UC CE UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources Cooperative Extension

October 2024

Controlling Brush, Weeds and Woody Regrowth Following Mastication

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Masticated Fuel Breaks

Fuel breaks are strategic projects that are manually implemented to break up large, continuous tracts of dense vegetation. They are often placed along ridge lines, access roads or outside of residential areas along the wildland urban interface (WUI). These footprints on the landscape provide opportunities for fire suppression resources to slow fire spread. To create fuel breaks, dense forests must be thinned and woody biomass either removed or modified to change the fuel structure of the area. One main objective is to remove dense brushy fuels and the continuity of fuels from the ground surface to tree canopies. To achieve this, several different methods can be done including mastication, brush piling and burning, and hand thinning. Mastication, also called forestry mulching, is a vegetation management method generally completed with a skid steer or excavator (Figure 1). A special attachment is able to mulch down smaller trees and brush into finer debris similar to what would come from a chipper. This reduces fuels in overgrown forests and is often the most cost effective treatment for large areas.

Figure 1. a) Fecon Bull Hog BH 80 masticator head is mounted to the boom of a Caterpillar 235 excavator (Photo: CalAg April-June 2006). b) Mastication, mechanically chewing up brush and branches, can be used to thin brush and trees (Photo: Michael Bataglia, U.S. Forest Service).

Following mastication, a park-like appearance is often the result with well-spaced trees and very little understory (Figure 2). In the years following mastication, brush growth occurs and, if left unchecked, the area will return to a similar condition before mastication occurred.

Figure 2. Following mastication, the forest understory has been opened eliminating any fuel laddering and smaller diameter trees removed to allow larger trees to flourish (Photo: Brian Allen, UCANR).

Mitchell Mine Demonstration

The Amador Fire Safe Council established the Mitchell Mine Fuel Break with Cal-FIRE funding starting in 2018. It spans 10.3 miles, covers 394 acres, and was developed to help protect the community of Pine Grove, CA from wildfire. Since mastication, many weeds, invasive shrubs, native shrubs and tree species have resprouted (Figure 3). In 2023, the University of California Cooperative Extension partnered with the Amador Resource Conservation District with funding from Cal-FIRE to develop a demonstration site on a section of the Mitchell Mine Fuel break to test various mechanical and chemical treatments for maintaining the fuel break. The site is located off Lupe Road in Pine Grove CA at 2,400 feet

elevation. Dominant trees in the area include ponderosa pine, douglas fir, madrone, live oak, and black oak. The brush understory consist of toyon, coyote brush, yerba santa, rabbit brush, poison oak, himalayan black berry, french broom, and mountain misery.

Figure 3. The demonstration site prior to treatment.

Figure 4 shows a plot map of the demonstration site with the 33 treatments including 2 untreated plots. Most treatments were 0.5 acre in size, with the grazing treatment (plot 2) being an acre and one of the organic treatments (plot 34) being 0.25 acre. Woody regrowth at the site averaged 2-3 feet in height with some trees having as much as 10 feet in regrowth.

Figure 4. Map of the 33 treatment plots and the 2 untreated control plots. Table 2 describes which treatment method was applied to each plot.

Treatment Results

Physical / Mechanical Treatments

Physical or mechanical control involves physical activities or type of equipment to physically remove or damage the aboveground portion of the plant. This can be done by mastication, chainsaws, loppers, McLeod, axe, bulldozing, grazing animals, flaming or other physical means. For the demonstration we tested grazing, flaming, lopping, and a combination of lopping immediately followed by an herbicide application.

Grazing: Many animal species, including cattle, goats, and sheep, are used to consume vegetation for prescribed grazing. Property owners may own their own animals, provide pasture to neighbors who own animals, or hire a contract grazer. Goats and sheep exhibit a particularly wide preference for many forb, shrub, and tree species. Locally sourced animals may have a higher appetite for the target plant species and result in better control. For this treatment, a local contract grazer utilized 48 goats, 2 sheep, and 1 livestock guardian dog to graze the area. The animals grazed the area for 14 days at $650 per acre. Grazing was conducted in the fall when woody plants were preparing to store carbohydrates from the above ground portion of the plant to the roots (Figure 5). By intensively grazing at this time, plants may be more susceptible to injury. This treatment provides rapid visual results with nearly all vegetation stripped and small diameter branches consumed. One year after treatment, this method was providing 70% control.

Figure 5. Goats and sheep being utilized to treat brush, tree and weed regrowth.

Flaming: This treatment involves using a torch and liquid propane to apply high intensity heat to

undesired plants without igniting them. The flame is waved over the plant to significantly raise its internal temperature, resulting in cell rupture and subsequent death (Figure 6). **Only** use this treatment during periods of low wildfire risk, such as immediately after a rain event, early in the growing season when surrounding vegetation is green, and in compliance with local fire restrictions. For this method, treating 1 acre took 11 hours and 14.5 gallons of propane for a total treatment cost of $247 per acre (minimum wage labor rate of $15/hr. used). Despite initial blackening of leaves, treatment only resulted in 4% control 16 months later.

Figure 6. Flaming utilizes a torch and liquid propane to apply high heat to leaf tissue resulting in cell death.

Lopping: Manual removal is the least technical but also the most labor-intensive method for vegetation control. Many tools are available, including loppers, mattocks, chainsaws, brush grubbers, weed wrenches, mastication, and other equipment. Mastication can be used as a re-treatment and would have been highly effective, but was not included in the demonstration due to the known cost, known efficacy, and small plot size. For this treatment loppers, axe, and mattock were used (Figure 7). As with any mechanical injury, certain shrub and tree species may continue to resprout, and repeat treatments may be required for complete control. For this method, the treatment took 13 hours and cost $197/acre at a rate of $15/hr. Cost of equipment was not included. This treatment remained 68% effective 16 months after treatment.

Figure 7. Lopping tools can include loppers, axe, mattock, chainsaw or other forms of equipment.

Lopping and Herbicide: Often referred to as a cut stump treatment, this method involves cutting woody material with loppers and then immediately applying an herbicide solution to the cut surface. This type of technique is more labor intensive than herbicide treatment alone, but has the added benefit of removing all standing vegetation. In general, this method should provide better control than lopping alone as the herbicide should help kill plants and prevent further growth. This method took 13 hours

and cost $296/acre for labor and herbicide. It remained 88% effective 16 months after treatment.

Chemical Control

Many weed problems can be managed by hand-weeding, mulching, grazing, shading and using other non-chemical methods. Following mastication, woody regrowth can be challenging as established plants can vigorously resprout. Herbicides are a type of pesticide designed to control undesirable plants. When using herbicides, follow label directions precisely. Otherwise, products will fail to control the weeds, and may damage desirable plants, or can limit your ability to replant in that area. Applying too much herbicide in an area also wastes money and can lead to it running off site and contaminating creeks and streams. In general, treating shrubs, trees and woody regrowth should be done when the plants are small. Waiting too long will allow the plants to get tall, requiring more herbicide and leaving more dead standing vegetation. Some important terms when discussing herbicides include:

Preemergence herbicides. Herbicides that are applied before the target weed germinates and emerges. Many, but not all, preemergence herbicides have little activity on existing vegetation. Instead, they act on the roots or shoots of newly germinated seeds – often killing the seedling before or right as they emerge from the soil. Generally, these materials can result in bare ground except for established plants that may occur on the site.

Residual activity. Preemergent herbicides have residual activity in that they continue to be active for several days, weeks, or months after application.

Postemergence herbicides. These herbicides are applied to the foliage of the target plant after it has emerged from the soil. Some postemergence herbicides also have preemergent activity while others have no activity once they reach the soil due to binding or rapid degradation.

Contact herbicides. This term generally refers to herbicides that only affect the tissue directly treated with the herbicide – the herbicide does not move to untreated parts of the plant after application. Good spray coverage is essential for acceptable control with contact materials.

Systemic herbicides. These herbicides can move from treated plant parts to untreated parts either through the xylem or phloem. For example, a systemic postemergence herbicide applied to the leaves could move to other leaves or to roots. Typically, systemic materials work better on established perennial plants than contact materials.

Tank mix. A mixture of two or more herbicides applied during the same application. Oftentimes a tank mix is used to broaden the spectrum of weed control such as mixing a broadleaf selective herbicide with a non-selective herbicide for broad spectrum weed control. It is also common to mix a postemergence herbicide with a preemergent herbicide to control any weeds present at the time as well as those that may emerge a bit later.

Trade name. This is the brand name of a commercial herbicide product that may contain one or more active ingredients, adjuvants, stabilizers, emulsifiers, or other inert ingredients. Herbicides are registered and labeled by their trade name and it is important to know that the same active ingredient may be available under different trade names. Roundup is the trade name for a common herbicide active ingredient, glyphosate. However, there are hundreds of trade named products with the same active ingredient made by different manufacturers.

Active ingredient. The active ingredient is the chemical molecule that has pesticidal activity on the target plant. We usually shorten the “chemical name” to a (somewhat) simpler “common name”. For example, the chemical *N*-(phosphonomethyl)glycine) is known by the common name “glyphosate”.

Twelve different trade name products for a total of thirty different chemical treatments were tested. Herbicides were tested either alone, tank mixed, at different times of the year (spring, summer, fall), or using multiple application techniques (spot spray versus drizzle). Some products are broadleaf selective herbicides that target woody shrubs, trees and other broadleaf weeds, while others are nonselective materials. The benefit of broadleaf selective herbicides is that they do not injure grasses which might be a goal for some landowners. As part of the project three organic herbicides were included. The mode of action between organics and synthetic herbicides differs. Organic herbicides are contact materials and cause immediate cell death at the point where they contact the plant and results are evident very soon after application. Synthetic herbicides are translocated throughout the plant where they tend to have prolonged effects over time. Signal words are found on pesticide labels and describe the acute (short-term) toxicity of the formulated product. The signal word can be either: DANGER, WARNING, or CAUTION. Products with the DANGER signal word are the most toxic. Products with the word CAUTION are lowest in toxicity. Although organic materials are often thought to be safe, they still can be toxic with a WARNING or DANGER signal word (Table 1).

Table 1. Herbicide products used and their characteristics.

Trade Name	Active Ingredient	Targets	Emergence	Signal Word	Class
Vista XRT	fluroxypyr	Broadleaf	Post	Warning	Synthetic
Garlon 4 Ultra	triclopyr ester	Broadleaf	Post	Caution	Synthetic
Accord XRT II	glyphosate	Non-Selective	Post	Caution	Synthetic
Vastlan	triclopyr choline	Broadleaf	Post	Warning	Synthetic
Brushtox	triclopyr ester	Broadleaf	Post	Caution	Synthetic
Capstone	aminopyralid, triclopyr amine	Broadleaf	Post & Pre	Caution	Synthetic
TerreVue	aminopyralid, florpyrauxifen-benzyl	Broadleaf	Post	Caution	Synthetic
RM43 Total Vegetation Killer	glyphosate, imazapyr	Non-Selective	Post & Pre	Danger	Synthetic
Imazapyr 4SL	imazapyr	Non-Selective	Post & Pre	Caution	Synthetic
Milestone	aminopyralid	Broadleaf	Post & Pre	Caution	Synthetic
Freelexx	2,4-D choline	Broadleaf	Post	Danger	Synthetic
Oust XP	sulfometuron-methyl	Non-Selective	Post & Pre	Caution	Synthetic
Homeplate	caprylic acid, capric acid	Non-Selective	Post	Caution	Organic
Axxe	ammonium nonanoate	Non-Selective	Post	Warning	Organic
Green Gobbler (Acetic acid)	acetic acid	Non-Selective	Post	Danger	Organic

Herbicides can be applied using various methods and are dependent on the plant species, the site situation, selected herbicide, and available application equipment. Following mastication, resprouting can be vigorous consisting of small diameter stems and numerous leaves. A systemic, postemergence herbicide applied to the foliage is often the most used method. Two types of foliar treatments were used in the study (Figure 8):

Spot Spray: This is a foliar treatment where target plants are sprayed-to-wet. With this treatment, systemic or contact herbicides can be applied. Treatments were made using a backpack sprayer calibrated to deliver 20 gallons of spray solution per acre using a Teejet AI8003 nozzle. Using a 4-gallon backpack sprayer, one load would be enough herbicide solution to treat approximately ⅙ of an acre. This method had an average treatment time of 1 hour 51 minutes per acre. The spot treatment that provided the best control was a tank mix of Garlon 4 Ultra 2% v/v + 1% Imazapyr 4SL + 3% Accord XRT II + 2% MSO v/v (methylated seed oil) This spring applied treatment provided 94% control 16 months after treatment. This treatment cost $152 / acre and was slightly higher than the average chemical cost of $104. Several other spot spray treatments provided excellent control (Table 2).

Ultra Low-Volume Drizzle: The drizzle technique is a modified foliar application that uses an ultra low-volume method of applying the herbicide solution to a portion of the plant. Instead of spraying the entire canopy as with a spot spray, the drizzle method applies large droplets scattered on the leaf surface (Figure 9).

This technique utilizes a spray gun with an orifice disk (#02) attached to a backpack or mounted sprayer. The drizzle gun emits a single stream that can reach plants up to 20 feet away. The applicator waves the gun from side to side to break up the stream into large droplets that hit the target plant. All drizzle treatments were applied at 5 gallons of spray solution per acre with an average treatment time of 25 minutes. Because of the ultra low-volume, a 4-gallon backpack can almost treat an entire acre making this treatment much faster than a spot spray. The amount of herbicide used between a spot spray and drizzle application are similar, with the only difference being the amount of carrier volume (water) used. The drizzle treatment that provided the best control was the Garlon 4 Ultra treatment at 8% v/v with 8% MSO. This treatment was tested both as a spring and fall treatment with the fall treatment providing slightly better control (86% compared to 75%) at a total cost of $65 per acre.

Figure 8. Standard backpack with a wand for spot spray (right) and a low volume gun for drizzle application (left).

Figure 9. Example of droplet spray pattern from a low volume drizzle application

Table 2: Treatment list with application time, percent control, material cost, labor cost and total treatment cost per acre.

Treatment #	Treatment	Application Time	Percent Control[1]	Material Cost / Acre	Labor Cost[2] / Acre	Total Cost / Acre
Physical / Mechanical Control						
2	Grazing	Fall	70			$650
4	Lopping	Spring	68	0	$197	$197
3	Flaming	Spring	4	70	$177	$247
Chemical Control						
5	Lopping plus Herbicide (Accord XRT II 1qt/ac, Vista XRT 20 oz/ac, Garlon 4 Ultra 1 qt/ac, MSO[3] 4pt/ac)	Spring	88	$99	$197	$296
Spot Spray Treatments						
26	Garlon 4 Ultra 2%, Imazapyr 4SL 1%, Accord XRT II 3%, MSO 2%	Spring	94	$122	$30	$152
31	Oust XP 3 oz/ac, Accord XRT II 6qt/ac, Rainer EA 0.5%	Fall	91	$57	$30	$87
30	Vista XRT II 20oz/ac, Accord XRT II 1qt/ac, Rainer EA 0.5%	Summer	89	$54	$30	$84
8	Garlon 4 Ultra 2%, MSO 1%	Spring	81	$48	$30	$78
13	Capstone 8 pints/acre, Rainer EA 0.5%	Spring	81	$74	$30	$104
12	Accord XRT II 1.5%, Garlon 4 Ultra 1%, Rainer EA 0.5%	Spring	79	$42	$30	$72
15	RM43 Total Vegetation Killer 4.5%, Rainer EA 0.5%	Spring	78	$71	$30	$101
18	Milestone 0.5%, Vastlan 2%, MSO 2%	Spring	69	$84	$30	$114
19	Milestone 0.5%, Garlon 4 Ultra 2%, MSO 2%	Spring	69	$75	$30	$105
10	Vastlan 2%, MSO 1%	Spring	53	$57	$30	$87
24	Brushtox 2%, MSO 1%	Summer	51	$51	$30	$81
6	Accord XRT II 2%, Rainer EA 0.5%	Spring	50	$29	$30	$59
28	Capstone 8 pts/ac, Accord XRT II 2 qt/ac, Rainer EA 0.5%	Fall	49	$103	$30	$133
20	Milestone 0.5%, Vastlan 2%, Freelexx 1%, MSO 2%	Spring	48	$92	$30	$122
21	TerreVue 2.5 oz/acre, Vastlan 2%, Freelex 1%, MSO 2%	Summer	45	$92	$30	$122
22	Accord XRT II 2%, Rainer EA 0.5%	Fall	33	$29	$30	$59
14	TerreVue 2.8 oz/ac, Rainer EA 0.5%	Summer	21	$24	$30	$54
33	Axxe (organic) 20%, Natural wet 0.8%	Summer	8	$223	$30	$253
32	Homeplate (organic) - 9% v/v, Natural wet 0.8%, Mixwell 0.04%	Summer	5	$151	$30	$181
34	Acetic acid (organic) 20% undiluted	Summer	1	$400	$30	$430
Low Volume Drizzle Treatments						
29	Garlon 4 Ultra 8%, MSO 8%	Fall	86	$59	$6	$65
9	Garlon 4 Ultra 8%, MSO 8%	Spring	75	$59	$6	$65
27	Garlon 4 Ultra 8%, Imazapyr 4SL 5%, Accord XRT II 7%, MSO 5%	Summer	63	$106	$6	$112
17	Imazapyr 4SL 5%, MSO 5%	Spring	60	$49	$6	$55
7	Accord XRT II 7%, Rainer EA 0.5%	Spring	58	$22	$6	$28
25	Brushtox 8%, MSO 8%	Summer	48	$62	$6	$68
23	Accord XRT II 7%, Rainer EA 0.5%	Fall	31	$22	$6	$28
11	Vastlan 8%, MSO 8%	Spring	24	$68	$6	$74
16	RM43 Total Vegetation Killer 4.5%, MSO 5%	Spring	10	$30	$6	$36

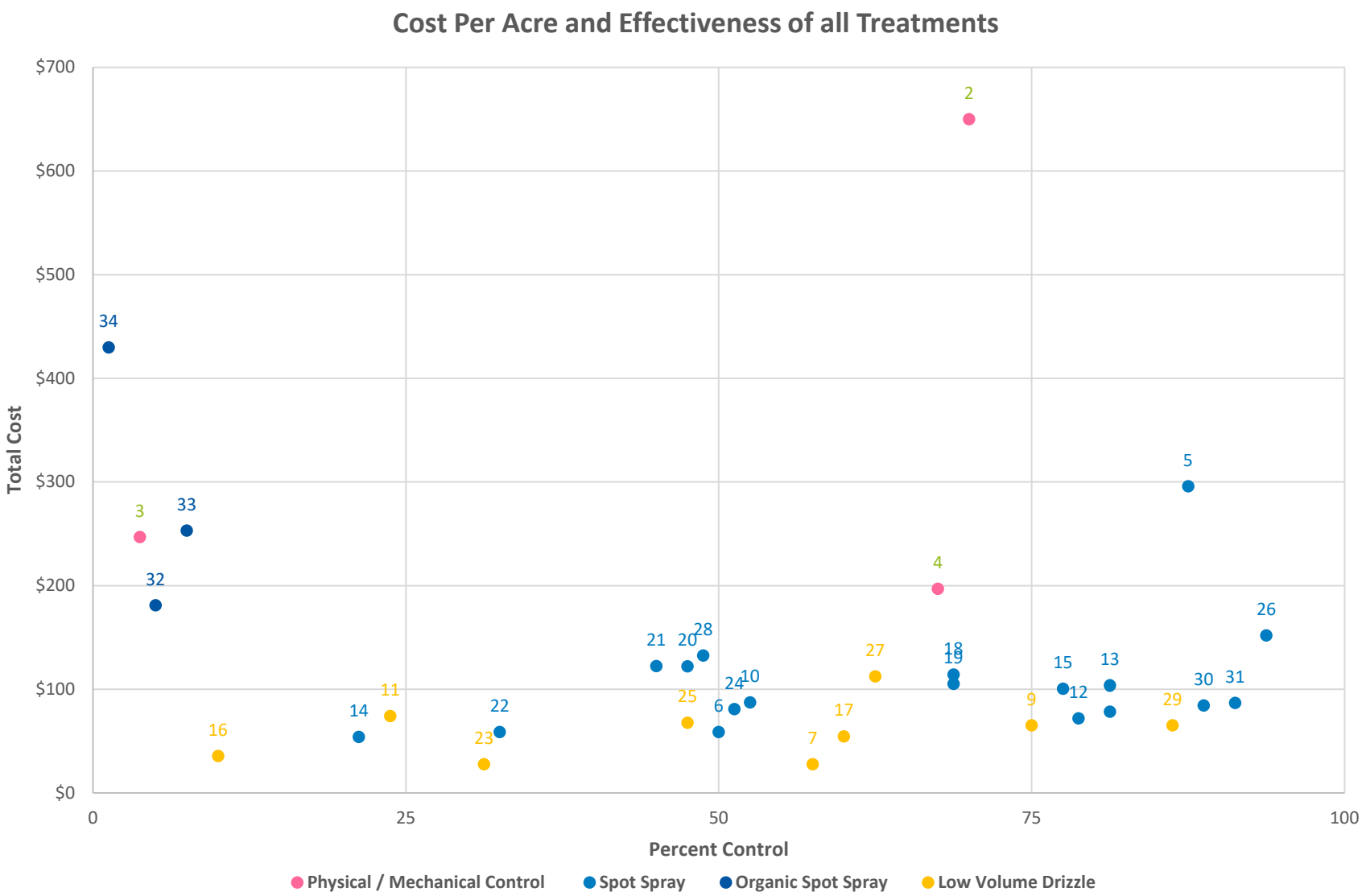
[1] Percent control ratings range from 12 months after treatment for Fall treatments, 14 months for Summer, and 16 months after Spring applications

[2] Labor cost is calculated at a rate of $15/hour (minimum wage)

[3] MSO - Hasten EA Methylated Seed Oil

Treatment #'s correspond to splatter plot

Table 3: Scatter plot showing total cost per acre and effectiveness of all treatments.



*Numbers on scatter plot correspond to treatment number on Table 2.

Treatments that provided the best overall control of vegetation, regardless of the cost. Untreated control provided for reference.

Treatment 1: Untreated
Control: 0%
Cost: $0/acre

Treatment 26: Garlon 4 Ultra 2%, Imazapyr 4SL 1%, Accord XRT II 3%, MSO 2%
Control: 94%
Timing: Spot Spray – spring
Cost: $152/acre

Treatment 31: Oust XP 3 oz/ac, Accord XRT II 6qt/ac, Rainer EA 0.5%
Control: 91%
Application: Spot Spray – fall
Cost: $87/acre – 2nd most cost effective

Treatment 30: Vista XRT II 20oz/ac, Accord XRT II 1qt/ac, Rainer EA 0.5%
Control: 89%
Application: Spot Spray – summer
Cost: $84/acre – 3rd most cost effective

Treatment 5: Lopping plus Herbicide (Accord XRT II 1qt/ac, Vista XRT 20 oz/ac, Garlon 4 Ultra 1 qt/ac, MSO 4pt/ac)
Control: 88%
Application: spring
Cost: $296/acre

Treatment 29: Garlon 4 Ultra 8%, MSO 8%
Control: 86%
Application: Low Volume Drizzle – fall
Cost: $65/acre – Most cost effective

Treatments that provided the least control of vegetation. Untreated control provided for reference.

Treatment 1: Untreated
Control: 0%
Cost: $0/acre

Treatment 34: Acetic acid (organic) 20% undiluted
Control: 1%
Timing: Spot Spray – summer
Cost: $430/acre – Most expensive chemical treatment

Treatment 3: Flaming
Control: 4%
Application: spring
Cost: $247/acre

Treatment 32: Homeplate (organic) - 9% v/v, Natural wet 0.8%, Mixwell 0.04%
Control: 5%
Application: Spot Spray – summer
Cost: $181/acre – 3rd most expensive herbicide

Treatment 33: Axxe (organic) 20%, Natural wet 0.8%
Control: 8%
Application: Spot Spray – summer
Cost: $253/acre - 2nd most expensive herbicide

Treatment 16: RM43 Total Vegetation Killer 4.5%, MSO 5%
Control: 10%
Application: Low Volume Drizzle – spring
Cost: $36/acre

Summary

This project was devised to evaluate the efficacy of several chemical and nonchemical treatment methods in maintaining established masticated fuel breaks. Ultimately, determining the most suitable treatment method depends on the unique needs and resources of individual property owners.

Manually lopping resprouting vegetation is a labor-intensive yet effective technique that may appeal to certain property owners on a small scale. This would not be feasible for large properties or projects. Combining lopping plus an herbicide will increase control.

Although not tested in this project, mastication can be a very effective retreatment for resprouting brush and would be an ideal choice for large projects. In this trial, grazing emerged as the most effective non-chemical treatment method, despite its longer implementation period and higher per-acre cost. Nonetheless, it presents an attractive solution for property owners who eschew herbicides and either possess their own livestock, have neighbors with animals, or utilize a contract grazer.

Herbicides were tested alone, tank mixed, at different times of the year (spring, summer, fall), or using multiple application techniques (spot spray versus drizzle).

The most effective herbicide treatment was a tank mix of Garlon 4 Ultra, Imazapyr 4SL and Accord XRT II applied as a spot spray application in the spring. This treatment resulted in 94% control at a total cost (herbicide + labor) of $152/acre. Notably, using Garlon 4 Ultra alone as a spot spray or low volume drizzle resulted in similar control at a lower cost. As a spot spray, Garlon 4 Ultra provided 81% control at $78/acre and for the low volume drizzle the cost was $65/acre. As a result, a single broadleaf selective herbicide, like Garlon 4 Ultra could be a viable option for property owners. This herbicide is a CAUTION material, which is the lowest acute toxicity rating.

Vista XRT II, which is also a broadleaf selective herbicide, gave excellent control as a spot spray application when tank mixed with Accord XRT II. The non-selective herbicide Oust XP also provided excellent control as a fall application when mixed with Accord XRT II.

Despite interest in organic herbicides over synthetic alternatives, they underperformed and incurred higher per-acre costs. All three resulted in the lowest control levels of all herbicide treatments. Furthermore, their acute toxicity levels can range from caution to danger which should be a consideration when using an herbicide.

Acknowledgements

Funding for this project was provided by the California Department of Forestry and Fire Protection's Forest Health Program through the Amador Resource Conservation District. Herbicides were donated by Corteva™ Agriscience.

In this article, discussing research results requires the use of pesticide trade names, but this does not constitute an endorsement of the products, nor does it imply that other products are not available. Some products mentioned may be for experimental use only and included for informational purposes. Pesticide Label is the law! Please follow all instructions and safety precautions on the label when applying pesticide products.