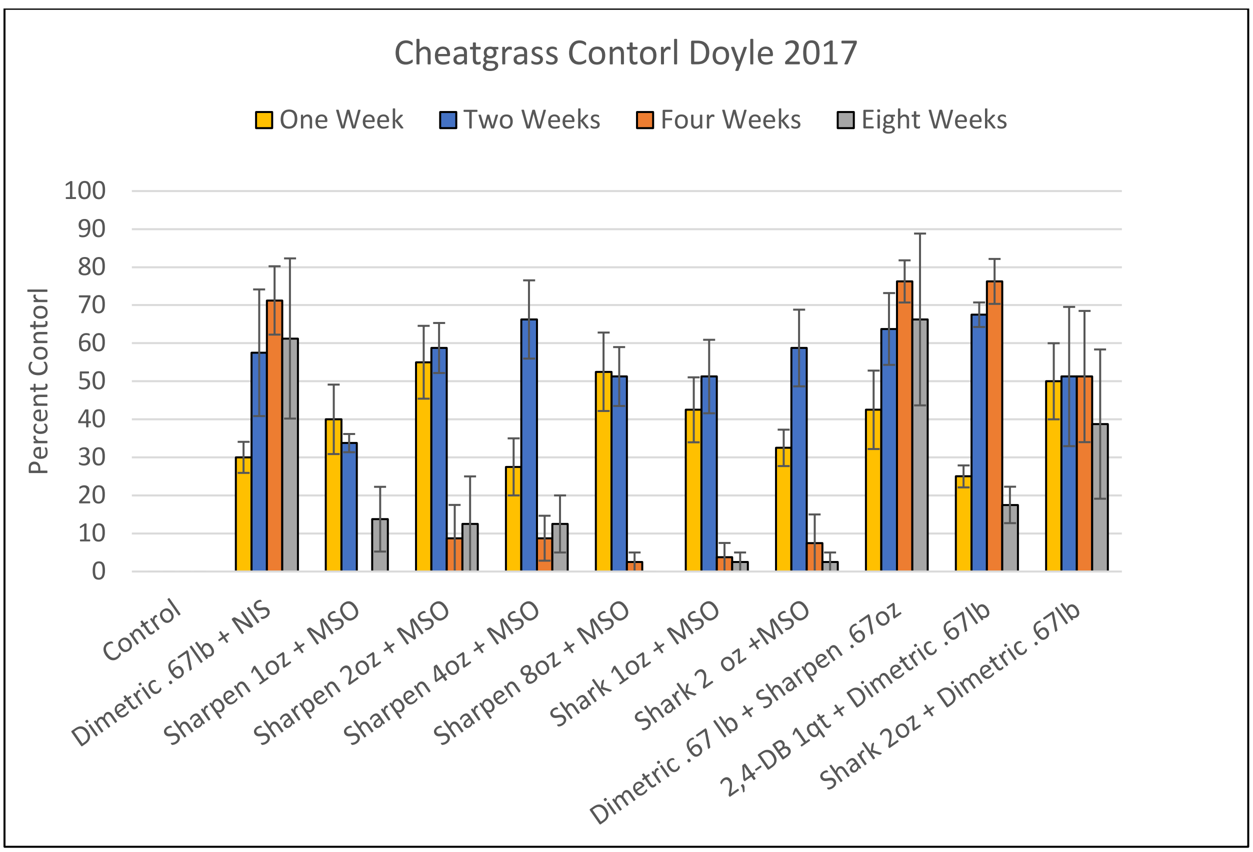


Figure nine: Cheatgrass control at the Doyle site, one, two, four and eight weeks after application.

Picture of Standish trial one week after treatment. Higher rates of Sharpen caused significant burn back of alfalfa, and a checkerboard pattern in the field between plots.

Some leaf spotting on older orchardgrass leaves one week after treatment.

The standish site four weeks after treatment. The checkerboard pattern in the field from treatments is no longer apparent. Most crop injury has subsided.

Fall Applications to Canada Thistle in Small Grain Rotations

Introduction: Canada thistle is one of the most problematic weeds in the Intermountain Region, both in agricultural settings and wildlands. It is a deep-rooted perennial plant, which can spread by roots, root fragments, or by seed. It is a very tenacious plant, and is difficult to kill even with the use of chemicals. One of the most effective chemicals is Milestone (aminopyralid) which has good safety for grasses, but is not labeled for agricultural use, as it has nearly a three-year plant back interval for sensitive broad leaf crops such as alfalfa.

Recently, a local Pest Control Advisor had been experiencing success controlling Canada thistle with a tank mix of 2,4-D and the contact herbicide Shark (carfentrazone). This study was set up to test the effectiveness of this tank mix as a fall application, compared to various other products including Milestone. Fall applications have been shown to be very effective on Canada thistle in other studies. The benefit of using 2,4-D and other products is a much shorter plant back interval to sensitive broad leaf plants.

Study Investigators: Tom Getts

Cooperators: Jack Hanson and Wyatt Hanson

Date of herbicide applications: Herbicide applications were conducted on September 19, 2017, at 8:30 am. It was a clear day with 1-3 mph winds, 47% relative humidity, and 50 degrees Fahrenheit outside. MSO was included at 1% v/v in all treatments except Roundup which received NIS 0.25% v/v.

Study design: Four replications of 10 x 20 ft. plots were laid out in a randomized complete block.

Thistle growth stage at application: The field had previously been taken out of permanent pasture, and triticale had been grown the previous season. After harvest, the field laid fallow until the application. It was a monoculture of Canada thistle with most plants in the basal rosette stage, 3-5 inches tall, and 4-7 inches in diameter. Occasional plants had bolted up to 12 inches tall. The field had not been irrigated since the grain harvest.

Data collected: Visual assessments of Canada thistle control were taken 10 days, 21 days, and 27 days after initial treatment. The field was then disked and planted to winter wheat.

Results: Ten days after treatment, Canada thistle had started to burn down in some plots, however, none of the treatments appeared to offer good control (figure one). Twenty-one days after treatment much more control was seen with all treatments, however, only Clarity+Roundup Powermax, Grazonext, Milestone, and Roundup Powermax+Shark offered 90% control. Twenty-seven days after application all treatments appeared more effective, and Clarity, 2,4-D +Clarity, Clarity+Shark, and Roundup Powermax alone, all passed the 90% control threshold. Some of the burn down could have been attributed to frost, however, most of the injury was herbicide related, compared to the untreated control.

***Canada thistle control one month after treatment is not indicative of long-term control. These plots will be monitored throughout 2018 to assess season long control of the fall treatments. Additionally, the field was disked and planted to winter wheat 2 days after the last assessment. Assessment of any injury to the wheat will be noted, particularly in the Milestone and Granzonnext plots which are not labeled for agricultural use.

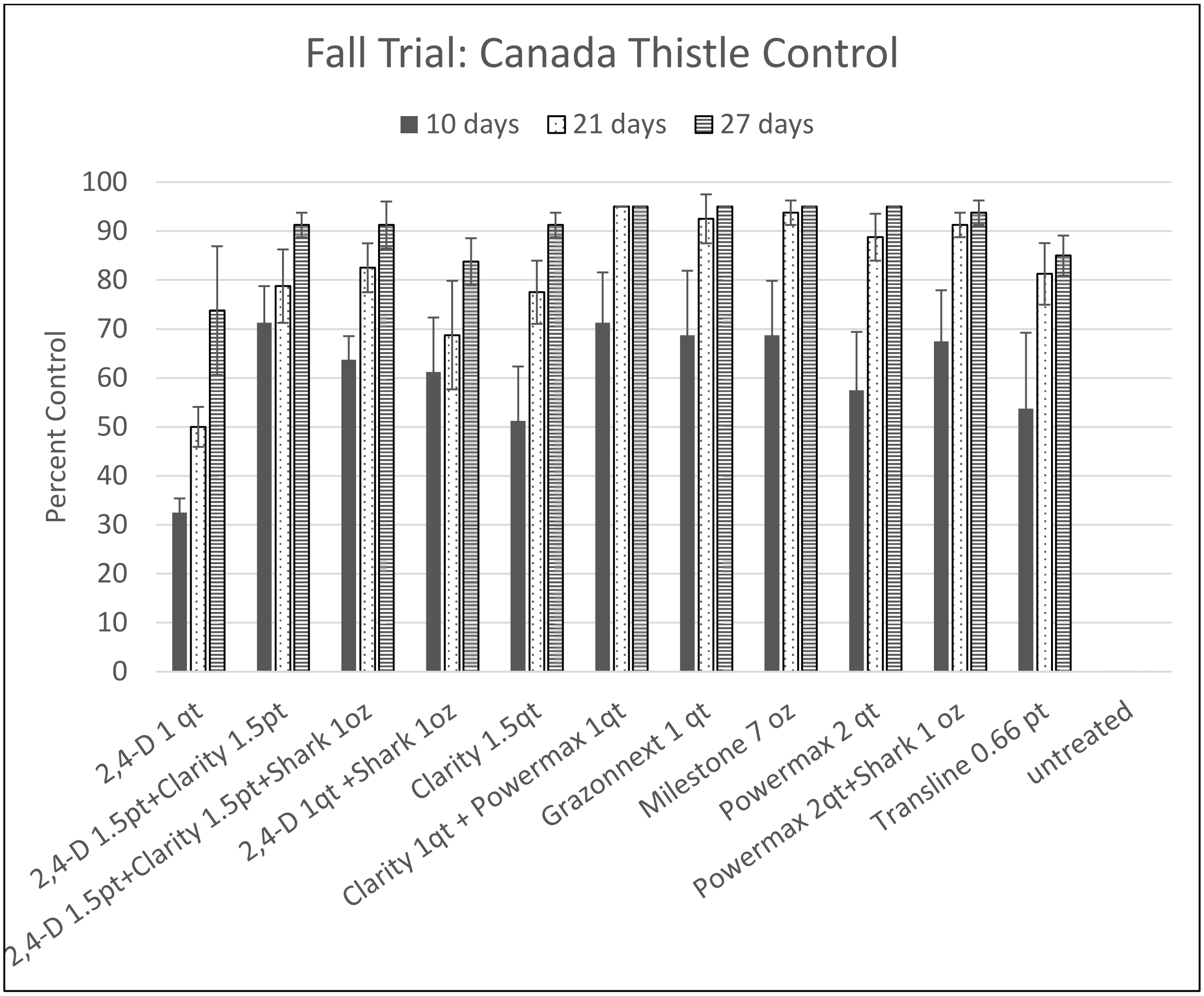


Figure one: Canada thistle control 10, 21, and 27 days after treatment. Bars indicate standard error.

Looking over untreated plot in Canada thistle trial 21 days after treatment. Notice necrosis and chlorosis in plots surrounding the green untreated check.

LESA Irrigation Trial

Introduction: LESA/LEPA (low energy spray application/low energy precision application) irrigation is an older irrigation technique initially developed in Texas and Oklahoma during the 80's. In the past 20 years the idea of altering sprinkler packages to increase irrigation efficiency and reduce pumping costs has spread to other parts of the country. Recent developments in sprinkler technology utilizing center pivot irrigation systems have made LESA/LEPA irrigation a potential fit for our area. The new sprinkler packages decrease the spacing between nozzles by increasing the number of drops on the machine. Additionally, the height of nozzles are lowered from the standard 48 inches off the ground to 18 inches (from mid-elevation application to low-elevation application). This has a three-fold benefit: first, decreasing evaporation from wind loss as nozzles are much closer to the ground; second, decreasing the pressure needed to operate the system; and thirdly, increasing application uniformity. There are downsides, such as the increased cost for double or triple the number of drops/nozzles, and potential pooling and runoff on heavy soils. Studies by Troy Peters in Washington and Steve Orloff in Siskiyou County have shown an increase in moisture levels from the use of these sprinkler packages compared to standard mid-elevation sprinkler applications. This study was initiated to help develop data on the sprinkler packages in the local area.

Study Investigators: Tom Getts and Steve Orloff

Cooperators: Luke Garrod and Einen Grandi

Date of Herbicide Applications: Moisture sensors were installed at Bird Flat Ranch on May 23, 2017.

Study Design: Case Study - Two Pivots

Methods: Current sprinkler packages were uninstalled on one span of each pivot in the spring of 2017 before the irrigation season started, and LESA/LEPA sprinklers were installed. Thanks to the Senninger irrigation company for donating the sprinkler packages. Each pivot had limited number of outlets on top of the machine, so double or triple goosenecks were utilized on each pivot to increase the number of drops to the correct spacing. The Grandi pivot had a drop every 36 inches, where the Bird Flat pivot had drops every 29 inches. Moisture sensors were installed at Bird Flat Ranch on May 23, 2017, and at the Grandi Ranch May 26, 2017. Decagon GSI volumetric water content moisture sensors were buried at 1, 1.5, 2, and 3 feet underground. Moisture sensors were placed in the middle of each span with the conventional and the new sprinkler packages.

Results: The first year faced difficulties with measurements taken by the moisture sensors at both sites. At the Grandi Ranch, moisture data is not presented. The initial site under the original sprinkler package did not register moisture changes after irrigation. New moisture sensors were installed mid-season at another location, but the datalogger was corrupted and no useful information was obtained. By the end of the 2017 field season moisture sensors were operating effectively. Information will be collected and presented in 2018.

At Bird Flat Ranch, things were more successful, but still not perfect. Moisture sensors under the standard pivot were disconnected from the datalogger by accident after the second cutting on August 6th. This was not discovered until August 24th when moisture sensors were reconnected. Data was successfully recorded until September 9th.

Results below are from Bird Flat Ranch for the time period where data was collected under spans with standard mid elevation sprinklers and the new LESA sprinkler package.

Figure 1 shows the volumetric water content for the four moisture levels under the LESA span, and Figure 2 shows the volumetric water content for the four moisture sensor depths under the original mid-elevation sprinkler package.

Figures 3 and 4 display the change in moisture sensor readings for each sensor depth after significant irrigation or precipitation for each sprinkler package.

Figures 5 through 7 display the average change in volumetric water content for each soil moisture sensor after each irrigation for various portions of the year at each sensor depth.

Overall, there was a larger change in moisture sensor readings under the LESA sprinklers compared to the standard sprinklers. The soil moisture sensors were wetter at greater depths under the LESA system throughout the growing season. From irrigations between June 23rd and when the moisture sensors were disconnected, moisture sensor values only increased at the 1 ft. depth under the standard sprinklers, where moisture levels spiked down to the 2 ft. sensor under the LESA system. On average, there was a 22%, 50%, and 66% larger change in volumetric water content for the 1, 1.5, and 2 ft. sensor depths after irrigation under the LESA system compared to the standard system.

More in-depth analysis will follow on a completed dataset from the upcoming 2018 field trial season.

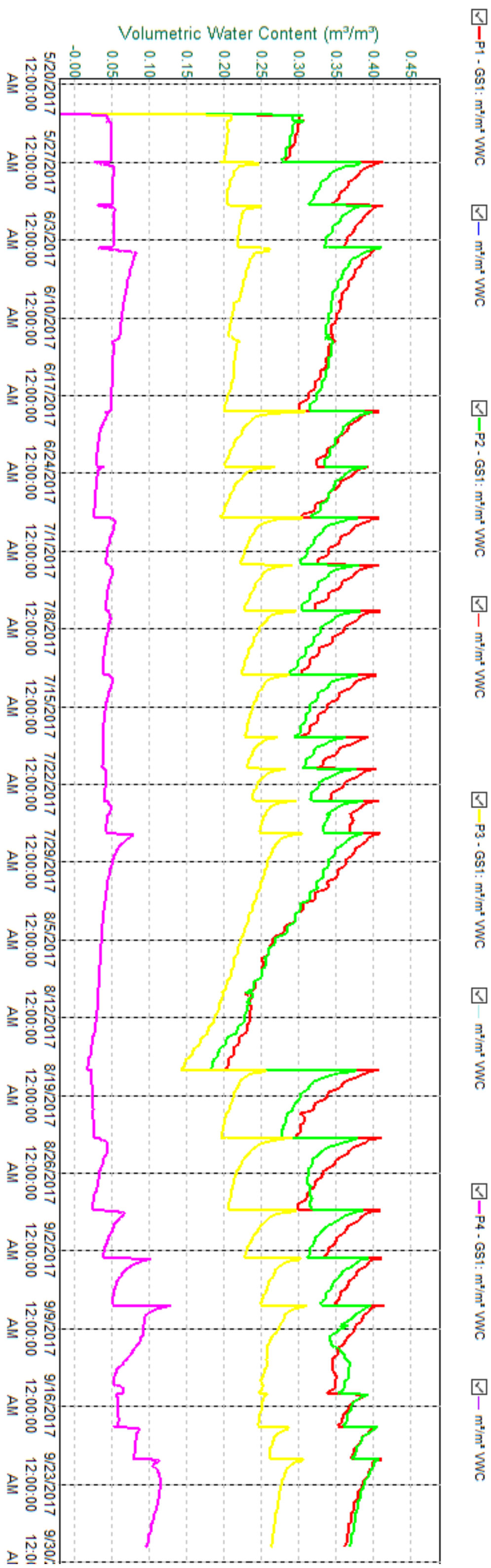


Figure 1: LESA volumetric water content chart from the Bird flat ranch. Red green yellow and purple lines indicate 1, 1.5, 2 and 3 ft. sensor depths respectively.

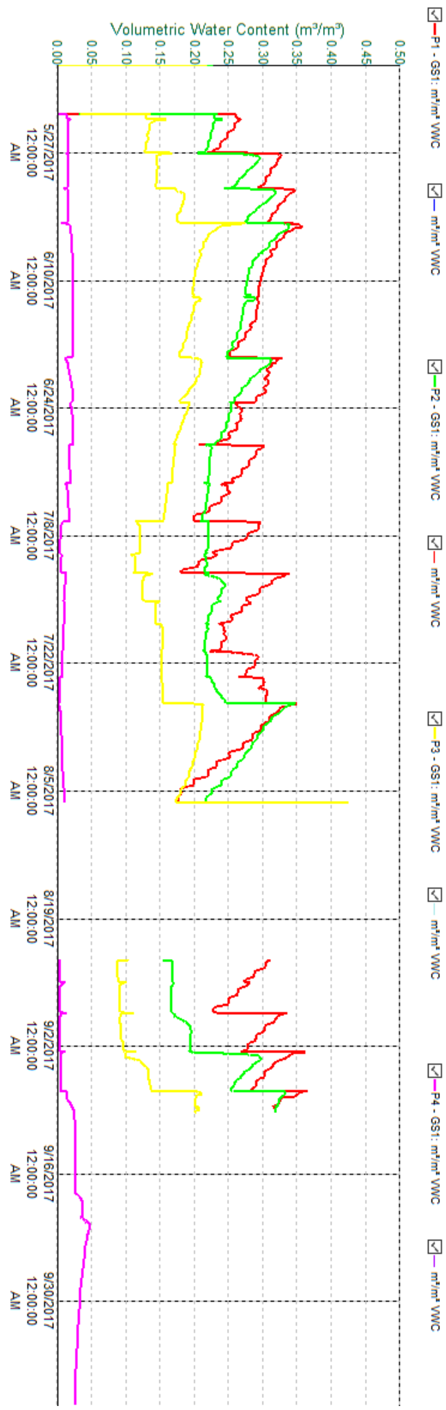


Figure 2: Standard volumetric water content chart from the Bird flat ranch. Red green yellow and purple lines indicate 1, 1.5, 2 and 3 ft. sensor depths respectively.

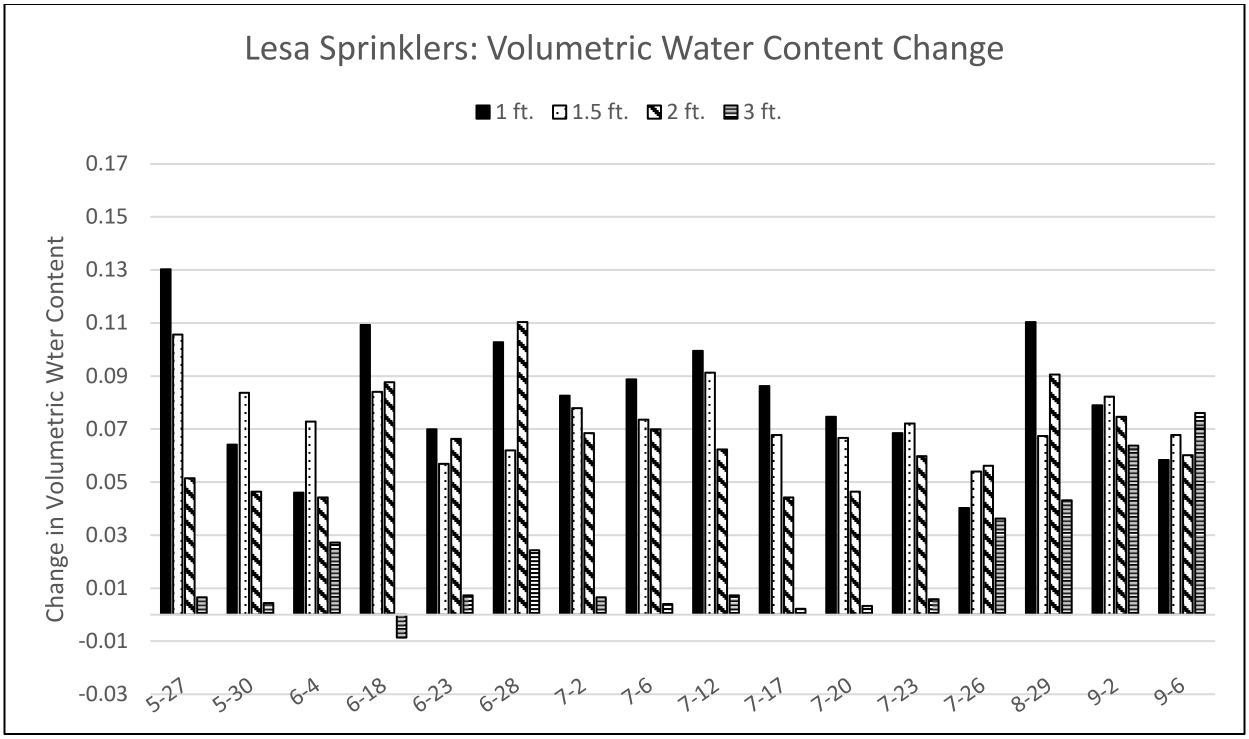


Figure 3: Change in volumetric water content for each sensor after each significant irrigation or precipitation under the LESA sprinkler package.

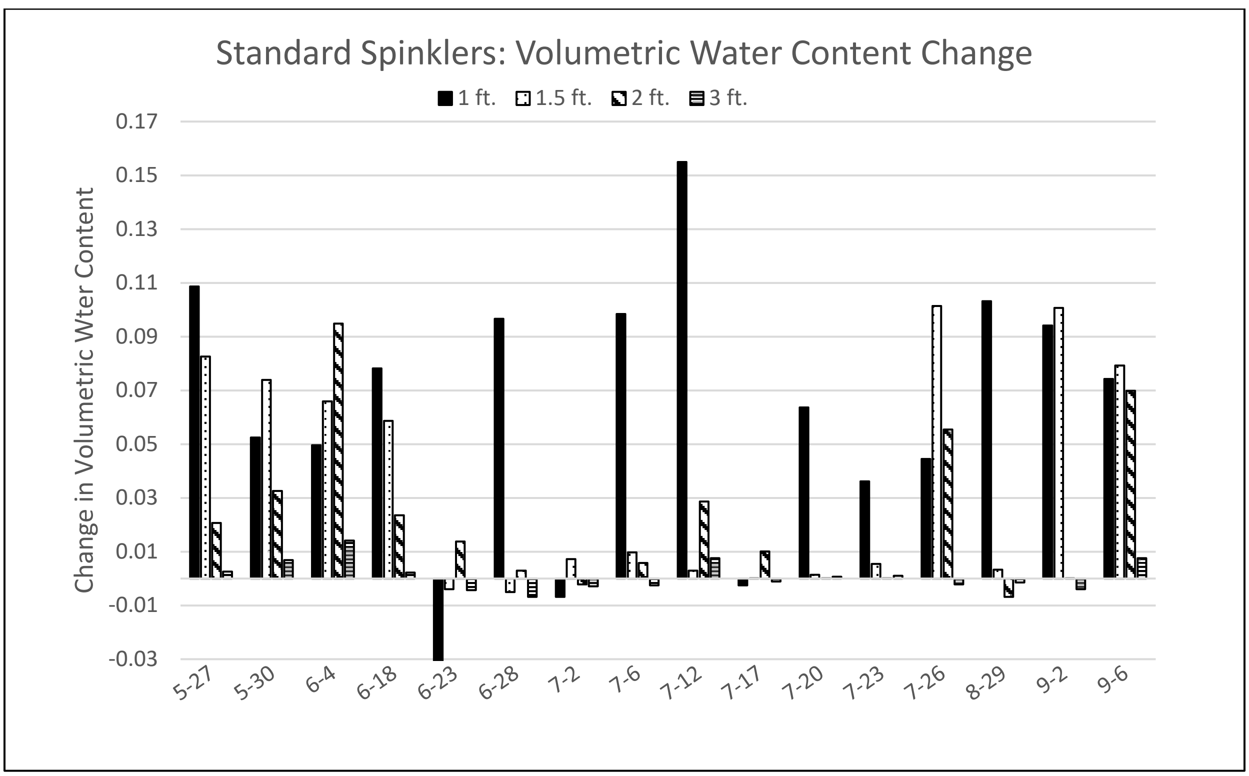


Figure 4: Change in volumetric water content for each sensor after each significant irrigation or precipitation under the Standard sprinkler package.

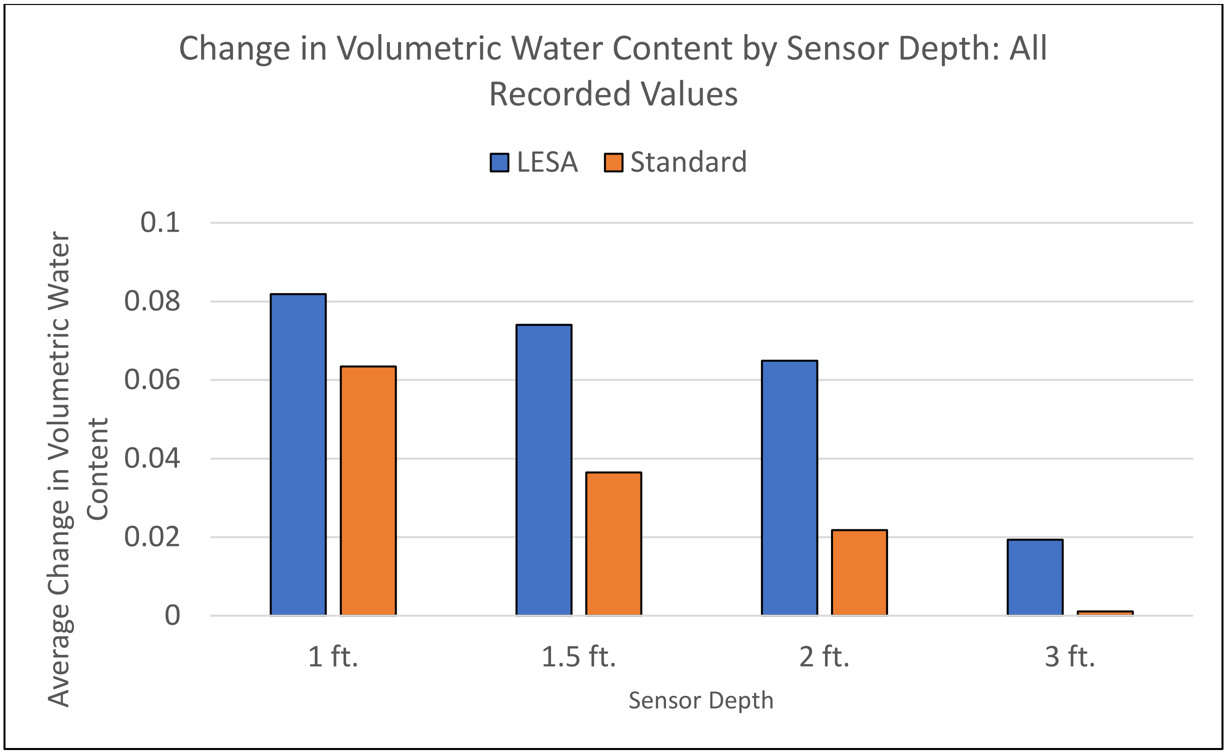


Figure 5: Average change in volumetric water content after irrigation for each sensor depth under each package.

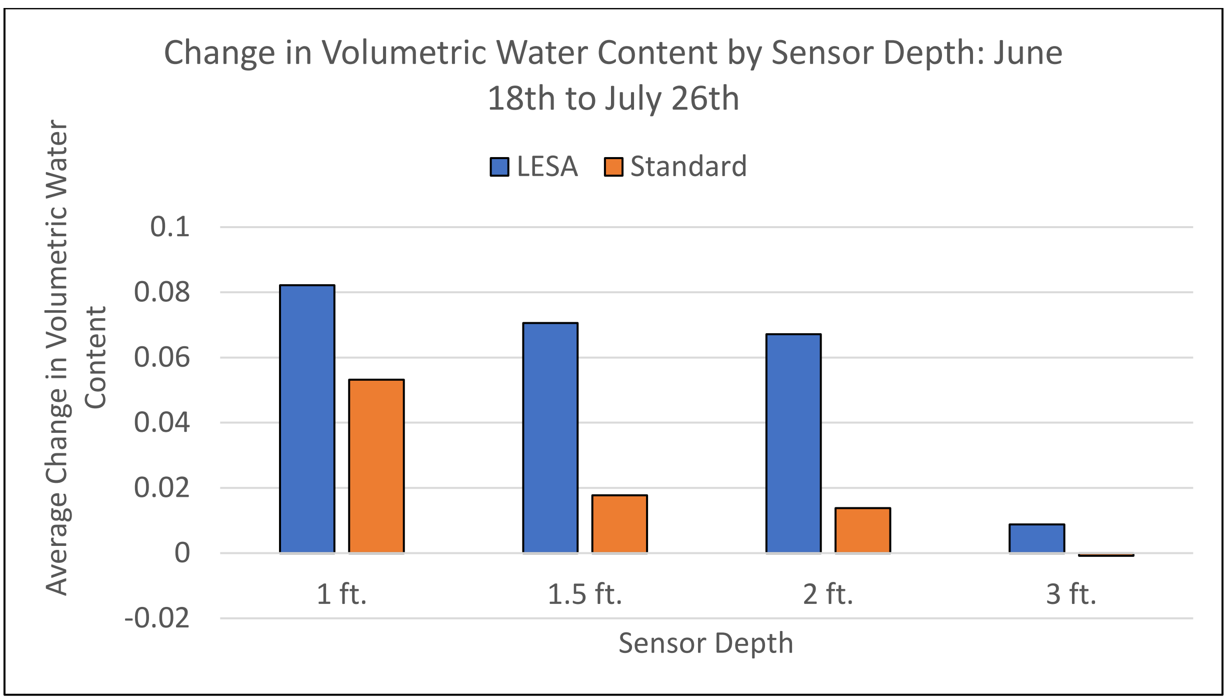


Figure 6: Average change in volumetric water content after irrigation for each sensor depth under each package during the hot season data was recorded for June 18th to July 26th.

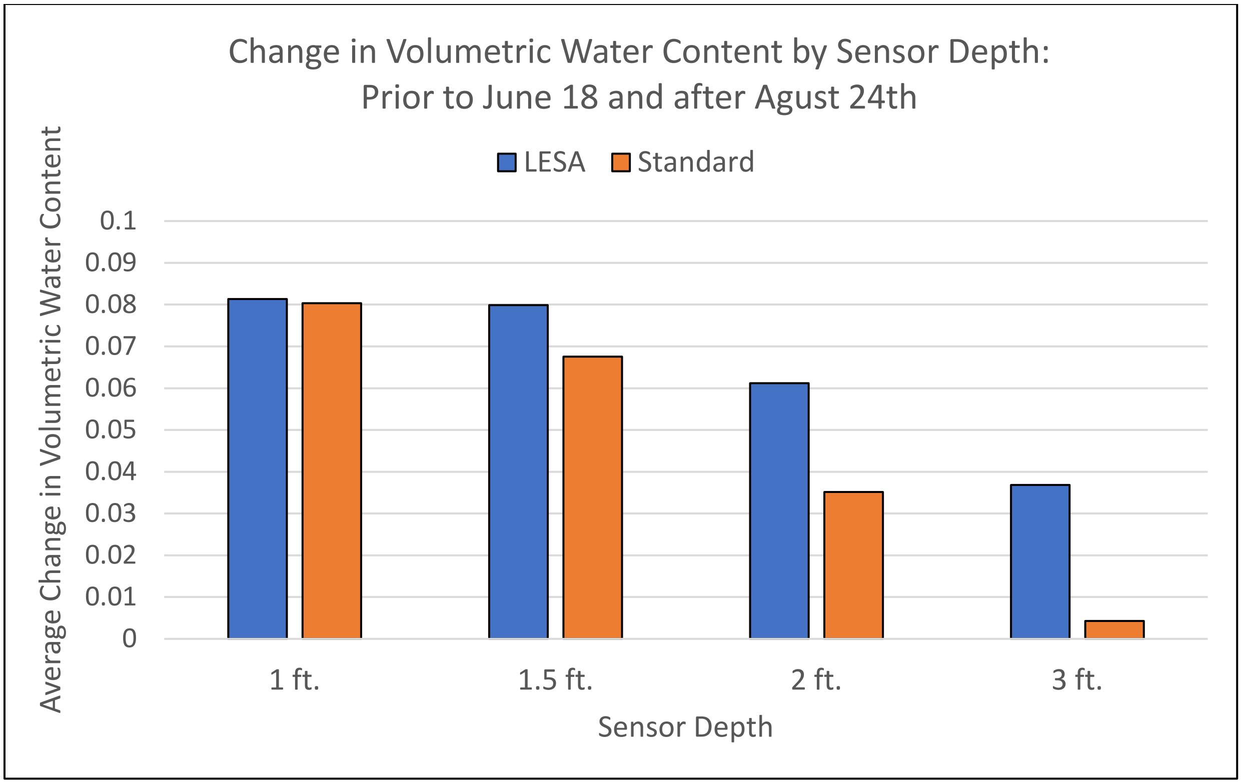


Figure 7: Average change in volumetric water content after irrigation for each sensor depth under each package during the cool season data was recorded for, prior to June 18th and after August 24th.

Double Goosenecks installed on the top of pipe, to double the number of drops. (The other pivot tested used triple goosenecks.

Photo of LESA system up front, bubbling water down, notice the wind blowing water from the standard sprinklers in the background.

LESA sprinklers down in the canopy of the grain, standard sprinklers in background on breezy day.

Investigation of Esplanade and Rimsulfuron for Bare Ground Applications

Introduction: In certain instances, it is desirable to have no vegetation present. Some of these instances include right of ways, roadsides, farmyards, and in defensible space. This trial was set up to investigate Esplanade and Rimsulfuron together and alone for achieving bare ground. Rimsulfuron in charts below is referred to as the trade name Rezilion, where the numbered compound IAF + RIZ Sodium is a combination of Esplanade and Rimsulfuron. Razor Pro (glyphosate) was included at 1 quart to control all actively growing vegetation at the time of application.

Study Investigator: Tom Getts

Cooperator: Susanville Airport

Date of herbicide applications: The applications were made on March 9, 2017, at 9:30 am. It was 55 degrees outside, with a relative humidity of 13% and 2.5 mph winds from the southwest. A CO2 pressurized 10 ft. hand-held boom sprayer was used to make the application at 20 gal/acre with 002 flat fan nozzles. The site had very sandy soil.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block.

Plant species at application: Cheatgrass, red stem filaree, and spring draba dominated site at time of application. Landowners indicated high populations of various other summer annual weed species. Only annual bursage appeared to be prevalent in every plot. The site had been burned in the previous year. Perennial species at time of application were dormant and appeared to be in low concentrations. Perennial grasses were assessed together until distinguishing characteristics were apparent. The main species present were Indian Rice Grass (*oryzopsis hymenoides*) and Intermediate Wheatgrass (*elymus hispidus*).

Data collected: Percent cover of each species was assessed in April, May, June, July, August and October.

Results:

In April, treatments which contained combinations of Esplanade (Indaziflam), Rimsulfuron or Oust (Sulfometuron) offered the highest percentage of bare ground (figure one). Other treatments had varying levels of annual broadleaf plants (spring draba mostly) and perennial grasses. In May, combination treatments offered the largest proportion of bare ground, where annual grasses started to dominate untreated plots (figure two). By June, Esplanade alone was only offering 60 percent bare ground, where Esplanade in combination with Oust offered nearly 95% vegetation control (figure three). In July, there was slightly more bare ground in most treatments as annual broadleaf plants sensed (figure four), and this trend continued into August (figure five). In October, Esplanade in combination with Oust, was the only treatment to offer 95% control (figure six).

It was not anticipated that there would be so many perennial species present on site after application. The percentage of bare ground may have been higher if application had been made later, after perennial species broke dormancy, and could have been controlled by Glyphosate. Perennial grasses seemed to survive the application, but many were stunted with limited seed head production in certain plots. The trial will be monitored in 2018 to assess control, as all treatments except Razor Pro have long soil residual activity.

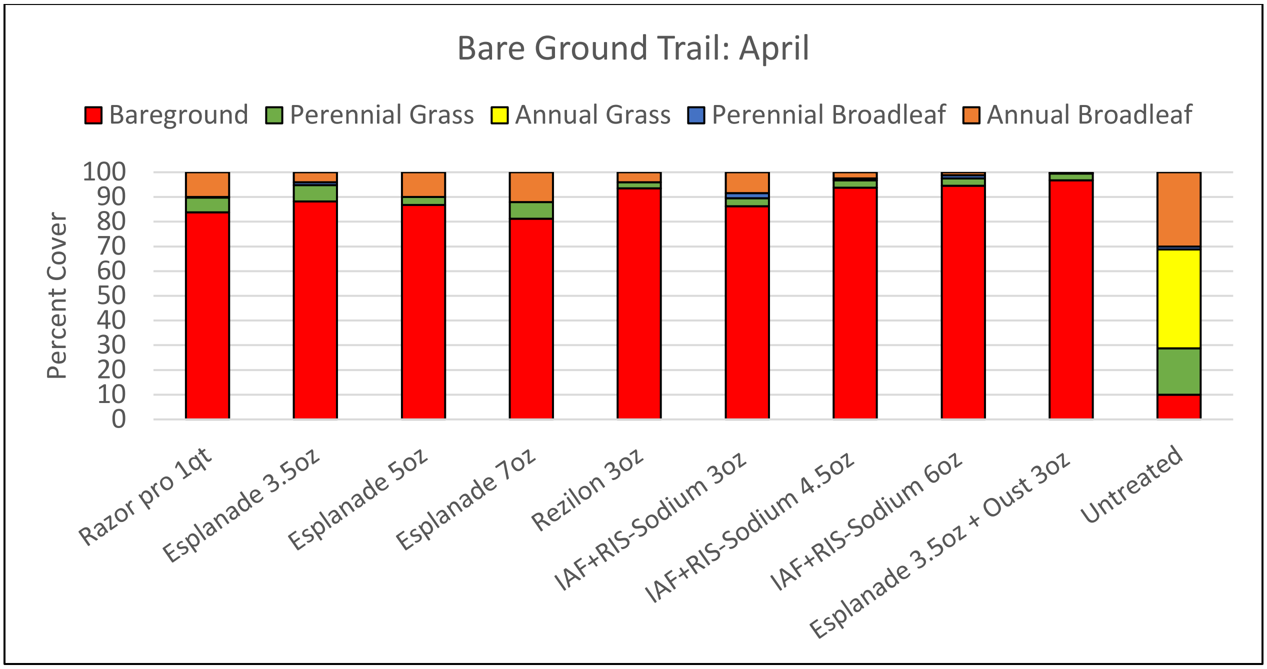


Figure one: Species percent cover by functional group within the bare ground trial in April of 2017.

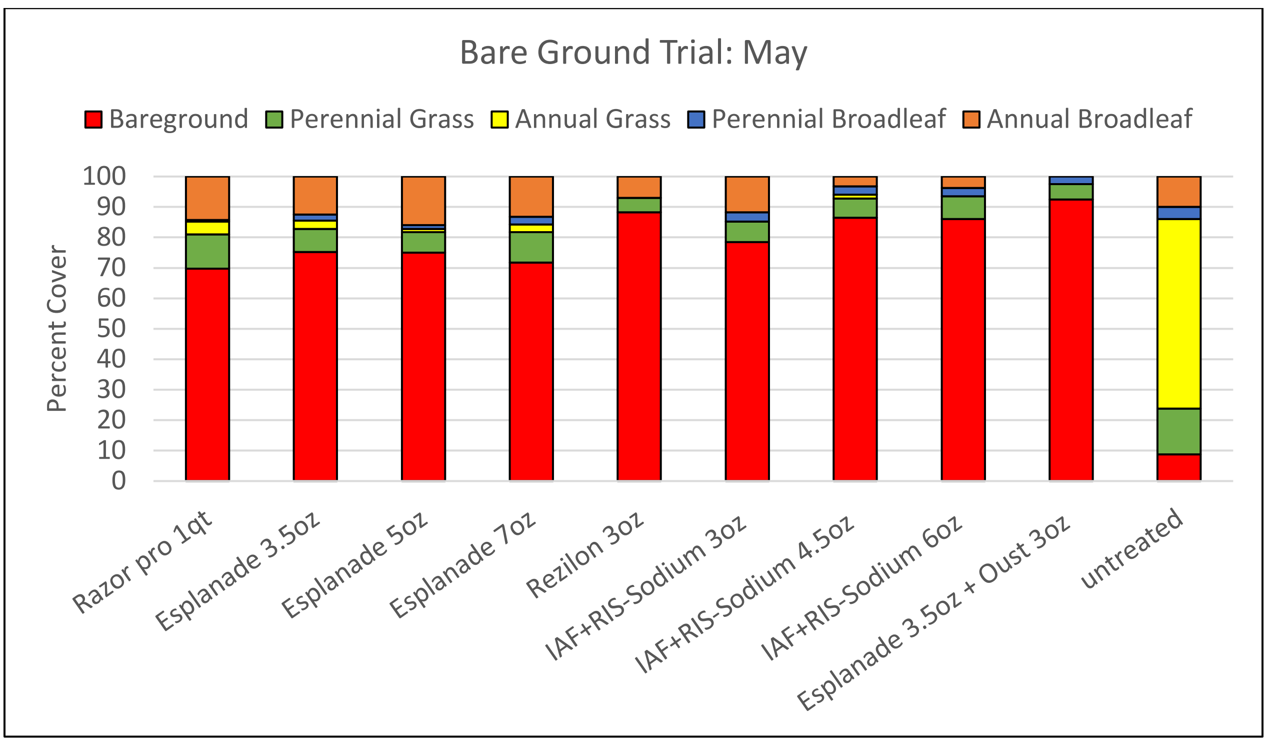


Figure two: Species percent cover by functional group within the bare ground trial in May of 2017.

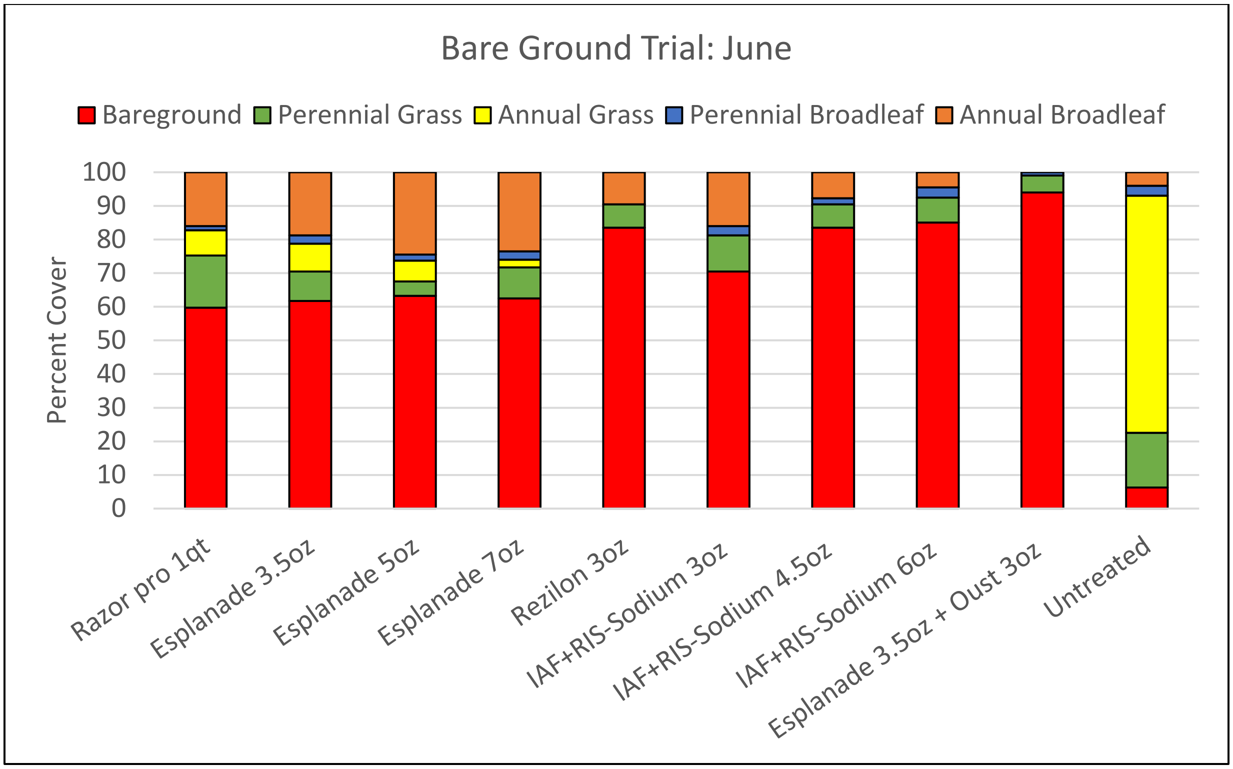


Figure three: Species percent cover by functional group within the bare ground trial in June of 2017.

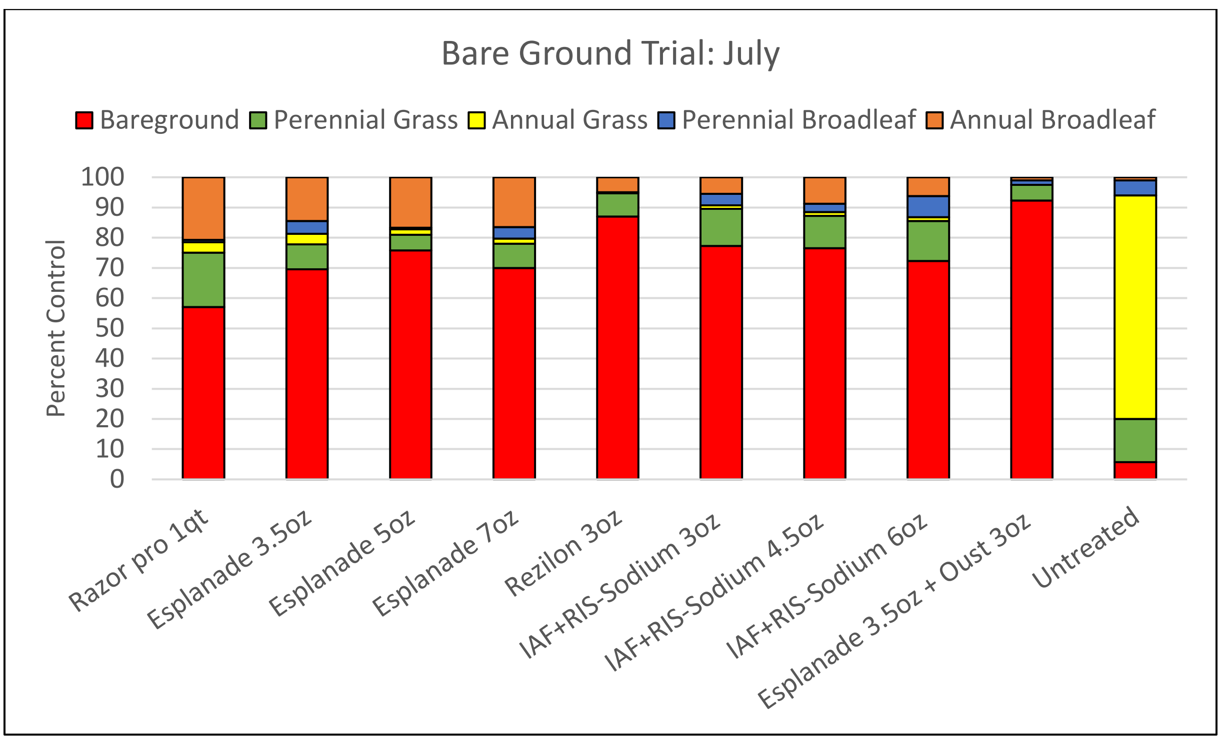


Figure four: Species percent cover by functional group within the bare ground trial in July of 2017.

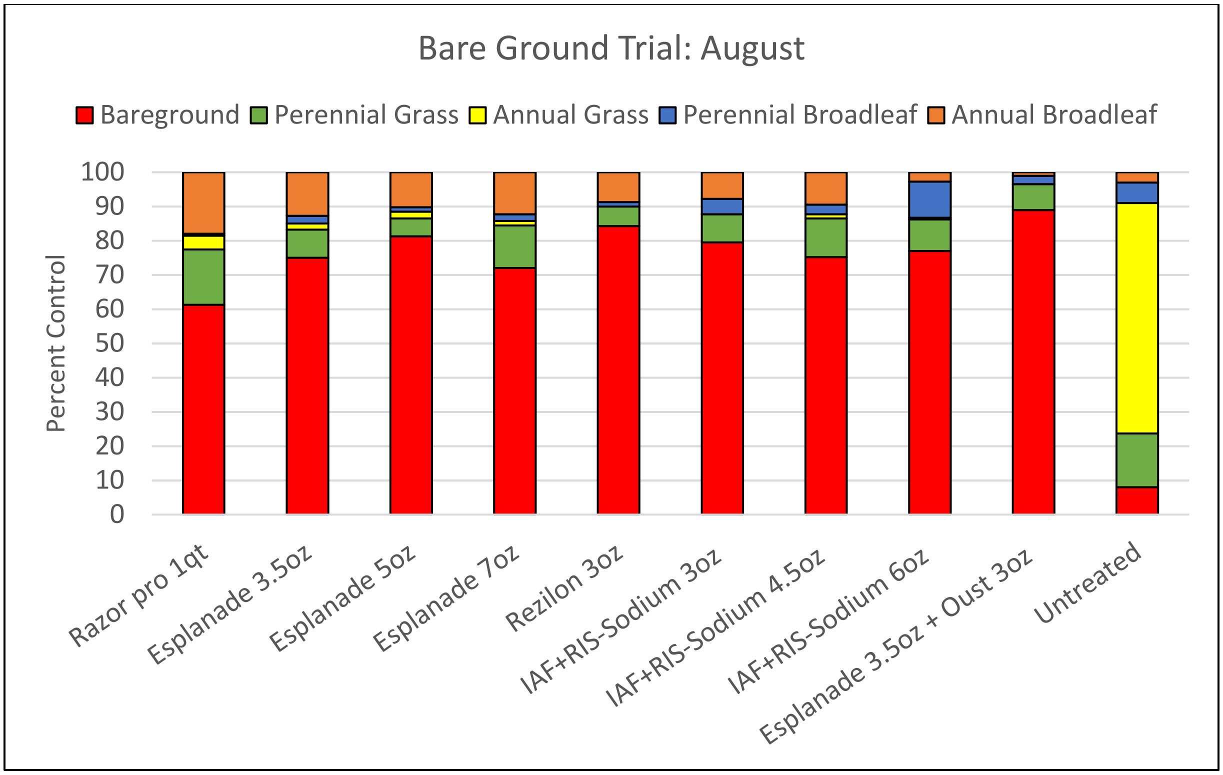


Figure five: Species percent cover by functional group within the bare ground trial in August of 2017.

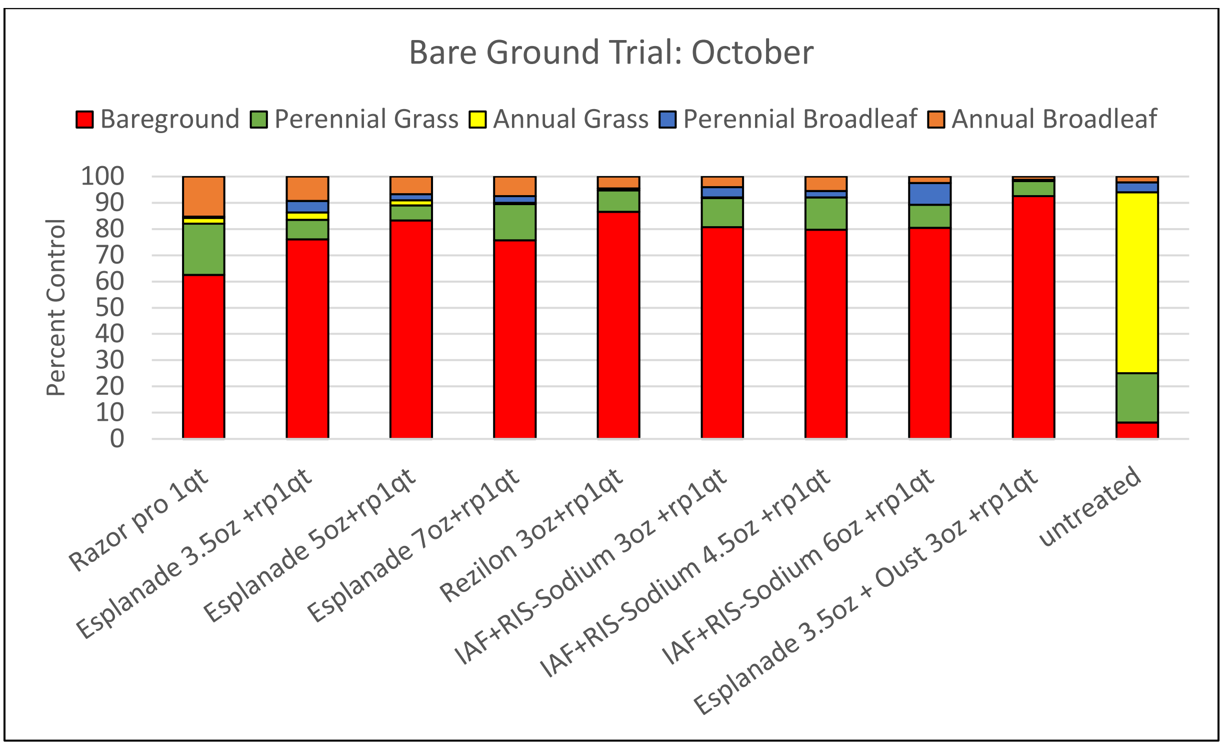


Figure six: Species percent cover by functional group within the bare ground trial in October of 2017.

Picture from the bare ground trial in June. Lots of cheatgrass and annual species outside of the plots.

Picture of an indaziflam (Esplanade) and Rimsulfuron (Relizon) plot in June (between two orange stakes).

Scotch Thistle Control with Aminocyclopyrachlor

Introduction: Scotch thistle is a very difficult-to-control biannual (sometimes annual or perennial) weed species which is problematic in pastures, rangeland, and field edges. Long soil seed life makes this thistle species very difficult to control. Research has shown that applications made at the rosette stage of the plant's life cycle are much more effective than applications made to bolting plants. Applications are sometimes made to fall rosettes, however, most research has focused on the spring rosette application. This study set out to test various herbicides which have long soil residual activity for fall, and spring applications to the basal rosettes. Long term control results will be collected and reported over the coming years.

Study Investigator: Tom Getts

Cooperators: Marty Svendsen and Ed Svendsen.

Date of herbicide applications: Fall applications were made October 22, 2016, at 10:30 am. It was 62 degrees F., with 36% relative humidity, with 1-3 mph winds from the north. Spring treatments were applied at 8:40 am on May 2, 2017. It was 59 degrees F, 52% relative humidity with 1-5 mph winds from the north. Applications were made with a 10 ft. CO2 pressured sprayer with 002 flat fan nozzles at a carrier volume of 20 gal/acre. The site was located near Doyle, California, in Long Valley adjacent to the creek on very sandy soils.

Study design: Four replications of the treatment were laid out in a completely randomized block design. The study was fenced off with electric fence to prevent grazing.

Thistle growth stage at application: In the fall, old thistle stocks from the previous growing season were knocked over utilizing a bull dozer with the blade lifted 6 inches off the ground. This was done to allow a boom sprayer to be utilized for herbicide applications. Scotch thistle was in the rosette growth stage, with rosettes ranging from 3-12 inches in diameter. Much of the Scotch thistle had yet to germinate at the time of application. In the spring, applications were made to Scotch thistle rosettes ranging from 4-22 inches in diameter, with generally two size cohorts, 4-6 inches and 8-14 inches in diameter.

Data collected: Scotch thistle control and species class percent cover was assessed in March, June, July, August, and October of 2017.

Results:

Fall applications provided excellent control of Scotch thistle (figure one). All treatments provided at least 88% control nearly one year after application, except Dicamba +2,4-D and Telar + 2,4 D. Greater than 98% control was achieved with Grazonnext, Method+Esplanade, and the highest rate of Method (not labeled for use). Five months after treatment, spring applications were slightly less effective than fall treatments, possibly because applications were made to Scotch thistle in larger growth stages. The 4 oz. rate of Method offered 12% less control in the spring compared to the fall. Other Method treatments offered similar control. Milestone applications in the spring offered slightly more control than when applied in the fall. Grazonnext and Telar+2,4-D offered nearly 30% better control as fall applications compared to spring applications. Dicmabia+2,4-D was much more effective as a spring application, however, still only provided Scotch thistle suppression.

Figures 2-5 display percent cover of each species class at the four assessment timepoints. Percent cover for the species classes changed slightly, but overall the October assessment captures the picture. Scotch thistle cover was relatively uniform across the site, but some variability did occur. In the untreated plots, just over 50% of the area was covered with Scotch thistle. (Other species were growing in the thistle understory, otherwise Scotch thistle cover would have been higher.) The annual grasses cheatgrass (*Bromus tectorum*) and foxtails (*Hordeum murinum*) populations increased with thistle control. Cheatgrass was controlled in both in fall Esplanade treatments, but the foxtails were not. Likewise, increases in annual broadleaves, perennial broadleaf, perennial grasses, and bare ground occurred when Scotch thistle was removed. Fall treatments resulted in a larger increase of broadleaf plants, whereas spring treatments favored grasses.

Plots will continue to be monitored in 2018 and 2019 to assess control multiple years after application.

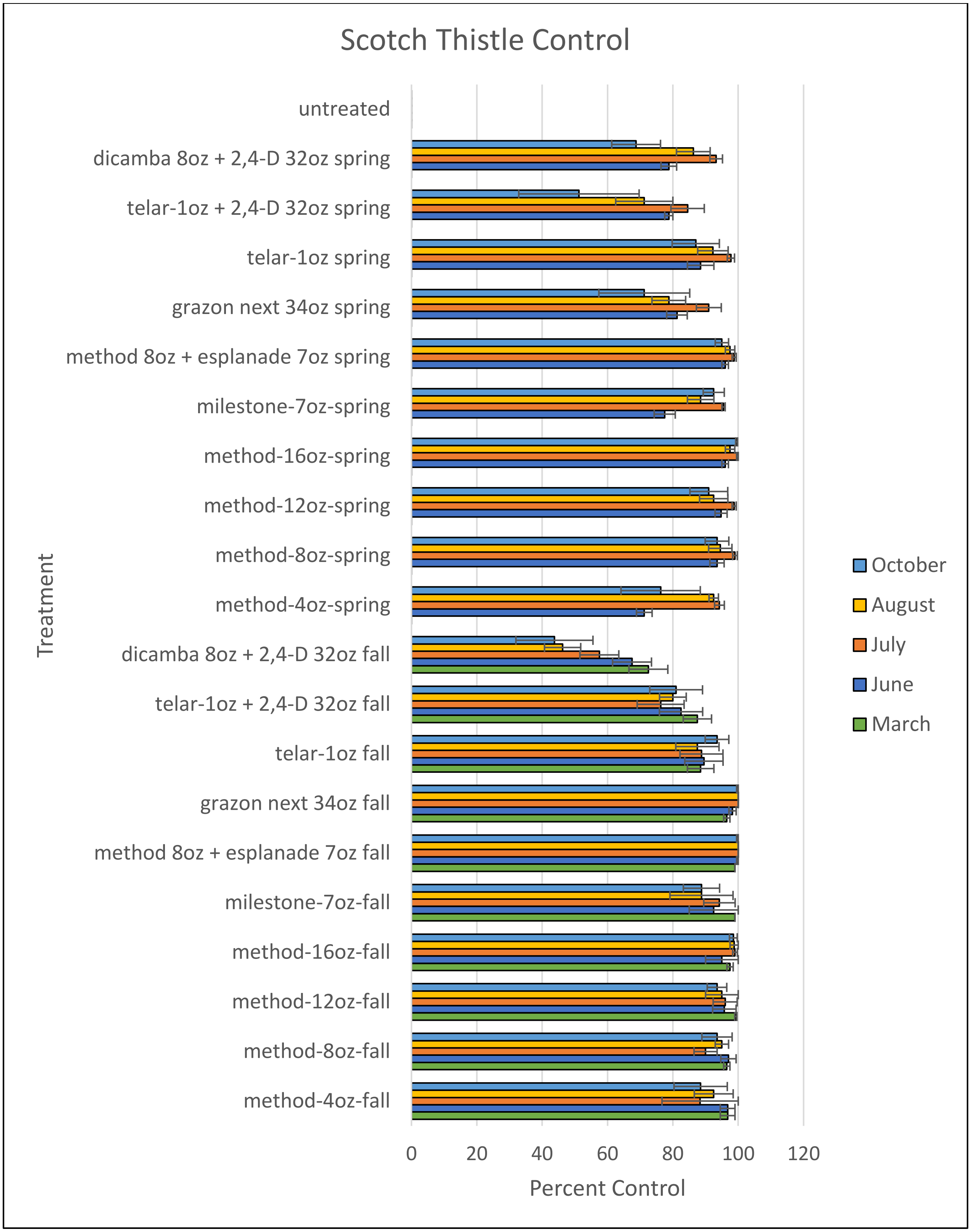


Figure one: Scotch thistle control assessments, in March, June, July, August and October of 2017. Error bars indicate standard error.

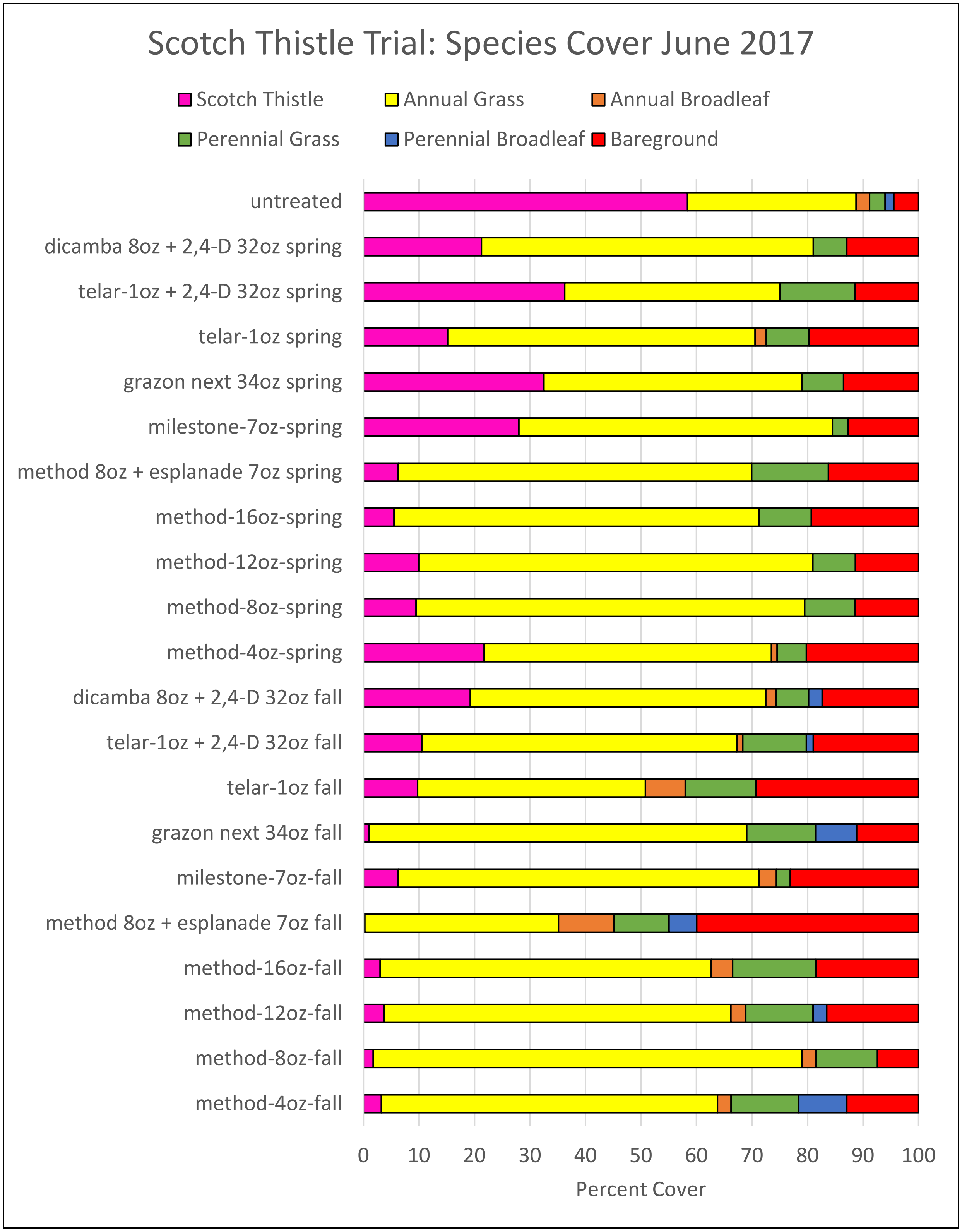


Figure two: Assessment of species class percent cover June 2017.

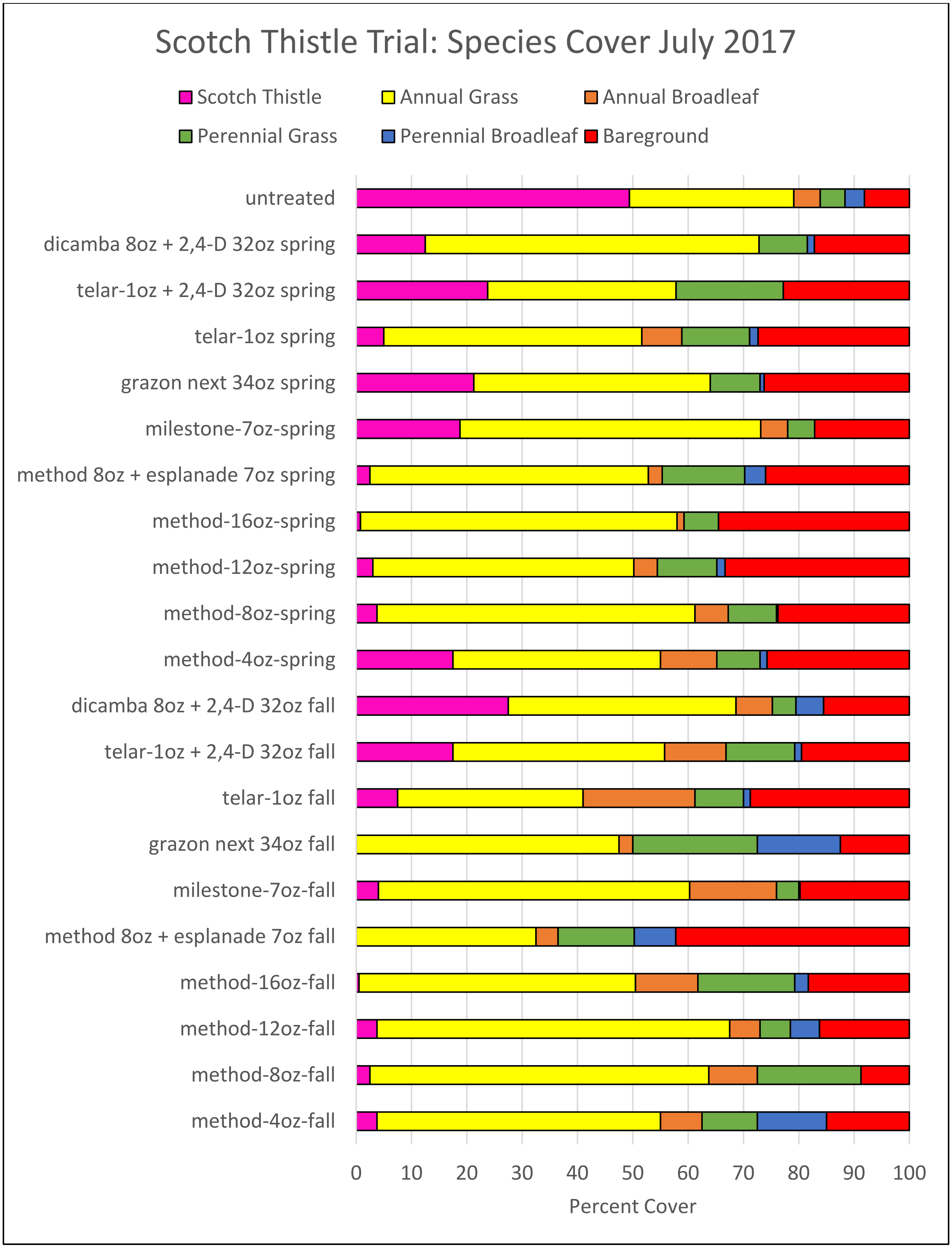


Figure three: Assessment of species class percent cover July 2017.

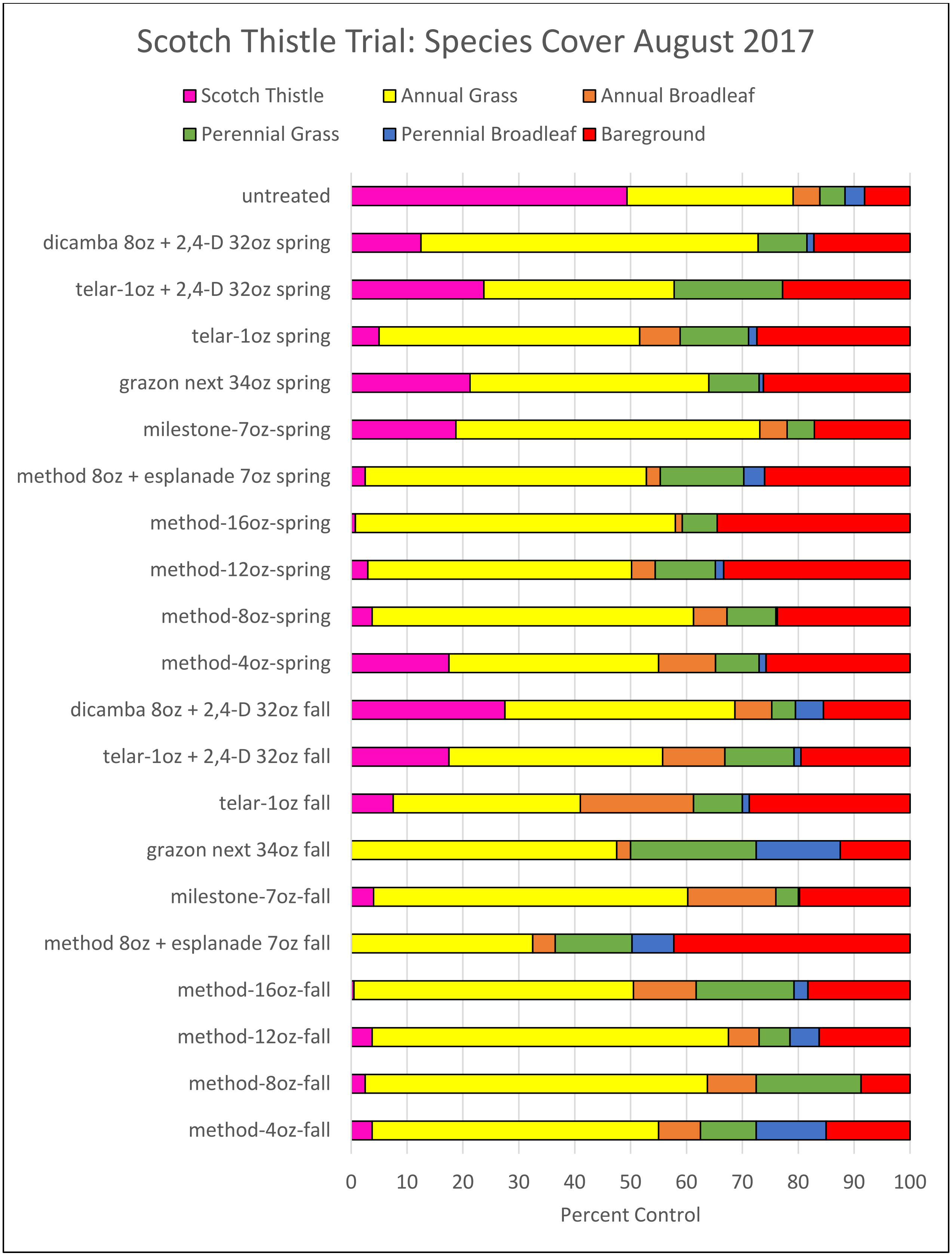


Figure four: Assessment of species class percent cover August 2017.

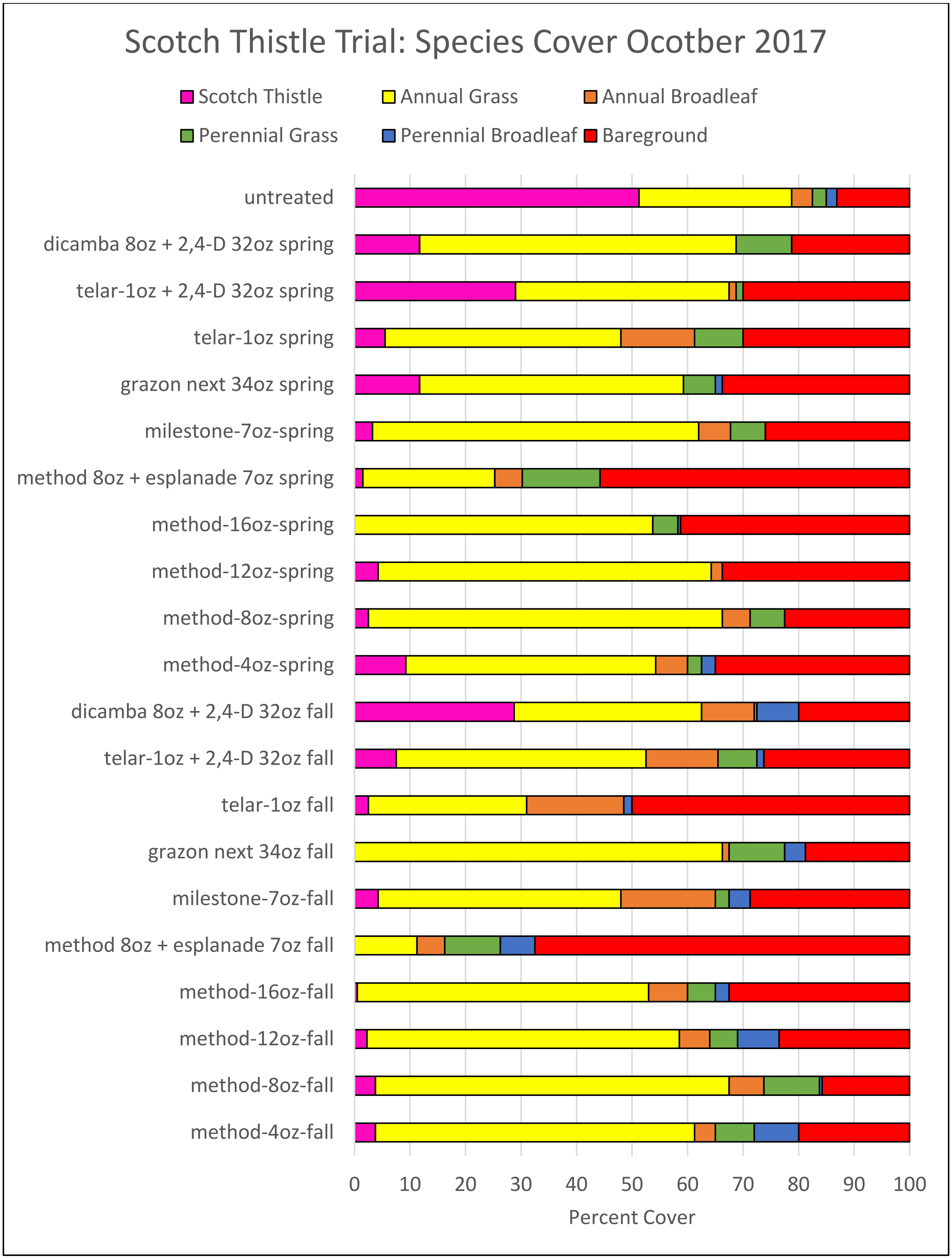


Figure five: Assessment of species class percent cover October 2017.

Untreated plot on left hand side looking over spring treatment of dicamba and 2,4-D in July.

Method 8oz/acre as a spring application, offering successful control, picture taken in July.

Medusahead Control and Perennial Grass Seeding

Introduction: Medusahead is an invasive winter annual grass which can form monocultures on rangelands throughout California, Oregon, Washington and Idaho. In northeastern California, medusahead is highly competitive on heavy clay, shrink swell soils. Medusahead forms a thick thatch layer and achieving control can be difficult. After controlling monocultures of invasive species, seeding is often needed to shift the plant community to a desirable state. This study set out to test spring applications of Esplanade and various other herbicides for medusahead control. All herbicides were tank mixed with Accord *(glyphosate)* to control the medusahead which was already emerged.

Study Investigators: Tom Getts, Laura Snell and Rob Wilson

Cooperators: Buck Parks and Herb Jasper

Study Design: Herbicides applied to 10 x 20 ft. plots replicated four times in a randomized complete block design, at two study sites. Applications were made with 110 02 flat fan nozzles at 20 gal/acre and all treatments included a 0.25% NIS v/v. Eight perennial grass species were planted within herbicide treatments.

Applications: Initial applications made on March 17, 2016, outside of Adin and March 19, 2016, outside of Willow Creek. Medusahead plants were 1-3 inches tall with 2-3 leaves. Accord XRT 2 *(glyphosate)* was included in all tank mixes to control actively growing medusahead. (*In the Accord XRT 2 only plot, an additional application was made on April 18th for a total of 32 fl oz/acre applied.) Control was not effective from initial Accord XRT 2 applications throughout the study, and all plots (besides the untreated) were retreated with Accord XRT 2 on May 13th.

Site conditions: Both sites had clay soils with dense medusahead infestations.

Seeding: Eight perennial grasses were seeded into the plots at the beginning of May in 2017, utilizing a no till drill with a 3 ft. planting width. Sherman big bluegrass, blue bunch wheatgrass, hycrest wheatgrass, western wheatgrass, intermediate wheatgrass, Russian wildrye, Great Basin wildrye and squirreltail were planted at 3.5 lbs/acre, 9.8 lbs/acre, 6.2 lbs/acre, 9.1 lbs/acre, 16.4 lbs/acre, 7 lbs/acre, 12 lbs/acre, and 7.8 lbs/acre respectively.

Data Collected and Results: Visual control evaluations were assessed on May 12, 2016. These evaluations indicated good control for some of the herbicide treatments - Panoramic 12 oz., and Esplanade+Method combinations (Figure 1). Other herbicide treatments had relatively poor control. Previous research indicated 12-16 oz/acre of formulated glyphosate would effectively control emerged medusahead. None of the treatments provided 100% control possibly because of a thick litter layer. In May, an additional application of glyphosate was made in all plots to control escaped medusahead and eliminate seed production in 2016 (except within the untreated check).

Additional medusahead control evaluations were then conducted on June 30, 2016, November 16, 2016, May 17, 2017, July 17, 2017 and October 17, 2017 (See results in Table 1). During the June evaluation, excellent control was achieved in all plots with no statistical differences noted. Evaluations made in November of 2017 focused on medusahead seedlings which had germinated that fall. All treatments containing Esplanade offered excellent control, followed by Panoramic applications. Method and Milestone treatments broke. In May of 2017, similar results were recorded, with further drop off of control of Milestone and Method treatments. Interestingly, Accord showed excellent control in May of 2017. In Accord plots, seedlings had germinated in November, but with no medusahead litter most seedlings were not alive by May of 2017. By July and November of 2017 only treatments containing Esplanade offered excellent medusahead control.

Species cover by functional class was also recorded in November of 2016, July 2017, and November of 2017. Differences between sites were noted, and results are reported in Figures 1-6. At the Adin Site medusahead was largely replaced by bare ground in November of 2016 (Figures 1-3). By July, there was a slight increase of annual broadleaf plants across many of the treatments where medusahead had been effectively controlled or suppressed. Similar trends were apparent in November of 2017. Prominent annual broadleaf species were prickly lettuce, annual sunflower, and turkey mullen among others. At the Willow Creek site, by November of 2016 much of the area previously occupied by medusahead, was occupied by either bare ground or perennial broadleaf species. Poverty weed and bindweed were the most prevalent broadleaf species, especially in one of the replications. By November of 2017, annual broadleaf species such as willow herb, prickly lettuce, and various winter annual mustards, had started to occupy some of the bare ground (Figure 6). Surprisingly perennial grasses, while rare at both study sites, were not killed by herbicide applications, but were initially suppressed.

Perennial Grass Establishment: After a historically wet 2016 winter, the field sites did not dry out enough to plant until the beginning of May 2017. Little precipitation was received at either field site after this point. No grasses established at the Willow Creek site. At the Adin site, small populations of grasses emerged. Table 2 displays the values for the three species that had the most germination in 2017. Intermediate wheatgrass by far had the most germination. The vast majority of perennial grass seedlings were present in plots where the medusahead had been controlled with Esplanade. Reseeding is planned for the spring of 2018.

Percent Medusahead Control						
	May 2016	June 2016	Nov. 2016	May 2017	July 2017	Nov. 2017
Accord 16 oz	94 a	100 a	63 e	96 ab	86 a	68 b
Panoramic 8oz	90 ab	99 a	89 cd	81 c	42 b	29c
Panoramic 12oz	95 a	100 a	91 bc	90 b	77 a	69 b
Milestone 14oz	73 cde	100 a	80 d	69 d	38 b	15 c
Method 4oz	70 de	98 a	70 e	58 e	27 b	9 c
Method 8 oz	76 bcd	100 a	70 e	61 de	36 b	21 c
Esplanade 5oz	61 de	99 a	97 abc	100 a	99 a	99 a
Esplanade 7oz	59 e	98 a	100 ab	99 ab	97 a	99 a
Esplanade 5 oz + Method 4oz	90 ab	100 a	99 ab	99 ab	97 a	99 a
Esplanade 5oz + Method 8oz	94 a	100 a	100 ab	100 a	96 a	99 a
Esplanade 7oz + Method 4oz	88 abc	100 a	100 a	100 a	97 a	98 a
Esplanade 7oz + Method 8oz	95 a	100 a	99 ab	100 a	100 a	100 a
Untreated Check	0	0	0	0	0	0

Table 1: Percent control across both sites. Site was not significant, so data was combined. Analysis ran separately by column excluding the untreated check. Tukey pair wise comparisons at the 95 percent confidence interval, were utilized to create letter reports.

Seeded Perennial Grass Stand Counts, Adin, November 2017			
Treatment	Intermediate Wheatgrass	Russian Wildrye	Western Wheatgrass
Accord 16 oz	0	1.6	0
Panoramic 8oz	0	0	0
Panoramic 12oz	0	0	0
Milestone 14oz	0	0	0
Method 4oz	0	0	0
Method 8 oz	0	0	0
Esplanade 5oz	1	3	0.3
Esplanade 7oz	1	0	0
Esplanade 5oz + Method 8oz	12.3	0.3	4
Esplanade 5 oz + Method 4oz	2.3	2	0
Esplanade 7oz + Method 4oz	10.3	0.6	0
Esplanade 7oz + Method 8oz	3	1.3	1
Untreated	0	0	0

Table 2: Number of perennial grass seedlings per plot at the Adin Site in November of 2017.

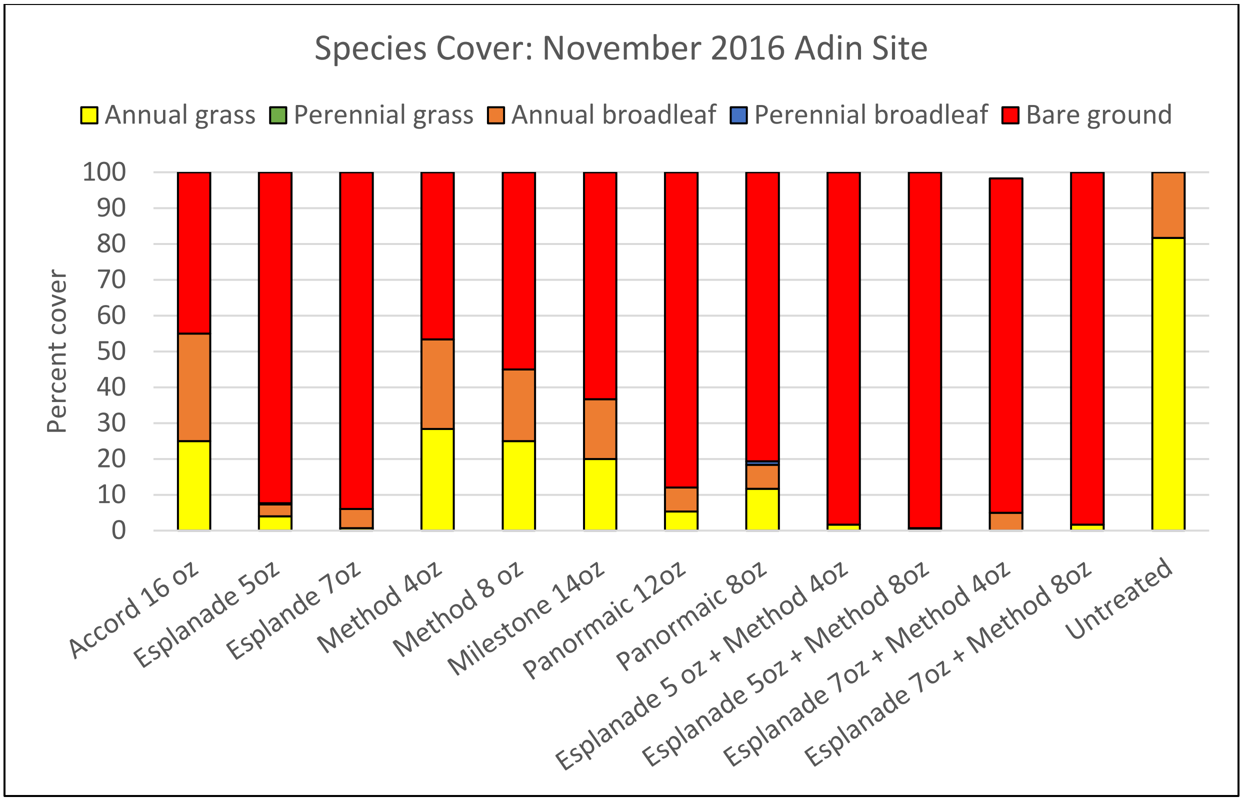


Figure 1: Percent cover of species by functional class at the Adin site November 2016.

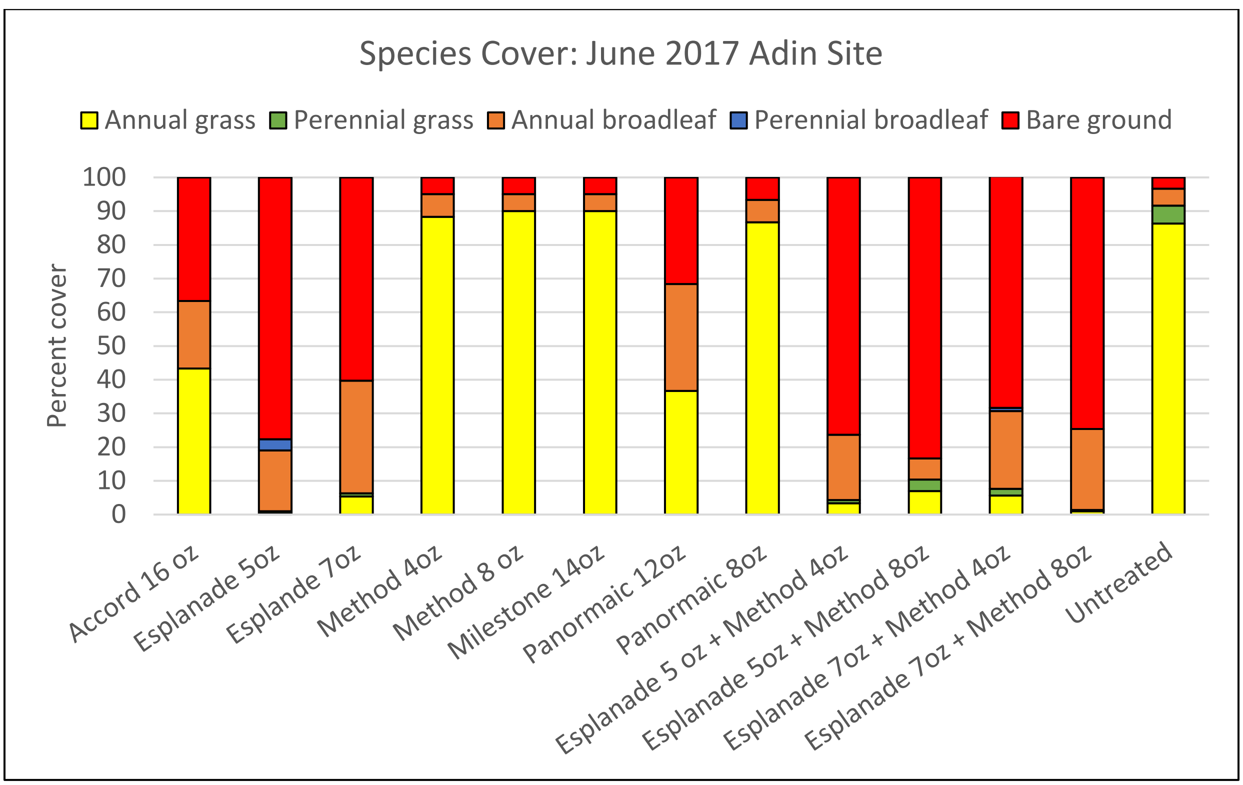


Figure 2: Percent cover of species by functional class at the Adin site June 2017.

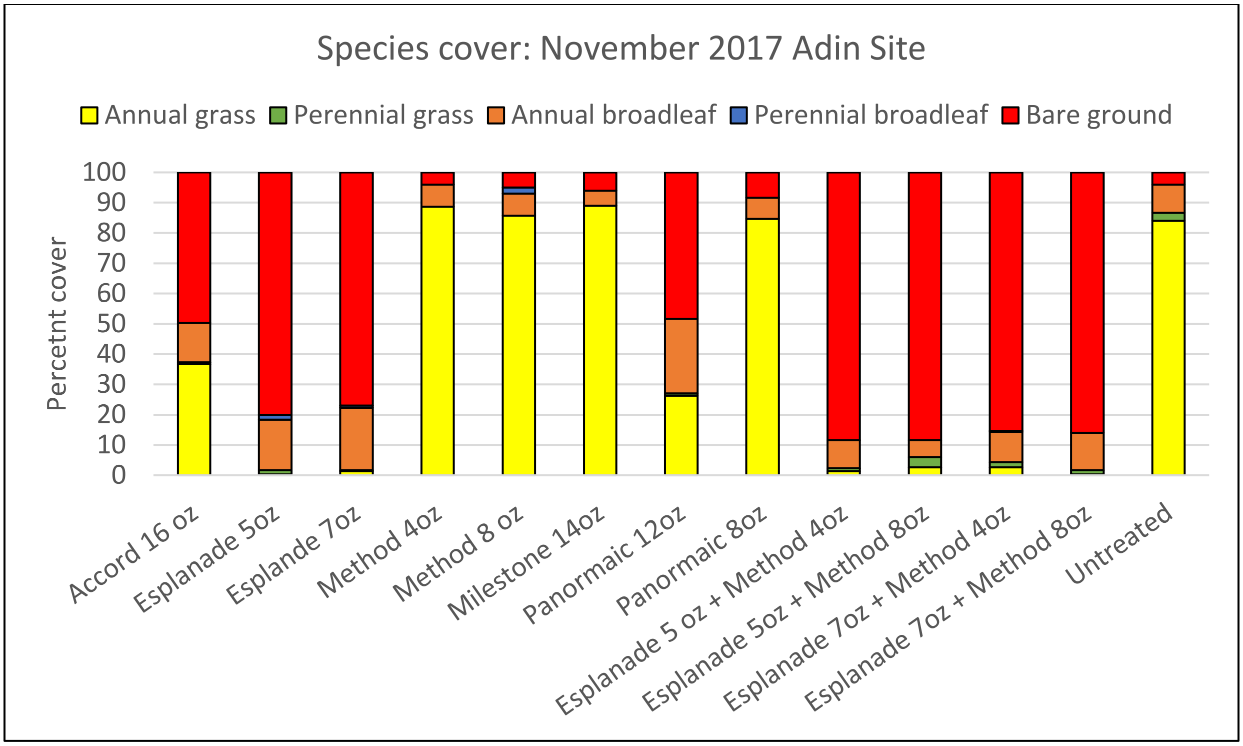


Figure 3: Percent cover of species by functional class at the Adin site November 2017.

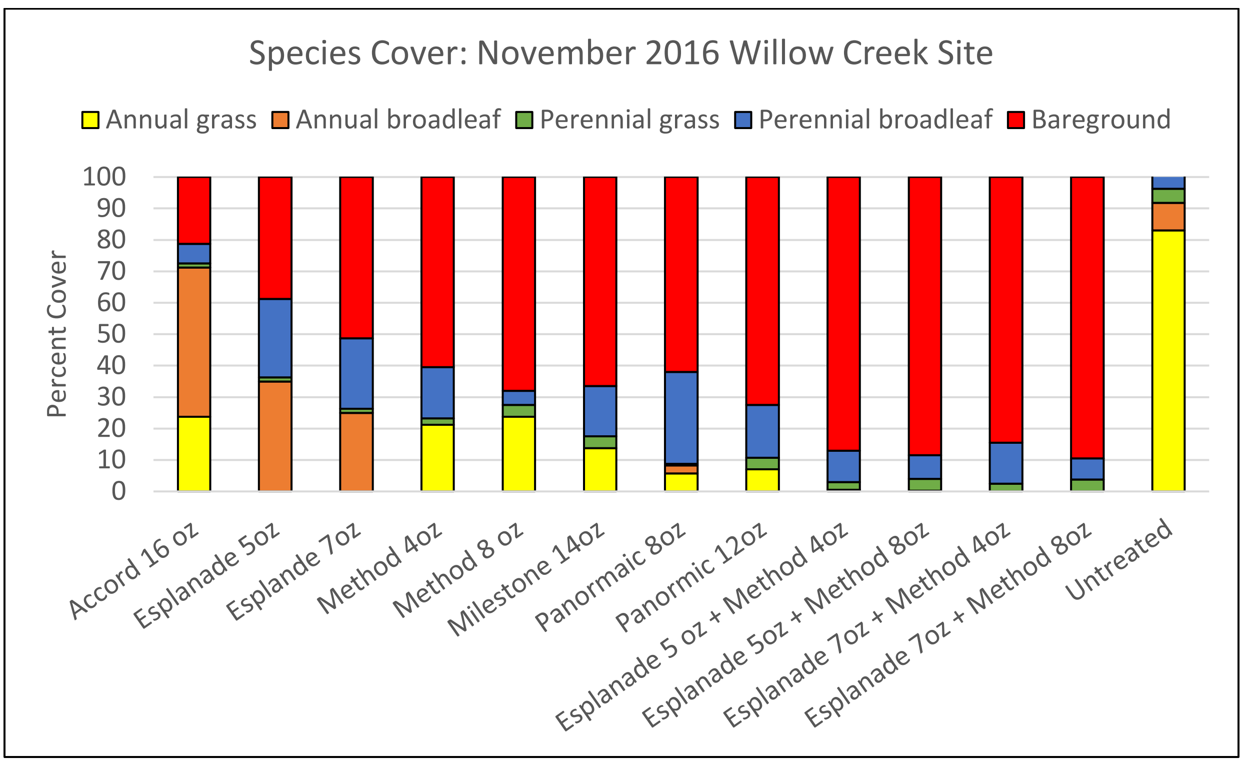


Figure 4: Percent cover of species by functional class at Willow Creek site November 2016.

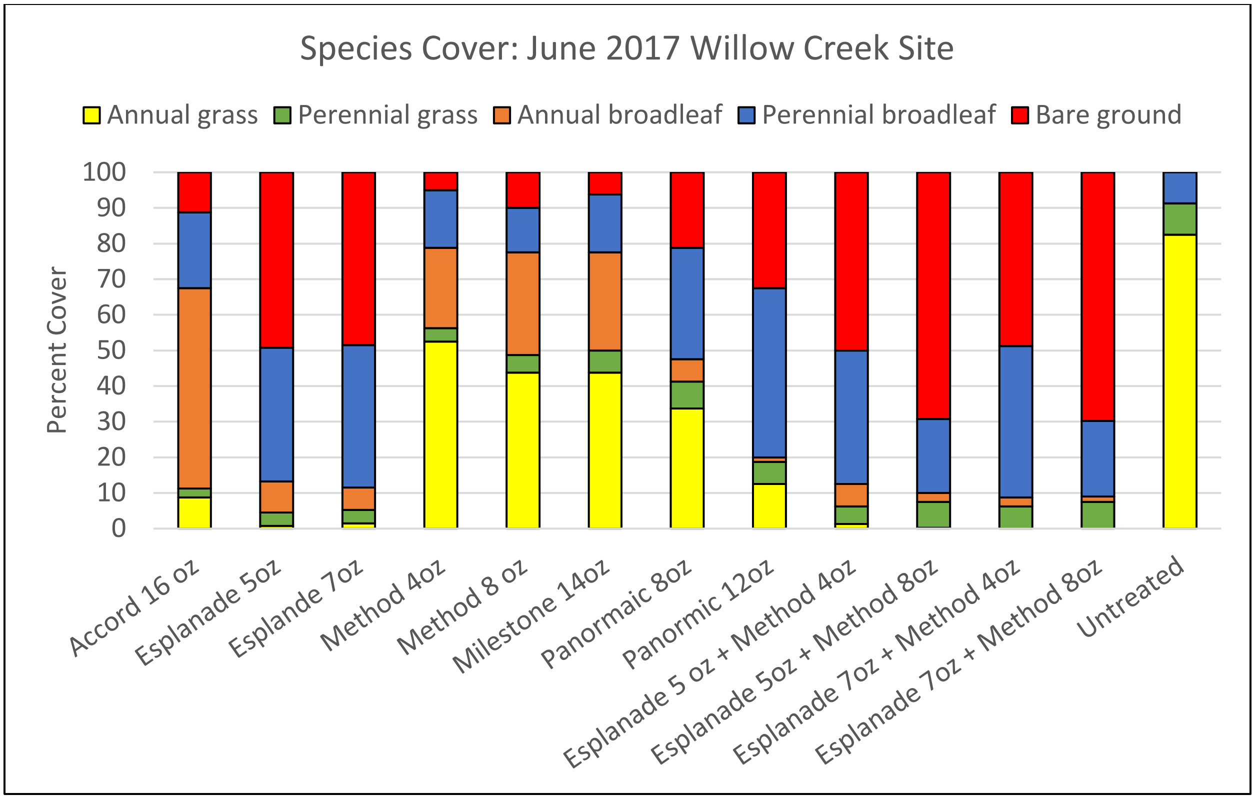


Figure 5: Percent cover of species by functional class at Willow Creek site June 2017.

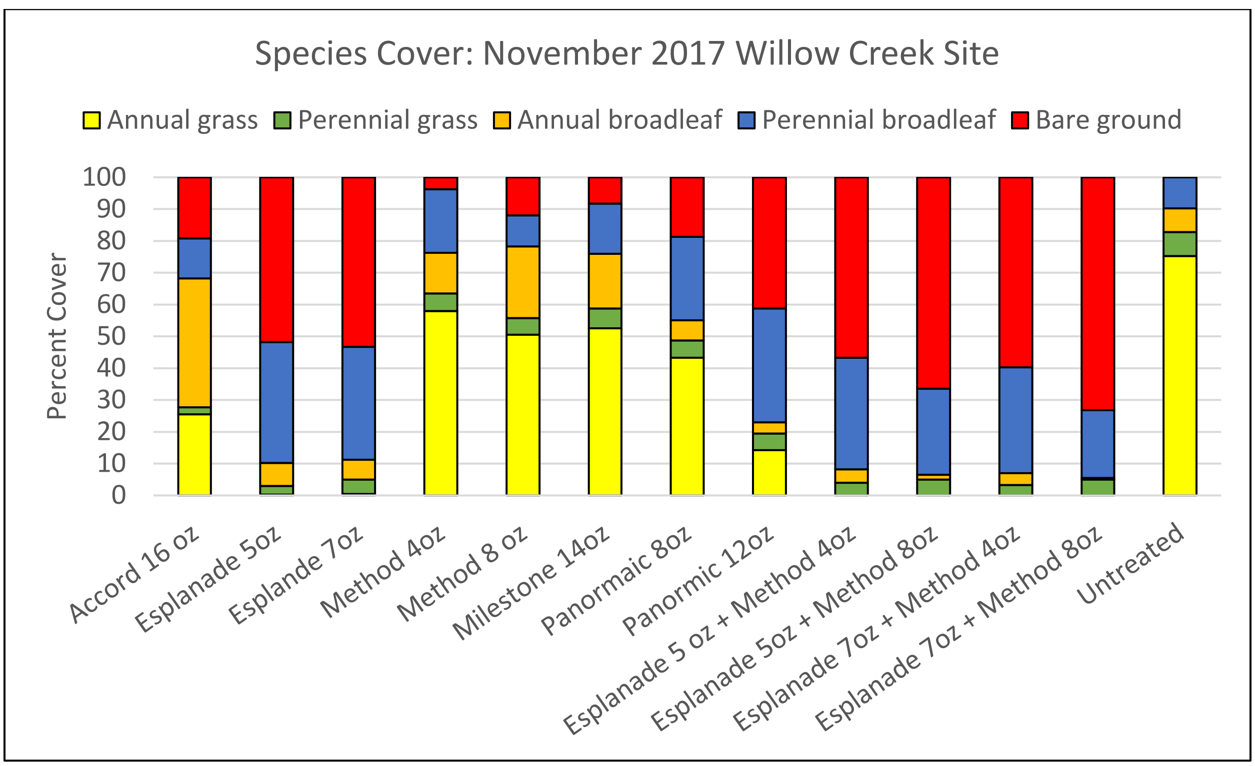


Figure 6: Percent cover of species by functional class at Willow Creek site November 2017.

Adin site November 2016 eight months after treatments. Little medusahead growing, in most of the treated plots.

Adin site October 2017 much more medusahead growing, the majority of plots with bare ground contained Esplanade.

Some perennial grass seedlings at the Adin site, 6 months after planting, most species did not germinate and grow. Establishment was only seen in plots with large proportions of bare ground.

Medusahead Control with Pre-Emergent Herbicide Applications

Introduction: Medusahead is an invasive winter annual grass which accumulates silica and does not provide quality forage for livestock. There are limited control options which are effective in the Intermountain Region of California. Fire and application of Milestone (aminopyralid) have been shown to work well in lower elevations. Fire, in combination with Panoramic (imazapic) and seeding, has been shown to work well in other states. However, Panoramic is not registered in California, and cannot be used or purchased in the state. Esplanade (indaziflam) has been shown to control cheatgrass for three years with a single application in Colorado. Some of these experiments in Colorado did nothing to remove the litter layer left behind, and still achieved good control of cheatgrass. This study was set up to assess pre-emergent control of medusahead using Esplanade, Milestone, Method and Panoramic.

Study Investigators: Tom Getts, Laura Snell and Rob Wilson

Cooperators: John Flournoy and Herb Jasper

Date of herbicide applications: Willow Creek Ranch applications were made September 8, 2016, at 9:30 am at 64 deg. F with 35% RH and 3 mph west wind. Likely site applications were made September 13, 2016 at 9:00 am at 51 deg. F with 40% RH and 1.25 mph north wind. Applications were made on top of litter layer from previous growing season. No medusahead had germinated at time of application. All treatments included a 0.25% NIS v/v, and were applied with a CO2 pressurized backpack sprayer at 20 gal/acre with 110 02 flat fan nozzles.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block design at both study sites. Method and Esplanade currently do not have a grazing label, so sites were fenced.

Plant community: Both sites were heavily dominated by medusahead, with small populations of cheatgrass and North African wiregrass. At the Likely site there were populations of various perennial bunchgrasses present. At the Willow Creek site, bulbous bluegrass and tall wheatgrass could be found in the plots.

Data collected: Visual evaluation of medusahead control was conducted in November of 2016, after germination occurred. Plants were in the 1-3 leaf growth stage. Additional visual assessments for medusahead control and plant cover were assessed in June of 2017 and November of 2017.

Results: Initial control was variable at both sites and across replications. In areas of thicker litter there appeared to be more medusahead growing. Initial results indicated some medusahead control with all treatments that included Esplanade in the first assessment (figures one and two). At both sites, control appeared to continue to increase for treatments containing Esplanade through 2017; however, complete control was not achieved, resulting in further seed rain onto the treated plots. Other treatments tested did not offer effective medusahead control. At the Willow Creek site in Esplanade treatments, medusahead was replaced with bare ground and remnant perennial grasses (figures three and four). In Esplanade treatments at the Likely site, there was a numerical increase in perennial grasses, but bare ground dominated the plots.

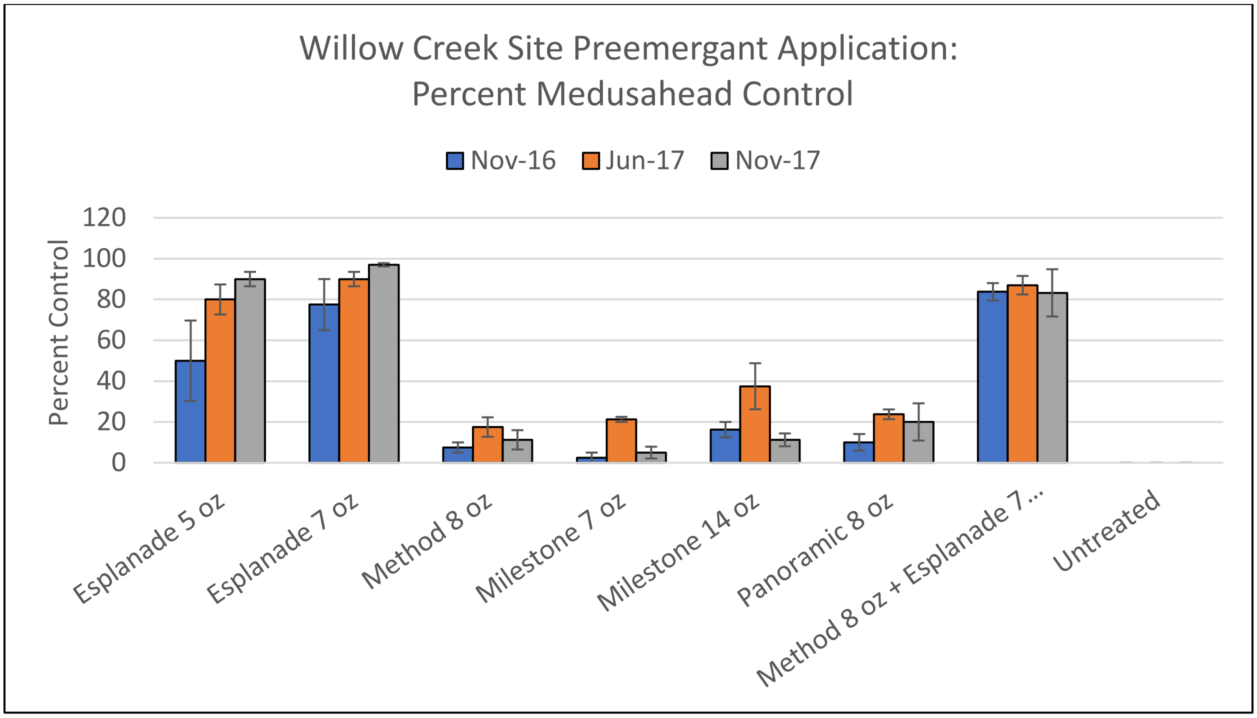


Figure one: Percent control of medusahead at the Willow Creek site for all three assessment periods. Error bars indicate standard error.

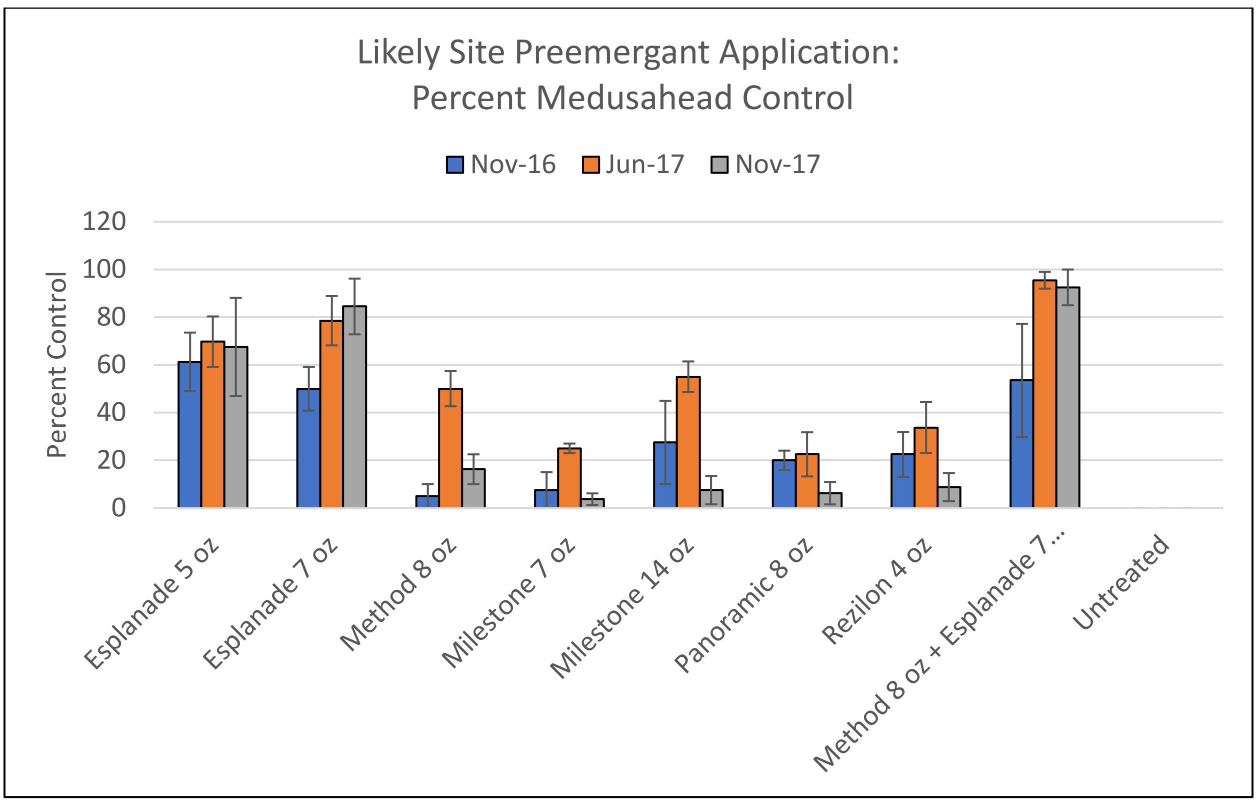


Figure two: Percent control of medusahead at the Willow Creek site, for all three assessment periods. Error bars indicate standard error.

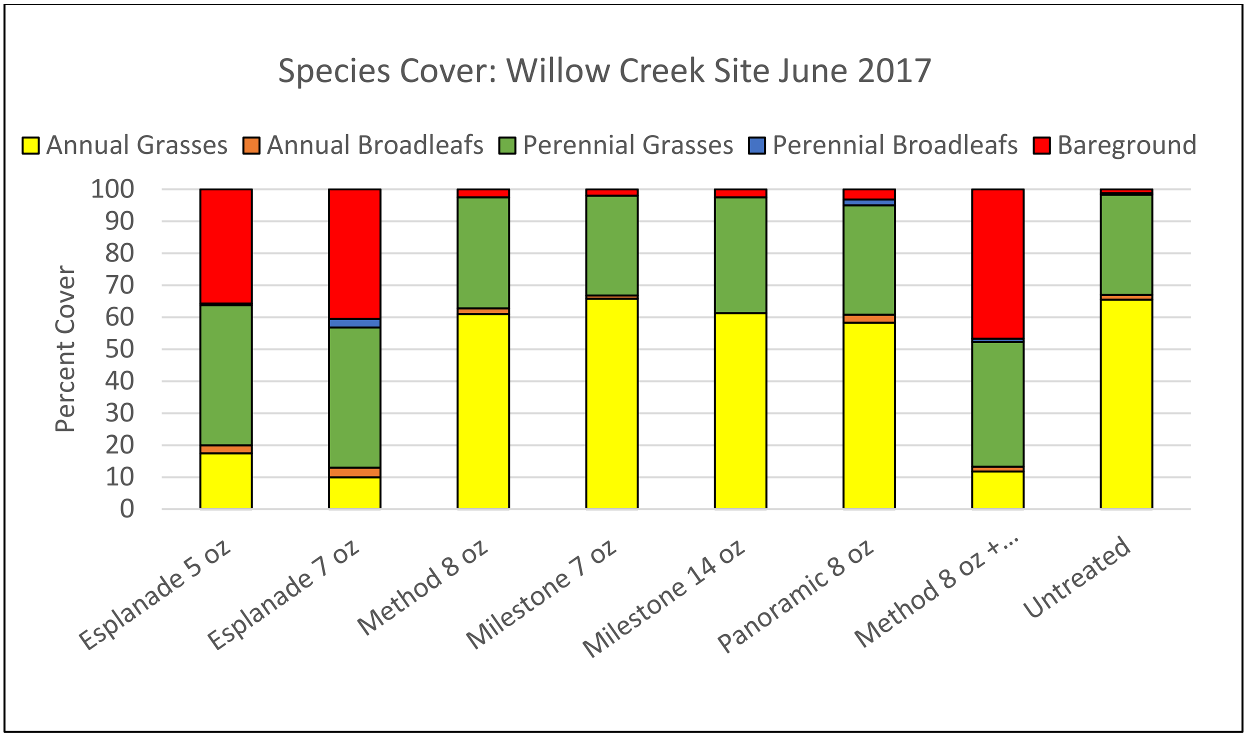


Figure three: Species percent cover separated by functional group in June 2017 at the Willow Creek ranch site.

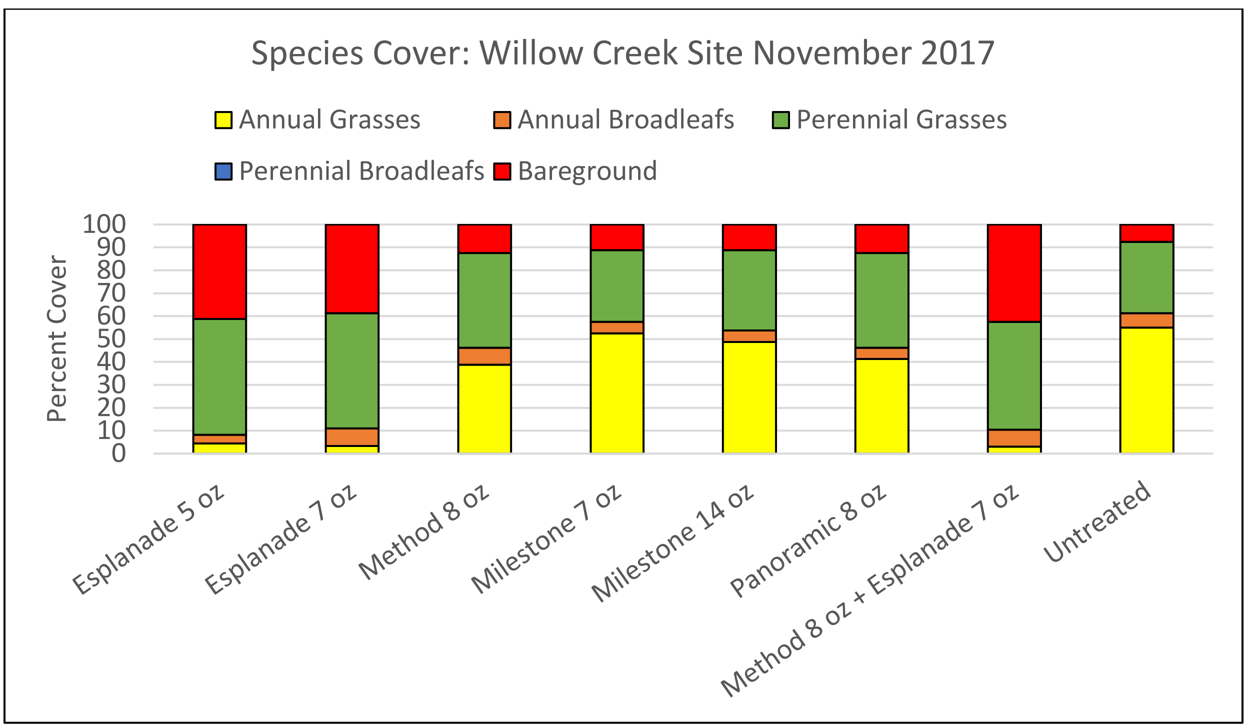


Figure four: Species percent cover separated by functional group in November 2017 at the Willow Creek ranch site.

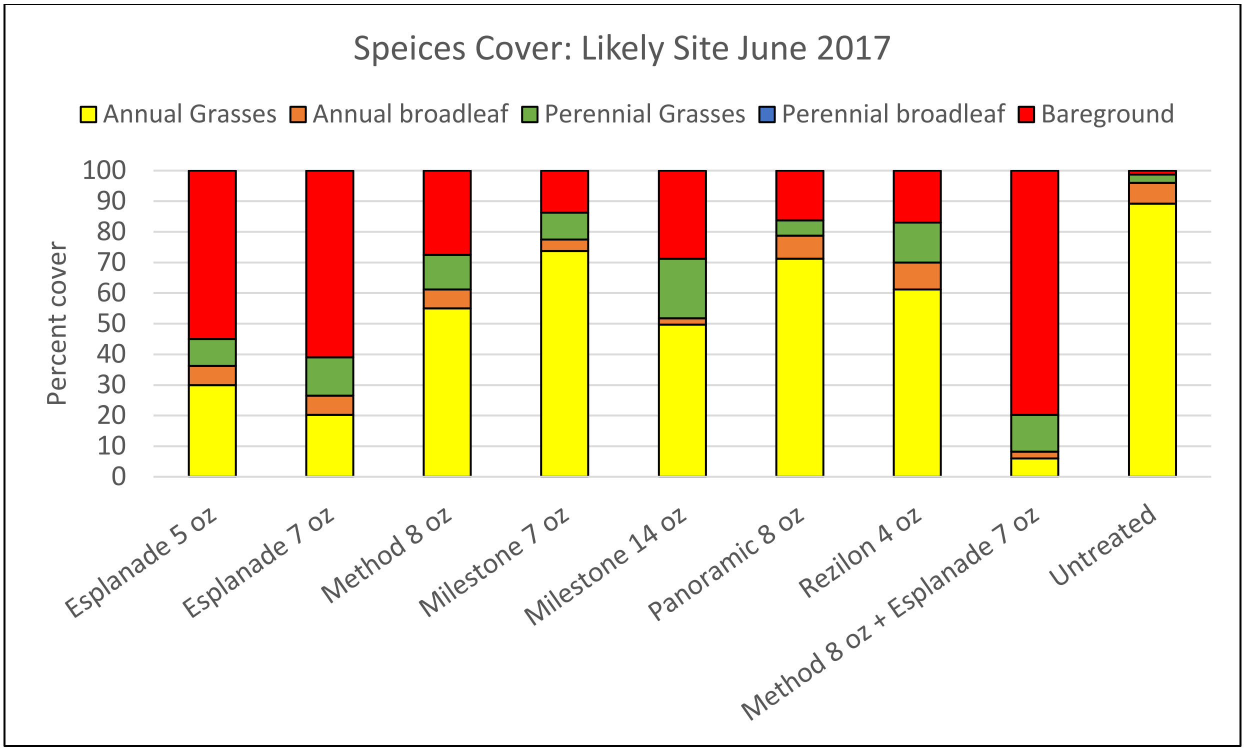


Figure five: Species percent cover separated by functional group in June 2017 at the Likely site.

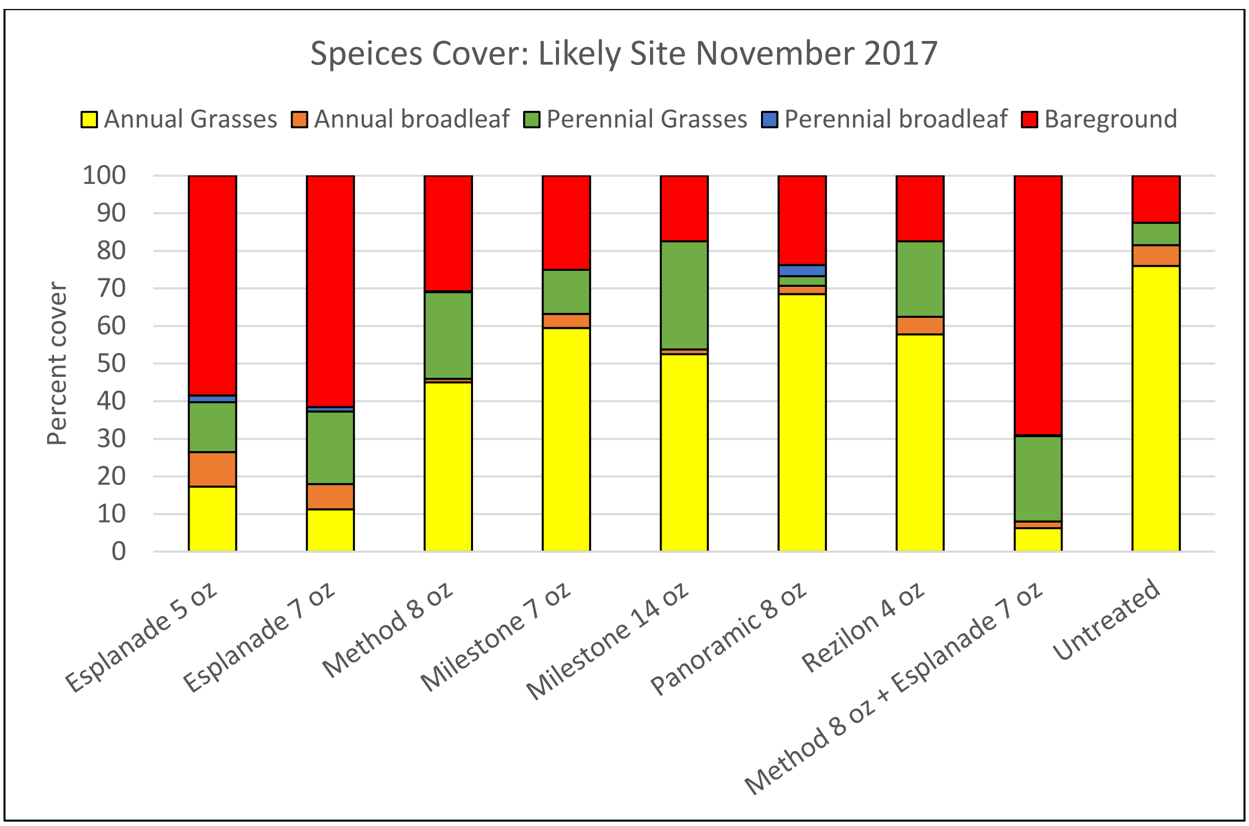
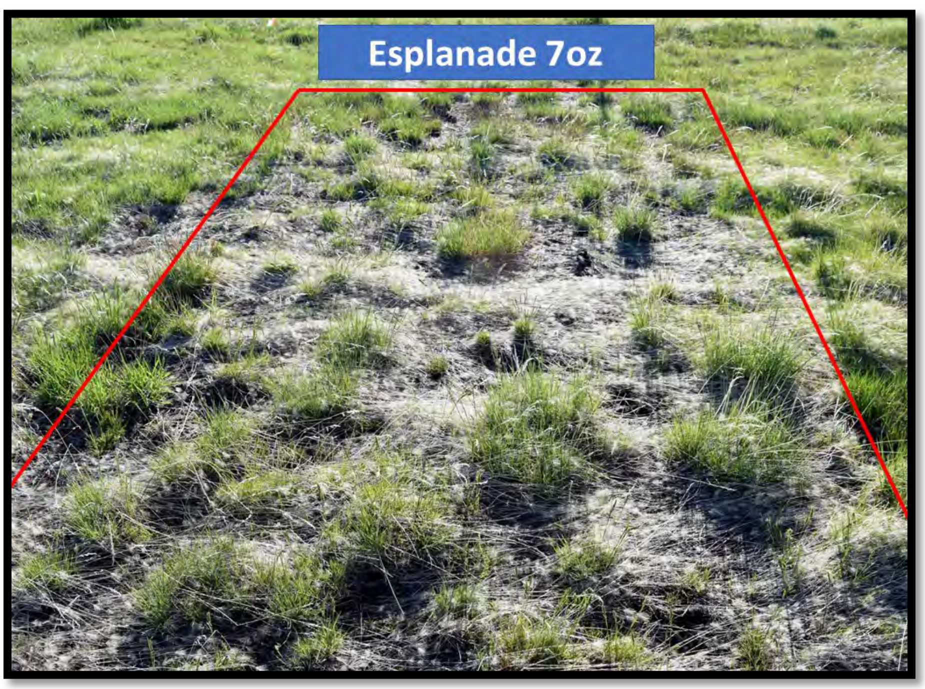


Figure six: Species percent cover separated by functional group in November 2017 at the Likely site.

An untreated check at Willow Creek the May following fall herbicide applications. Medusahead growing in the interspaces of the perennial grasses.



An Esplanade 7oz/acre plot at Willow Creek the May following fall herbicide applications. There was no actively growing medusahead between interspaces of perennial grasses, only the medusahead littler left from the previous growing season.

Medusahead Fall Application Post-Emergence Trial

Introduction: Medusahead is an invasive winter annual grass which accumulates silica and does not provide quality forage for livestock. There are limited control options which are effective in the Intermountain Region of California. *Rimsulfuron was recently approved for use by the BLM for rangeland. Additionally Rimsulfuron in combination with Esplanade (indaziflam) has been a very effective combination of products in tree and vine crops down in the valley. This trial set out to test the effectiveness of various herbicides as post emergence applications in the fall, including Rimsulfuron, Esplanade, Milestone, Plateau, and Roundup Weatherwax.*Rimsulfuron will be referred to as Rezilion in the graphs below. Other trade names for products containing Rimsulfuron labeled for rangeland are Laramie 25 Df, Hinge, and Solida. Rimsulfuron was previously marketed for rangeland markets as Matrix, and is still currently marketed as Matrix in other cropping systems.

Study Investigator: Tom Getts

Cooperator: John Flournoy

Date of herbicide applications: Likely site applications were made November 4, 2016, at 11:30 am at 67 deg. F with 21% RH and a 5 mph southern wind. Applications were made on top of litter layer from previous growing season. Medusahead had germinated at time of application, and plants were 1- 5 inches tall in the 1-3 leaf stage. Other populations of winter annual plants were limited. All treatments were applied with a CO_2 pressurized backpack sprayer at 20 gal/acre with 110 02 flat fan nozzles. All treatments were mixed with NIS 0.25% v/v.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block. Method and Esplanade currently do not have a grazing label, so sites were fenced.

Plant community: The site was heavily dominated with medusahead, with small populations of cheatgrass and North African wiregrass. There were limited populations of other plants, including Mediterranean sage, few perennial grasses, and prickly lettuce.

Data collected: Visual evaluation of medusahead control and functional group percent cover was conducted in June of 2017 and November of 2017.

Results: Treatments that included Esplanade and a combination of either Roundup Weathermax, or Rezilon, offered excellent initial control (figure one). Weathermax alone offered over 85% medusahead control at the June assessment. Likewise, Esplanade alone offered at least 74% control in June, which was unexpected as Esplanade is a seeding growth inhibitor, and applications were made after medusahead had germinated. A theory is that medusahead roots may have been affected post emergence, with the above average precipitation year. All treatments showed less control in November, except Esplanade alone. Likewise, Esplanade in combination with other products still offered greater than 87% control. Treatments which did not contain Esplanade showed a reduction in percent control of 25%, indicating the treatments broke. There were small populations of various species in the plots where medusahead was controlled, such as California dandelion, prickly lettuce, Mediterranean sage, and squirreltail to indicate a few. However, the vast majority of space previously occupied by medusahead was converted to bare ground (figure two and figure three). Plots will continue to be monitored during 2018.

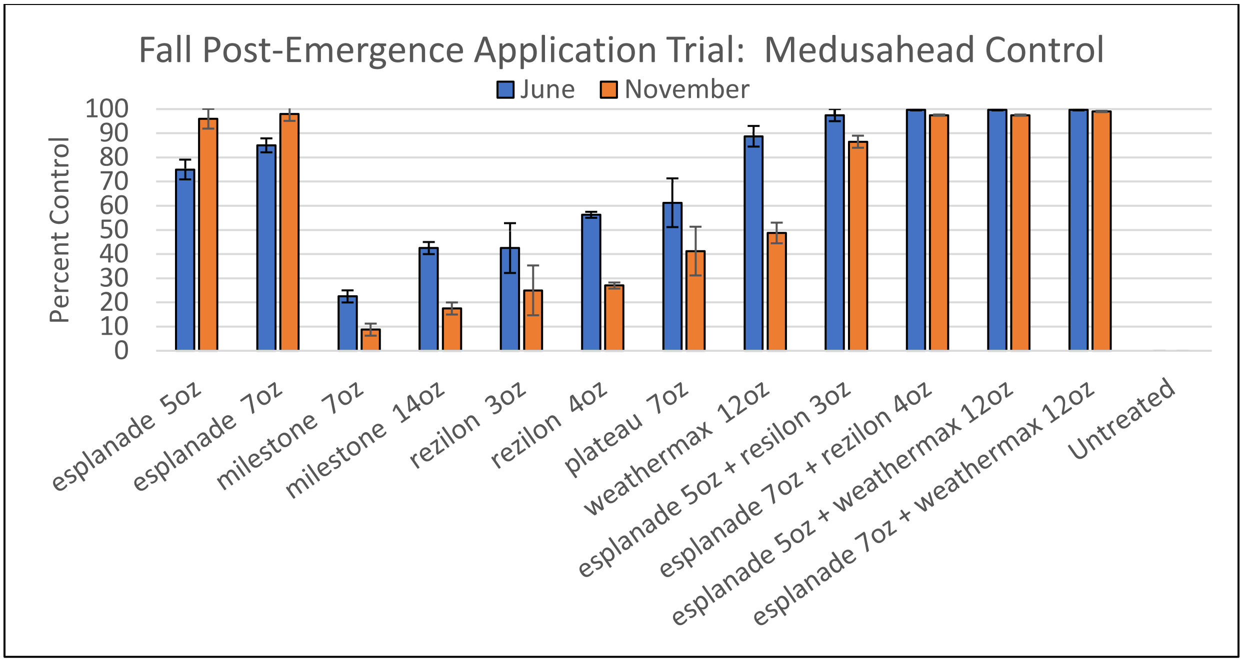


Figure one: Displays medusahead percent control for assessments in June and November of 2017. Error bars indicate standard error.

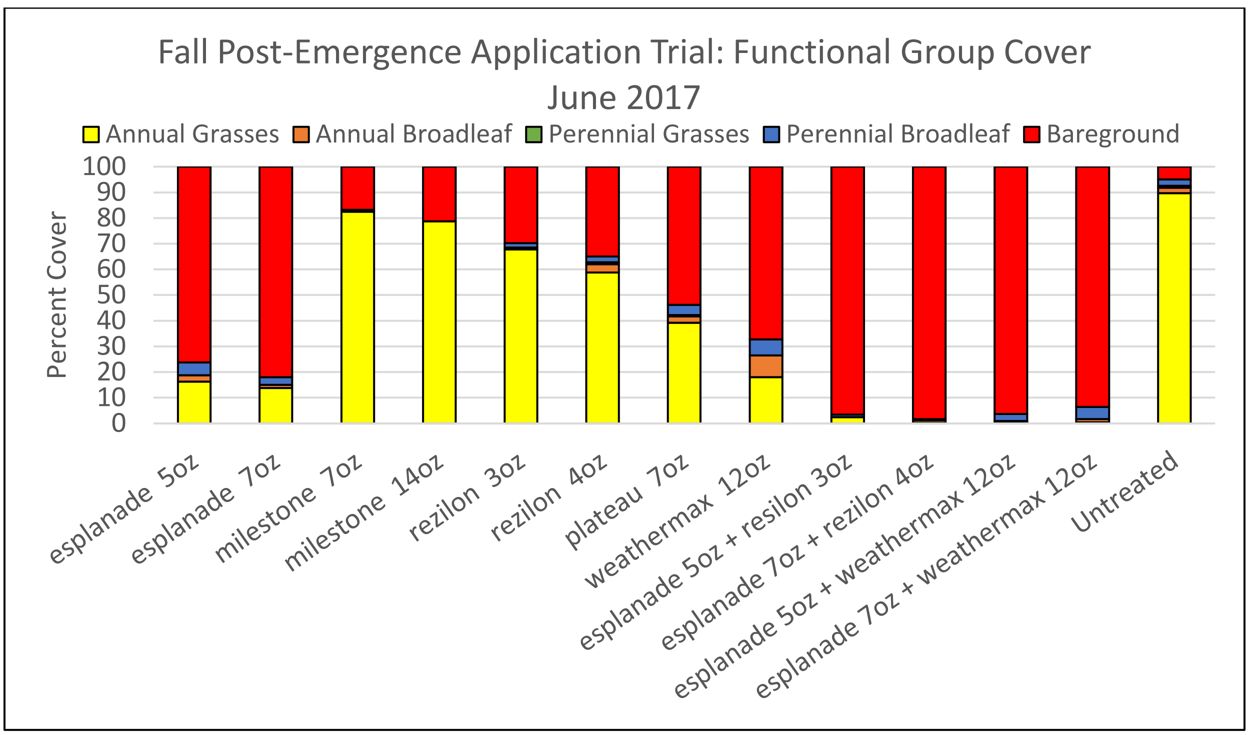


Figure two: Species percent cover separated by functional group in June 2017.

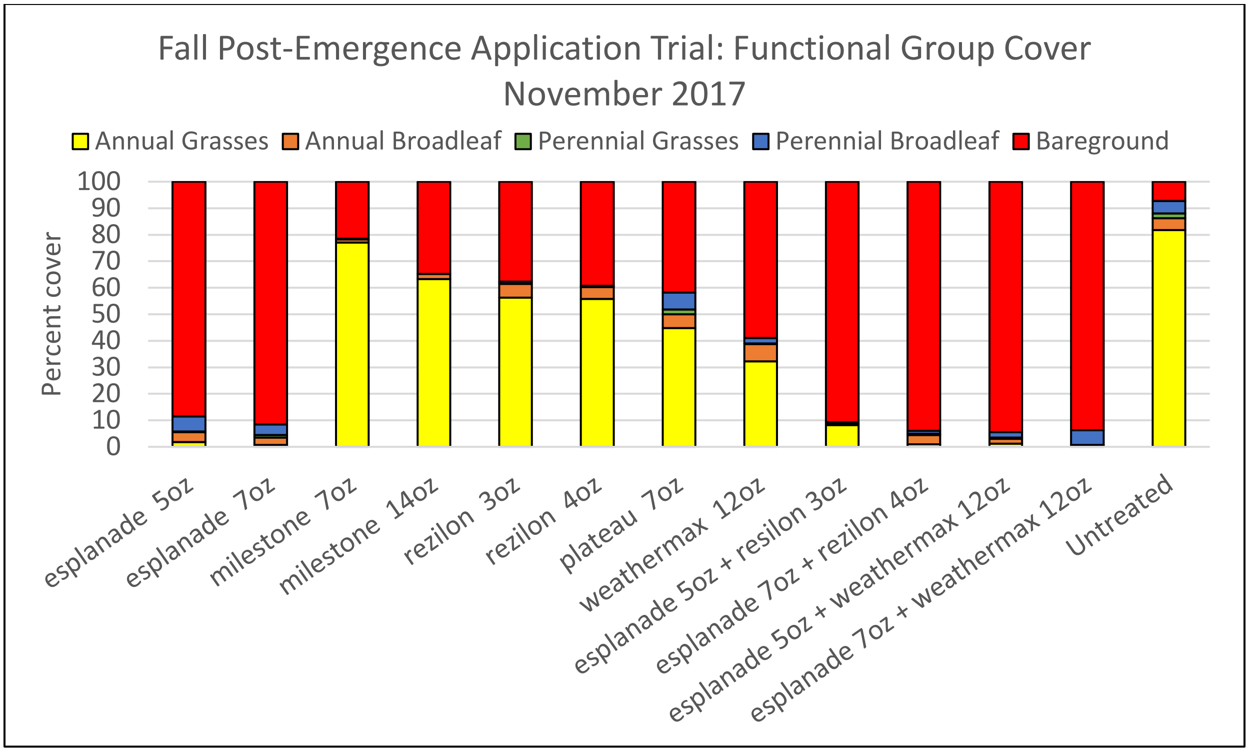


Figure three: Species percent cover separated by functional group in November 2017.

Esplanade 7oz + Weatherwax 12oz, 1 year after treatment, no actively growing medusahead in the plot.

Medusahead Control with Post-Emergent Herbicide Applications MSO vs NIS

Introduction: Medusahead is an invasive winter annual grass which accumulates silica and does not provide quality forage for livestock. There are limited control options which are effective in the Intermountain Region of California. This trial was set up to test if Lambient (propoxycarbazone), Method (aminocyclopyrachlor), Plateau (imazapic) and Esplanade (indaziflam) are more effective in combination with either Methylated seed oil or a Non-Ionic Surfactant.

Study Investigator: Tom Getts

Cooperator: John Flournoy

Date of herbicide applications: Likely site applications were made November 4, 2016, at 10:00 am at 41 deg. F with 36% RH and a 4 mph southern wind. Applications were made on top of litter layer from previous growing season. Medusahead had germinated at time of application, and plants were 1- 5 inches tall in the 1-3 leaf stage. Other populations of winter annual plants were limited. All treatments were applied with a CO2 pressurized backpack sprayer at 20 gal/acre with 110 02 flat fan nozzles.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block. Method and Esplanade currently do not have a grazing label, so sites were fenced.

Plant community: The site was heavily dominated with medusahead, with small populations of cheatgrass and North African wiregrass. There were limited populations of other plants including Mediterranean sage, few perennial grasses, and prickly lettuce.

Data collected: Visual evaluation of medusahead control and functional group percent cover was conducted in June of 2017 and November of 2017.

Results: In the June assessment, there appeared to be a slight advantage to using MSO for all herbicides besides Esplanade, however, this advantage was not apparent by the November assessment. Only treatments which contained Esplanade offered sufficient control, with all of those treatments offering more than 95% control during the November assessment (figure one). However, this reduction in medusahead was generally not replaced by more desirable vegetation, with lots of bare ground present in the plots during the November assessment (figure three). Assessments will continue to be taken throughout the 2018 growing season.

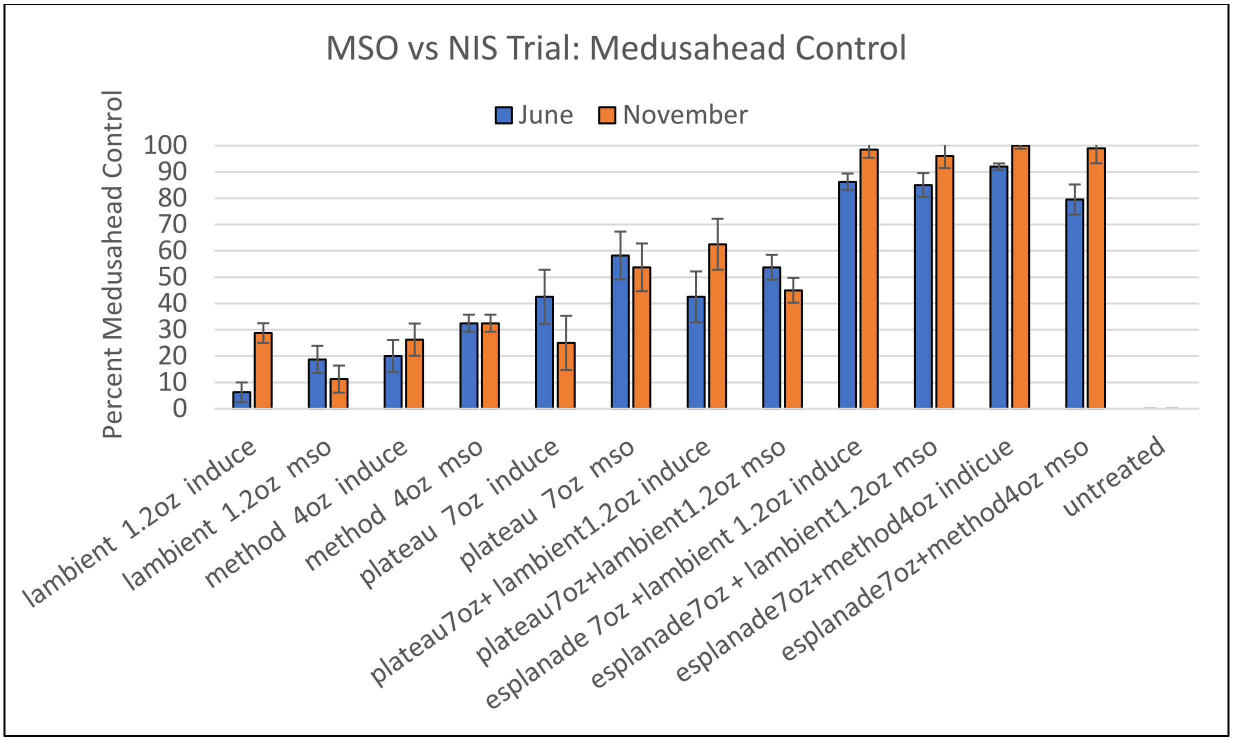


Figure one: Displays the percent medusahead control for the MSO vs NIS trial at both the June and November assessment.

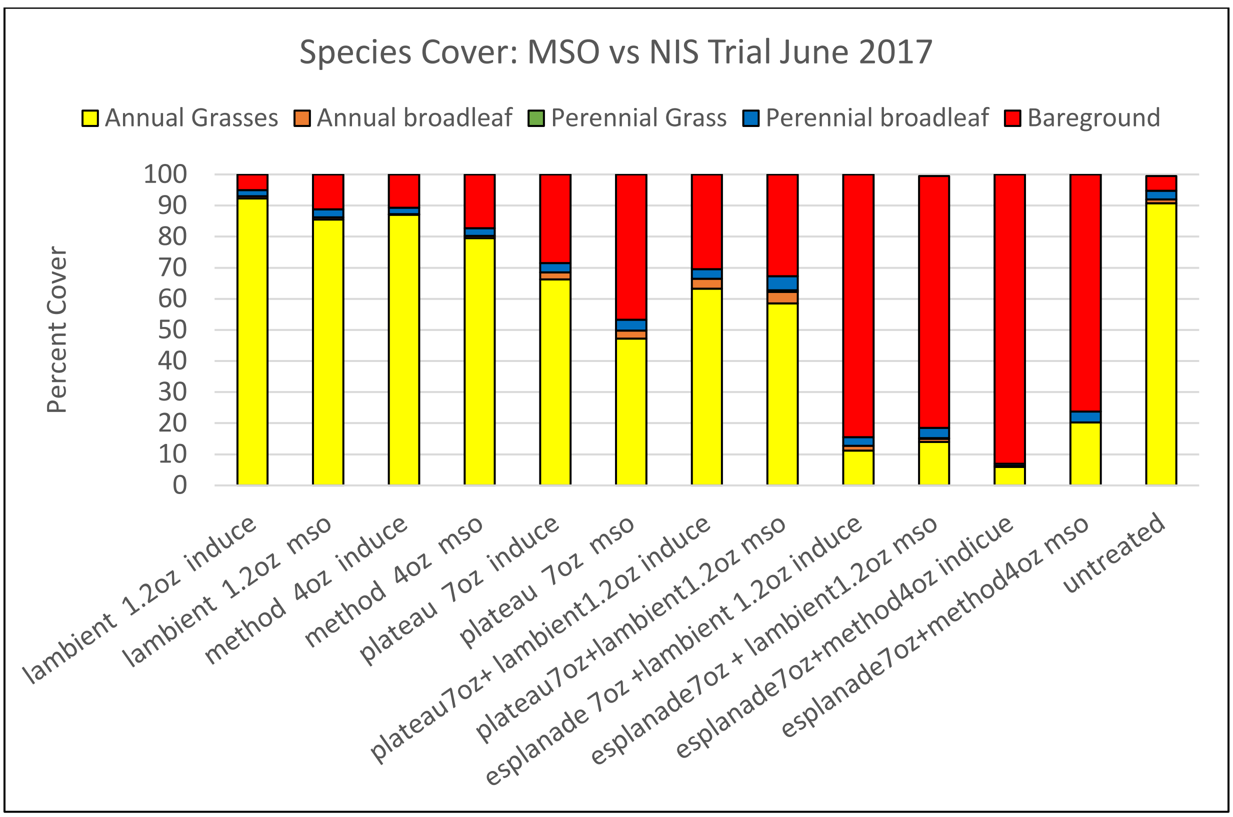


Figure two: Species percent cover separated by functional group in June 2017.

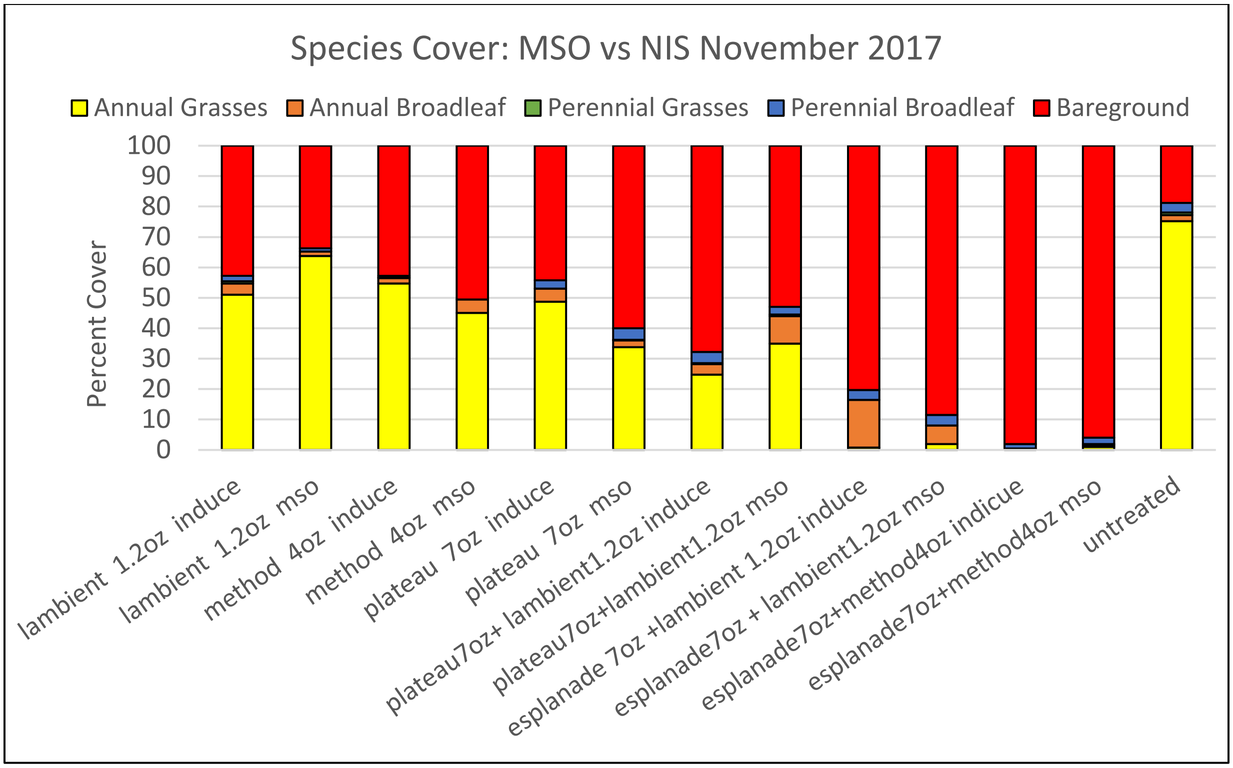


Figure three: Species percent cover separated by functional group in November 2017.

Large Mediterranean sage rosette 1 year after application growing within a Esplanade 7oz + Lambient 1.2oz treated plot.

Tall Whitetop Control with Drizzle Applications

Introduction: Tall whitetop (perennial pepperweed) is a tough-to-control perennial weed with deep roots. Previous research has shown a combination of physical methods with application of herbicides at the bud stage can be effective. These studies set out to test the drizzle method of herbicide application for tall whitetop. The drizzle method was developed in Hawaii to treat weeds economically, and has been shown to be effective on other perennial weeds. It involves applying herbicides at a very low application volume of 2-5 gallons per acre. Typical tractor or ATV applications apply herbicides anywhere from 10 to 20 gallons per acre. Backpack herbicide application volumes typically range from 20 gallons to over 100 gallons per acre. This means that small backpacks and spray tanks need to be refilled frequently. If effective, the drizzle method would require fewer fill-ups to cover the same amount of area.

Study Investigator: Tom Getts

Cooperator: Craig Hemphill

Date of herbicide applications: Applications were made at 9:30 am on July 7, 2016. There was a 1-2 mph wind, clear sky, a relative humidity of 30%, and it was 75 degrees F. Broadcast applications were made with a CO_2 powered backpack sprayer with a 10 ft. boom. Drizzle method applications were made at 5 gallons/acre using a CO_2 pressurized spray gun, with a 0.02 inch diameter orifice disk, replicating work from Phil Motooka in Hawaii. Broadcast applications were made at 20 gallons/acre.

Study design: Four replications of 10 x 20 ft. plots laid out in a randomized complete block.

Plant species at application: Perennial pepperweed was 3-5 feet tall at time of application in the bloom stage of growth. Lower leaves of the perennial pepperweed had started to senesce in two of the blocks treated, however, upper leaves and flowers were still actively growing.

Data collected: Perennial pepperweed control was assessed in August 2016, April 2017 and July 2017.

Results: Initial control in August of 2018 appeared to be good for most treatments tested (figure one). However, the assessment was difficult as most of the plants had senesced for the year. The April assessment showed less perennial pepperweed control, where only Telar and Rodeo drizzle, and Grazonnext drizzle, offered at least 80 percent control. By July 2017, only Grazon Next drizzle offered 80 percent perennial pepperweed control.

While the results from this trial are less than promising, as the positive control Telar didn't have good control, it is hypothesized that lack of control may have been due to a mistimed application. An earlier application may have been more effective for all treatments.

An additional trial was implemented to investigate the drizzle method for perennial pepperweed control in the summer of 2017. Monitoring will continue into 2018, and results will be presented next year.

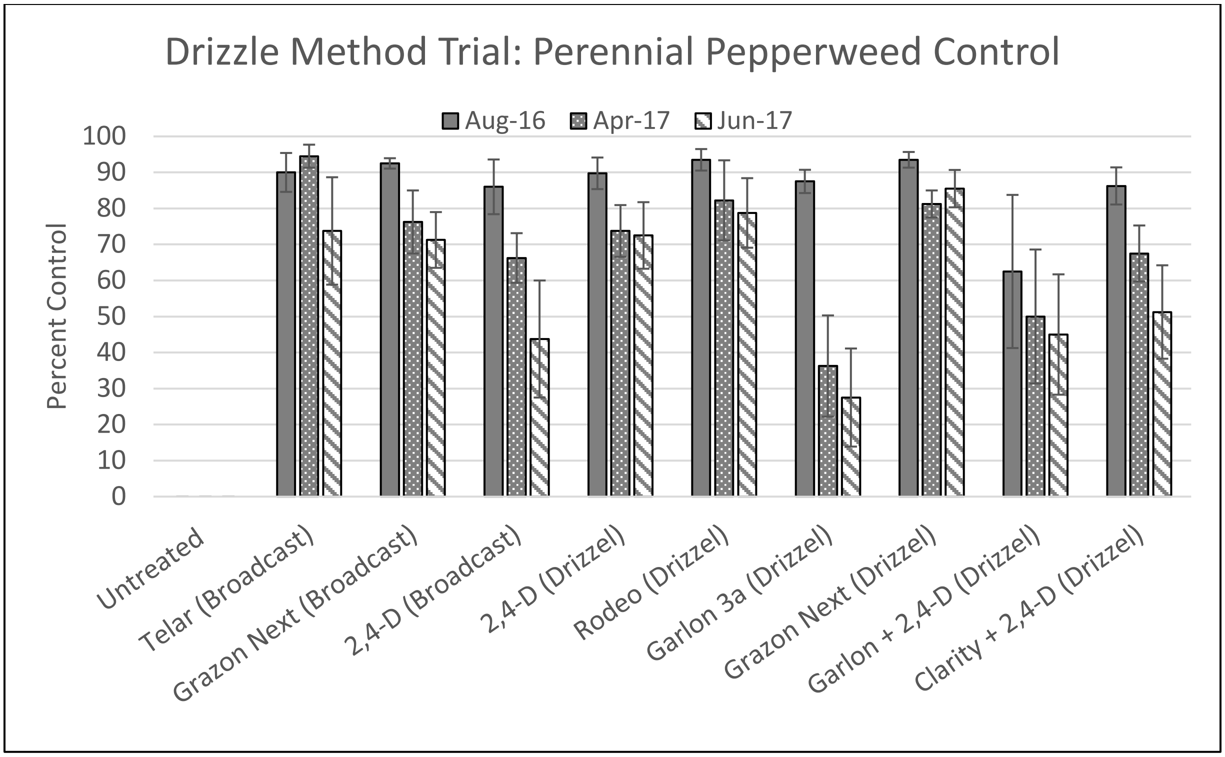


Figure one: Perennial pepperweed control in August 2016, April 2017 and June 2017. Error bars indicate standard error.

Plots one year after treatment, with a lot of perennial pepperweed growing inside and outside of treated areas.

Russian Knapweed Biocontrol Release

Summary: Russian knapweed is a B list noxious weed species that is problematic in portions of Lassen, Modoc, and Plumas counties. It invades both agricultural systems and natural areas forming monocultures. It is a perennial species that can spread from either the root or the seeds of the plant. Biocontrol for invasive weeds utilizes the concept of bringing natural predators of the weed from its native range. Biocontrol species for weeds can consist of insects, and fungal or bacterial pathogens; however, it is very important they are species specific, so they do not spread to agronomic or native species.

Two insect species have been vetted and introduced to help control Russian knapweed in the US, and have successfully established in both Colorado and Montana. The gall midge (*Jaapiella ivannikovi)* was introduced to California but did not become established. This project's focus is to see if Russian knapweed gall wasp (*Aulacidea acroptilonica)* will establish in North Eastern California. Both of these insects lay their eggs on the plant, and their larvae form galls in the stem of the plant, helping prevent seed formation.

In conjunction with Mike Picarin from the CDFA, releases of the gall wasp were made at three locations within Lassen County in the spring of 2017 (additional releases were also made in Siskiyou county). Release sites were revisited in the fall. Gall formation was found on multiple Russian knapweed plants at two of the release sites in Lassen county! This is good news as this is the first step towards population establishment. Release sites will continue to be monitored in 2018 and addition releases will be made.

Gall formation on the stem of Russian knapweed. The fall following release of the gall midge biocontrol agent.