

# Sierra-Cascade Intensive Forest Management Research Cooperative

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Series Report No. 17



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<http://ucanr.edu/sites/SCIFMRC/>

***ANNUAL REPORT***  
**2016**

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The year 2016 marked the seventeenth year as an organization for the Sierra Cascade Intensive Forest Management Research Cooperative.

Membership increased in 2016 as Jefferson Resource Company, Inc. joined in February. The current membership consists of a mixture of landowners, forestry-related industries, State of California and federal agencies. There are currently seventeen member organizations in the Co-op.

The annual business meeting was held at the Forest Service office March 3, 2016 in Redding (a summary of the meeting can be found in this Annual Report). Seventeen Co-op members and guests attended. The first item of business was a review of the budget. The Co-op ended 2015 with a surplus of \$33,332.60. Dues received for 2016 at the time of the annual meeting totaled \$54,000, with another \$10,000 promised.

Following the discussion on the budget, updates on recently funded Co-op studies were presented: Proposal 13-03 Pondosa Remeasure; Proposal 14-02 Pondosa Soils; Proposal 14-01 Pindar Over-the-Top; and Proposal 15-01 Rodeo.

The next item of business at the annual meeting was the presentation of new proposals for possible Co-op funding in 2016. Three new proposals were presented. Ed Fredrickson presented two proposals for herbicide trials: (1) Pindar GT, Derigo, and Transline and (2) Penoxsulam. The third new proposal was presented by Dave Loveless and Ed Fredrickson for a pre-plant site preparation study at Boggs Mountain

Demonstration State Forest featuring Pindar GT and Velpar DF. All three proposals were funded by the Co-op. Executive Summaries for the three new funded proposals plus Proposal 15-01 Rodeo appear in this Annual Report.

Spring treatments for the Boggs study were applied on April 1<sup>st</sup>. Spring treatments for the Derigo study were applied on April 7<sup>th</sup> at the Oak Run site and April 15<sup>th</sup> at the Montgomery Creek site. Spring treatments for the Penoxsulam study were applied June 11<sup>th</sup> at the Fruit Growers Supply site and June 18<sup>th</sup> at the Roseburg Resources site. Fall treatments for the Penoxsulam study were applied August 24<sup>th</sup> at the Fruit Growers site and August 25<sup>th</sup> at the Roseburg site.

The Co-op field trip scheduled for June 14<sup>th</sup>, with most stops located on the Day Fire out of Bieber, had a good turnout with 18 Co-op member and guests attending. Stops included studies featuring Pindar GT and Hexazinone trials, Pindar GT/Esplanade trials, Pindar GT/Derigo trials, an Esplanade trial, a Velpar trial, a Pindar GT, Accord, and Velpar trial, and Esplanade and Milestone trials. Additional stops featured gopher control and biomass chipping.

First year evaluations for the Boggs study were conducted on July 5<sup>th</sup> and August 29<sup>th</sup>. First year evaluations for the Derigo study were conducted at the Oak Run site on July 15<sup>th</sup> and on July 16<sup>th</sup> at the Montgomery Creek site. Second year (final) evaluations on the Rodeo study were conducted on August 23<sup>rd</sup> and 26<sup>th</sup>. First year evaluations for the Penoxsulam study were conducted on September 20<sup>th</sup> and 21<sup>st</sup>.

A meeting was held on September 12<sup>th</sup> to work on an upcoming proposal by Mark Gray concerning post-fire erosion and mitigation treatments. Pacific Southwest Research Station research hydrologist Joe Wagenbrenner was in attendance and agreed to join with the Co-op in developing this proposal. Jeff TenPass, Forest Service Regional Soil Scientist, has also agreed to help with this proposal. An update on this new proposal will be presented at the 2017 business meeting on March 8<sup>th</sup>.

The year 2017 should be another busy one for the Co-op. New proposals are currently

being submitted to the Co-op for funding consideration. Several funded study sites will have second year measurements taken. Based on the interest shown for field trips featuring Co-op study sites, another trip will be planned for 2017. Results from Co-op studies will continue to be presented at the Forest Vegetation Management Conference. Articles on research funded or partially funded by the Co-op are being featured in peer-reviewed journals on a regular basis.

## 2016 MEMBERSHIP

### Land Manager Membership

California Department of Forestry  
Fruit Growers Supply Co.  
Roseburg Resources Co.  
Sierra Pacific Industries  
Soper-Wheeler Co.  
Timber Products Co.  
W.M. Beaty & Associates, Inc.

### Associate Corporate Membership

Cal Forest Nurseries & Mountain Gate Gardens

### Affiliate Membership

Bayer CropScience  
Dow AgroSciences  
Silver Butte Timber Co.  
Thunder Road Resources  
Jefferson Resource Company, Inc.

### Supporting Members

California Forestry Association  
PSW Research Station  
University of California  
USDA Forest Service

## Sierra Cascade Intensive Forest Management Research Cooperative

### Annual Meeting March 3, 2016

The 2016 annual meeting was held at the Forest Service office in Redding, CA on March 3, 2016. Seventeen Co-op members and guests attended.

The 2015 Annual Report was the first item of business. Membership status was discussed. The Co-op added a new member as Jefferson Resource Company, Inc. joined in February. About 85% of the members from 2015 have paid their 2016 dues. Those that have not paid to date indicated that their dues payments are on the way. There are currently seventeen member organizations in the Co-op.

The next item of business was a discussion on the budget. The Co-op ended 2015 with a surplus of \$33,332.60. Dues received for 2016 at the time of the annual meeting totaled \$52,000, with another \$10,000 promised. To supplement the summary of the 2015 budget found in the Annual Report, spread sheets of the proposed budget and annual workload for 2016-2020 were presented to the membership.

Plans for the 2016 field trip were discussed next. The 2015 field trip had planned to visit the Day Fire and the Idler Fire but due to slow response and growth of the brush at the Day Fire, the field trip featured stops on the Idler Fire only. Results of release and site preparation treatments are quite evident on the Day Fire this year so our field trip will tour the new fire and possibly the old Day Fire. Ed Fredrickson has 5 chemical

trials in the area, Sierra Pacific has aerial Pindar treatments as well as Milestone and Velpar treatments in the area, and W.M. Beaty has Velpar and Oust treatments here. The field trip is scheduled for June 14<sup>th</sup>. The trip will start and end at the Caltrans Park and Ride location at the intersection of highways 299 and 89 east of Burney at 8:00.

The next items on the agenda were funded proposal updates. Jianwei Zhang reported on results for Proposal 13-03 Pondosa Remeasure and 14-02 Pondosa Soils. Results from these two proposals have been reported in a manuscript submitted in January and accepted for publication by Forest Ecology and Management (the manuscript was published on March 8, 2016). Ed Fredrickson reported on results for Proposal 14-01 Pindar Over- the-Top and Proposal 15-01 Rodeo. Executive summaries for the three studies updated are found in the 2015 Annual Report.

Questions from the membership were raised about the future of the Pondosa compaction study site and the Pondosa Garden of Eden study site. Jeff Webster stressed the value of the compaction study, especially the controls, for training purposes. Ken Scott agreed to protect the study site for the next two years in order to allow for a remeasurement in that time frame. The plots need to be retagged prior to this remeasurement. PSW agreed to let Ken know about plans, if any, for the Pondosa

G.O.E. site by late summer. If no other research activities are planned, Ken would like to thin the site.

Mark Gray updated the membership on a possible proposal that was brought up at the 2015 annual meeting. This was for a stock type trial of sugar pine and incense cedar. More of the details of the proposal have been worked out since the 2015 meeting and Mark will take the lead and present a proposal for funding at the 2017 annual meeting. Adequate seed are already available for the study. There will be 3-4 replications per site with 2-3 study sites. The stock will be all container stock with 3 sizes of styro containers. Possible study sites need to be frost-free and fencing may be required. No more than one acre will be required for the study at each site. Spacing will be 8 feet by 8 feet and the study will be carried for at least 5 years, with 10 years being an option. Planting will be in the fall of 2017 or the spring of 2018. The following members have shown an interest in having one of the study sites on their land: Silver Butte Timber, Sierra Pacific Industries, Roseburg Resources, W.M. Beaty, and Soper Wheeler.

Following the discussion of funded proposals, three new proposals were presented to the membership for possible funding in 2016. Ed Fredrickson presented two proposals for herbicide trials: (1) Pindar GT, Derigo, and Transline and (2) Penoxsulam. Both of these proposals have options for the number of sites to be installed. The third new proposal was presented by Dave Loveless and Ed Fredrickson for a pre-plant site preparation

study on Boggs Mountain Demonstration State Forest featuring Pindar GT and Velpar DF.

After questions from members about the new proposals were addressed, it was decided that the voting membership would be canvassed by email to determine how many and at what level the Co-op would fund the proposals. Emails were sent to the voting members on March 7<sup>th</sup>.

The next item of business was a recapping of the results of a motion initiated at the 2015 annual meeting by Scott Worden. At that meeting, Scott proposed that the Co-op make a donation to the Robert Powers Scholarship Fund. An email was sent to the membership asking for their approval/disapproval of this motion and the amount of the donation if the motion was approved. There was such a small response to this email that the motion was put on hold until additional discussions could be held at the 2016 annual meeting. The membership decided to send another email to voting members only and request a quick response (this was done in the March 7<sup>th</sup> email mentioned above).

The status of another motion made at the 2015 annual meeting was next on the agenda. At the 2015 meeting, Bob Amesbury suggested that since Co-op members make presentations (using data from Co-op funded studies) at almost all Forest Vegetation Management Conferences, it might be appropriate for the Conference to contribute to the Co-op. The Co-op membership agreed with this suggestion and Scott Worden, a member of the Conference Executive Board, agreed to

take it up with that Board. Scott presented this idea to the 2016 Conference Committee which was receptive to the idea with the stipulation that the Co-op develop a process as to how this could best be accomplished. At our 2016 meeting it was decided by the membership that the best approach would be for the Co-op to request a speakers' fee for any presentations made at the conference by Co-op members. The minimum fee would be \$1,000.00 and these fees would go directly to the Co-op. A formal proposal will be developed by the Co-op and submitted to the Conference Executive Board.

Another motion at the 2015 annual meeting concerned the California Reforestation Manual. Scott Worden felt the Co-op should contribute to this effort. After a discussion by the membership, the motion was withdrawn due to lack of a clear understanding of how the funding process

was going. Scott would follow up on this and report to the membership at our 2016 annual meeting. At our March 3<sup>rd</sup> meeting, Ed Fredrickson reported that the funding for the manual revision was adequate but there was a cash-flow problem. This ended the discussion concerning the Co-op's help in funding the manual.

The final item on the agenda was an update by Matt Busse on his presentation to the California Forest Association's Executive Board in December, 2015. Matt presented a short history of the Co-op and updates on the projects the Co-op was working on. The Board seemed well pleased with the accomplishments of the Co-op. Some of the Board members suggested that the Co-op should recruit members from land owners with holdings on the coast. This suggestion got mixed reviews from Co-op members.

The meeting adjourned at this time.

**Sierra Cascade Intensive Forest Management Research Cooperative Proposals 16-01  
Boggs Mountain State Forest**

Principal Investigators: Dave Loveless and Ed Fredrickson

Title: Pre-Plant Site Preparation with Velpar DF and Pindar GT

Year Approved: 2016

**Executive Summary**

On September 12, 2015, the Valley Fire swept through southern Lake County, California. The fire consumed 76,067 acres. The 3,500 acre Boggs Mountain Demonstration State Forest (BMDSF), located adjacent to the community of Cobb and 10 miles north of Middletown was severely impacted by the fire, with nearly 90% of all vegetation on the forest either consumed or killed. The site is unique in that it lies on the fringe of the timbered region in Lake County. Boggs Mountain is a fairly isolated piece of timberland that has some interesting characteristics. The organic matter content in the soils runs from six to nine percent. This is right on the margin of being too high for hexazinone applications to work effectively. Hexazinone binds tightly to organic matter and can be rendered ineffective when the organic matter content becomes too high.

The Forest is in the process of implementing a salvage and rehabilitation plan to re-establish a successful conifer forest on this highly productive site I and II timberland. Some of the conifer species included in this plan are intolerant to hexazinone. With the introduction of Cleantraxx to forestry, it gives another option for hexazinone

intolerant conifers. It has not been tested on sites near Boggs Mountain. The site preparation plan includes the use of herbicides to control competing vegetation with both pre and post reforestation treatments.

While located in the coast range, pre-fire vegetation on BMDSF was composed of inland species including ponderosa pine, Douglas-fir, sugar pine, and a small amount of incense cedar in the overstory. Overstory hardwoods include black oak and live oak. Predominant understory brush species include Sonoma manzanita, Konocti manzanita, and coffeeberry. The soils on Boggs Mountain are moderately deep to very deep, well-drained very gravelly loam and loam derived mainly from the Mountain's lava cap of andesite, basalt, and dacite. Igneous rock derived Aiken and Collayomi are the Forest's most productive soils. A limited amount of timber soils and most of the non-timber soils are derived from Great Valley formation sandstone or shale parent material.

This objective of this study is to evaluate the efficacy of various rates of hexazinone formulated as Velpar DF and Cleantraxx with and without Accord XRT II for

efficacy for pre-plant site preparation to control herbaceous broadleaf weeds and woody plant seedlings in conifer plantations on Boogs Mountain Demonstration State Forest.

**The Study:** The trial will be installed on the Aiken soil series which comprises the majority of the soil types on the forest. The site will have been recently logged with no further site preparation. The site is approximately 3500 feet elevation with a relatively flat aspect. Herbicide applications will occur in the spring of 2016 prior to the final spring rains.

The trial is a completely randomized block design with four replications per treatment. The plot size will be 10 feet by 25 feet and will be staked at both ends of the centerline with PVC pipe. Plots will be sprayed with a CO<sub>2</sub> powered backpack sprayer equipped with a 10 foot boom. All applications will be made at 10 gallons per acre at a consistent pressure of 30 psi. All plots will be sprayed with one timed pass.

Evaluations will occur in the summer and fall of 2016 and consist of ocular estimates of percent bare ground and percent cover by species. Statistical analysis will be conducted by Liz Cole of Oregon State University. All treatment installation, evaluation, and write up will be accomplished by Thunder Road Resources.

**Treatments:** Will consist of three rates of Velpar DF at 2, 3, and 4 pounds product per acre and Cleentraxx (Pindar GT) at 3 pints

and 4.5 pints per acre with and without 2 quarts of Accord XRT II.

**2016:** The site chosen for this study is on the west side of the forest at approximately 3500 feet elevation on a slight north aspect and zero to five percent slope. The site had burned in the 2015 wildfire and salvaged logged in early 2016. No further site preparation had been done to the site.

Plots were sprayed on April 1<sup>st</sup>. Evaluations were conducted on July 5<sup>th</sup> and August 29<sup>th</sup>.

Data were analyzed using SAS statistical software. Vegetation and seedling data were analyzed using analysis of variance. Treatments were compared using a Tukey's test with adjusted probabilities. Initial seedling size parameters were used as covariates within the ANOVA's for height, caliper, and volume. Analyses for size were weighted by the number of surviving seedlings in each plot. Least squared means for size included adjustments for the covariates, which resulted in some differences for the raw data means. Analyses utilized PROC MEANS, PROC MIXES and PROC GLIMMIX in SAS. PROC GLIMMIX was used when variances were unequal, and either the Poisson or gamma distribution was used.

The entire fire area was clean of vegetation at the time of treatment. Unfortunately, the site where the trial was installed stayed free of vegetation throughout the entire year. No significant differences existed between treatments at either evaluation time during the season (Table 1). Due to lack of

vegetation, it was impossible to determine whether either herbicide was effective. The trial was left in place with the hope some value may be gained from it in 2017. Due to the lack of vegetation, only the fall data were presented in this document.

Treatment	% Bare Ground
2 lbs Velpar DF	99.3 (1.0) a
3 lbs Velpar DF	96.8 (2.4) a
4 lbs Velpar DF	98.5 (1.2) a
3 pts Pindar GT	99.3 (0.8) a
4.5 pts Pindar GT	98.8 (0.5) a
3 pts Pindar GT + 2 qts Accord XRT II	97.3 (1.0) a
4.5 pts Pindar GT + 2 qts Accord XRT II	99.8 (0.3) a
Control	97.3 (1.2) a

Table 1. August percent bare ground data for the Boggs Experimental Forest Residual Herbicide Trial. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

**Sierra Cascade Intensive Forest Management Research Cooperative Proposal 16-02  
Pindar GT and Derigo**

Principal Investigator: Ed Fredrickson

Title: Improving Post Emergent Herbaceous Control and Conifer Tolerance with Pindar GT,  
Derigo, and Transline

Year Approved: 2016

**Executive Summary:**

For the past several years this Co-op and others have been looking at Pindar GT as a new forest site preparation tool. Great results have been shown in California and southwest Oregon regarding pre-emergent herbaceous weed and brush control and conifer tolerance. The one application timing that is proving to be inconsistent is spring post-emergent herbaceous weed control.

There are basically two possible ways to deal with this situation. The first is to tank mix Pindar GT with another herbicide that provides a good foliar knock down of existing vegetation such as glyphosate. This presents a problem however if seedlings have already been planted on the site, due to conifer tolerance issues. The number of herbicides that have foliar activity on existing herbaceous vegetation and adequate conifer tolerance to go over the top of freshly planted seedlings is very limited.

The second option is to add an adjuvant to Pindar GT to try to increase what foliar activity there is using Pindar GT. There are a variety of adjuvants that act as surfactants for herbicides including non-ionic, silicone, petroleum, and seed oil based products.

Each may work differently depending on the herbicide used, vegetation being treated, and time of year of the application.

This study will look at several methods to improve knock down of herbaceous vegetation while maintaining conifer tolerance, including evaluating types of surfactants and tank mixes with several other products. A new herbicide that has proven knock down ability and some residual control will be tested.

The adjuvants to be tested will include a methylated seed oil (MSO), silicon surfactant (Sylgard 309), and a non-ionic surfactant (R-11). This study will also look at the potential for the herbicide Transline to assist in improving knock down.

A new product that has been tested extensively in bare ground trials and is currently registered in the United States as a turf herbicide is Derigo. Derigo contains three ALS inhibiting active ingredients, iodosulfuron and foramsulfuron, which are two sulfonylurea herbicides, and thiencazone which is in the sulfonyl amino carbonyl triazolinone family. All three active ingredients have both foliar and

soil activity. Testing in non-forestry markets in California has shown excellent knock down on a variety of herbaceous broadleaved plants. It is not known at this time whether Derigo has sufficient conifer tolerance to be applied over freshly planted seedlings.

Derigo has an excellent fit for forest landowners. The product has extremely low toxicities for all three active ingredients and very short half-lives in the environment (2 to 55 days). All three active ingredients are fairly mobile in the soil, but the short half-lives make the risk of soil mobility minimal. All three show high degrees of safety toward mammals, birds, and aquatic life.

The objectives of this study are to determine the partial contributions of surfactant and Transline to post-emergent broadleaf weed control with Pindar GT and Derigo, as well as assess the potential benefits of Derigo for forest weed control and conifer tolerance.

**The Study:** This study is proposed for two sites where normal procedures would include spring herbaceous treatments over freshly planted conifer seedlings. The treatments will occur post-planting and after the majority of herbaceous vegetation has emerged in the spring. Applications need to occur prior to the end of the spring rain season.

The trials are completely randomized block designs with three replications per treatment. Plot size is 10 feet by 25 feet. Plots will be staked at each end of the centerline with PVC pipe and numbered. Planting will

occur on Derigo treated plots only and the non-treated controls. Each plot will be planted with ten trees each of two conifer species prior to the application. Planters and seedlings will be provided by the timber companies. Thunder Road Resources will supervise the planting. Conifer species will vary depending on the site. Trees will be measured initially at planting for height and caliper.

Herbicide applications will occur immediately after planting. All applications will be applied at 20 gallons per acre at 30 psi with a CO2 powered backpack boom sprayer with a 10 foot boom. Six 80015 nozzles will be utilized for the application. The sprayer will be calibrated prior to application. Plots will be sprayed with one timed pass. Initial vegetation cover will be taken at the time of application for total percent cover and percent cover for the major species present.

Data collected consists of percent bare ground, percent total cover, percent cover and control by species for the dominant species on each site. Vegetation data will be recorded at the end of the first and second growing season. Trees will be measured for caliper and height at planting and will be re-measured at the end of the second growing season. Ocular estimates of survival, percent brown out, needle and bud damage will be measured at the end of the first and second growing season.

All statistics will be run by Liz Cole of Oregon State University. Statistics will consist of analysis of variance with Tukey's

tests with adjusted probabilities for multiple comparisons. Initial seedling size will be evaluated for significance and if so will be analyzed using covariate procedures. All layout, evaluations, data interpretation, and annual progress reports will be completed by Thunder Road Resources.

**Treatments:** Will include: 3 pts. Pindar GT; 3 pts Pindar GT with 1% and 3% MSO, 0.1% Sylgard 309, 0.25% R-11, 3 oz Derigo + 1% MSO and 8 oz Transline + 1% MSO; 3 oz Derigo; 3 oz, 4.5 oz, and 6 oz Derigo with 1% MSO; 3 oz and 6 oz Derigo with 8oz Transline + 1% MSO; 8 oz Transline + 1% MSO; and non-treated controls.

**2016:** Two sites were chosen for this trial, one near Montgomery Creek, California and the other near Oak Run, California on the west side of the Cascade Range. The Montgomery Creek site is located on property owned and managed by Sierra Pacific Industries. The site is approximately 2,500 feet elevation on a flat aspect. The site was logged as part of a timber harvest plan in 2013. Prior to logging it was pre-harvest sprayed with glyphosate and imazapyr. Following logging, the site was ripped, and planting occurred in 2014. The Oak Run site is on property owned and managed by Roseburg Resources Company. The site is approximately 4,000 feet elevation on a flat aspect. The unit was a clear cut as part of normal logging operations. It was pre-harvest sprayed using imazapyr and glyphosate. The site was logged in 2013 and planted in the spring of 2014. No further site preparation treatments have occurred on the site.

The Montgomery Creek site was planted with styro-4 ponderosa pine and styro-6 Douglas-fir on April 13<sup>th</sup> and the Oak Run site was planted with styro-5 ponderosa pine and styro-6 Douglas-fir on April 6<sup>th</sup>. Since abundant conifer tolerance data have already been obtained for Pindar GT, only plots sprayed with Derigo and the non-treated controls were planted.

Spraying occurred on April 15<sup>th</sup> on the Montgomery Creek site and on April 7<sup>th</sup> on the Oak Run site.

Evaluations occurred on July 16<sup>th</sup> for the Montgomery Creek site and July 15<sup>th</sup> on the Oak Run site.

Data were analyzed using SAS statistical software. Vegetation and seedling data were analyzed using analysis of variance. Treatments were compared using Tukey's test with adjusted probabilities. Initial seedling size parameters were used as covariates within the ANOVA's for height, caliper, and volume. Analyses for size was weighted by the number of surviving seedlings in each plot. Least squared means for size included adjustments for the covariates, which resulted in some difference from the raw data means. Analyses utilized PROC MEANS, PROC MIXES, and PROC GLIMMIX in SAS. PROC GLIMMIX was used when variances were unequal, and either the Poisson or gamma distribution was used. When statements are made regarding statistically significant differences in this document, the alpha level is  $P \leq 0.05$ .

These trials were basically separated into two parts. The first dealt with post emergent applications of Pindar GT with various surfactants to attempt to improve knock down of existing vegetation. The second was a screening trial for vegetation control and conifer tolerance with Derigo.

**Montgomery Creek Site:** Vegetation control with Pindar GT varied by species (Table 1). The addition of an adjuvant significantly improved control of Spanish clover compared to Pindar GT without (Figure 1). The methylated seed oil adjuvant had better control than Sylgard 309 or R-11 but not significantly. The addition of adjuvant did not make a significant difference with Pindar GT for control of Scotch broom or rattail fescue. Although not significant, it is interesting that the methylated seed oil treatment has the worst control of rattail fescue and Sylgard 309 and R-11 were the best. This is the opposite of what happened with Spanish clover. Percent bare ground did not differ significantly by treatment for Pindar GT, but the highest percent bare ground occurred with either the Derigo or Transline tank mixes.

The addition of a second herbicide significantly improved control on several species. Transline significantly improved control of Spanish clover over the Pindar GT with no adjuvant and the treatments with Sylgard 309 and R-11. The addition of Derigo improved control of Scotch broom and rattail fescue, but due to higher variability, not significantly over the other Pindar GT treatments.

Derigo treatments initially provided very good knock down of the vegetation that was present on the site. By the time of the first evaluation, vegetation had started to re-invade the plots as Derigo has a very short residual life. Adding an MSO to Derigo increased percent bare ground over the no adjuvant treatment but not significantly. Increasing the Derigo rate to 6 ounces per acre did have a significant increase in bare ground over the three ounce treatment with no adjuvant and the non-treated control. Bare ground increased with six ounces plus an MSO over the three and four and half ounce rate with an MSO, but not significantly. The highest percent bare ground was achieved with the Derigo plus Transline tank mix. Both tank mix treatments had significantly more bare ground than the three ounce rate of Derigo with no MSO and the non-treated control.

Scotch broom control was variable with Derigo, but it definitely inhibited growth and suppressed some germination. However, Scotch broom control was not significantly affected by treatment. Most of this can be attributed to variability of Scotch broom cover among plots. Although treatment differences were not significant, there were less Scotch broom and smaller plants in the Derigo treated plots compared to Pindar GT, Transline alone or in the untreated controls.

All rates of Derigo provided significantly better control of rattail fescue than non-treated control or the treatment with Transline alone except for the three ounce rate of Derigo with MSO. Control of rattail

fescue was slightly better with Derigo compared to Pindar GT treatments, but not significantly. Spanish clover was initially knocked down very well shortly after treatment, but recovered as the season went on. Best control was achieved with the Derigo plus Transline tank mixes. The six ounce rate of Derigo with MSO, Transline alone, and the two Derigo plus Transline tank mixes had significantly better control of Spanish clover than the three ounce Derigo treatment with no MSO, the 4.5 ounce Derigo treatment with MSO and the non-treated control. Transline controlled Spanish clover very well on its own.

Both ponderosa pine and Douglas-fir were significantly affected by treatment (Table 2, Figure 2). Bud damage was significantly increased for both species with Derigo at any rate compared to the no-treated control. Needle damage was significantly increased with Derigo at all rates on Douglas-fir compared to the non-treated control. Needle damage was higher with Derigo treatments for ponderosa pine, but not significantly. Survival and percent brownout were not significantly affected by treatment for either species.

**OAK RUN SITE:** The Oak Run site was comprised of a good mix of weeds to evaluate the two herbicides. For the Pindar GT treatments, percent bare ground was significantly influenced by treatment (Table 3). All treatments with Pindar GT except for the three pint rate with no adjuvant and the three pint with Transline had significantly more bare ground than the non-treated control. Percent bare ground did not

differ significantly among Pindar GT treatments. However, there were some apparent trends. The addition of an adjuvant did increase the percent bare ground but not significantly. Little difference existed between adjuvants but R-II provided the most bare ground of the ones tested. The most bare ground was achieved with the tank mix with Derigo while Transline added little on this site.

This site was dominated by a fairly rare weed in forestry, but one that is starting to invade forestry sites. Rush skeleton weed was abundantly present here. All Pindar GT treatments provided significantly more control than the non-treated control. Treatments did not differ significantly among Pindar GT treatments, but the addition of an adjuvant definitely increased control over the three pints of Pindar GT without an adjuvant. All Pindar GT treatments with an adjuvant controlled rush skeleton weed fairly well. Control was increased more when Derigo or Transline was tank mixed with three pints of Pindar GT.

All Pindar GT treatments provided significantly more annual grass control than the non-treated control, but again, did not differ significantly from one another. All treatments provided good control except the Pindar GT plus Transline tank mix. Squirrel tail is a common perennial grass common to this area that was also abundant on this site. Pindar GT is inherently weak on perennial grasses and this was apparent on this site. Control of squirrel tail was poor and no

Pindar GT treatment differed significantly from the non-treated control.

All treatments with Derigo except the three ounce rate with no adjuvant and the four and a half ounce rate with MSO had significantly more bare ground than the non-treated control or the treatment with Transline alone. No treatment with Derigo significantly differed from each other regarding bare ground and no obvious trends were present.

Control of rush skeleton weed was poor with Derigo alone at any rate, even with MSO. All treatments with Derigo alone had significantly poorer control than either Derigo tank mix with Transline or Transline alone. Transline alone at eight ounces per acre controlled rush skeleton weed one hundred percent.

Annual grass control with Derigo was excellent, but the addition of MSO significantly improved control of the three ounce rate. All treatments containing Derigo had significantly more annual grass control than the non-treated control and Transline alone with the exception of the three ounce Derigo rate with no MSO which was only significantly different from the non-treated control. No Derigo treatments with MSO were significantly different from each other.

Control of squirrel tail was sporadic at best. The six ounce rate of Derigo with MSO provided significantly more control of squirrel tail than either the three ounce rate without MSO or Transline alone, but not the

untreated control. This may be an artifact. No other differences existed between Derigo treatments

Similar to the Montgomery Creek site, ponderosa pine nor Douglas-fir survival or percent brownout were significantly affected by treatment (Table 4). However, all treatments with Derigo had significantly more bud and needle damage on ponderosa pine and significantly more bud damage on Douglas-fir compared to the non-treated control. Needle damage was also higher with Derigo treatments for Douglas-fir, but not significantly.

Overall, both of these sites showed that adjuvants increased control for both Pindar GT and Derigo. The type of adjuvant that provided the best control varied by species for Pindar GT. Only an MSO was tested with Derigo. The most consistent and largest gains were achieved by tank mixing Pindar GT or Derigo with an additional herbicide. This was similar to results observed in the analogous two trials conducted by the Certified Forest Research Group. Pindar GT and Derigo both exhibited weaknesses when perennial grasses were present.

Both sites showed unacceptable levels of conifer injury from over-the-top applications to freshly planted conifers from Derigo. It was not determined whether pre-plant applications had an acceptable level of conifer safety. While survival and brownout were not affected, the applications caused significant levels of leader and needle stunting resulting in growth loss. From

these data it does not appear that over-the-top applications with Derigo are a feasible option for forestry applications.

Treatment	% Bare Ground	% Cov Scotch Broom	% Cont Scotch Broom	% Cov Spanish Clover	% Cont Spanish Clover	% Cov RT Fescue	% Cont RT Fescue
3 pt Pind GT	15.0 (7.6) abc	19.3 (15.3) a	0.0 (0.0) a	63.3 (21.9) abc	16.7 (16.7) f	13.3 (13.3) abc	70.0 (30.0) ab
3 pt Pind GT + 1% MSO	31.7 (19.2) abc	2.3 (1.5) a	33.3 (33.3) a	35.0 (23.6) bcd	63.3 (23.3) abcd	20.0 (15.3) abc	60.0 (30.6) abc
3 pt Pind GT + 3% MSO	38.3 (15.9) abc	14.3 (8.1) a	3.3 (3.3) a	27.3 (13.9) abcd	61.7 (18.8) abcd	2.3 (1.5) abc	50.0 (28.9) abc
3 pt Pind GT + 0.1% Sylgard	18.3 (10.9) abc	5.0 (2.5) a	0.0 (0.0) a	33.3 (28.3) bcd	35.0 (15.0) bcde	6.0 (4.6) abc	80.0 (15.3) a
3 pt Pind GT + 0.25% R-11	15.0 (7.6) abc	4.3 (3.0) a	33.3 (33.3) a	39.0 (26.4) abcd	40.0 (20.8) cdef	6.0 (4.5) abc	73.3 (12.0) a
3 pt Pind GT + 3 oz Derigo + 1% MSO	66.6 (4.4) a	2.0 (1.0) a	63.3 (18.6) a	16.6 (3.3) bcd	70.0 (0.0) abc	3.3 (1.6) abc	90.0 (5.8) a
3 pt Pind GT + 8 oz Transline + 1% MSO	78.3 (9.3) a	5.7 (2.3) a	10.0 (10.0) a	1.0 (0.6) e	96.7 (1.7) a	3.3 (3.3) bc	76.7 (23.3) a
3 oz Derigo	6.7 (4.4) bc	5.0 (2.9) a	33.3 (33.3) a	71.6 (18.6) ab	13.3 (8.3) ef	3.3 (1.6) abc	76.7 (14.5) a
3 oz Derigo + 1% MSO	33.3 (15.9) abc	1.7 (1.7) a	66.7 (33.3) a	36.7 (14.5) abcd	53.3 (6.7) abcd	23.3 (18.3) abc	43.3 (21.9) abc
4.5 oz Derigo + 1% MSO	35.0 (17.6) abc	2.0 (0.0) a	51.7 (26.8) a	63.3 (16.9) ab	26.7 (21.9) def	1.7 (1.7) c	93.3 (6.7) a
6 oz Derigo + 1% MSO	76.7 (13.6) a	0.7 (0.3) a	50.0 (28.9) a	21.7 (14.8) cd	76.7 (14.5) abc	0.7 (0.7) c	96.7 (3.3) a
6 oz Derigo + 8 oz Transline + 1% MSO	86.7 (6.0) a	0.7 (0.7) a	66.7 (33.3) a	9.0 (3.8) de	88.3 (4.4) ab	0.7 (0.7) c	98.3 (1.7) a
3 oz Derigo + 8 oz Transline + 1% MSO	93.3 (1.7) a	1.0 (1.0) a	66.7 (33.3) a	1.7 (0.3) e	95.0 (0.0) a	1.7 (1.7) c	95.0 (5.0) a
8 oz Transline + 1% MSO	53.3 (20.5) ab	7.3 (3.9) a	0.0 (0.0) a	0.0 (0.0) e	100.0 (0.0) a	26.7 (12.0) ab	13.3 (13.3) bc
Control	3.3 (1.7) c	9.0 (5.6) a	0.0 (0.0) a	81.7 (6.0) a	0.0 (0.0) f	33.3 (14.8) a	0.0 (0.0) c

Table 1. Montgomery Creek Pindar GT/Derigo vegetation assessments. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	PP Surv	PP % Br Out	PP Bud Dam	PP Needle Dam	DF Surv	DF % Br Out	DF Bud Dam	DF Needle Dam
3 pt Pind GT + 3 oz Derigo + 1% MSO	93.3 (6.7) a	13.3 (8.8) a	5.0 (1.1) a	2.7 (0.9) a	86.7 (6.7) a	18.3 (4.4) a	7.3 (0.3) ab	7.3 (0.3) a
3 oz Derigo	93.3 (3.3) a	21.7 (7.3) a	4.7 (1.7) a	4.0 (2.0) a	86.7 (13.3) a	25.0 (12.6) a	5.7 (1.7) b	7.0 (1.2) a
3 oz Derigo + 1% MSO	100.0 (0.0) a	8.3 (1.7) a	5.3 (0.3) a	3.3 (0.9) a	90.0 (5.8) a	21.7 (6.7) a	7.0 (0.6) ab	7.3 (0.3) a
4.5 oz Derigo + 1% MSO	86.7 (13.3) a	20.0 (15.0) a	6.3 (0.9) a	4.3 (2.3) a	83.3 (8.8) a	25.0 (10.4) a	7.7 (0.3) a	8.0 (0.6) a
6 oz Derigo + 1% MSO	96.7 (3.3) a	13.3 (3.3) a	6.0 (0.6) a	3.7 (0.7) a	93.3 (6.7) a	16.7 (9.3) a	7.3 (0.3) ab	7.3 (0.3) a
6 oz Derigo + 8 oz Transline + 1% MSO	93.3 (3.3) a	13.3 (3.3) a	6.0 (0.6) a	3.3 (1.3) a	83.3 (8.8) a	26.7 (7.3) a	7.7 (0.3) a	7.3 (0.3) a
3 oz Derigo + 8 oz Transline + 1% MSO	100.0 (0.0) a	8.3 (1.6) a	5.0 (0.6) a	4.7 (1.2) a	96.7 (3.3) a	11.7 (4.4) a	7.0 (0.0) ab	7.0 (0.0) a
Control	93.3 (6.7) a	13.3 (8.8) a	0.7 (0.3) b	1.7 (0.9) a	100.0 (0.0) a	3.3 (1.7) a	0.0 (0.0) c	1.7 (0.9) b

Table 2. Montgomery Creek Pindar GT/Derigo conifer tolerance data. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	% Bare Ground	% Cov Squirrel Tail	% Cont Squirrel Tail	% Cov Ann. Grass	% Cont Ann. Grass	% Cov Rush Skeleton Weed	% Cont Rush Skeleton Weed
3 pt Pind GT	23.3 (13.3) abc	60.0 (15.3) a	6.7 (6.7) bc	1.7 (1.7) bc	93.3 (6.7) a	2.3 (1.5) bc	50.0 (28.9) ab
3 pt Pind GT + 1% MSO	40.0 (10.0) ab	51.7 (15.9) a	3.3 (3.3) bc	7.3 (6.4) ab	80.0 (15.3) ab	0.7 (0.7) c	86.7 (13.3) a
3 pt Pind GT + 3% MSO	46.7 (14.5) ab	41.7 (8.3) a	20.0 (15.3) abc	1.7 (1.7) bc	88.3 (11.7) a	1.0 (0.6) c	88.3 (9.3) a
3 pt Pind GT + 0.1% Sylgard	40.0 (0.0) ab	46.7 (8.8) a	21.7 (21.7) abc	0.0 (0.0) c	100.0 (0.0) a	0.3 (0.3) c	90.0 (10.0) a
3 pt Pind GT + 0.25% R-11	56.7 (8.8) a	31.7 (10.1) ab	0.0 (0.0) c	1.7 (1.7) bc	96.7 (3.3) a	1.0 (0.0) c	93.3 (6.7) a
3 pt Pind GT + 3 oz Derigo + 1% MSO	68.3 (6.0) a	31.7 (6.0) ab	46.7 (6.7) abc	0.0 (0.0) c	100.0 (0.0) a	0.0 (0.0) c	100.0 (0.0) a
3 pt Pind GT + 8 oz Transline + 1% MSO	40.0 (18.0) abc	46.7 (21.9) ab	36.7 (18.6) abc	13.3 (8.8) a	58.3 (22.0) abc	0.0 (0.0) c	100.0 (0.0) a
3 oz Derigo	23.3 (3.3) abc	46.7 (14.5) a	10.0 (10.0) bc	10.0 (5.0) a	33.3 (24.0) c	11.0 (4.9) a	16.7 (16.7) bc
3 oz Derigo + 1% MSO	55.0 (13.2) a	33.3 (8.8) ab	53.3 (6.7) ab	0.7 (0.7) bc	96.7 (3.3) a	6.0 (4.6) ab	33.3 (33.3) bc
4.5 oz Derigo + 1% MSO	35.0 (17.6) abc	36.7 (14.5) ab	36.7 (6.7) abc	0.0 (0.0) c	100.0 (0.0) a	3.7 (1.3) bc	26.7 (26.7) bc
6 oz Derigo + 1% MSO	65.0 (7.6) a	8.3 (1.7) b	81.7 (6.0) a	0.0 (0.0) c	100.0 (0.0) a	1.3 (0.7) c	33.3 (33.3) bc
6 oz Derigo + 8 oz Transline + 1% MSO	53.3 (16.9) ab	38.3 (22.1) ab	43.3 (26.0) abc	0.0 (0.0) c	100.0 (0.0) a	0.0 (0.0) c	100.0 (0.0) a
3 oz Derigo + 8 oz Transline + 1% MSO	43.3 (6.7) ab	43.3 (12.0) a	26.7 (12.0) abc	1.7 (1.7) bc	93.3 (6.7) a	0.0 (0.0) c	100.0 (0.0) a
8 oz Transline + 1% MSO	11.7 (4.4) bc	70.0 (15.3) a	0.0 (0.0) c	4.0 (1.0) ab	53.3 (27.3) bc	0.0 (0.0) c	100.0 (0.0) a
Control	6.7 (1.7) c	35.0 (7.6) ab	16.7 (16.7) abc	13.3 (3.3) a	0.0 (0.0) d	10.3 (5.5) a	0.0 (0.0) c

Table 3. Oak Run Pindar GT/Derigo vegetation assessments. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	PP Surv	PP % Br Out	PP Bud Dam	PP Needle Dam	DF Surv	DF % Br Out	DF Bud Dam	DF Needle Dam
3 pt Pind GT + 3 oz Derigo + 1% MSO	80.0 (15.3) a	30.0 (15.3) a	7.7 (0.7) a	6.7 (1.2) a	86.7 (3.3) a	21.7 (1.7) a	7.3 (0.3) a	7.3 (0.3) a
3 oz Derigo	70.0 (20.0) a	41.7 (16.9) a	8.0 (0.6) a	7.7 (0.6) a	83.3 (12.0) a	40.0 (10.0) a	7.7 (0.3) a	7.7 (0.3) a
3 oz Derigo + 1% MSO	83.3 (3.3) a	25.0 (5.0) a	7.0 (1.0) a	6.7 (0.7) a	63.3 (8.8) a	48.3 (10.1) a	8.0 (0.6) a	8.0 (0.6) a
4.5 oz Derigo + 1% MSO	63.3 (6.7) a	46.7 (6.7) a	8.0 (0.0) a	8.3 (0.3) a	60.0 (5.8) a	53.3 (3.3) a	8.3 (0.3) a	9.0 (0.0) a
6 oz Derigo + 1% MSO	83.3 (3.3) a	33.3 (4.4) a	8.3 (0.3) a	7.0 (0.6) a	83.3 (12.0) a	28.3 (8.3) a	8.0 (0.6) a	7.6 (0.3) a
6 oz Derigo + 8 oz Transline + 1% MSO	60.0 (25.2) a	50.0 (22.9) a	8.0 (0.6) a	7.0 (1.5) a	60.0 (30.6) a	46.7 (27.3) a	8.3 (0.9) a	8.0 (1.0) a
3 oz Derigo + 8 oz Transline + 1% MSO	90.0 (10.0) a	25.0 (7.6) a	7.3 (0.7) a	7.3 (0.3) a	76.6 (6.7) a	30.0 (7.6) a	7.7 (0.7) a	8.0 (0.6) a
Control	86.7 (3.3) a	25.0 (2.9) a	1.0 (0.0) b	3.3 (0.7) b	73.3 (3.33) a	33.3 (4.4) a	1.0 (0.0) b	6.3 (1.7) a

Table 4. Oak Run Pindar GT/Derigo conifer tolerance data. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.



Figure 1. Control of Spanish Clover with 6 oz of Derigo five months after treatment.



Figure 2. Douglas-fir bud and needle stunting from Derigo applications.

**Sierra Cascade Intensive Forest Management Research Cooperative Proposal 16-03  
Penoxsulam With and Without Surfactant**

Principal Investigator: Ed Fredrickson

Title: Weed Control with Directed Spray of Penoxsulam with and without Surfactant at  
Two Timings

Year Funded: 2016

**Executive Summary:**

For the past several years, the Sierra Cascade Intensive Forest Management Research Cooperative has been evaluating Pindar GT (oxyfluorfen + penoxsulam) as a pre or post plant herbaceous site preparation treatment. Dow AgroScience recently changed the name of Pindar GT to Cleantraxx. Over the course of many studies, it was determined that penoxsulam had the ability to inhibit seed germination of some woody brush species, mainly Ceanothus. Penoxsulam is an ALS inhibitor much like imazapyr and sulfometuron. Imazapyr has excellent activity on woody brush whereas sulfometuron has none. The amount of activity penoxsulam alone has on brush species is unknown. Previous testing has shown penoxsulam to be extremely tolerant to conifers and is used at unprecedented low use rates. It was also observed in several operational applications, once the product had been registered, that Cleantraxx had at least some foliar activity on herbaceous and woody plants. Due to superior control of woody brush seedlings with Cleantraxx compared to GoalTender (oxyfluorfen only), a mid-summer broadcast foliar trial on bracken fern was conducted by Dow AgroSciences with Cleantraxx. Early results showed excellent foliar knock down of bracken fern compared to glyphosate, but also significant foliar activity on snow berry. Since oxyfluorfen has no activity on woody

brush, the interest in penoxsulam rapidly grew.

Broadcast foliar applications of a herbicide usually provide somewhat lesser control than directed applications. To date, penoxsulam has not been formally evaluated for its ability to control woody brush or difficult to control herbaceous plants with directed applications. There would be several benefits if directed penoxsulam applications were feasible. The treatments would provide a very low use rate application, reducing the amounts of overall herbicides used. It would also provide the landowner with a product that had very high margins of conifer safety, reducing the risk of accidental damage and the time required to protect seedlings, hence reducing application costs. In the long-term, it is Dow AgroSciences goal to replace the oxyfluorfen in Cleantraxx with a new environmentally sound and conifer safe soil active herbicide.

It is the objective of this trial to test applications of penoxsulam, formulated as Sapphire, on a variety of woody brush species on several sites.

**The Study:** There will be three sites for this study. Each site should contain two vegetative species of interest to evaluate. Brush should not be greater than three feet tall. Good access and flat to

moderate slopes are beneficial. The sites should be located on the east or west side of the Cascade Range but no further south than Lake Almanor, or further east than Bieber, CA.

The experimental design is a completely randomized block with ten replications per treatment. Each brush clump is considered one replication. Each clump will be tagged and numbered prior to application. Each timing will be installed as a separate trial on each site. The timings utilized for this trial will be June and August.

Clumps will be sprayed with a CO<sub>2</sub> powered backpack sprayer equipped with a wand and fitted with an 8003 tapered flat fan nozzle. Target volume per acre will be 25 gallons. Clumps will be sprayed to obtain complete coverage, but not to runoff.

Evaluations will be completed at the end of the first and second growing season and will consist of ocular estimates of percent control by species.

All layout, application, evaluation, statistical interpretation, write up, and annual reporting will be completed by Thunder Road Resources. All statistical evaluation will be completed by Liz Cole of Oregon State University. Statistical analysis will consist of analysis of variance and Tukeys tests with adjusted probabilities for multiple comparisons.

**Treatments:** Will include three rates of Sapphire at 0.25, 0.5, and 0.75 percent as a volume per volume solution with no adjuvant and with one percent methylated seed oil. All treatments will be compared to an operational standard which is two percent Chopper plus two

percent Accord XRT II with five percent methylated seed oil and a non-treated control.

**2016:** Three sites were chosen for this trial with two brush species per site. The first site is located on property owned and managed by Fruit Growers Supply Company near Burney, California. The site is a fuel break that had been thinned to a wide spacing approximately ten years prior to this study. The site is approximately 3,500 feet elevation on a slight south slope with five to ten percent slope. Deerbrush and Greenleaf manzanita are the two woody brush species on the site. The second site is located on property owned and managed by Roseburg Resources Company near Montgomery Creek, California. The site is approximately 5,000 feet in elevation in a timber stand that was chip thinned in the late 1900's. Golden chinquapin and snowberry are the two species on this site. The final site is also located on property owned and managed by Fruit Growers Supply Company. It is located in the 2014 Eiler Fire near Burney, California. The site was logged and chipped after the fire with no further site preparation. The site is approximately 5,000 feet elevation on a slight south aspect and a ten to fifteen percent slope. Squaw carpet and snowbrush are the two woody brush species on this site.

The Fruit Growers manzanita and deerbrush site was sprayed on June 10<sup>th</sup> and August 24<sup>th</sup>. The Fruit Growers squaw carpet and snowbrush site was sprayed on June 11<sup>th</sup> and August 24<sup>th</sup>. The Roseburg snowberry and chinquapin site was sprayed on June 18<sup>th</sup> and August 25<sup>th</sup>.

All sites were evaluated between September 20<sup>th</sup> and 21<sup>st</sup>.

Data were analyzed using SAS statistical software. Vegetation and seedling data were analyzed using analysis of variance. Treatments were compared using a Tukey's test with adjusted probabilities. Initial seedling size parameters were used as covariates within the ANOVA's for height, caliper, and volume. Analyses for size was weighted by the number of surviving seedlings in each plot. Least squared means for size included adjustments for the covariates, which resulted in some difference from the raw data means. Analyses utilized PROC MEANS, PROC MIXES, and PROC GLIMMIX in SAS. PROC GLIMMIX was used when variances were unequal, and either the Poisson or gamma distribution was used. June and August treatments were compared using a standard T-test. When statements are made regarding statistically significant differences in this document, the alpha level is  $P \leq 0.05$ .

Timing played a significant role for snowbrush and deerbrush, but had no significant effect for any other brush species. June treatments had better control compared to August treatments for snowbrush and deerbrush, but part of that may be due to the fact that there was only about one month between the August application and the evaluation periods because evaluations had to take place before fall senescence occurred (Tables 1 & 2). Second year evaluations will most likely give a better indication of timing effects.

Snowberry was the most sensitive woody brush species to Sapphire tested in this trial (Figure 1). There was no

significant difference between June and August spray timings and rate played no significant role in efficacy. The addition of a methylated seed oil significantly increased percent control for both June and August applications. All treatments with an MSO were significantly different from all treatments without an MSO and the non-treated controls for either timing. The adjuvant effects regarding the snowberry were very apparent. The operational standard had better control than all the Sapphire without an MSO, but was only significantly different from the low rate of Sapphire with an MSO in June. The operational standard was not significantly different from any Sapphire treatments with an MSO in August, although control was slightly better. Treatments without an MSO were not significantly different from the non-treated control.

Sapphire treatments had no significant effect on golden chinquapin at either timing compared to the non-treated control. Surfactant effects were slight and mostly not significant with the exception of the comparison of the low rate of Sapphire without an MSO to both the low and high rate of Sapphire with an MSO which were significantly different in the August timing. The operational standard was significantly different from all the other treatments in August, but not different from any in June.

Sapphire treatments were not significantly different from the non-treated controls for squaw carpet regardless of MSO or timing. The operational standard provided significantly better control than all other treatments in June, but only the non-

MSO treatments and the high rate of Sapphire with an MSO were significantly different from the operational standard in August.

Sapphire treatments had no significant effect on snowbrush in August compared to the non-treated control, but did show some significant differences in June. In June, all treatments provided significantly better control than the non-treated controls with the exception of the two lowest rates of Sapphire without an MSO. The highest rate of Sapphire with an MSO provided significantly better control than all other Sapphire treatments and the non-treated control, but significantly less control than the operational standard.

Similar to snowbrush, Sapphire treatments had no significant effect on deerbrush in August and were not significantly different from the non-treated control with the exception of the high rate of Sapphire with an MSO but this appears to be an artifact. The operational standard provided significantly better control than all Sapphire treatments and the non-treated control in August with the exception of the one Sapphire treatment that appears to be an artifact. June treatments were significantly affected by treatment. Sapphire had no effect on control, but the addition of MSO did. All Sapphire

treatments with MSO had significantly better deerbrush control than treatments without MSO with the exception of the lowest rate of Sapphire with no MSO. Non MSO Sapphire treatments were not significantly different from the non-treated controls, but all of the treatments with an MSO were. The operational standard provided significantly better control than all Sapphire treatments and the non-treated control.

Greenleaf manzanita was not significantly affected by treatment at all in August, even compared to the operational standard. No Sapphire treatment was significantly different from the non-treated controls in June. The operational standard was significantly different from all other treatments in June.

While some decent effects on woody brush were observed, it does not appear that Sapphire alone is an adequate control treatment, at least based on the first year data. The trials did provide some important information in regards to Cleantraxx applications in that it definitively showed the importance of adding an MSO to maximize control on established vegetation.

Treatment	% Cont Snow Berry	% Cont G. Chinq	% Cont Squaw Carpet	% Cont Snowbrush	% Cont Deerbrush	% Cont GL Manz
0.25% Sapphire	17.0 (3.2) c	19.0 (9.1) a	2.0 (1.0) c	8.5 (0.7) cd	24.5 (8.8) bc	9.0 (1.6) b
0.5% Sapphire	15.0 (1.7) c	10.5 (1.4) a	7.5 (3.3) bc	12.0 (1.3) cd	14.0 (1.9) c	13.0 (1.9) b
0.75% Sapphire	20.5 (4.9) c	20.0 (9.1) a	6.0 (2.1) bc	17.0 (3.7) c	13.5 (2.0) c	10.0 (1.5) b
0.25% Sapphire + 1% MSO	51.5 (9.3) b	13.5 (1.5) a	8.0 (1.5) bc	17.0 (1.3) c	36.5 (5.6) b	12.0 (2.1) b
0.5% Sapphire + 1% MSO	57.0 (8.1) ab	17.5 (8.7) a	7.0 (1.9) bc	18.5 (1.5) c	34.0 (5.5) b	10.5 (1.4) b
0.75% Sapphire + 1% MSO	67.0 (6.0) ab	10.5 (1.7) a	11.0 (1.6) b	44.0 (7.0) b	33.0 (4.8) b	12.5 (1.3) b
2% Chop +2% Acc XRT II + 5% MSO	96.0 (3.1) a	52.5 (14.9) a	55.5 (8.8) a	98.3 (0.74) a	95.5 (3.0) a	85.5 (6.8) a
Control	19.5 (5.1) c	26.5 (12.3) a	4.0 (1.0) bc	6.5 (1.1) d	13.0 (1.7) c	12.0 (1.3) b

Table 1. June efficacy data for the directed penoxsulam (Sapphire) trial. All rates expressed as percent solution v/v. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	% Cont Snow Berry	% Cont G. Chinq	% Cont Squaw Carpet	% Cont Snowbrush	% Cont Deerbrush	% Cont GL Manz
0.25% Sapphire	9.0 (2.2) b	6.5 (1.1) c	5.0 (1.7) bc	6.5 (1.1) b	13.5 (1.3) b	11.5 (1.5) a
0.5% Sapphire	8.0 (2.3) b	8.5 (1.3) bc	1.5 (0.8) b	6.5 (1.3) b	15.0 (1.8) b	13.0 (2.4) a
0.75% Sapphire	6.5 (1.8) b	8.5 (1.5) bc	5.0 (1.8) bc	7.5 (1.1) b	15.0 (1.5) b	11.5 (1.5) a
0.25% Sapphire + 1% MSO	63.5 (7.3) a	14.0 (1.8) b	5.5 (1.2) abc	6.5 (0.8) b	16.5 (1.3) b	16.0 (3.1) a
0.5% Sapphire + 1% MSO	63.0 (5.7) a	13.5 (2.8) bc	8.5 (2.2) ab	9.5 (1.9) b	18.5 (1.7) b	13.0 (1.3) a
0.75% Sapphire + 1% MSO	72.0 (4.5) a	16.0 (1.6) b	4.5 (1.2) bc	8.0 (1.1) b	17.5 (1.3) a	11.0 (1.3) a
2% Chop +2% Acc XRT II + 5% MSO	75.5 (2.4) a	39.0 (3.8) a	18.0 (2.8) a	34.0 (4.2) a	72.5 (6.0) a	20.5 (5.4) a
Control	8.5 (1.3) b	9.5 (2.0) bc	7.5 (2.7) abc	12.0 (6.5) b	16.0 (2.3) b	15.0 (2.7) a

Table 2. August efficacy data for the directed penoxsulam (Sapphire) trial. All rates expressed as percent solution v/v. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.



Figure 1. Snowberry control with 0.75% Sapphire plus 1% MSO.

## Sierra Cascade Intensive Forest Management Research Cooperative Proposal 15-01 Glyphosate (Rodeo) Over the Top

Principal Investigator: Ed Fredrickson

Title: Efficacy and Conifer Tolerance of Rodeo with and without the Surfactant Penetron with Spring and Late Summer Applications Over the Top of Ponderosa Pine, Douglas-fir and Incense Cedar

Year Approved: 2015

### Executive Summary

Over the past several years, much of the attention with new chemicals has focused on new residual soil active products with improved conifer tolerance as potential replacements for atrazine in forestry. While several excellent products have proven effective, the majority of their activity is pre-emergent and often a combination treatment with glyphosate is necessary for complete knockdown of existing vegetation in a post-emergent setting. This is not a problem for pre-plant applications, but can be a potential issue with post-plant timings. The majority of glyphosate products on the market either do not have a broadcast release treatment on the label, or conifer tolerance is lost due to the type of surfactant formulated in the product.

For years foresters had no problems with broadcast applications over the top of western conifers with the original formulation of Roundup. When Roundup went off patent and the formulation was changed, the original tallow amine surfactant (Entry II) was removed and replaced with a different type of adjuvant. The result of this was a loss of conifer

tolerance and the aerial release label for Roundup was discontinued. The many generic copies of Roundup that were produced over the years eventually removed their aerial release labels as well and contained surfactants that did not have the same conifer safety as Entry II. Entry II was manufactured as a stand-alone surfactant for several years before being discontinued. The only glyphosate formulations that could be safely applied over the top of existing conifers contained no surfactants in the formulations. This had a negative effect on efficacy, and no tallow-amine surfactant like Entry II was available on the market to add to it.

Currently there is a new surfactant by Loveland Industries on the market that has recently been registered for use in forestry. Its trade name is Penetron and is supposedly a clone of Entry II. It has yet to be tested in an operational setting. Rodeo is the glyphosate formulation by Dow AgroSciences that is formulated without a surfactant. It does have an aerial release label, but applications over the top of conifers are restricted to plantations that

have been planted for at least a year prior to application. If the formulation of Penetron is true to the old Entry II formulation, it may be possible to make a glyphosate tank mix similar in conifer tolerance and efficacy to the original Roundup formulation. This may be of particular importance now, relevant to the new residual herbicides on the market that require the addition of glyphosate to achieve adequate brownout of existing herbaceous vegetation.

The ideal tank mix partner for early spring applications of either Esplanade F or Pindar GT would be glyphosate. The ability to go over the top of freshly planted seedlings would reduce future treatment needs and reduce application costs significantly. The addition of Rodeo would provide the post-emergent knock down required. The restriction on the Rodeo label currently prohibits applications to seedlings in their first growing season.

The objective of this study is to evaluate the partial contributions of rate, timing and surfactant on conifer tolerance and efficacy for ponderosa pine, Douglas-fir and incense cedar in their first growing season and to generate data to remove the first year restriction on the Rodeo label.

This trial will be replicated on two sites. Due to the inclusion of Douglas-fir and incense cedar, both sites should be in areas where these species naturally occur.

The trial will be a completely randomized block design with four replications per treatment. Plot size will be 12 feet by 36.3

feet (0.01 acres) and the center lines marked on each end with PVC. All plots will be planted prior to the application of herbicides in the spring of 2015. Seedlings and several planters are to be provided by the local cooperating timber company. Ten trees of each species will be planted in rows within the plots. Thunder Road Resources will be on site during planting to supervise.

Treatments will include: 0.75 qt/ac Rodeo; 1.5 qt/ac Rodeo; 0.75 qt/ac Rodeo + 5 oz/ac Penetron; 1.5 qt/ac Rodeo + 5 oz/ac Penetron; 0.75 qt/ac Rodeo + 10 oz/ac Penetron; 1.5 qt/ac Rodeo + 10 oz/ac Penetron; and a non-treated control. Each of these treatments will be applied in the spring and then in the fall.

Half of the plots will be treated several days after planting in the spring of 2015 prior to bud break with the other half being treated in the late summer of 2015 after bud set. All plots will be sprayed at 10 gallons per acre at 30 psi using a calibrated CO2 backpack boom sprayer with a 12 foot boom. All plots will be sprayed with one timed pass.

Evaluations will occur in the fall of 2015 and again in the fall of 2016. Due to the nature of glyphosate damage, no seedling measurements will be taken. All conifer assessments will consist of visual percent survival, percent brownout, and needle and bud damage ratings. Vegetation will be assessed as percent control by species.

All plot installation (with the exception of planting and seedling acquisition), evaluations, statistical analysis, and annual

progress reports in the fall of 2015 and 2016 will be completed by Thunder Road Resources.

**2015:** Two study sites were chosen for this study. The first site is on property owned and managed by Fruit Growers Supply Company out of Hilt, California. The site is located in a recent wildfire approximately 30 miles west of Yreka, Ca. Elevation of the site is approximately 4000 feet on zero slope and a flat aspect. The site had been salvage logged after the fire and tractor piled. No further activity had occurred. The second site is on property owned and managed by Soper Wheeler Company out of Strawberry Valley, California. The site is approximately ten miles northwest of Strawberry Valley. The site is a clear-cut that was logged in 2013, tractor piled and ripped in 2014 and planted in 2015. The area where the trial was placed did not receive chemical treatments of any kind. Elevation of the site is approximately 3500 feet with five percent slope and a very slight southerly aspect.

The study design was the same for both sites with the exception that incense cedar was added to the Soper Wheeler site. Plot size was 10 feet by 25 feet (the original proposal was 12 feet by 36.3 feet). The Soper Wheeler site was planted on April 15 with 10 trees per species per plot of Styro 8 ponderosa pine, Douglas-fir and incense cedar. The Fruit Growers site was planted on April 22 with ten trees per species per plot of Styro 6 ponderosa pine and Douglas-fir. The seedlings were not measured at

planting date due to all conifer assessments being strictly visual.

Two spray timings were utilized for this study. The first was an early spring timing applied immediately after planting on April 14 and April 22 and the second was after bud set in the late summer on September 1 and August 27 for the Soper Wheeler and Fruit Growers sites, respectively. All plots were sprayed at ten gallons per acre with a CO<sub>2</sub> powered backpack sprayer equipped with a ten foot boom (the original proposal was a twelve foot boom) and six 80015 nozzles. All applications occurred at 30 psi. The sprayer was calibrated prior to each application and all plots were sprayed with one timed pass.

Evaluations consisted of percent bare ground and percent cover by species for the vegetation assessments and survival, percent brownout and damage rating for conifer assessments. First evaluations were conducted on October 16 and 22 for the Fruit Growers and Soper Wheeler sites, respectively. Final evaluations will occur in the fall of 2016.

Data were analyzed using SAS statistical software. Vegetation and seedling data were analyzed using analysis of variance. Treatments were compared using a Tukey's test with adjusted probabilities. Analyses utilized PROC MEANS, PROC MIXED and PROC GLIMMIX in SAS. PROC GLIMMIX was used when variances were unequal, and either the Poisson or gamma distribution was used. Where statements are made regarding statistically significant

differences in this document, the alpha level is  $P \leq 0.05$ .

Application timing and Rodeo rate had the largest influence on conifer tolerance at the Fruit Growers site. Surfactant and surfactant rate had a minor influence. Conifer damage was greatest in the spring treatments. Neither herbicide or surfactant rate had any significant influence on survival, percent brownout, or damage rating in the late summer timing for either ponderosa pine or Douglas-fir.

In the spring treatments, the lower rate of Penetron did not significantly affect survival, brownout or damage rating for Douglas-fir seedlings compared to the no surfactant treatments. Adding 10 ounces of Penetron per quart of Rodeo to the high Rodeo rate did significantly increase the damage rating over the no surfactant and the 5 ounce Penetron treatments with Douglas-fir. Adding a surfactant at any rate, did not significantly affect survival, brownout or damage rating for ponderosa pine (Tables 1 & 2).

Douglas-fir had lower survival, higher percent brownout and higher damage ratings over all treatments when the Rodeo rate was increased from 0.75 to 1.5 quarts per acre in the spring. Douglas-fir survival was significantly lower with the high rate of Rodeo and the high rate of Penetron than all other treatments. Douglas-fir brownout was also significantly greater with the high rates of Rodeo and Penetron than the non-treated controls, the low rate of Rodeo alone in the spring and most of the fall treatments with

the exception of one. Damage ratings for Douglas-fir were highest again with the high rates of Rodeo and Penetron in the spring and were significantly different from all other treatments. Damage ratings were significantly higher with all spring high rate Rodeo treatments than all fall treatments and non-treated controls with the exception of the high rate of Rodeo in the fall with 5 ounces of Penetron. Rate had a much more pronounced effect on ponderosa pine. Survival decreased and percent brownout and damage ratings increased across all treatments when the Rodeo was increased. Differences due to rate in the no surfactant treatments were not significant for survival or brownout with ponderosa pine. The treatments with surfactant were. Although damage ratings increased with increasing rate for ponderosa pine, the differences were not significant.

Vegetation on the Fruit Growers site was mainly limited to herbaceous vegetation. At the time of treatment in the spring, the majority of herbaceous vegetation had not germinated yet, and by the late summer treatment most of it had senesced for the season. As a result, Rodeo applications did little to affect the presence of vegetation on site for these timings. Only percent ground cover was analyzed because of this. Treatment did not significantly affect percent bare ground, however, spring treatments did have more bare ground on average than fall treatments or the non-treated controls (Table 1).

The factor with the largest influence on conifer tolerance on the Soper Wheeler site

was timing. Herbicide and surfactant rate also influenced damage but to a lesser degree. Conifer damage was much greater in the spring treatments. Neither herbicide or surfactant rate had any significant influence on survival, brownout or damage rating for ponderosa pine, Douglas-fir or incense cedar in the late summer timing.

The effects of adding Penetron at any rate in the spring were not statistically significant, but some general trends were apparent. The addition of surfactant to the low rate of Rodeo made little difference in survival, brownout or damage rating for ponderosa pine, Douglas-fir or incense cedar (Tables 3 & 4). Either rate of Penetron added to the high Rodeo rate decreased survival and increased percent brownout and damage ratings for ponderosa pine. Only the high rate of Penetron showed similar trends on Douglas-fir. The addition of Penetron at either rate did not seem to affect incense cedar.

The general trend in the spring showed that increasing Rodeo rate decreased survival and increased percent brownout and damage rating for ponderosa pine, Douglas-fir and incense cedar. However, increasing rodeo rate only produced significant differences for survival in the 10 ounce Penetron treatments.

The vegetation trends on the Soper Wheeler site were similar to the Fruit Growers site. Vegetation present was primarily herbaceous that was affected by the timing of application. Only percent bare ground was analyzed. Treatment did not

significantly affect percent bare ground again due to not much vegetation being present at the time of application in the spring, and well into senescence at the late summer timing (Table 3). Treatments in the spring generally did have more bare ground than the late summer treatments, but not significantly.

It appears from the first year data that applications of Rodeo with or without Penetron in the spring produce too much conifer damage to be of practical value. Conifer tolerance did increase significantly by the late summer timing. Applications at this timing at either rate of Rodeo with or without Penetron appear to be possible. This could potentially have significant implications regarding aerial release treatments in first year plantations.

**2016:** Final evaluations for this study were conducted on August 23 and 26.

Vegetation was not significantly affected by treatment at the end of the second growing season following treatment at the Fruit Growers site (Table 5). First season data showed similar results due to the majority of vegetation being herbaceous and was predominately not germinated by the timing of the spring treatment and had gone into senescence by the late treatment.

Douglas-fir was not significantly affected by treatment for survival, percent brownout or damage rating although damage still tended to be greater in the spring treatment than the late summer treatment (Table 5).

Ponderosa pine was significantly affected by treatment. The most critical factor regarding ponderosa pine damage was application timing. Spring treatments with the high rate of Rodeo with no surfactant and the low rate of Penetron treatments had significantly lower survival and higher brownout than any treatment in late summer. Late summer treatments with either no surfactant or the high rate of Penetron at either rate of Rodeo had significantly lower damage ratings than the high rates of Rodeo with no surfactant or the low Penetron rate or the low rate of Rodeo with the low rate of Penetron.

The addition of Penetron did not have a significant effect on conifer tolerance at any rate with spring or late summer treatments at the end of the second growing season. Rodeo rate did have a significant effect on ponderosa pine survival with no surfactant and the low Penetron rate treatments in the spring. Rate did not play a significant role with the late summer timing.

Any effect on vegetation from Rodeo treatments had disappeared by the end of the second growing season at the Soper Wheeler site (Table 6). Rodeo had little effect on the vegetation even during the first season as the majority of vegetation on the site was herbaceous and had not totally germinated at the time of first treatment and had gone into senescence by the time of the late summer treatment. Neither percent bare ground nor any individual species assessment was significantly affected by treatment.

Conifers had begun to recover from any damage which occurred from the spring

treatments by the end of the second growing season, yet differences due to application timing were still significantly apparent for ponderosa pine and incense cedar. Douglas-fir was unaffected by treatment for any evaluation criteria (Table 6). The highest rates of Rodeo in the spring with Penetron had significantly lower survival than any late summer treatment for ponderosa pine and incense cedar.

Percent brownout and damage ratings were not significantly affected by treatment for ponderosa pine although both brownout and damage ratings still tended to be higher in the spring. Percent brownout and damage ratings for incense cedar were highest in the spring (Table 7). The highest rate of Rodeo with the high rate of Penetron had significantly more brownout and higher damage ratings than any treatment in the late summer with the exception of the same treatment in late summer regarding brownout. The high rate of Rodeo with the low rate of Penetron and the low rate of Rodeo with the high rate of Penetron had significantly less brownout than the high rate of Rodeo alone or the high rate of Rodeo with the high rate of Penetron in the spring.

Herbicide rate did not have a significant influence on conifer damage at all in the late summer timing. Survival was significantly lower for incense cedar with the high Penetron rate treatment at the high rate of Rodeo. Other than that, no significant differences due to rate alone were seen for any species, although damage tended to be higher overall with high rate treatments.

The addition of surfactant did not play a significant role in conifer tolerance at either application timing.

Overall, the major influence on conifer tolerance was application timing. Spring treatments even by the end of the second growing season showed more conifer damage than late summer treatments. Rodeo rate only played a significant role in the spring. Penetron at either rate appears to be a safe addition to herbicide mixes at

either rate or timing. Unfortunately, it does not appear that over the top Rodeo applications shortly after planting will be a feasible treatment to assist in post emergent knock down of existing vegetation due to conifer tolerance issues.

The 2016 measurements/analysis are the final work on this proposal. The complete report and all supporting data are available at the Co-op office in Redding.

Treatment	% Bare Ground	Doug Fir % Survival	Doug Fir % Brown Out	Doug Fir Damage Rating
0.75 qts Rodeo - Spring	87.5 (3.2) a	95.0 (2.9) a	6.3 (3.8) bc	1.3 (0.3) bc
1.5 qts Rodeo - Spring	91.5 (4.3) a	80.0 (5.8) ab	26.3 (6.6) ab	5.0 (1.5) b
0.75 qts Rodeo + 5 oz Penetron/qt - Spring	95.0 (0.0) a	87.5 (7.5) a	12.5 (7.5) abc	2.8 (1.2) bc
1.5 qts Rodeo + 5 oz Pendetron/qt - Spring	96.8 (0.6) a	82.5 (6.3) ab	23.8 (6.6) abc	5.0 (1.2) b
0.75 qts Rodeo + 10 oz Penetron/qt - Spring	94.3 (1.5) a	92.5 (4.8) a	10.0 (5.4) abc	1.3 (0.3) bc
1.5 qts Rodeo + 10 oz Penetron/qt - Spring	93.0 (2.7) a	60.0 (10.8) b	48.8 (11.6) a	6.8 (1.1) a
0.75 qts Rodeo - Fall	83.8 (5.2) a	97.5 (2.5) a	3.8 (2.4) bc	0.5 (0.3) c
1.5 qts Rodeo - Fall	90.8 (2.7) a	100.0 (0.0) a	0.0 (0.0) c	0.5 (0.3) c
0.75 qts Rodeo + 5 oz Penetron/qt - Fall	87.0 (6.3) a	92.5 (4.8) a	7.5 (4.8) bc	0.8 (0.3) c
1.5 qts Rodeo + 5 oz Pendetron/qt - Fall	78.3 (8.4) a	92.5 (4.8) a	11.3 (4.7) abc	2.5 (1.2) bc
0.75 qts Rodeo + 10 oz Penetron/qt - Fall	86.0 (7.3) a	100.0 (0.0) a	0.0 (0.0) c	0.3 (0.3) c
1.5 qts Rodeo + 10 oz Penetron/qt - Fall	89.5 (2.6) a	95.0 (5.0) a	5.0 (5.0) bc	0.8 (0.5) c
Control	85.5 (7.0) a	95.0 (2.9) a	7.5 (4.8) bc	1.0 (0.7) c

Table 1. Fruit Growers year one percent bare ground and Douglas-fir percent survival and brownout and damage rating for the 2015 Rodeo Release trial. Standard errors are in parenthesis. Means with the same letter are not significantly different ( $P \leq 0.05$ ).

Treatment	P Pine % Survival	P Pine % Brown Out	P Pine Damage Rating
0.75 qts Rodeo - Spring	72.5 (11.1) ab	43.8 (6.6) ab	5.0 (1.6) ab
1.5 qts Rodeo - Spring	52.5 (16.5) b	58.8 (15.3) a	7.5 (1.2) a
0.75 qts Rodeo + 5 oz Penetron/qt - Spring	87.5 (4.8) a	18.8 (5.5) bc	4.0 (1.2) ab
1.5 qts Rodeo + 5 oz Penetron/qt - Spring	47.5 (10.3) b	61.3 (10.9) a	8.5 (0.3) a
0.75 qts Rodeo + 10 oz Penetron/qt - Spring	97.5 (2.5) a	8.8 (4.3) cd	3.0 (1.1) abc
1.5 qts Rodeo + 10 oz Penetron/qt - Spring	42.5 (17.0) b	62.5 (17.0) a	8.0 (1.0) a
0.75 qts Rodeo - Fall	97.5 (2.5) a	3.8 (2.4) cd	0.3 (0.3) c
1.5 qts Rodeo - Fall	100.0 (0.0) a	0.0 (0.0) d	0.0 (0.0) c
0.75 qts Rodeo + 5 oz Penetron/qt - Fall	100.0 (0.0) a	0.0 (0.0) d	0.0 (0.0) c
1.5 qts Rodeo + 5 oz Penetron/qt - Fall	97.5 (2.5) a	2.5 (2.5) d	0.8 (0.5) bc
0.75 qts Rodeo + 10 oz Penetron/qt - Fall	97.5 (2.5) a	2.5 (2.5) d	0.8 (0.3) bc
1.5 qts Rodeo + 10 oz Penetron/qt - Fall	100.0 (0.0) a	1.3 (1.3) d	0.3 (0.3) c
Control	100.0 (0.0) a	1.3 (1.3) d	1.3 (1.3) c

Table 2. Fruit Growers year one ponderosa pine percent survival and brownout and damage rating for the 2015 Rodeo Release trial. Standard errors are in parenthesis. Means with the same letter are not significantly different ( $P \leq 0.05$ ).

Treatment	% Bare Ground	Doug Fir % Survival	Doug Fir % Brown Out	Doug Fir Damage Rating
0.75 qts Rodeo - Spring	82.5 (5.2) a	97.5 (2.5) a	5.0 (2.0) a	1.0 (0.4) a
1.5 qts Rodeo - Spring	91.3 (2.4) a	92.5 (4.8) a	26.3 (11.4) a	1.3 (0.5) a
0.75 qts Rodeo + 5 oz Penetron/qt - Spring	88.8 (3.2) a	92.5 (7.5) a	12.5 (7.8) a	2.5 (1.2) a
1.5 qts Rodeo + 5 oz Penetron/qt - Spring	93.8 (1.3) a	90.0 (4.1) a	10.0 (3.5) a	1.8 (0.5) a
0.75 qts Rodeo + 10 oz Penetron/qt - Spring	94.8 (2.0) a	90.0 (10.0) a	11.3 (9.7) a	2.8 (1.8) a
1.5 qts Rodeo + 10 oz Penetron/qt - Spring	91.0 (3.5) a	65.0 (11.9) a	38.8 (12.1) a	4.8 (1.7) a
0.75 qts Rodeo - Fall	91.8 (2.7) a	95.0 (2.9) a	6.3 (2.4) a	1.0 (0.4) a
1.5 qts Rodeo - Fall	93.5 (2.0) a	97.5 (2.5) a	5.0 (3.5) a	0.8 (0.5) a
0.75 qts Rodeo + 5 oz Penetron/qt - Fall	78.8 (14.7) a	90.0 (7.1) a	15.0 (8.7) a	2.3 (1.3) a
1.5 qts Rodeo + 5 oz Penetron/qt - Fall	89.5 (3.1) a	95.0 (2.9) a	11.3 (2.4) a	2.0 (0.0) a
0.75 qts Rodeo + 10 oz Penetron/qt - Fall	88.8 (4.7) a	90.0 (4.1) a	10.0 (4.1) a	1.0 (0.4) a
1.5 qts Rodeo + 10 oz Penetron/qt - Fall	90.0 (5.3) a	100.0 (0.0) a	20.0 (6.1) a	2.5 (1.2) a
Control	70.0 (14.1) a	77.5 (19.3) a	23.8 (20.6) a	2.5 (2.2) a

Table 3. Soper Wheeler year one percent bare ground and Douglas-fir percent survival and brownout and damage rating for the 2015 Rodeo Release trial. Standard errors are in parenthesis. Means with the same letter are not significantly different ( $P \leq 0.05$ ).

Treatment	P Pine % Surv	P Pine % Brown Out	P Pine Damage Rating	Inc Cedar % Surv	Inc Cedar % Brown Out	Inc Cedar Damage Rating
0.75 qts Rodeo - Spring	87.5 (12.5) ab	17.5 (12.7) ab	3.8 (1.8) ab	65.0 (5.6) ab	48.8 (17.1) ab	6.3 (1.6) abcd
1.5 qts Rodeo - Spring	77.5 (11.1) abc	26.3 (11.4) ab	4.3 (1.5) ab	47.5 (14.4) b	66.3 (10.7) a	7.0 (1.7) abc
0.75 qts Rodeo + 5 oz Penetron/qt - Spring	75.0 (13.2) abc	28.8 (12.6) ab	5.8 (1.3) ab	57.5 (14.9) ab	63.8 (6.3) a	7.8 (0.6) ab
1.5 qts Rodeo + 5 oz Penetron/qt - Spring	45.0 (6.5) c	55.0 (6.5) a	8.5 (0.3) a	50.0 (5.8) ab	58.8 (5.2) a	8.5 (0.3) a
0.75 qts Rodeo + 10 oz Penetron/qt - Spring	80.0 (5.8) ab	20.0 (5.8) ab	3.3 (1.9) ab	72.5 (17.0) ab	45.0 (13.2) ab	5.3 (1.9) abcd
1.5 qts Rodeo + 10 oz Penetron/qt - Spring	52.5 (13.1) c	53.8 (12.0) a	7.8 (1.0) a	45.0 (3.2) b	67.5 (11.1) a	8.0 (0.7) ab
0.75 qts Rodeo - Fall	92.5 (4.8) a	8.8 (4.3) b	1.3 (0.3) ab	100.0 (0.0) a	6.3 (6.3) c	0.8 (0.5) d
1.5 qts Rodeo - Fall	97.5 (2.5) a	2.5 (2.5) b	1.0 (0.7) b	95.0 (2.9) ab	8.8 (1.3) abc	1.5 (0.3) cd
0.75 qts Rodeo + 5 oz Penetron/qt - Fall	100.0 (0.0) a	1.3 (1.3) b	1.3 (1.3) b	95.0 (2.9) ab	10.0 (3.5) abc	1.5 (0.5) cd
1.5 qts Rodeo + 5 oz Penetron/qt - Fall	100.0 (0.0) a	2.5 (1.4) b	0.5 (0.3) b	95.0 (2.9) ab	10.0 (2.0) abc	2.0 (0.0) bcd
0.75 qts Rodeo + 10 oz Penetron/qt - Fall	97.5 (2.5) a	3.8 (3.8) b	0.5 (0.5) b	95.0 (2.9) ab	12.5 (6.0) abc	1.3 (0.5) d
1.5 qts Rodeo + 10 oz Penetron/qt - Fall	100.0 (0.0) a	1.3 (1.3) b	0.3 (0.3) b	100.0 (0.0) a	8.8 (2.4) abc	1.3 (0.3) cd
Control	90.0 (10.0) a	10.0 (10.0) b	2.0 (2.0) b	100.0 (0.0) a	8.8 (5.2) bc	1.0 (0.6) d

Table 4. Soper Wheeler year one ponderosa pine and incense cedar percent survival and brownout and damage rating for the 2015 Rodeo Release trial. Standard errors are in parenthesis. Means with the same letter are not significantly different ( $P \leq 0.05$ ).

Treatment	Timing	% Bare Ground	D. Fir Survival	D. Fir % Brownout	D. Fir Damage	P. Pine Survival	P. Pine % Brownout	P. Pine Damage
0.75 qts Rodeo	Spring	38.8 (6.6) a	90.0 (4.1) a	15.0 (3.5) a	1.5 (0.5) a	65.0 (8.7) ab	38.8 (10.1) ab	2.0 (0.7) ab
1.5 qts Rodeo	Spring	43.8 (9.4) a	75.0 (2.9) a	30.0 (2.9) a	2.3 (0.5) a	35.0 (12.6) c	68.8 (11.8) a	3.3 (0.9) a
0.75 qts Rodeo + 5 oz Penetron/qt	Spring	48.8 (9.2) a	85.0 (8.7) a	18.8 (8.0) a	2.3 (0.8) a	82.5 (7.5) a	20.0 (7.4) abcd	2.3 (1.0) ab
1.5 qts Rodeo + 5 oz Penetron/qt	Spring	48.8 (11.6) a	75.0 (6.5) a	33.8 (4.7) a	2.3 (0.8) a	37.5 (10.3) bc	66.3 (9.7) a	3.0 (0.71) a
0.75 qts Rodeo + 10 oz Penetron/qt	Spring	32.5 (7.5) a	92.5 (4.8) a	10.0 (5.4) a	2.0 (0.6) a	92.5 (4.8) a	12.5 (6.6) bcd	3.0 (0.71) a
1.5 qts Rodeo + 10 oz Penetron/qt	Spring	50.0 (10.9) a	57.5 (18.0) a	45.0 (18.5) a	2.0 (0.7) a	60.0 (17.8) abc	43.8 (17.7) abc	2.0 (1.1) ab
0.75 qts Rodeo	Fall	47.5 (10.9) a	97.5 (2.0) a	5.0 (2.0) a	1.0 (0.4) a	95.0 (2.9) a	5.0 (2.9) bcd	0.3 (0.3) b
1.5 qts Rodeo	Fall	36.3 (5.5) a	100.0 (0.0) a	5.0 (2.0) a	1.3 (0.5) a	100.0 (0.0) a	1.3 (1.3) d	0.3 (0.3) b
0.75 qts Rodeo + 5 oz Penetron/qt	Fall	32.5 (4.3) a	92.5 (4.8) a	11.3 (5.1) a	1.5 (0.6) a	97.5 (2.5) a	5.0 (5.0) cd	1.3 (1.3) ab
1.5 qts Rodeo + 5 oz Penetron/qt	Fall	43.8 (6.9) a	82.5 (7.5) a	20.0 (8.9) a	1.5 (0.6) a	95.0 (2.9) a	5.0 (2.9) bcd	0.5 (0.3) ab
0.75 qts Rodeo + 10 oz Penetron/qt	Fall	43.8 (10.5) a	95.0 (5.0) a	8.8 (5.5) a	1.5 (0.3) a	97.5 (2.5) a	2.5 (2.5) d	0.0 (0.0) b
1.5 qts Rodeo + 10 oz Penetron/qt	Fall	35.0 (10.2) a	95.0 (5.0) a	7.5 (5.9) a	1.5 (0.6) a	100.0 (0.0) a	0.0 (0.0) d	0.3 (0.3) b
Control		52.5 (4.8) a	77.5 (19.3) a	23.8 (22.1) a	2.8 (2.0) a	75.0 (25.0) abc	25.0 (25.0) bcd	2.8 (2.4) ab

Table 5. Fruit Growers Rodeo/Penetron trial. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	Timing	% Bare Ground	D. Fir Survival	D. Fir % Brownout	D. Fir Damage	P. Pine Survival	P. Pine % Brownout	P. Pine Damage
0.75 qts Rodeo	Spring	68.8 (4.3) a	72.5 (18.0) a	6.3 (2.4) a	2.5 (0.5) a	82.5 (17.5) ab	3.8 (2.4) a	2.0 (0.7) a
1.5 qts Rodeo	Spring	72.5 (3.2) a	82.5 (6.3) a	7.5 (1.4) a	1.8 (0.3) a	75.0 (11.9) ab	6.3 (3.1) a	2.5 (0.9) a
0.75 qts Rodeo + 5 oz Penetron/qt	Spring	63.8 (5.5) a	58.5 (22.4) a	5.0 (3.5) a	1.8 (0.5) a	72.5 (12.5) ab	6.3 (2.4) a	3.0 (1.2) a
1.5 qts Rodeo + 5 oz Penetron/qt	Spring	40.0 (11.0) a	72.5 (8.5) a	11.3 (3.1) a	3.0 (0.8) a	42.5 (4.8) b	3.8 (1.3) a	1.5 (0.6) a
0.75 qts Rodeo + 10 oz Penetron/qt	Spring	63.8 (8.5) a	87.5 (9.5) a	8.8 (1.3) a	2.0 (0.4) a	75.0 (6.5) ab	1.3 (1.3) a	0.5 (0.3) a
1.5 qts Rodeo + 10 oz Penetron/qt	Spring	70.0 (8.4) a	52.5 (15.5) a	13.8 (2.4) a	3.5 (0.5) a	47.5 (11.8) b	10.0 (3.5) a	3.0 (0.8) a
0.75 qts Rodeo	Fall	48.9 (7.2) a	92.5 (2.5) a	6.3 (1.3) a	2.8 (0.8) a	90.0 (4.1) a	2.5 (1.4) a	1.5 (0.9) a
1.5 qts Rodeo	Fall	62.5 (7.5) a	92.5 (7.5) a	8.8 (1.3) a	2.5 (0.6) a	97.5 (2.5) a	3.8 (2.4) a	1.5 (1.2) a
0.75 qts Rodeo + 5 oz Penetron/qt	Fall	53.8 (10.7) a	67.5 (22.9) a	30.0 (23.4) a	3.8 (2.1) a	82.5 (14.4) ab	12.5 (12.5) a	1.8 (1.8) a
1.5 qts Rodeo + 5 oz Penetron/qt	Fall	62.5 (7.8) a	72.5 (8.5) a	20.0 (6.1) a	4.3 (1.3) a	97.5 (2.5) a	1.3 (1.3) a	0.3 (0.3) a
0.75 qts Rodeo + 10 oz Penetron/qt	Fall	52.5 (5.9) a	72.5 (6.3) a	8.8 (2.4) a	3.0 (0.7) a	95.0 (2.9) a	2.5 (1.4) a	1.0 (0.7) a
1.5 qts Rodeo + 10 oz Penetron/qt	Fall	48.8 (15.7) a	45.0 (17.6) a	13.8 (6.6) a	4.0 (1.2) a	95.0 (5.0) a	2.5 (2.5) a	1.0 (1.0) a
Control		46.3 (9.0) a	72.5 (24.3) a	27.5 (24.2) a	3.3 (2.3) a	77.5 (22.5) ab	0.0 (0.0) a	0.3 (0.3) a

Table 6. Soper Wheeler Rodeo/Penetron trial. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Treatment	Timing	Inc Cedar Survival	Inc Cedar % Brownout	Inc Cedar Damage
0.75 qts Rodeo	Spring	45.0 (15.5) ab	38.8 (21.1) abc	5.8 (1.9) ab
1.5 qts Rodeo	Spring	27.5 (12.5) ab	48.8 (19.8) ab	7.0 (1.6) ab
0.75 qts Rodeo + 5 oz Penetron/qt	Spring	35.0 (18.5) ab	12.5 (6.3) abc	3.0 (0.7) ab
1.5 qts Rodeo + 5 oz Penetron/qt	Spring	7.5 (4.8) b	52.5 (27.4) abc	5.8 (2.5) ab
0.75 qts Rodeo + 10 oz Penetron/qt	Spring	52.5 (13.1) a	32.5 (14.4) abc	5.3 (1.9) ab
1.5 qts Rodeo + 10 oz Penetron/qt	Spring	7.5 (4.7) b	76.3 (17.2) a	8.5 (0.9) a
0.75 qts Rodeo	Fall	97.5 (2.5) a	5.0 (2.0) bc	1.3 (0.5) b
1.5 qts Rodeo	Fall	92.5 (2.5) a	3.8 (1.3) bc	1.3 (0.5) b
0.75 qts Rodeo + 5 oz Penetron/qt	Fall	80.0 (16.8) a	3.8 (2.4) bc	0.8 (0.5) b
1.5 qts Rodeo + 5 oz Penetron/qt	Fall	90.0 (0.0) a	2.5 (1.4) c	0.8 (0.3) b
0.75 qts Rodeo + 10 oz Penetron/qt	Fall	90.0 (5.8) a	2.5 (1.4) c	0.5 (0.3) b
1.5 qts Rodeo + 10 oz Penetron/qt	Fall	85.0 (8.7) a	6.3 (2.4) abc	1.3 (0.5) b
Control		85.0 (11.9) a	5.0 (0.0) abc	1.3 (0.3) b

Table 7. Soper Wheeler Rodeo/Penetron trial. All rates are per acre. Standard errors in parenthesis. Values with the same letter are not significantly different at the  $p \leq 0.05$  level.

Sierra Cascade Intensive Forest Management Research Cooperative  
Income/Expense Statement  
Calendar Year Report for the Period Jan. 1 to Dec. 31, 2016

Beginning Balance on January 1, 2016	\$33,332.60
Total Income (Membership Dues)	\$62,000.00
Expenses	
Powers Scholarship	\$1,000.00
Site Maps	\$70.00
G.O.E. Study	\$8,162.33
New Proposals	\$33,650.00
Co-op Manager Expenses	\$35,000.00
Total Expenses	\$77,882.33
Year End Balance as of December 31, 2015	\$17,450.29

## WORKING GROUP MEMBERSHIP

### **Working Group I** Seed to Establishment

Tom Jopson, Chair  
Bob Amesbury  
Scott Carnegie  
Mark Gray  
Scott Worden  
Tom Young

### **Working Group II** Out-planting through Precommercial Thinning

Scott Worden, Chair  
Bob Amesbury  
Scott Carnegie  
Mark Gray  
Ken Scott  
Tom Young