ALASKA OREGON WASHINGTON

PACIFIC NORTH WEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

PNW-285 December 1976

HERBICIDES FOR GRASS AND FORB CONTROL IN DOUGLAS-FIR PLANTATIONS

by

H. Gratkowski, *Research Forester*

ABSTRACT

Tests of 10 chemicals were conducted to determine their relative effectiveness for grass and forb control in Douglas-fir plantations. Atrazine at 4 lb ai per acre and terbacil at 2 lb ai per acre should be useful in broadcast or aerial sprays to release small Douglas-firs. Atrazine reduced grass cover for 1 year, but had little effect on broadleaved weeds. Terbacil reduced both grass and forbs through two summers after application. Dalapon and a granular formulation of dichlobenil damaged the conifers but should be useful for site preparation in grass-forb communities.

KEYWORDS: Herbicides, grass control, forb control, release, spraying (aerial), herbicide preparations.

Dense stands of grasses and broadleaved weeds prevent establishment and retard growth of Douglas-fir seedlings on forest land in western Oregon and Washington. Shading and matting by weeds and grasses reduce survival and growth of small trees in dense grass-forb communities; however, root competition for limited soil moisture during the dry summer season is probably far more important.

Late winter aerial application of 4 lb ai (active ingredient) of atrazine per acre has proved effective in controlling most grasses but is relatively ineffective against many broadleaved weeds. As a result, atrazine releases not only conifers but forbs as well. Fast-growing forbs then multiply and dominate the site, shading the trees, using valuable soil moisture, and smothering small trees under a mat of dead stems and leaves when the weeds die during summer and autumn. Foresters need a broad-spectrum herbicide that will control most species of grasses and broadleaf weeds without damaging young conifers.

HERBICIDES[1/] AND METHODS

Ten herbicides (table 1) were tested in southwestern Oregon for grass and broadleaf weed control in three plantations of established young Douglas-firs 6 to 15 inches tall. Two study areas were on wet sites in the Siskiyou National Forest: one on the coastal slope of the Siskiyou Mountains near Brookings; one near the crest of the Coast Range west of Powers. The third area was in a Bureau of Land Management plantation on a dry site in the foothills of the Cascade Range east of Roseburg. Two additional replications (without conifers) were also installed on a very dry site in the Rogue River Valley west of Grants Pass.

Different rates of herbicides and combinations of herbicides provided 22 treatments on each site. All herbicides were applied on 1/100th-acre plots, and each replication contained one untreated plot for comparison. The screening test was installed as a randomized complete block experiment with one block of treatments on each of the five sites. Most of the chemicals are soil-active herbicides absorbed through roots of susceptible species. Therefore, all plots were sprayed between March 7 and April 18, 1969, when sufficient rainfall could be expected after application to leach the chemicals into the soil.

All chemicals except 2,4-D were applied as the active ingredient listed in table 1; 2,4-D was a low volatile ester formulation. All chemicals were applied in water carriers at a rate of 100 gallons of spray per acre. The wettable powder formulation of dichlobenil was included on all five sites, but a 4 percent active ingredient granular form of dichlobenil arrived late and was only included in the Brookings, Powers, and Roseburg replications.

Degree of grass control and effects of the herbicides on broadleaf weeds and young Douglas-firs were observed on three dates. A late June 1969 examination was made to detect effects of the herbicides on annual grasses and broadleaf weeds that would die naturally during summer. This examination provided a basis for evaluating results of a second examination in September 1969 which measured grass and weed control at the end of the first growing season. The third examination in September 1970 determined whether any herbicides showed residual effects indicated by second year mortality of grasses or broadleaved weeds or delayed reinvasion of the sprayed plots.

1/ Use of trade, firm or corporation names is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be equally suitable.

Table 1--*Chemicals tested for grass and forb control in young Douglas-fir plantations in Southwestern Oregon*

Common name	Chemical name	Formulation
ACP 68-72	pyrido(3,2-d)pyrimidine-2,4(H,3H)-dione, 3-sec butyl.	Wettable powder
atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine	Wettable powder
cacodylic acid	hydroxydimethylarsine oxide	Liquid
chlorthiamid	2,6-dichlorothiobenzamide	Granular powder
dalapon	2,2-dichloropropionic acid	Soluble powder
dichlobenil	2,6-dichlorobenzonitrile	Granular (4% ai)
dichlobenil	2,6-dichlorobenzonitrile	Wettable powder (50% ai)
2,4-D	(2,4-dichlorophenoxy)acetic acid	Liquid
propazine	2-chloro-4,6 bis(isopropylamino)-s-triazine	Wettable powder
terbacil	3-tert-butyl-5-chloro-6-methyluracil	Soluble powder

During each examination, an ocular rating was made of percentage reduction in grass and broadleaved weed cover on treated plots as compared to an untreated control plot and adjacent areas outside the spray plots. Effects of the herbicides were also observed on 15 young Douglas-firs, five on each plot in the three replications stocked with Douglas-fir seedlings. For each tree, notes were taken on whether the tree was dead or alive. If alive, an estimate was made of percentage of crown defoliated, damaged, and killed.

RESULTS

Both grass control and broadleaf weed control varied among chemicals and with rates of application. Generally, first-year control was better than that achieved with residues that remained in the soil the second summer after application.

Grass Control

By far the most effective chemicals at the end of the first summer were **terbacil**, **atrazine**, and **dalapon** in that order (table 2). Terbacil at 2 and 3 lb active ingredient per acre provided excellent grass control for two growing seasons after application. In contrast, atrazine allowed a rapid recovery of grasses when fall rains began at the end of the first summer and had little or no residual effect the following year. Adding small amounts of either 2,4-D or cacodylic acid and 2,4-D to atrazine seems inadvisable; they had little effect on grasses and did not appreciably increase broadleaf weed control.

Dalapon at 6.8 and 13.6 lb ai per acre produced acceptable grass control the first summer, but residues in the soil had much less effect on grasses the second summer after application.

Table 2--*First- and second-year control of grasses and forbs following chemical treatment during March-April 1969*

Treatments			Grass control		Forb control	
Chemicals	lb/acre[1/]	Carrier	Autumn 1969	Autumn 1970	Autumn 1969	Autumn 1970
			Percent killed			
atrazine	3 ai	Water	63	8	14	2
atrazine	4 ai	Water	85	10	34	2
atrazine + 2,4-D	3 ai 1/2 ae	Water	70	5	27	13
atrazine + cacodylic acid + 2,4-D	3 ai 1/2 ae 1/2 ae	Water	70	6	26	4
ACP 68-72	2 ai	Water	21	29	13	17
ACP 68-72	4 ai	Water	55	46	28	33
ACP 68-72	6 ai	Water	48	5	18	2
terbacil	1 ai	Water	75	42	52	11
terbacil	2 ai	Water	88	74	62	51
terbacil	3 ai	Water	85	87	59	63
dalapon	6.8 ai	Water	69	21	11	28
dalapon	13.6 ai	Water	80	28	8	7
chlorthiamid	2 ai	None	24	1	3	0
chlorthiamid	4 ai	None	45	30	23	13
chlorthiamid	6 ai	None	67	33	36	29
propazine	4 ai	Water	57	11	14	8
dichlobenil WP[2/]	2 ai	Water	9	12	6	4
dichlobenil WP	4 ai	Water	14	7	3	4
dichlobenil WP	6 ai	Water	56	24	27	9
dichlobenil G4[3/]	2 ai	None	30	12	12	15
dichlobenil G4	4 ai	None	60	50	28	22
dichlobenil G4	6 ai	None	65	52	40	15

1/ Pounds active ingredient (ai) or acid equivalent (ae).

2/ Wettable powder.

3/ Granular.

Granular **dichlobenil** was far more effective than the wettable powder formulation. Although first-year grass control was less than that of terbacil, atrazine, and dalapon, both the 4 and 6 lb per acre rates of granular dichlobenil appreciably reduced grass cover for two summers after application. Residual effects, the second summer, however, were not as great as those of terbacil.

Chlorthiamid was not quite as effective as equal rates of granular dichlobenil. This is not surprising, since chlorthiamid is converted to dichlobenil in soils (Benyon and Wright 1972), and grass control is probably achieved as dichlobenil rather than as chlorthiamid. Undoubtedly, some chlorthiamid is lost or degraded during conversion to dichlobenil in the soil, leaving less of the active ingredient to act on the grasses and broadleaf weeds.

ACP 68-72 was less effective than the chemicals described above, although it did have some residual effect the second summer after application. Development of this chemical has been discontinued by the manufacturer.

Propazine was less effective than an equal amount of atrazine per acre. Grass control with propazine was appreciably less than that obtained with atrazine the first summer after application, and residual effects on grasses the second summer were not great enough to be of practical value. Broadleaf weed control was no better than that obtained with atrazine.

Broadleaf Weed Control

Terbacil, granular dichlobenil, and **chlorthiamid** were the only chemicals that produced potentially useful reductions in forb cover. Of these, only terbacil residues produced a significant

reduction the second summer after application. Terbacil is considered the only promising chemical for use where 2-year control of competitive vegetation is desired in grass-forb communities. Until registered, however, terbacil cannot be used for this purpose on forest land.

Conifer Damage

Only **atrazine** and **terbacil** appear useful for releasing young Douglas-firs from grasses (table 3). Although the data show some damage to Douglas-fir from the 3 lb per acre rate of atrazine, most of this occurred on one tree on a dry interior valley plot. Trees sprayed with atrazine at a higher rate of 4 lb ai per acre and those treated with all rates of terbacil appeared normal, healthy, and undamaged at the end of the second summer following spraying. Newton (1969) stated that adding 2,4-D plus cacodylic acid to atrazine proved especially effective in releasing young Douglas-firs from grasses and broadleaved weeds. Adding small amounts of 2,4-D or 2,4-D plus cacodylic acid to atrazine did not damage the young firs in these tests, but their failure to appreciably increase broadleaf weed control does not seem to justify the increased expense.

Although both atrazine and terbacil should be useful for conifer release in grass-forb communities, only atrazine is registered for conifer release in western Oregon and Washington; terbacil is not. Atrazine may be used only in combination with dalapon east of the Cascade Range. Terbacil is not registered for use on forest land.

Table 3--*Young Douglas-firs killed or damaged and degree of damage sustained by the injured trees sprayed with herbicidal chemicals during March-April, 1969*

Treatment		1969					1970			
Chemical	lb/acre[1/]	Sprayed trees			Damaged trees		Sprayed trees		Damaged trees	
		Examined	Dead	Damaged	Defoliation	Crown kill	Dead	Damaged	Defoliation	Crown kill
		Number			Percent[2/]		Number		Percent[2/]	
atrazine	3	15	0	3	13	0	1	4	44	25
atrazine	4	14	0	1	20	0	0	0	0	0
atrazine D	3+1/2	15	0	1	5	0	0	1	5	4
atrazine CD	3+1/2+1/2	15	0	4	10	2	0	0	0	0
ACP 68-72	2	15	0	5	19	0	0	0	0	0
ACP 68-72	4	15	2	7	50	44	2	4	59	50
ACP 68-72	6	15	1	8	24	14	1	4	52	36
terbacil	1	15	0	2	27	2	0	1	1	1
terbacil	2	15	0	2	12	6	0	0	0	0
terbacil	3	15	0	4	10	18	0	0	0	0
dalapon	6.8	15	0	6	12	0	0	3	30	7
dalapon	13.6	15	0	9	34	4	0	7	25	7
chlorthiamid	2	15	0	3	30	0	0	2	35	2
chlorthiamid	4	15	0	3	8	3	0	1	10	2
chlorthiamid	6	15	0	0	0	0	0	0	0	0
propazine	4	15	0	0	0	0	0	1	15	0
dichlobenil WP	2	15	0	4	10	0	0	3	22	2
dichlobenil WP	4	15	0	5	11	0	1	3	52	33
dichlobenil WP	6	15	1	5	34	21	0	0	0	0
dichlobenil G4	2	15	0	3	13	0	0	2	33	5
dichlobenil G4	4	15	0	1	15	5	0	0	0	0
dichlobenil G4	6	15	0	4	30	1	0	2	17	1

1/ Active ingredient or acid equivalent as shown in table 2.
2/ Average defoliation and crown kill on the damaged trees.

Both **dalapon** and **ACP 68-72** damaged young Douglas-firs when applied as foliage sprays in these tests. Dalapon seems more suitable for site preparation rather than in broadcast sprays to release young conifers. Dalapon is the only chemical now registered for use east of the Cascade Range, where it may be used for site preparation (Stewart and Beebe 1974) or as a directed spray in combination with atrazine to release conifers in Oregon, Washington, and Idaho. Interim State registrations permit broadcast and aerial application of Dowpon® M plus atrazine mixtures as foliage sprays only west of the crest of the Cascade Range in Oregon and Washington.

This registered combination of dalapon and atrazine has proved useful in western Oregon and Washington. Newton and Overton (1973) reported that foliage sprays of dalapon injured young Douglas-firs and grand firs (*Abies grandis* (Dougl.) Lindl.). Dalapon, however, at rates of 4 to 12 lb per acre did not injure the trees when combined with atrazine and low volatile esters of 2,4-D at rates of 3 and 4 lb per acre, respectively. Newton recently indicated that use of cacodylic acid is no longer recommended in herbicidal mixtures to be applied as foliage sprays on young conifers; rates $\geq$ 1 lb per acre injure the trees[2/].

Dichlobenil and **chlorthiamid** caused some second-year defoliation of Douglas-fir seedlings. Considering its greater effect on broadleaf weeds and 2-year control of grasses, however, granular dichlobenil may prove a useful chemical for site preparation on sites occupied by mixed stands of grasses and broadleaf weeds. In England, a granular formulation of chlorthiamid is registered for release of trees from grasses and forbs, although Allen (1966) reported injury and mortality in conifers treated with 5 to 8 lb ai of chlorthiamid per acre. Chlorthiamid is not registered for forest use in the United States.

SUMMARY

Atrazine and **terbacil** proved the most useful chemicals for grass control and conifer release in these tests. Foliage sprays of both chemicals controlled grasses without permanent damage to Douglas-fir seedlings. For many years, atrazine at 4 lb ai per acre has proved effective in releasing young conifers from grasses without damaging the trees, but it is effective for only one summer and does not control broadleaf weeds. Terbacil at 2 lb ai per acre appears promising as an alternative. Although this chemical damaged a few firs during the first summer after spraying, no trees were killed and all were healthy and vigorous at the end of the second summer.

Granular dichlobenil at 4 to 6 lb ai per acre also controlled grasses and forbs for two summers but produced persistent damage on young Douglas-firs. Dichlobenil seems potentially more useful for site preparation than for conifer release on sites occupied by grasses and broadleaf weeds. Because of persistent damage through the second summer, reforestation would probably have to be delayed until at least three summers elapse after application. By that time, however, grass and broadleaf weed control may not be sufficient to favor the conifers; benefits may not warrant the expenditure.

2/ Personal communication, August 1976.

LITERATURE CITED

Allen, M. G.
1966. Experiments with 2,6-dichlorothiobenzamide (chlorthiamid) in planted areas of soft and hardwoods. Proc. 8th Brit. Weed Control Conf., p. 135-140. (Cited from Weed Abstr. 16(2): 511.)

Beynon, K. I., and A. N. Wright.
1972. The fate of the herbicides chlorthiamid and dichlobenil in relation to residues in crops, soils, and animals. Residue Rev. 43: 23-53.

Newton, M.
1969. Herbicide interaction in reforestation grass sprays. *In* 1969 Res. Prog. Rep., West. Soc. Weed Sci., p. 23-30.

Newton, M., and W. S. Overton.
1973. Direct and indirect effects of atrazine, 2,4-D, and dalapon mixtures on conifers. Weed Sci. 21(4): 269-275.

Stewart, R. E., and T. Beebe.
1974. Survival of ponderosa pine seedlings following control of competing grasses. Proc. West. Soc. Weed Sci. 27: 55-58.

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.

GPO 997-643