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SUPPLEMENTAL TREATMENTS TO AID PLANTED DOUGLAS-FIR IN DENSE BRACKEN FERN

by

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Why do some forest lands restock quickly and well after timber cutting but others do not? Answers have been slow in coming--partly because of empiricism in research, partly because of the problem's general complexity. A part of the general problem concerns the poor survival of planted Douglas-fir (Pseudotsuga menziesii var. menziesii) on cutovers densely infested with western bracken fern (Pteridium aquilinum pubescens). Though there is some evidence that bracken can serve as an effective "nurse" cover to Douglas-fir,[1/] a generalization about bracken's protection of natural or planted seedlings would be misleading under certain conditions. On sites where bracken grows to 6 feet in height, as in Washington's coastal zones, growth and survival of planted trees is effectively reduced,[2/] and natural regeneration is virtually eliminated.

To survive, an individual conifer seedling must successfully compete for light, nutrients, and moisture as well as withstand the annual smothering effect of the matted, dead fern fronds. Also,

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[1/] McCulloch, W. F. The role of bracken fern in Douglas-fir regeneration. Ecology 23: 484-485. 1942.

[2/] Worthington, Norman P. A comparison of conifers planted on the Hemlock Experimental Forest. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 111, 5 pp. 1955.

because areas of dense bracken fern form highly favorable habitats for wildlife, browsing and clipping by various mammals may seriously curtail growth--and ultimately survival--of young conifers.[3/]

THE STUDY

A planting site under dense bracken fern cover was selected on the Hemlock Experimental Forest[4/] near Hoquiam, Wash. The area was logged about 1900, and repeated subsequent fires presumably stimulated bracken growth and eliminated most conifer regeneration. Surrounding conifer stands now contain western hemlock (Tsuga heterophylla), either pure or in mixture with Douglas-fir and western redcedar (Thuja plicata), ranging in age from 45 to 60 years.

Objectives.--The purpose of study was to assess the value of a fertilizer application and of two mechanical fern-suppression methods, used in conjunction with planting Douglas-fir on the above site. The fertilizer used was a pelletized, slow-release type.[5/] The two mechanical treatments were use of paper overlays and periodic cutting of bracken, both applied around individual seedlings.

Experimental design.--Six treatments were tested in a randomized block design:

1. Seedlings unfertilized, control
2. Seedlings unfertilized, building paper overlay
3. Seedlings unfertilized, bracken periodically cut
4. Seedlings fertilized, control
5. Seedlings fertilized, building paper overlay
6. Seedlings fertilized, bracken periodically cut

A row of 25 seedlings was used per treatment, and treatments were randomized within each block. The three adjacent replications required the planting of 450 seedlings (18 rows of 25 per row) at an 8- by 8-foot spacing.

[3/] Staebler, George R., Lauterbach, Paul, and Moore, A. W. Effect of animal damage on a young coniferous plantation in southwest Washington. Jour. Forestry 52: 730-733. 1954.

[4/] Maintained in cooperation with St. Regis Paper Co.

[5/] Austin, R. C., and Strand, R. F. The use of slowly soluble fertilizers in forest planting in the Pacific Northwest. Jour. Forestry 58: 619-627, illus. 1960.

Treatments.--Seedlings used for the test were standard 2-0 Douglas-fir stock that had been raised at the Capitol Forest Nursery of the Washington State Department of Natural Resources from seed gathered near Quinault, Wash. Seedlings were planted during April 10 to 18, 1957.

Fertilizer was applied at time of planting by dropping one nitrogen-phosphorus fertilizer pellet[6/] into each planting hole. Placement of a pellet just below the roots of a seedling required only slight additional effort to normal slit-planting routine. A small amount of soil was allowed to cover each pellet to reduce possible "burning" of seedling roots.

For the paper treatment, double thickness kraft paper, with an asphalt sticker between the paper layers, was placed on the ground surrounding each seedling. Overlays measured 2 by 3 feet with a 1-inch hole in the center to accommodate the seedling. Installation required some scalping of dead bracken fronds and other brush to insure a close contact between ground and paper. Available loose dirt, wood chunks, or other debris were used to hold down corners of each overlay. Scalping and paper-laying were moderately time consuming.

Periodic bracken cutting treatment was preceded at time of planting by scalping all dead fronds, brush, and roots down to mineral soil for a radius of 30 inches around each seedling. Done with a planting hoe, scalping was the most laborious treatment supplemental to normal planting. Developing fern fronds, were then cut back by hand sickle as they reached a height between 2 and 3 feet. Cuttings were in May, June, and July of each growing season for 3 years, and each cutting required about 3 man-hours.

Since considerable animal damage was anticipated at the outset, some means of protecting the seedlings was needed to reduce the confounding of test results. All seedlings had been sprayed in the nursery with ZAC repellent before outplanting, and later control was

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[6/] Individual pellets weighed 15 grams with 11.25 grams of N source and 3.75 grams of P source. Source compounds were urea-formaldehyde and phosphoric acid. Pellets for the study were supplied by Crown Zellerbach Corp.

attempted by annually spraying each seedling with a contact repellent--primarily to discourage clipping by snowshoe rabbits (Lepus americanus washingtonii Baird). Spraying was carried out during late summer or early fall coincident with each annual examination.[7/]

Since paper overlays proved ineffective during the first few growing seasons, all seedlings thus treated were given a supplementary chemical treatment on July 29, 1960, to reduce bracken competition and to assess the effect of an experimental phytocide spray on planted Douglas-fir seedlings. The chemical[8/] was applied in 8-foot strips on the six rows previously treated with paper overlays. Solution strength was 8 pounds acid equivalent of active ingredient per 100 gallons of water. Spraying was done with a backpack pump can when bracken fronds were at nearly full development. An application rate of 50 gallons solution per acre was approximated.

RESULTS

No treatment especially enhanced total height growth or survival of planted Douglas-fir seedlings (table 1). Mechanical bracken suppression with paper overlays, followed by chemical suppression 3 years later, significantly reduced both total seedling height growth and survival. However, this reduction was slight, and stocking currently remains at acceptable levels.

[7/] Harry Hartwell, formerly of the U.S. Fish and Wildlife Service and now Wildlife Biologist, Department of Natural Resources, State of Washington, assisted in all annual plantation measurements and repellent spraying operations. Sprays used were: 1957 (in nursery), 10 percent ZAC (Zinc dimethyldithiocarbamate cyclohexylamine complex); 1957, 10 percent ZAC; 1958, 10 percent ZAC; 1959, 10 percent ZAC plus TMTD (Tetramethylthiuram disulfide); 1960, 10 percent TMTD; 1961, 10 percent TMTD; 1962, 10 percent TMTD.

[8/] The chemical was supplied by John H. Kirch of Amchem Products, Inc. Designated as ACP M-251, the formulation contained 4 pounds per gallon of butoxy ethanol ester of 4-chloro-phenoxy acetic acid.

Table 1.--Condition of Douglas-fir seedlings in 1962

Treatment	Average total height	Survival	Average annual incidence of animal damage[1/]		
			Rabbits	Deer	Both
	Inches	Percent	Percent		
Unfertilized:					
Control	17.9	79	23	5	28
Paper overlay	12.6	63	20	6	26
Bracken cutting	19.1	84	35	13	48
Fertilized:					
Control	18.7	85	25	4	29
Paper overlay	14.3	72	23	7	30
Bracken cutting	20.3	88	41	12	53

1/ Animal damage included only removal of the upper portion of the terminal shoot--either through clipping by hares or browsing by deer. Browsing or clipping of lateral shoots was ignored.

A notable incidental result was the comparatively high level of clipping by rabbits[9/] and browsing by black-tailed deer (Dama hemionus columbiana (Richardson))[10/] of seedlings that had been released from bracken competition by periodic frond cutting.

Fertilizer.--Pelletized fertilizer gave little stimulus to Douglas-fir seedling growth or survival, and no burning effects were noted. Treatment means indicate that the fertilized seedlings were somewhat taller in all years (table 2) and survived slightly better after 1959 (table 3). However, these differences when tested at the 5-percent level of probability failed to show significance.

9/ Mountain beaver (Aplodontia rufa rufa (Rafinesque)) frequented the experimental site and may have caused some of the damage attributed to rabbits.

10/ Wapiti (Cervus canadensis roosevelti Merriam) may also have caused some of the browsing damage recorded.

Table 2.--Average total height of Douglas-fir seedlings

Treatment	1957	1958	1959	1960	1961	1962
	Inches					
Unfertilized:						
Control	4.3	4.8	7.9	11.6	17.3	17.9
Paper overlay[1/]	4.2	4.4	7.1	10.0	11.7	12.6
Bracken cutting	4.3	4.2	7.4	10.6	15.7	19.1
Fertilized:						
Control	5.0	5.7	8.9	11.9	16.8	18.7
Paper overlay[1/]	4.3	4.9	8.2	11.3	13.9	14.3
Bracken cutting	4.7	4.6	8.0	11.7	18.0	20.3

[1/] Effects of phytocide spray superimposed from 1960 through 1962.

Table 3.--Survival of Douglas-fir seedlings

Treatment	1957	1958	1959	1960	1961	1962
	Percent					
Unfertilized:						
Control	97	95	85	81	80	79
Paper overlay[1/]	97	88	76	71	68	63
Bracken cutting	99	93	87	85	84	84
Fertilized:						
Control	97	91	89	85	85	85
Paper overlay[1/]	100	93	84	76	73	72
Bracken cutting	100	93	91	89	88	88

[1/] Effects of phytocide spray superimposed from 1960 through 1962.

Paper overlays. -- The failure of paper overlays to achieve desired objectives was obvious within the first few months of the 1957 growing season. The paper was ineffective in either suppressing bracken or protecting seedlings. Vigorous bracken shoots penetrated the paper in most instances or grew up around its edge and partially lifted the overlay from the ground. In a few cases, the lifted paper blocked sunlight and killed the seedling. Furthermore, a number of papers were dislodged or penetrated by the hooves of deer. However, no significantly adverse effects from the paper overlays occurred during the first three growing seasons, at the end of which time the paper had almost completely disintegrated.

The spraying with phytocide in 1960 had some measurable consequences. All fronds within each application zone were killed back the first season after spraying. Evidently, a considerable quantity of chemical also reached the underlying rhizomes, since frond growth was severely curtailed in 1961 and moderately suppressed in 1962. This result seems particularly important since the treated zones were narrow (8 feet) and surrounded by healthy plants that could be expected to hasten regrowth of the treated bracken.

Nearly all seedlings within the sprayed zones were adversely affected by chemical treatment. Needle browning was common, as was a peculiar fusing of needles on some growing shoots. Increased mortality of seedlings within the sprayed zones was significant (5-percent level) by 1962 (table 3). Total height was reduced--the differences being highly significant (1-percent level) in 1961 and significant (5-percent level) in 1962.

Bracken cutting. -- This treatment is of interest--more because of its effect on animal damage to seedlings than its influence on growth or survival. During the 1957 season, rabbits clipped terminal shoots on 72 percent of all planted Douglas-fir seedlings. Moreover, the damage to seedlings exposed by bracken cutting (85 percent) differed with high significance (1-percent level) from that to the controls (66 percent). Though this trend seemed to persist (table 4) in ensuing years, it was not again significant (1-percent level) until 1960. During that year, browsing by deer was recorded for the first time. Both browsing and clipping damage on the bracken cutting treatments differed with high significance (1-percent level) from that on controls during 1961. However, only browsing damage remained significant (1-percent level) in 1962. Retarded growth of fern fronds, though ameliorating, was still evident 3 years after

periodic cutting had ceased. Curiously, clipping by rabbits in 1962, though moderate throughout all treatments, was significantly greater (1-percent level) on fertilized than on unfertilized seedlings.

Table 4.--Annual incidence of animal damage to terminal shoots of Douglas-fir seedlings

Type of damage and treatment	1957	1958	1959	1960	1961	1962	Annual average 1957-62
	Percent						
Clipping (rabbits):							
Unfertilized:							
Control	68	48	5	7	3	8	23
Paper overlay	57	35	11	8	1	9	20
Bracken cutting	79	41	7	55	17	15	35
Fertilized:							
Control	65	37	1	19	4	23	25
Paper overlay	72	32	9	9	3	13	23
Bracken cutting	91	51	3	67	13	20	41
Browsing (deer):							
Unfertilized:							
Control	0	0	0	1	1	25	5
Paper overlay	0	0	0	0	3	29	6
Bracken cutting	0	0	0	11	16	49	13
Fertilized:							
Control	0	0	0	0	3	21	4
Paper overlay	0	0	0	1	3	36	7
Bracken cutting	0	0	0	5	12	57	12

DISCUSSION AND CONCLUSIONS

Seedling survival was surprisingly high despite very heavy bracken competition. Even in the unfertilized control treatment, 79 percent of the seedlings survived after 6 years. Exceptionally good first-year survival (averaging 98 percent for all treatments) probably contributed greatly to this performance record. In an earlier planting study in the same general area, only 50 percent of the seedlings survived after 6 years.

Seedling height on all treatments, averaging 17.2 inches 6 years after planting, remained low. Both these results--high survival and poor height growth--undoubtedly tended to obscure treatment effects.

Contrary to general opinion, which holds that most animal damage occurs during the late fall, winter, and early spring months, the bulk of browsing and clipping damage appeared to have occurred during the summer. Fresh clipping by rabbits was common in nearly all years in the late summer. Browsing, on the other hand, seemed to be concentrated around late June or early July, when terminal shoots were nearing full growth but still succulent. A similar pattern of summer damage was recorded on 100 unsprayed seedlings planted adjacent to the study. Since spraying with contact repellent was done only at examination time, spray applications were, for the most part, ineffective in protecting seasonal shoot growth.

A definite change from clipping by rabbits in the early years of the study toward browsing by deer in later years (table 5) was apparent. This change seemed logical since small seedlings growing under dense cover would probably be less attractive to deer or wapiti than larger ones. The seedlings appeared equally attractive to rabbits and deer in 1961 but more attractive to deer in 1962.

The more frequent browsing and clipping damage to seedlings released by periodic fern cutting was undoubtedly due to increased seedling exposure. The harmful effects of increased animal damage in this treatment, however, appeared to be offset by the benefits of release from bracken competition since final heights and survival did not differ significantly from the controls.

Of greatest import was the extremely slow growth of Douglas-fir seedlings under all treatments. Seedlings averaged only about 17 inches in total height 5 years after planting, or 7 years from seed.

Several more years will be necessary for the seedlings to outstrip bracken and show reduced susceptibility to animal damage. On forest lands of high site quality, such long regeneration periods are excessively costly in time and expense. Measures more effective than those tested are needed to supplement planting in regenerating Douglas-fir under dense bracken cover.