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FOLIAGE SPRAYS For Site Preparation And Release From Six Coastal Brush Species

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ABSTRACT

Fifteen herbicides or combinations of herbicides were tested as ground-applied foliage sprays on red alder, salmonberry, western thimbleberry, vine maple, California hazel, and salal. Picloram produced the best overall control of the six species, although not even picloram produced acceptable control of salal. Foliage sprays of 2,4,5-T were effective on all species except salal. Herbicides were generally more effective when applied in late spring than in midsummer. However, adequate control for release of conifers can be obtained with midsummer sprays of 2,4,5-T on red alder, salmonberry, and western thimbleberry. Herbicidal treatments suitable for conifer release and site preparation are recommended for each species.

KEYWORDS: Herbicide applications, brush control, Coniferae, silviculture.

Abbreviations used in the text are:

ae is acid equivalent.

aehg is weight of parent material mixed in 100 gallons of solution (acid equivalent per 100 gallons).

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PESTICIDE PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

Herbicides have been used as a silvicultural tool in management of coastal Oregon and Washington forests for over a decade. Despite common acceptance of these tools, published information on response of coastal species to herbicides is extremely limited. Treatments recommended for conifer release and site preparation are frequently based on empirical trials rather than on results of controlled experiments. Such trials by foresters have resulted in the development of many useful treatments (Lauterbach 1961), but more precise information is needed to refine and improve these treatments.

For example, amitrole-T and 2,4,5-T are recommended for salmonberry control, yet there is little information to support this recommendation. Studies on salmonberry (Krygier and Ruth 1961, Gratkowski 1971) and western thimbleberry (Gratkowski 1971) showed foliage sprays of 2,4,5-T to be effective on both species. Although Finnis (1964) briefly reported that amitrole-T, dicamba, and 2,4,5-T were promising herbicides, the basis for selection of amitrole-T as the recommended treatment for salmonberry is impossible to find in published reports. There are few studies on species other than salmonberry. Finnis (1967) found picloram and picloram plus 2,4-D to be effective as foliage sprays on vine maple. Rediske (1961) compared a number of herbicides on Coast Range species. His results show 2,4,5-T to be effective on several shrub and weed tree species. Other than trials by Finnis (1964, 1967) and Gratkowski (1971), effects of combinations of herbicides or herbicides other than phenoxyacetic acids have not been reported.

Without specific knowledge concerning response of individual species to particular herbicides, the forester's ability to prescribe treatments is limited. He may not be able to explain variations in observed results nor predict which species will be resistant to the selected treatment. Further, in the absence of screening trials, the forester may not be able to recognize nor effectively use new herbicidal treatments except by costly trial and error.

The screening tests reported here are an initial step toward solution of these problems. The results provide a sound basis for the development of herbicidal treatments to control coastal brush species.

METHODS

Tests were started in 1970 to determine the effects of various herbicides and combinations of herbicides as foliage sprays on six brush species found in the Coast Ranges of Oregon and Washington. All six species are major competitors in forest plantations and are commonly associated in coastal brushfields. Vigorous plants in recent clearcuts near Coos Bay or in nonstocked brushfields near Nashville in the Oregon Coast Ranges were selected for treatment (fig. 1). The species were:

Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Western thimbleberry	*Rubus parviflorus*
Vine maple	*Acer circinatum*
California hazel	*Corylus cornuta californica*
Salal	*Gaultheria shallon*

Herbicides were applied with knapsack sprayers during late spring and midsummer to learn if there are differences in response between early and late stages of the growing season. Each treatment was sprayed to drip point on 10 individual plants of each species except salal. Salal was sprayed on an area basis by applying treatments in a carrier volume equivalent to 200 gallons per acre on ten 1/1,000-acre plots.

Fifteen herbicides and combinations of herbicides were selected for study. Similar treatments were applied on commonly associated species such as salmonberry and western thimbleberry or vine maple and California hazel. Herbicides were usually applied in water carriers, although a 3-percent black diesel oil-in-water emulsion was used with 2,4,5-T on salmonberry, western thimbleberry, and salal. Herbicides and combinations tested were:

Common name [chemical name]	Formulation
(1) 2,4-D [2,4-dichlorophenoxy acetic acid]	Propylene glycol butyl ether ester (PGBE)[1/]
(2) 2,4,5-T [2,4,5-trichlorophenoxyacetic acid]	PGBE ester[1/]
(3) Silvex [2-(2,4,5-trichlorophenoxy) propionic acid]	PGBE ester[1/]
(4) Amitrole-T [3-amino-1,2,4-triazole plus NH_4SCN]	Water-soluble liquid[2/]
(5) MSMA [monosodium methane-arsonate]	Water-soluble acid[2/]
(6) Picloram [4-amino-3,5,6-trichlorpicolinic acid]	Potassium salt[1/]
(7) Dicamba [3,6-dichloro-o-anisic acid]	Dimethylamine salt[3/]
(8) Bromacil [5-bromo-3-*sec*-butyl-6-methyluracil]	Lithium salt[4/]
(9) MSMA + 2,4-D	(5) + (1)
(10) MSMA + 2,4,5-T	(5) + (2)
(11) MSMA + amitrole-T	(5) + (4)
(12) Dicamba + 2,4-D	(7) + (1)
(13) Dicamba + 2,4,5-T	(7) + (2)
(14) 2,4-D + dichlorprop [2-(2,4-dichlorophenoxy) propionic acid]	Butoxyethanol esters (BEE)[2/]
(15) 2,4-D + dichlorprop + 2,3,6-TBA [2,3,6-trichlorobenzoic acid]	Dimethyl- and triethanolamine salts[2/]

Test samples provided by:

1/ The Dow Chemical Company
2/ Amchem Products, Inc.
3/ Velsicol Chemical Company
4/ E. I. DuPont de Nemours and Company.

Figure 1.--*Vigorous plants such as this vine maple were treated with knapsack sprayers.*

Herbicides such as 2,4-D, 2,4,5-T, silvex, amitrole-T, MSMA, and combinations of these are known to be selective at certain rates and stages of plant development. These were tested for possible use as release sprays for conifers. Less selective herbicides such as picloram, dicamba, and bromacil were tested for use in site preparation sprays.

Plants were examined during September of 1971, 16 months after the early sprays and 13 months after the late sprays were applied. Topkill, number and size of basal sprouts, and number of dead plants (complete topkill with no resprouting) were recorded. Many salmonberry, western thimbleberry, vine maple, and California hazel plants were not completely topkilled but had few or no resprouts. Therefore, treated plants of these four species were reexamined in June of 1972 to determine the degree of recovery. Any plant with complete crown kill and no resprouts by the third growing season was considered dead.

EFFECTS OF HERBICIDES ON SPECIFIC SPECIES

Topkill, plant kill, and number and size of basal sprouts are tabulated for each species. In addition, results of selected treatments are briefly discussed, and a summary table of the best treatments for each species is provided.

In the discussion and tables that follow, the terms early and late are used to designate treatment dates. These terms were selected for convenience only and correspond to the *early foliar* and *midsummer* spray seasons, respectively.

Red Alder

Red alder plants were sprayed on May 25 (early treatment), when stems were actively growing and three-quarters of the leaves were fully expanded. The late application was made on July 28, when older leaves were mature but secondary growth flushes were beginning.

Red alder was highly susceptible to 11 of the 12 treatments tested, MSMA being the only exception (table 1). Combinations of herbicides were no more effective than herbicides applied singly. Timing of application for good control was not critical; early and late applications were equally effective. By the end of the second growing season, most dead plants were uprooted and lying on the ground (fig. 2).

An early application of 2,4-D is often recommended for releasing conifers from red alder if conifers are shielded from spray by the alder foliage. However, conifers are actively growing during this period and may be damaged by sprays if exposed. In contrast, conifers are more resistant by midsummer after growth ceases and buds are set (Gratkowski 1961). Results from this study suggest that late foliage sprays of either 2,4-D or 2,4,5-T at 2 lb ae per acre applied in a water carrier will produce good control of red alder with minimum damage to conifers. Early or late applications of either herbicide should be effective for site preparation in pure red alder brush types. These herbicides are also more selective and less expensive than the others tested.

Figure 2.--*This red alder had fallen by the end of the second summer after treatment.*

Table 1.--*Effects of herbicides on red alder*

Treatment			Topkill	Plant kill[2/]	Basal sprouts		
Herbicide[1/]	Rate (lb. aehg)	Time			Plants with sprouts	Average number	Average height
			Percent				*Inches*
2,4-D	1	early	100	100	0	--	--
		late	100	100	0	--	--
	3	early	100	100	0	--	--
		late	100	100	0	--	--
2,4,5-T	1	early	100	100	0	--	--
		late	100	100	0	--	--
	3	early	100	100	0	--	--
		late	93	90	0	--	--
MSMA	2.2	early	32	20	30	14	26
		late	99	80	20	5	22
Picloram	1	early	100	100	0	--	--
		late	100	100	0	--	--
Dicamba	1	early	100	100	0	--	--
		late	100	100	0	--	--
MSMA + 2,4-D	2.2 + 1	early	100	100	0	--	--
		late	100	100	0	--	--
MSMA + 2,4,5-T	2.2 + 1	early	100	100	0	--	--
		late	100	100	0	--	--
Dicamba + 2,4-D	1 + 1	early	100	100	0	--	--
		late	100	100	0	--	--
2,4-D + dichlorprop	1 + 1	early	100	100	0	--	--
		late	100	100	0	--	--
2,4-D + dichlorprop + 2,3,6-TBA	1+1 + 3/4	early	93	90	10	10	16
		late	100	100	0	--	--

[1/] All herbicides applied in water carriers.

[2/] Plants dead at end of second growing season.

Salmonberry

Late spring salmonberry treatments were applied on May 20 (early treatment), when three-quarters of the leaves were fully developed and berries were forming. Shoot growth had ceased and berries were falling by August 4, the late application date.

Herbicides applied alone were generally at least as effective as the various combinations tested (table 2). A combination of 0.6 lb each per acre of MSMA plus 2 or 3 lb amitrole-T has been used in aerial sprays to control salmonberry. This study suggests that higher rates of MSMA do not increase effectiveness of amitrole-T. In fact, a late spring application of 2.2 lb of MSMA produced results equivalent to 3 lb of amitrole-T.

Of the 10 herbicides and combinations tested, picloram, amitrole-T, and 2,4,5-T were the most effective. Seasonal differences were not pronounced with 2,4,5-T, but picloram was most effective as a late spray and amitrole-T as an early spray.

Both rates of amitrole-T produced acceptable plant kill; however, the low degree of topkill reflects the variation in results. Live plants stem-sprouted profusely and crowns had returned to pretreatment foliage densities by the end of the second growing season. Amitrole-T also resulted in a very erratic pattern of basal sprouting, with a complete reversal in sprout response between early and late season applications for the two rates tested. In addition, numbers of basal sprouts on live shrubs were nearly equal to the original number of stems. For ground sprays, the slight additional control produced by the higher rate of amitrole-T would not justify the increased chemical cost.

In contrast to amitrole-T, effects of picloram and 2,4,5-T sprays were fully developed by the end of the second growing season. Both herbicides produced complete topkill with limited basal sprouting (fig. 3). Sprouts had not attained the original crown height by late spring of the third growing season.

Early season sprays of 2 lb ae per acre of 2,4,5-T in a water carrier can be used to release conifers if trees are adequately protected from direct application by the salmonberry canopy. For late season sprays, experience on the Siuslaw National Forest indicates that herbicidal rate should be increased to 3 lb ae per acre. The spray should be applied in an oil-in-water emulsion containing one-half gallon of diesel oil per acre to increase herbicidal penetration into mature salmonberry leaves.

For site preparation, 3 lb ae per acre of 2,4,5-T in an oil-in-water emulsion containing 1/2 to 3/4 gallon of diesel oil per acre will produce good control of salmonberry if applied early in the season when salmonberry shrubs are actively growing. Better control can be obtained with foliage sprays of picloram. Aerial applications of picloram in combination with 2,4,5-T are being evaluated.

Table 2.--*Effects of herbicides on salmonberry*

Treatment			Topkill	Plant kill[2/]	Basal sprouts		
Herbicide[1/]	Rate (lb. aehg)	Time			Plants with sprouts	Average number	Average height
			Percent				*Inches*
2,4,5-T	3	early	100	50	40	2	20
		late	99	40	30	2	21
Amitrole-T	1	early	62	70	10	8	10
		late	41	70	0	--	--
	3	early	74	80	0	--	--
		late	58	70	20	6	3
MSMA	2.2	early	74	70	0	--	--
		late	43	10	50	4	26
Picloram	1	early	100	70	20	1	23
		late	100	100	0	--	--
Dicamba	1	early	43	0	40	2	34
		late	27	10	10	7	32
	3	early	61	20	30	7	25
		late	59	0	50	4	29
MSMA + 2,4,5-T	2.2 + 1	early	98	40	60	4	28
		late	77	10	60	6	19
MSMA + amitrole-T	2.2 + 1	early	77	70	0	--	--
		late	45	30	40	3	17
Dicamba + 2,4,5-T	1 + 1	early	81	20	50	6	24
		late	86	0	40	6	29
2,4-D + dichlorprop	1 + 1	early	92	10	80	5	20
		late	31	0	30	2	31
2,4-D + dichlorprop + 2,3,6-TBA	1 + 1 + 3/4	early	69	20	40	5	18
		late	38	0	40	4	26

[1/] All herbicides applied in water carriers except 2,4,5-T which was applied in a 3-percent oil-in-water emulsion.

[2/] Plants dead at beginning of third growing season.

Figure 3.--*Basal sprouts on live salmonberry shrubs were limited in number and size 24 months after spraying with 2,4,5-T.*

Western Thimbleberry

Late spring western thimbleberry treatments were applied on May 20 (early treatment) when three-quarters of the leaves were fully developed and flowers were beginning to open. By midsummer, August 4 (late), growth had ceased and berries were mature and firm.

Herbicides applied alone were at least as effective as the various combinations tested (table 3). Only foliage sprays of picloram and 2,4,5-T produced acceptable topkill and control of resprouting on western thimbleberry. Seasonal differences were not pronounced, although picloram was slightly more effective in midsummer.

Salmonberry and western thimbleberry, common associates on disturbed sites, respond in a similar manner to picloram and 2,4,5-T. This similarity was previously reported by Gratkowski (1971) who also noted the ineffectiveness of amitrole-T on thimbleberry. Observations of aerial spray results by silviculturists emphasize the importance of this difference. Use of amitrole-T to control salmonberry may convert sprayed areas to western thimbleberry within a few years after spraying.

Where western thimbleberry is an important associate of salmonberry, use of 2,4,5-T is recommended for releasing conifers. Application rates and timing should be the same as those suggested for salmonberry control. Either 2,4,5-T or picloram may be used in site preparation sprays.

Table 3.--*Effects of herbicides on western thimbleberry*

Treatment			Topkill	Plant kill[2/]	Basal sprouts		
Herbicide[1/]	Rate (lb. aehg)	Time			Plants with sprouts	Average number	Average height
			Percent				*Inches*
2,4,5-T	3	early	100	50	40	4	22
		late	99	60	40	3	15
Amitrole-T	1	early	84	10	90	6	17
		late	51	0	50	11	28
	3	early	90	20	60	7	17
		late	80	0	70	8	17
MSMA	2.2	early	92	10	70	6	26
		late	92	30	60	5	29
Picloram	1	early	100	70	20	3	35
		late	100	80	0	0	0
Dicamba	1	early	81	0	60	2	32
		late	59	0	55	7	25
	3	early	76	20	60	8	29
		late	92	0	90	5	18
MSMA + 2,4,5-T	2.2 + 1	early	100	40	60	7	18
		late	93	20	70	7	24
MSMA + amitrole-T	2.2 + 1	early	99	10	90	7	25
		late	84	10	70	7	24
Dicamba + 2,4,5-T	1 + 1	early	99	60	30	3	18
		late	89	0	70	6	30
2,4-D + dichlorprop	1 + 1	early	90	20	60	5	25
		late	87	10	70	4	26
2,4-D + dichlorprop + 2,3,6-TBA	1 + 1 + 3/4	early	96	10	60	2	19
		late	71	10	40	3	22

[1/] All herbicides applied in water carriers except 2,4,5-T which was applied in a 3-percent oil-in-water emulsion.

[2/] Plants dead at beginning of third growing season.

Vine Maple

Vine maple shrubs were sprayed on June 3 (early treatment) and July 29 (late treatment). In early June, three-quarters of the leaves were fully developed, twigs were actively growing, and plants varied from full bloom to early samara development. By late July, new growth was woody and samaras were mature.

Of the nine herbicides and combinations tested, only high rates of picloram, 2,4,5-T, and silvex produced acceptable control (table 4). All three were more effective in late spring than in midsummer, but best long-term control of vine maple in this test was obtained with an early foliar spray of 2 lb aehg of picloram. Finnis (1967) also found picloram to be effective as a foliage spray. Plants killed by picloram broke at the root collar during the second winter after treatment (fig. 4).

MSMA increased the effect of a 1 lb aehg spray of 2,4,5-T on vine maple. However, results were no better than those obtained with 3 lb aehg of 2,4,5-T and probably less than those obtained with bud-break aerial sprays of 2,4,5-T applied in a diesel oil carrier.

Bud-break sprays of 2,4,5-T at 2 lb ae per acre in an oil carrier are presently recommended for vine maple control. This treatment is more effective on vine maple and less damaging to conifers than early foliar sprays. However, results from this study suggest that control adequate for conifer release can be obtained with early foliar sprays of 3 lb per acre of 2,4,5-T or silvex if conifers are protected from direct application. For site preparation, best control can be obtained with picloram if applied after full leaf development while vine maple shrubs are actively growing.

Figure 4.--*Vine maple shrubs killed by picloram broke during the second winter after treatment.*

Table 4.--*Effects of herbicides on vine maple*

Treatment			Topkill	Plant kill[2/]	Basal sprouts		
Herbicide[1/]	Rate (lb. aehg)	Time			Plants with sprouts	Average number	Average height
			Percent				*Inches*
2,4,5-T	1	early	34	0	0	0	0
		late	58	0	50	14	13
	3	early	95	40	40	15	12
		late	85	30	90	9	10
Silvex	1	early	44	10	0	0	0
		late	62	0	80	10	11
	3	early	80	30	30	21	10
		late	70	30	80	7	7
MSMA	2.2	early	68	20	10	25	15
		late	79	20	60	12	9
Picloram	1	early	71	40	10	4	3
		late	55	30	20	18	9
	2	early	96	80	10	3	2
		late	76	40	10	17	6
Dicamba	1	early	2	0	0	0	0
		late	2	0	0	0	0
MSMA + 2,4,5-T	2.2 + 1	early	85	30	40	20	9
		late	78	30	40	23	13
Dicamba + 2,4,5-T	1 + 1	early	55	30	10	13	15
		late	39	10	30	17	19
2,4-D + dichlorprop	1 + 1	early	30	0	20	13	25
		late	21	0	0	0	0
2,4-D + dichlorprop + 2,3,6-TBA	1 + 1 + 3/4	early	8	0	0	0	0
		late	9	0	0	0	0

[1/] All herbicides applied in water carriers.

[2/] Plants dead at beginning of third growing season.

California Hazel

Late spring California hazel treatments were applied on June 16 (early treatment), when three-quarters of the leaves were fully developed and nuts were 1/4 to 1/2 inch in diameter. By midsummer, August 11 (late treatment), growth had ceased and nuts were mature.

California hazel shrubs have a growth habit similar to that of vine maple and frequently are associated with it. Surprisingly, California hazel was more susceptible than vine maple to foliage sprays and timing effects were pronounced (table 5). In general, combinations of herbicides were no more effective than herbicides applied alone and early foliar sprays were more effective than late foliar sprays.

Acceptable control was obtained with early applications of 1 lb aehg of picloram, 1 lb aehg each of 2,4-D and dichlorprop, or 3 lb aehg of 2,4,5-T (fig. 5). A lower rate of 2,4,5-T and both rates of silvex were less effective. MSMA did not increase the effect of a 1 lb aehg spray of 2,4,5-T.

Early foliar sprays of 2,4,5-T can be used to release conifers if trees are protected from direct application by the California hazel canopy. For site preparation, either picloram or a mixture of 2,4-D and dichlorprop will produce good control if applied when shrubs are actively growing.

Figure 5.--*Late spring sprays of 1 lb aehg picloram produced good control of California hazel shrubs.*

Table 5.--*Effects of herbicides on California hazel*

Treatment			Topkill	Plant kill[2/]	Basal sprouts		
Herbicide[1/]	Rate (lb. aehg)	Time			Plants with sprouts	Average number	Average height
			Percent				*Inches*
2,4,5-T	1	early	99	20	70	3	18
		late	61	10	30	2	14
	3	early	100	60	30	4	15
		late	84	40	40	2	12
Silvex	1	early	88	40	50	3	12
		late	21	0	20	2	17
	3	early	84	10	90	4	16
		late	53	20	50	2	13
MSMA	2.2	early	95	0	100	9	12
		late	89	10	90	10	15
Picloram	1	early	100	80	20	4	16
		late	74	70	20	2	15
Dicamba	1	early	77	20	30	3	13
		late	58	0	30	2	20
MSMA + 2,4,5-T	2.2 + 1	early	96	0	100	8	18
		late	81	10	80	7	14
Dicamba + 2,4,5-T	1 + 1	early	100	40	60	4	13
		late	75	20	60	2	15
2,4-D + dichlorprop	1 + 1	early	99	90	10	1	15
		late	99	80	40	1	14
2,4-D + dichlorprop + 2,3,6-TBA	1 + 1 + 3/4	early	100	70	40	3	10
		late	93	20	70	2	18

[1/] All herbicides applied in water carriers.

[2/] Plants dead at beginning of third growing season.

Salal

One-milacre plots of salal were sprayed on June 16 (early treatment) and August 11 (late treatment). Plant development was highly variable on both dates. Flowers were open in June but new growth was not apparent. By midsummer, new growth was woody but flowers and mature berries could be found on the same stem.

Results were inconsistent and no treatment produced good control (table 6). Gratkowski (1970) obtained similar results using amitrole-T, 2,4,5-T, and mixtures of picloram with phenoxy herbicides. Of the nine herbicides and combinations tested in the present study, only picloram produced an appreciable amount of top-kill and reduction in salal cover. Late spring sprays of picloram were more effective than sprays applied in midsummer. Although results were not satisfactory, combinations of MSMA or dicamba with 2,4,5-T were more effective than any of the three applied alone on the most effective spray date.

Salal forms a dense, compact ground cover and high carrier volumes will probably be necessary to obtain adequate distribution and coverage of the spray. Oil-in-water emulsion or straight oil carriers may be required to penetrate the thick, waxy cuticle of salal leaves. Future tests should consider both carrier type and carrier volume in addition to screening different herbicides.

Table 6.--*Effects of herbicides on salal*

Treatment			Topkill[2/]	Live salal cover
Herbicide[1/]	Rate (lb. per acre)	Time		
			Percent	
Untreated	--	--	0	90
2,4,5-T	1	early	8	80
		late	2	86
MSMA	2.2	early	2	89
		late	12	80
Picloram	1	early	74	22
		late	4	78
Dicamba	1	early	2	86
		late	2	82
	3	early	5	86
		late	6	81
Bromacil	6	early	3	88
		late	14	82
MSMA + 2,4,5-T	2.2 + 1	early	1	84
		late	36	70
Dicamba + 2,4,5-T	1 + 1	early	40	58
		late	1	87
2,4-D + dichlorprop	1 + 1	early	14	76
		late	6	89
2,4-D + dichlorprop + 2,3,6-TBA	1 + 1 + 3/4	early	0	79
		late	2	86

[1/] All herbicides applied in water carriers except 2,4,5-T which was applied in a 3-percent oil-in-water emulsion.

[2/] Recorded at end of second growing season.

DISCUSSION AND RECOMMENDATIONS

High volume, ground-applied foliage sprays of 15 herbicides or combinations of herbicides were tested on red alder, salmonberry, western thimbleberry, vine maple, California hazel, and salal. In general, combinations were no more effective than herbicides applied individually. For example, dicamba plus 2,4,5-T and MSMA plus 2,4,5-T or amitrole-T have recently been advocated for use as foliage sprays on salmonberry for site preparation and release, respectively. Results of this study suggest that better results may be obtained with 2,4,5-T or amitrole-T alone. In fact, on species where direct comparisons are possible, neither dicamba nor MSMA increased effectiveness of 2,4,5-T sufficiently to justify the additional cost and loss of selectivity.

Picloram at 1 lb aehg produced the best overall control of all six species, although not even picloram produced acceptable control on salal. This study demonstrates the general usefulness of 2,4,5-T for control of coastal brush species. Foliage sprays of 2,4,5-T at 3 lb aehg were effective on all species except salal. The most promising treatments for control of red alder, salmonberry, western thimbleberry, vine maple, and California hazel are compared in table 7.

Shrubs and weed trees rarely grow in pure stands; they usually are found associated with other species. To predict effects of particular treatments on mixed brush communities, topkill and plant kill can be compared in the appropriate species tables or in table 7.

Herbicides were generally more effective when applied in late spring than in midsummer. However, control adequate for release of conifers can be obtained with midsummer sprays of 2,4,5-T on red alder, salmonberry, and western thimbleberry. Limited aerial application trials on the Siuslaw National Forest suggest that optimum rates will be between 2 and 3 lb per acre.

Several Douglas-firs 3 to 6 feet high were treated with the various herbicides on each application date. Results of this informal study agreed with effects shown earlier by Gratkowski (1961). Herbicidal damage was greater for sprays applied in late spring, when Douglas-firs were actively growing, than in midsummer, when most trees had set buds. In addition, 2,4,5-T and silvex were slightly more damaging than 2,4-D. Picloram, dicamba, bromacil, and 2,4-D plus dichlorprop produced extensive defoliation and topkill of conifers on both application dates and would not be suitable for release sprays. Combinations of MSMA with 2,4,5-T or amitrole-T produced more defoliation of Douglas-firs than either 2,4,5-T or amitrole-T applied alone.

For release, early sprays should be applied in water carriers after three-quarters of the leaves on brush species have attained full size but before new growth on conifers exceeds 2 inches. To minimize spray damage, conifers should be shielded from direct application by the brush canopy. Late sprays should be applied in midsummer, after conifer growth ceases but at least 1 month before leaf abscission of brush species.

Site preparation sprays should be applied after full leaf development while plants are actively growing. For example, the Siuslaw National Forest uses 3 lb ae per acre of 2,4,5-T in an oil-in-water emulsion carrier applied between late May and late June to prepare brushy sites for burning.

Aerial spray tests of picloram in combination with 2,4-D or 2,4,5-T for preburn desiccation and site preparation are currently being evaluated. Initial results indicate that use of picloram may reduce resprouting of shrubs after burning, compared with phenoxy herbicide sprays. Burning the sprayed brush may reduce picloram residues in the soil and allow early replanting of conifers.

Table 7.--*Degree of control of selected herbicides in water carriers when applied as foliage sprays on five coastal brush species*

Herbicide and rate (lb. aehg)	Application season	Estimated degree of control[1/] of:				
		Red alder	Salmonberry	Western thimbleberry	Vine maple	California hazel
1 lb. 2,4-D	early	100/100	--	--	--	--
	late	100/100	--	--	--	--
1 lb. 2,4,5-T	early	100/100	--	--	--	--
	late	100/100	--	--	--	--
3 lb. 2,4,5-T[2/]	early	100/100	100/50	100/50	95/40	100/60
	late	100/100	99/40	99/60	85/30	84/40
3 lb. silvex	early	--	--	--	80/30	84/10
	late	--	--	--	70/30	53/20
3 lb. amitrole-T	early	--	74/80	90/20	--	--
	late	--	58/70	80/0	--	--
1 lb. picloram	early	100/100	100/100	100/70	71/40[3/]	100/80
	late	100/100	100/100	100/80	55/30	74/70

[1/] Topkill in percent/percentage of plants dead.

[2/] Applied in an oil-in-water emulsion carrier on salmonberry and western thimbleberry.

[3/] Degree of control with 2 lb. aehg picloram as early and late foliage sprays is 96/80 and 76/40, respectively.

LITERATURE CITED

Finnis, J. M.
1964. Chemical control of salmonberry. West. Weed Control Conf. Res. Prog. Rep. 1964: 48.

———
1967. The effect of Tordon on vine maple. Down to Earth 22(4): 22-23, illus.

Gratkowski, H.
1961. Toxicity of herbicides on three northwestern conifers. USDA For. Serv. Pac. Northwest For. & Range Exp. Stn., Portland, Oreg. Res. Pap. 42, 24 p., illus.

———
1970. Foliage sprays fail on salal. West. Soc. Weed Sci. Res. Prog. Rep. 1970: 18.

———
1971. Midsummer foliage sprays on salmonberry and thimbleberry. USDA For. Serv. Res. Note PNW-171, 5 p., illus. Pac. Northwest For. & Range Exp. Stn., Portland, Oreg.

Krygier, James T., and Robert H. Ruth
1961. Effect of herbicides on salmonberry and on Sitka spruce and western hemlock seedlings. Weeds 9(3): 416-422, illus.

Lauterbach, P. G.
1961. Herbicides and their use in forest management in west side forests. *In* Herbicides and their use in forestry, p. 57-63. Oreg. State Univ., Corvallis.

Leonard, O. A., and W. A. Harvey
1965. Chemical control of woody plants. Calif. Agric. Exp. Stn. Bull. 812, 26 p., illus.

Rediske, J. H.
1961. Chemical selectivity on woody plants. *In* Herbicides and their use in forestry, p. 23-32. Oreg. State Univ., Corvallis.

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