Managing Competing Vegetation with Herbicide:
Considerations for Post-Fire Conifer Reforestation

Importance of Post-fire Management of Competing Vegetation

Recent, extensive high-severity wildfires have impeded natural tree regeneration, limiting the reforestation of Sierra-Nevada mixed conifer forest (Welch et al. 2016). Post-fire reforestation efforts require prioritization and adaptation to changing conditions, like climate, to encourage successful restoration outcomes (Meyer et al. 2021). Site-preparation and post-planting release treatments are critical stages of reforestation which help ensure the survival and flourishment of tree seedlings. Competing vegetation management treatments are essential tools to control the growth of undesired plant species that will inhibit the survival and development of planted tree seedlings. Overabundant resprouting species, as well as invasives, often dominate and thrive in disturbed landscapes. Without vegetation control, competition for limiting factors, like soil moisture, can lead to the suppression of planted and native herbaceous species (Plamboeck et al. 2009).

As one of the most prevalent instruments in vegetation management, herbicides are well known for their efficacy and cost effectiveness. While other tools –mastication, grazing, and prescribed fire – are also used in reforestation, it is critical to consider the selectivity, timing, and cost tradeoffs of each treatment (*See Factsheet)*. Often, multiple tools are required in order to achieve management objectives. Concerns over the potential environmental impact of herbicides, specifically glyphosate, have prompted further investigation regarding its use in forestry (Busse et al. 2001, UCANR Glyphosate). Numerous research studies , including a 20-yearlong study from the USFS Pacific Southwest Research Station, documented how herbicides can be used to encourage tree seedling growth, to both rapidly restore forests and promote larger trees that are no longer found in high-severity landscapes (Zhang et al. 2022; McDonald and Fidler 2010; North et al. 2022). Less competitive native plant species also benefit from the removal of dominating post-fire shrub species, like *Ceanothus spp.* and *Arctostaphylos spp., as* increasing native plant species richness has been shown in reforested areas treated with herbicide (DiTomaso et al. 1997; Bohlman et al. 2016). By managing for competing vegetation with treatments, post-fire reforestation efforts have the opportunity to introduce both long-term structural heterogeneity and plant species diversity that promote future forest health and ecosystem resilience.

Herbicides – What are they?

Herbicides are a subclass of pesticides used to target and control undesirable plants via contact through the foliage, stem, or soil. Forest vegetation management treatments often rely on herbicides to modify vegetative composition before planting (site preparation) and/or post-planting (conifer release). In an integrated pest management program herbicides are only used when necessary at the lowest possible rates, to achieve management objectives.

Pre-emergent herbicides are applied to the soil before the germination or emergence of the targeted plant species prior to tree seedling planting as a site preparation treatment. Pre-emergent herbicides may be preferred for reforestation as they are less likely impact tree seedlings that are yet to be planted (Reforestation Practices for Conifers in California, p.31).

Post-emergent herbicides act on the direct contact to the foliage of the target species and are applied after they have already emerged from the soil to release seedlings from competition. This is often

applied in post-fire environments, where naturally regenerated and planted seedlings may be intermixed with surviving and resprouting competing vegetation species. However, the timing of application is critical – since the cost of release treatments accrue as more time passes, as the target species becomes larger and more laborious to manage. Herbicide selection is dependent on target vegetation species, conifer tolerance, and local environmental considerations in given areas. Sometimes a combination of herbicides is required to address complex vegetative understory.

Mode of Action, Selectivity, & Timing

Other differences between herbicides are based on their: mode of action, selectivity, timing, and application method. Herbicides work through various metabolic mechanisms, or **modes of action**, to disrupt plant growth. Generally, common modes of actions for herbicides used within forestry are auxin mimickers, aceto-lactase-synthase (ALS) inhibitors, and photosynthetic inhibitors (*See table below*).

Selectivity refers to the ability of an herbicide to effectively control the desired target species while not negatively impacting non-target plants. The properties of an herbicide can influence selectivity, such as the active ingredient, formulation, and application rate. Selectivity can also be influenced by the timing and location of the application. The desired selectivity of an herbicide is a critical component of a vegetation management plan and determines the recommended herbicide by a licensed professional.

Timing of application influences the efficacy of treatment by targeting the growth stages of non-desired species, while avoiding detrimental impacts on the desired species. Applications during the dormant season (fall), or after certain conifer growth stage may help with desired species safety. Or applying the product directly to the undesirable vegetation. Application methods vary from broadcast or direct foliar spraying, stem injectors, and others depending on desired selectivity.

Use in Conifer Reforestation Efforts

Conifer tolerance of herbicide is of critical importance, as some species and methods of herbicide application may impact the growth and survival of some species over others (Reforestation Practices for Conifers in California, p.28). Pre-emergent herbicides are advantageous to post-fire reforestation efforts, as they act before invasives and shrubs germination and prior to seedling planting, which prevents potential injury to conifer seedlings that could occur with foliar spraying. If left untreated, planted seedlings will be overtopped by competing vegetation and will not successfully establish. Post-emergent herbicides can be used selectively with directed applications to the target plant's foliage. To avoid impact on conifer growth, foliar applications should ideally occur between late summer and fall after the buds have hardened. Often, an integrated approach can used that combines both post- and pre-emergent herbicides to achieve effective control over competing vegetation and ensure the continued growth of conifer seedlings.

Regulations, Safety, and Compliance

The use of herbicides is subject to regulatory oversight to ensure their safe and responsible application. The California Department of Pesticide Regulation (DPR) regulates the licensing, sale, and use of pesticides under state laws, which are often more restrictive than EPA federal regulations and most other states. California regulations require that a licensed pest control advisor (PCA) provides a written recommendation based upon a strict adherence to product guidelines and restrictions, and in consideration of local ecology. Only certified PCAs and those operating under a DPR applicator license may apply herbicides, wearing PPE. Regulations and permitting may vary by county, so be sure to contact your local County Agricultural Commissioner (CAC) for regulatory information, as well as local certified technical assistance.

Common Herbicides for Conifer Reforestation

Active Ingredient	Most Common Trade Name	Mode of Action	Application/ Timing	Conifer tolerance and Timing of Highest Tolerance	Directed Use	Relative Toxicity (LD-50 mg/kg) Oral Rat*
2,4-D ester (*Restricted Material*)	Weedone LV-6	Auxin Mimic" (HRAC group 4)	Foliar, Spring/Fall	Foliar - low; dormant season	Site prep/directed release	1380
Aminopyralid	Milestone	Auxin Mimic" (HRAC group 4)	Foliar/Soil, Spring/Fall	Foliar - low, Soil - moderate; Spring/Fall	Site prep/directed release	>5000
Atrazine	Atrazine 4L	Photosystem II Inhibitor. (HRAC group 5)	Soil, Rainfall required for activation	Foliar/Soil – high; Spring/Fall	Site prep/ release	>2000
Clopyralid	Transline	Auxin Mimic" (HRAC group 4)	Foliar/Soil, Spring/Fall	Foliar/Soil – high; Spring/Fall	Site prep/ release	>5000
Fluroxypyr	Vista XRT	Auxin Mimic" (HRAC group 4)	Foliar, Spring/Fall	Foliar– low/moderate; dormant season	Site prep/direct release	>5000
Glyphosate	Accord XRT II	Inhibition of ESPS (HRAC group 9)	Foliar, Fall	Foliar– low/moderate; post-bud set in fall	Site prep/ release	>5000
Hexazinone	Velpar DF	Photosystem II Inhibitor. (HRAC group 5)	Soil, Rainfall required for activation	Foliar/Soil – moderate; Spring/Fall	Site prep/ release	1310
Imazapyr	Polaris AC	ALS inhibitors (HRAC group 2)	Foliar/Soil, Rainfall required for activation	Foliar/Soil – low; Spring/Fall	Site prep	>5000
Sulfometuron-methyl	Oust XP	ALS inhibitors (HRAC group 2)	Soil, Rainfall required for activation	Foliar/Soil – low/moderate; Spring/Fall (Coastal Species only)	Site prep/ release	>5000
Triclopyr ester	Forestry Garlon XRT	Auxin Mimic" (HRAC group four)	Foliar, Spring/Fall	Foliar– low; dormant season	Site prep/direct release	2966

**Adapted from Reforestation Practices for Conifers in California, pg. 24, 31*

**Relative Toxicity LD-50 is the lethal concentration required to kill 50% of terrestrial organisms and is one way to measure toxicity. For comparison the LD-50 for rats of caffeine – 376/mg/kg and vitamin D – 42/mg/kg.*

Key Works Cited

[1]Bohlman, G. N., M. North, and H. D. Safford. 2016. Shrub removal in reforested post-fire areas increases native plant species richness. Forest Ecology and Management. 374:195–210.

[2]Busse, M. D., A. W. Ratcliff, C. J. Shestak, R. F. Powers, P. S. R. Station, and U. F. Service. 2001. Non-Target Effects of Glyphosate on Soil Microbes 52.

[3]McDonald, P.M., and G.O. Fiddler. 2011. Twenty-five years of managing vegetation in conifer plantations in Northern and Central California: Results, application, principles, and challenges. USDA Forest Service PSW-GTR-231. USFS, Pacific Southwest Research Station. 87 p.

Suggested Further Reading

[4]Fredrickson, E., Gray, M. 2021. *Chapter 8: Vegetation Management.* Reforestation Practices for Conifers in California.

[5]US Forest Service. 2005. Noxious Weed Treatment Project EIS Appendix E: Herbicide Information

To look up the mode of action of the herbicide you are using, visit the Herbicide Resistance Action Committee.

View the discussion on herbicide use in forestry via UCCE Forest Stewardship Managing Vegetation in Fuel Breaks Webinar on the UC Forestry and Range Chanel

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