FOREST RESEARCH LABORATORY

RESEARCH NOTE 70

CAN WE CONTROL BRUSH BY HELICOPTER SPRAYING BEFORE TIMBER HARVEST?

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ABSTRACT

Aerial application of fosamine ammonium or glyphosate at moderate rates was not adequate for controlling understory brush before final harvesting of mature Douglas-fir (*Pseudotsuga menziesii*) stands or for reducing vigor of post-harvest sprouting. Symptoms of herbicide injury were those associated with low application rates, suggesting that the canopy intercepted too much of the chemicals for adequate brush treatment. Site-preparation effects of logging were more pronounced than those of herbicide treatment in curbing future dominance by brush. Shrub species composition did not change as a result of spraying, logging, or both. Controlling understory brush with herbicides before harvest may require aerial application at higher rates or use of ground equipment where coniferous overstories are dense.

INTRODUCTION

Brush competition is a serious problem on cutover forest lands planted to conifers in western Oregon. Considerable evidence indicates that brush problems present before harvesting may cause competitive problems later (Malavasi 1977, Kelpsas 1978). Therefore, brush control is imperative on sites where abundant brush species have higher dominance potential than young conifers.

We used a helicopter to apply systemic herbicides before harvest through the forest canopy of mature Douglas-fir (*Pseudotsuga menziesii*) [1] stands in an attempt to control brush inconspicuously, before it becomes a regeneration problem, and when carbohydrate reserves render it incapable of quick recovery. Logging was to follow spraying once systemic translocation of the herbicide was complete. Abundance and vigor of understory species after treatment were viewed as indicators of the relative ability of these species to assert full dominance potential during early post-harvest succession (Newton 1973). We recorded presence of woody and herbaceous vegetation before and after treatment and used relative changes in abundance as an index of treatment effectiveness.

[1]Scientific and common names of plants from Gilkey and Dennis (1975) throughout.

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STUDY AREA

Two sets of stands of mature (90- to 110-year-old) Douglas-fir were selected for study. One (the McDonald site) was located in Oregon State University's McDonald Forest about 13 km north of Corvallis, Oregon, and the other (the Starker site) on Starker Forest land about 30 km west of Corvallis, near Blodgett, Oregon. Both locations range from site index (height in feet at 100 years of age) 140 to 160 for Douglas-fir (McArdle and Meyer 1949). The stands had been subjected to partial cutting, in some cases heavy, during the past 15 to 20 years and supported basal areas of 22 to 50 m^2/ha.

Preharvest understory was characterized mainly by vine maple (*Acer circinatum*), western hazel (*Corylus cornuta californica*), bracken fern (*Pteridium aquilinum*), thimbleberry (*Rubus parviflorus*), bigleaf maple (*Acer macrophyllum*), and sword fern (*Polystichum munitum*); such understories typically resprout vigorously after partial cutting or clear felling. Scattered regeneration of Douglas-fir and grand fir (*Abies grandis*) was found in disturbed areas of low residual density.

TREATMENTS

Three 8-ha treatment units were established at each site (Table 1). Thirty-six permanent vegetation-observation points were located in each treatment unit on a 20- by 20-m grid. All points were a minimum of 40 m from the edge of treated stands.

Fosamine ammonium and glyphosate were applied by helicopter in September 1977 to treatment units at rates of 3.41 kg/ha and 1.25 kg active/ha, respectively. Herbicide usage followed routine procedures for treating low brush cover on cutover land except that the herbicide was sprayed from above the standing timber. Chemicals were delivered in a water-based spray volume of 93 liters/ha. Nozzles were D-8's without spinners, angled 45° back. This type of equipment normally delivers a volume-based median drop size of 350 to 450 μ. Flying speed was about 80 kph,

TABLE 1.

SITE CHARACTERISTICS AND TREATMENTS APPLIED TO STUDY AREAS.

Treatment unit, by site	Soil type	Slope, %	Sprayed	Logged
McDonald site				
MF	Price-Ritner complex	20-30	Fosamine ammonium	--
MG	Jory silty clay loam	12-20	Glyphosate	--
MC (control)		2-30	--	Spring 1979
Starker site				
SF	Mostly Honeygrove silty clay loam	25-50	Fosamine ammonium	October 1977
	Some Klikitat gravelly clay loam	50-75		
SG	Ritner-Price complex	30-75	Glyphosate	November 1977
SC (control)			--	November 1977

and swaths were 20 m wide. Plots were single-flown (each point receiving a single application at full delivery rate) rather than double-flown (each point receiving a half dose twice to minimize skips). Herbicide deposit in the understory was not measured. For units that were logged the winter after herbicide treatment, a combination of tractors and cable systems was used to minimize surface disruption.

Before treatment, data recorded at each observation point included (a) basal area of the dominant conifer stand, (b) number of individuals of nonconiferous woody plants, by species and size class, within a 3.55-m radius and of ground cover species (herbs), and (c) existing conifer regeneration. Presence and condition of woody species were then noted and recorded after treatment, in the fall of 1978 and 1979. Jaccard's (Mueller-Dombois and Ellenberg 1974) index of similarity between plant communities was used to show the presence-absence relationship of species on the treatment units to reflect change, if any, in species composition. This coefficient expresses the ratio of number of species common to a pair of treatment units to the total number of species in those two units.

Herbicide damage to all woody species was recorded. Degree of injury was classified according to frequency of tip kill (damage occurring on the terminal 10 cm of growing shoots) and overall crown kill (percentage of the crown killed more than 10 cm from growing tips, i.e., not crown shrinkage). Sprouting after treatment also was observed.

RESULTS

SPECIES COMPOSITION

Changes in species composition were negligible as a result of either logging or herbicide application (Table 2). Differences in composition notable before treatment remained so through all treatments even though the appearance of vegetation changed markedly due to logging. Logging removed 300 to 600 metric tons/ha (20 to 40 Mbf/acre, Scrib.) of large timber. Equipment operation and dragging of logs with partial suspension caused physical breakage of branches and stems but did not kill shrubs or most herbs.

HERBICIDE INJURY

Symptoms of herbicide injury were minor on all units.

Unlogged Plots

Western hazel, Pacific dogwood (*Cornus nuttallii*), poison oak (*Rhus diversiloba*),

TABLE 2.

COMPARISON OF JACCARD'S INDEX VALUES, CALCULATED FOR ALL POSSIBLE PAIRINGS OF TREATMENT UNITS, BEFORE AND AFTER TREATMENTS.[a]

	Before treatment						After treatment					
All species	SC	SF	SG	MC	MF	MG	SC	SF	SG	MC	MF	MG
SC	100	93	73	24	37	50	100	80	75	24	37	53
SF		100	63	25	39	53		100	59	25	41	59
SG			100	32	33	41			100	29	37	56
MC				100	64	47				100	53	52
MF					100	56					100	59
MG						100						100

[a]See Table 1 for key to abbreviations.

rose (*Rosa* spp.), bigleaf maple, Pacific madrone (*Arbutus menziesii*), trailing blackberry (*Rubus ursinus*), thimbleberry, and snowberry (*Symphoricarpos albus*) were injured by fosamine application, according to the survey the first year after treatment (1978). All except bigleaf maple, madrone, and thimbleberry showed increased but still relatively minor injury the second year after treatment (1979). Understory conifers were apparently unaffected.

The most prevalent (25 percent) type of injury to shrubs was tip kill, according to the 1978 survey. However, recovery was evident by 1979, with only 14 percent exhibiting residual tip injury. The number of individuals with some evidence of crown kill was constant at 4 percent the first and second years after treatment, although degree of crown kill ranged from 5 to 75 percent among the few affected by fosamine.

More injury was visible after treatment with glyphosate, though it still was not severe. Bigleaf maple, western hazel, rose, thimbleberry, trailing blackberry, snowberry, vine maple, Pacific dogwood, and cascara buckthorn (*Rhamnus purshiana*) were injured by glyphosate application the first year after treatment. All except vine maple, dogwood, and cascara showed increased injury the second year after treatment. However, mortality was small (10 percent of hazel, 6 percent of thimbleberry, and 13 percent of bigleaf maple).

In contrast to fosamine treatment, glyphosate resulted in equal numbers of individuals with tip kill and crown kill the first year. By 1979, however, the proportion with crown kill had dropped from 32 to 15 percent and that for tip kill from 32 to 26 percent, indicating a tendency for partly defoliated shrubs to regenerate new buds and sprouts enroute to recovery. Degree of crown kill ranged from 5 to 100 percent the first year, but symptoms were uncommon in any species by the end of the second year.

No clear patterns of brush control were apparent where chemicals were applied without logging. Species exhibited varying degrees of damage, including none at all, at different observation points within the same treatment, probably indicating substantial but variable interceptions of herbicide by the overstory.

Logged Plots

Vine maple, cascara buckthorn, western hazel, rose, salal (*Gaultheria shallon*), Pacific dogwood, Himalayan blackberry (*Rubus procerus discolor*), oceanspray (*Holodiscus discolor*), snowberry, red alder (*Alnus rubra*), thimbleberry, and red huckleberry (*Vaccinium parvifolium*) were injured by the combination of logging and fosamine the first year after treatment. All except cascara, rose, salal, dogwood, snowberry, and alder showed increased injury the second year after treatment. However, no mortality occurred. The proportion of individuals of all species with tip kill decreased from 22 percent in 1978 to 17 percent in 1979; however, crown kill increased from 2 percent in 1978 to 8 percent in 1979, a trend that was not apparent in the unlogged unit sprayed with fosamine on the McDonald site. This suggests that disturbances and stresses during and after logging may be compounded with herbicide injury to produce more substantial plant damage.

Vine maple, western hazel, oceanspray, Oregon grape (*Berberis nervosa*), rose, red huckleberry, and blue elderberry (*Sambucus caerulea*) were injured by the combination of logging and glyphosate the first year after treatment. Only vine maple, hazel, and oceanspray showed increased injury the second year. Hazel, vine maple, and salmonberry (*Rubus spectabilis*) each had one individual killed. Tip kill affected 38 percent of individuals in 1978 and 14 percent by 1979, and crown kill remained relatively constant at 9 percent both years. Again, recovery was observed.

SPROUTING

After logging, sprouting was vigorous in all shrubs and hardwoods. In most instances, the degree of sprouting in the herbicide-treated areas was similar to that in the unsprayed but logged controls. The effectiveness of sprouting as a means of achieving dominance has been previously documented (Roberts 1980), and failure to restrict sprouting showed that herbicides did not improve site preparation measurably when applied before timber harvest.

DISCUSSION

The physical impacts of logging were more pronounced and different than those in the areas treated with herbicides only. Shrubs and hardwoods present before logging were often of much lower stature after, due to disturbance; most reduction in shrub cover was attributable to the yarding operation. The unlogged and sprayed plots (McDonald site) showed little evidence of treatment by the third year, whereas planted seedlings in all logged plots developed well in their first several years. Sprout growth of shrubs will have to be monitored so that the need for release can be determined later.

The spotty brush control in the present study is not consistent with patterns observed in chemical site preparation of brushfields with fosamine and glyphosate (Newton and Roberts 1979). The suggestion that herbicides probably did not target species evenly is consistent with the character of the overstory through which they were sprayed. Traveling downward over 60 m through the conifer canopy, herbicide spray may have been intercepted by one or more layers of vegetation or by inert surfaces such as branches, boles, and lichens, or may have been reduced by evaporation and loss of droplets.

Excellent understory brush control has been observed after overstory sprays of glyphosate on mature and immature alder whose understory was principally salmonberry (M. Newton, unpublished data). Aerial application of glyphosate at the relatively low nominal rate of 1.2 kg/ha through dense overstory resulted in good control of salmonberry, thimbleberry, western hazel, and cascara buckthorn. The sharp contrast between efficiency of spray application in a hardwood stand and that in a conifer stand may be the result of higher leaf area indices and flying at higher altitude above the ground in the latter. Waring and Franklin (1979) reported that the average leaf area index in a Pacific Northwest coniferous forest is 15 m^2 of leaf surface area per square meter of ground surface; this exceeds by 50 percent the leaf area index of 10 m^2/m^2 calculated for dense red alder in the Pacific Northwest (Zavitkovski and Stevens 1972, Waring and Franklin 1979). Even allowing for relatively low density in our stands, there was substantial opportunity for interception.

IMPLICATIONS

The present study suggests that for site preparation, preharvest aerial application of fosamine ammonium or glyphosate at moderate rates through dense overstory will provide little benefit beyond the effects of logging. Logging disturbance resulted in greater overall injury to shrubs than that observed in areas sprayed with herbicides, but also a high degree of sprouting, hence regrowth. Where bigleaf maple and alder were absent, however, the degree of sprouting was usually compatible with survival and growth of vigorous Douglas-fir transplants. Complete brush control is not necessary to promote dominance of conifers. If brush is moderately injured by logging, herbicides, or both for two or three seasons, a shift in dominance ratio favoring the conifers will occur if vigorous conifers are planted among damaged brush immediately after logging. Conifers with a slow start will probably need release later. These findings cannot be expected to extend to sites with substantial moisture limitation, however.

The technique of herbicide application used here will have to be refined if it is to yield an effective and cost-efficient method of understory brush control. Using a tractor-mounted mist blower or backpack sprayer to apply herbicides would give much more consistent results on gentle terrain with relatively open understories. On steep sites, improved success may require helicopter application at higher rates or other spray technology giving better canopy penetration. Confirming data are needed. Even if higher aerial application rates were to prove effective in reducing sprouting of understory brush, overstory treatment wastes more herbicide than ground treatment and is subject to greater loss from chemical drift than conventional release. We therefore recommend that pre-existing brush be controlled after logging primarily by planting large, vigorous transplants in brush-threatened sites, with provision for timely release if and when brush impinges.

REFERENCES

GILKEY, H.M., and L.J. DENNIS. 1975. Handbook of northwestern plants. Oregon State University Bookstores, Inc., Corvallis. 505 p.

KELPSAS, B.R. 1978. Comparative effects of chemical, fire, and machine site preparation in an Oregon coastal brushfield. M.S. Thesis, School of Forestry, Oregon State University, Corvallis. 97 p.

MALAVASI, U.C. 1977. Early plant biomass trends following forest site preparation in the Oregon Coast Range. M.S. Thesis, School of Forestry, Oregon State University, Corvallis. 77 p.

McARDLE, R.E., and W.H. MEYER. 1949. The yield of Douglas-fir in the Pacific Northwest. USDA Forest Service Technical Bulletin 201. Washington, D.C. 74 p.

MUELLER-DOMBOIS, D., and H. ELLENBERG. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York. 547 p.

NEWTON, M. 1973. Forest rehabilitation in North America: some simplifications. Journal of Forestry 71(3):159-162.

NEWTON, M., and C.A. ROBERTS. 1979. Brush control alternatives for forest site preparation. Proceedings and Research Progress Report, 28th Annual Weed Control Conference, Salem, Oregon. 10 p.

ROBERTS, C.A. 1980. Cooperative brush control study. Unpublished second-year report. C.A. Roberts, Consultant, Corvallis, Oregon. 35 p.

WARING, R.H., and J.F. FRANKLIN. 1979. Evergreen coniferous forests of the Pacific Northwest. Science 204:1380-1386.

ZAVITKOVSKI, J., and R.D. STEVENS. 1972. Primary productivity of red alder ecosystems. Ecology 53:235-242.

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BRITISH/METRIC CONVERSIONS

1 acre (ac)	=	0.4047 hectare (ha)
1 foot (ft)	=	0.3048 meter (m)
1 mile (mi)	=	1.6093 kilometers (km)
1 pound (lb)	=	0.4536 kilogram (kg)
1 gallon (gal.)	=	3.785 liters
1 inch (in.)	=	2.54 centimeters (cm)

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