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Growth of Douglas-fir in Southwestern Oregon After Removal of Competing Vegetation

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Abstract

After three growing seasons, young Douglas-fir trees in plots of various sizes that had been totally cleared of nonconifer vegetation were larger than trees in plots that had been partially cleared or not cleared at all. On the Bybee unit (Illinois Valley Ranger District, Siskiyou National Forest), height and diameter differences were highly significant between treatments. Diameter differences between the treatments were highly significant on the Squaw unit (Illinois Valley Ranger District, Siskiyou National Forest).

Keywords: Competition, Douglas-fir growth, brush removal.

Introduction

Southwestern Oregon is an important timber-growing region where the growth of conifer crop trees is often perceived to be hampered by competition from hardwood trees, shrubs, and nonwoody vegetation. The region has a prolonged dry season (May through September), in which only about 13 percent of the average annual precipitation occurs (McNabb and others 1982). These characteristics have led to a need to quantify the interactions among commercial conifers and other plant species.

Growth of crop trees can often be increased by reduction or elimination of vegetation that competes with the trees for site resources such as light and moisture. Stewart and others (1984) have compiled and abstracted an extensive bibliography that reports numerous studies describing vegetation management strategies that enhance growth of several commercial tree species. For instance, in the McKenzie River drainage of the Oregon Cascades, Petersen and Newton (1982) found that 5- and 10-year-old Douglas-fir stands showed greater height growth when they were released from snowbrush (*Ceanothus velutinus* Dougl.) and forbs.

Oliver (1984) found that competing brush significantly reduced the growth of thinned ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) in northern California. He found that stem volume production increased dramatically when brush was removed. McDonald (1982) reported that after 19 years, planted pines growing with manzanita (*Arctostaphylos* spp. Adans.) and ceanothus (*Ceanothus* spp. L.) were only 27 percent as large in diameter and 35 percent as tall as pines free of brush competition.

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In the Coast Ranges of Oregon and Washington, Harrington and Wagner (1986) found that diameter growth of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) was enhanced by removal of vegetation. Petersen and Newton (1985) determined that in the Cascade Range of Oregon, Douglas-fir growth in 5- and 10-year-old plantations was dependent on the extent of brush control, the age of the Douglas-fir trees when they were released, and the method of release. In southwestern Oregon, Hobbs and Wearstler (1985) found that the growth rate of Douglas-fir temporarily increased soon after brush removal, but 3 years later, differences in the growth rate in treated areas were not significant. They pointed out that additional information was needed about how tree growth is affected by various amounts of competing vegetation.

This note reports the growth responses of planted Douglas-fir seedlings after 3 years of treatment to various levels of competition. Treatments used to obtain these growth responses are not recommended as potential management strategies. The treatments were used primarily to create different ecological environments to test seedling response to such environments.

Study Methods

Study Sites

The study was located on two clearcuts on the Illinois Valley Ranger District of the Siskiyou National Forest near Cave Junction, Oregon. Bybee, a 25-acre unit, is at an elevation of 2,400 feet (732 m). Located directly south of Cave Junction near the east fork of the Illinois River, it has a 45-percent slope that faces primarily southeast. The unit was harvested in 1976. Woody, nonconifer species were cut by hand after logging, and the unit was planted with 2-0 bare-root Douglas-fir seedlings in 1979. Two years after planting, study plots were established and treatment was begun.

The 96-acre Squaw unit is at an elevation of 2,800 feet (853 m). This unit is east of Cave Junction and about 16 air miles northeast of the Bybee unit. It has a 30-percent southwest-facing slope and was harvested in 1980. Woody, nonconifer species were cut by hand the same year. The unit was broadcast burned shortly before it was planted with 2-0 bare-root Douglas-fir seedlings in 1981. In 1982, study plots were installed and treatment was begun. Both sites have loamy soils and a site index of 110.

Major associated species on the Bybee unit are tanoak (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.), Pacific madrone (*Arbutus menziesii* Pursh), several manzanita species, poison oak (*Rhus* spp. L.), snowbrush (*Ceanothus velutinus* Dougl.), and deerbrush (*Ceanothus integerrimus* H. & A.). The same species are prevalent on the Squaw unit except that poison oak is virtually absent. The woody vegetation on both units was not much taller than or was about the same height as the conifers when the study was begun (fig. 1). The conifers were not overtopped.

Figure 1—Vegetation on the Bybee unit in spring 1981 when study plots were established.

Study Design

The experimental treatments were seven levels of vegetation control around Douglas-fir seedlings—15 per treatment on the Bybee unit and 10 per treatment on the Squaw unit. The treatments were randomly assigned to healthy planted trees that were at least 24 feet (7.3 m) apart within a 528- by 528-foot (161- by 161-m) area on the Bybee unit and a 432- by 432-foot (132- by 132-m) area on the Squaw unit. The treatments were:

1. No vegetation removed (untreated control).
2. One-half of the vegetation (based on stem or plant counts) periodically removed within a 4-foot (1.2-m) radius of the seedling.
3. One-half of the vegetation periodically removed within an 8-foot (2.4-m) radius.
4. One-half of the vegetation periodically removed within a 12-foot (3.7-m) radius.
5. All vegetation periodically removed within a 4-foot (1.2-m) radius of the seedling.
6. All vegetation periodically removed within an 8-foot (2.4-m) radius.
7. All vegetation periodically removed within a 12-foot (3.7-m) radius.

Monthly during each growing season, vegetation was removed from the plots by cutting at ground level, pulling, or grubbing.

Douglas-fir growth was determined from total heights and stem diameters at 6 inches (15 cm) above the ground at the beginning and end of each growing season. These data were analyzed separately for each cutting unit with analysis of variance and the Duncan's multiple range test (Gomez and Gomez 1984).

Results and Discussion

Bybee Unit

Over all treatments, the mean total height of Douglas-firs tripled in three growing seasons (table 1). Diameters averaged over all treatments also increased nearly threefold (table 2). Growth of the conifers among the treatments differed significantly. Trees totally free of competing vegetation for a radius of 12 feet had the greatest gains in growth, followed by those free for an 8- and a 4-foot radius. Least growth occurred in the control plots. Heights of trees in untreated control plots differed significantly from those in plots that were totally cleared of competing vegetation (table 1). Significant differences in growth also occurred between those plots that had been partially cleared and those that had been totally cleared. Diameter growth responses followed the same pattern as height growth (table 2).

Tanoak, poison oak, and deerbrush were the most abundant woody plant species throughout the unit (table 3). Overall, in three growing seasons, the average number of stems per acre increased by 10,681. Deerbrush showed the largest percentage increase, followed by snowbrush, poison oak, and tanoak. The reduction in numbers of manzanita and Pacific madrone (table 3) was likely caused by winter kill (heavy snow creep that resulted from steep slopes). The conifers were overtopped by nonconifer species in the control plots (fig. 2).

Table 1—Average total height of Douglas-fir at the beginning of the study and after 3 growing seasons on the Bybee unit, Illinois Valley Ranger District, Siskiyou National Forest, Oregon

Treatments	Height[a] March 1981	October[b] 1983	Growth,[c] 1981-83	Gain
	- - - - - Centimeters	- - - - -		Percent
Untreated control (not cleared)	37.3a	96.9a	59.6a	260
Partially cleared to 4-foot radius	39.9a	101.5ab	61.6ab	254
Partially cleared to 8-foot radius	43.8a	119.6abc	75.8abc	273
Partially cleared to 12-foot radius	45.6a	125.2abc	79.6abc	275
Totally cleared to 4-foot radius	42.9a	131.5bcd	88.6abcd	307
Totally cleared to 8-foot radius	42.3a	140.3cde	98.0cd	332
Totally cleared to 12-foot radius	41.1a	146.9cde	105.8d	357
Average	41.8	123.1	81.3	294

[a]Means followed by the same letter in each column are not significantly different from each other at the 5-percent probability level (Duncan's multiple range test).

[b]Analysis of variance shows highly significant treatment differences in heights of Douglas-fir. F=3.228 (probability level < 0.01).

[c]Analysis of variance shows highly significant treatment differences in height growth responses of Douglas-fir. F=4.222 (probability level < 0.001).

Table 2—Average total stem diameter of Douglas-fir at the beginning of the study and after 3 growing seasons on the Bybee unit, Illinois Valley Ranger District, Siskiyou National Forest, Oregon

Treatments	Stem diameter[a] March 1981	October[b] 1983	Growth,[c] 1981-83	Gain
	- - - - - Centimeters	- - - - -		Percent
Untreated control (not cleared)	9.3a	19.6a	10.3a	211
Partially cleared to 4-foot radius	9.4a	21.2a	11.8a	226
Partially cleared to 8-foot radius	10.3a	25.7ab	15.4ab	250
Partially cleared to 12-foot radius	10.9a	29.8bc	18.9b	273
Totally cleared to 4-foot radius	10.7a	30.1bc	19.4b	281
Totally cleared to 8-foot radius	10.7a	35.6cd	24.9c	333
Totally cleared to 12-foot radius	10.3a	38.1d	27.8c	370
Average	10.2	28.6	18.4	278

[a]Means followed by the same letter in each column are not significantly different from each other at the 5-percent probability level (Duncan's multiple range test).

[b]Analysis of variance shows highly significant treatment differences in diameters of Douglas-fir. F=8.965 (probability level < 0.001).

[c]Analysis of variance shows highly significant treatment differences in diameter growth responses of Douglas-fir. F=11.336 (probability level < 0.001).

Table 3—Average number of stems per acre for the most abundant woody plants on the Bybee and Squaw units, Illinois Valley Ranger District, Siskiyou National Forest, Oregon

Species	Bybee March 1981	October 1983	Gain	Squaw May 1982	October 1984	Gain
	- Stems per acre -		Percent	- Stems per acre -		Percent
Deerbrush	687	3,513	411	181	2,950	1,530
Manzanita	353	340	0	48	60	25
Pacific madrone	340	225	0	674	2,541	277
Poison oak	931	3,956	325	0	0	0
Snowbrush	161	816	407	0	0	0
Tanoak	3,391	7,694	127	16,305	17,497	7
Total overall	5,863	16,544	182	17,208	23,048	34

Figure 2—Douglas-fir tree in untreated control plot overtopped by competing vegetation on the Bybee unit in spring 1983.

Squaw Unit

Overall, total height of Douglas-firs increased five times in three growing seasons (table 4). Trees freed from competing vegetation to an 8-foot radius were the tallest, followed by trees in plots partially cleared to a 12-foot radius and plots totally cleared to a 12-foot radius. Least growth occurred in plots partially cleared to a radius of 8 feet. The differences, however, were not statistically significant. Plots partially cleared to a 12-foot radius and plots totally cleared to 8- and 12-foot radii did show above-average growth (table 4). Control plots, plots partially cleared to 4 and 8 feet, and plots totally cleared to 4 feet were below average.

Diameters increased, on the average, almost fivefold (table 5). Average diameters were largest in plots totally cleared to radii of 12, 8, and 4 feet. Trees grew least in plots partially cleared to 8 feet. The differences in diameters were highly significant. Diameters of trees in the control plots and plots partially cleared to 4- and 8-foot radii were significantly smaller than those in plots totally cleared of vegetation to 8- and 12-foot radii.

Tanoak, deerbrush, and Pacific madrone are the most abundant species throughout the Squaw unit (table 3). The overall average number of stems per acre increased by 5,840 in three growing seasons.

Table 4—Average total height of Douglas-fir at the beginning of the study and after 3 growing seasons on the Squaw unit, Illinois Valley Ranger District, Siskiyou National Forest, Oregon

Treatments	Height[a] March 1982	October 1984	Growth, 1982-84	Gain
	- - - - - Centimeters - - - - -			Percent
Untreated control (not cleared)	24.8a	119.6a	94.8a	482
Partially cleared to 4-foot radius	21.3a	118.0a	96.7a	554
Partially cleared to 8-foot radius	23.3a	107.9a	84.6a	463
Partially cleared to 12-foot radius	24.7a	136.0a	111.3a	551
Totally cleared to 4-foot radius	25.4a	114.5a	89.1a	451
Totally cleared to 8-foot radius	24.9a	138.3a	113.4a	555
Totally cleared to 12-foot radius	21.5a	132.5a	111.0a	616
Average	23.7	123.8	100.1	525

[a]Means followed by the same letter in each column are not significantly different from each other at the 5-percent probability level (Duncan's multiple range test).

Table 5—Average total stem diameter of Douglas-fir at the beginning of the study and after 3 growing seasons on the Squaw unit, Illinois Valley Ranger District, Siskiyou National Forest, Oregon

Treatments	Stem diameter[a] March 1982	October[b] 1984	Growth,[c] 1982-84	Gain
	- - - - - Centimeters - - - - -			Percent
Untreated control (not cleared)	5.4a	20.0a	14.6a	370
Partially cleared to 4-foot radius	4.8a	21.5a	16.7a	448
Partially cleared to 8-foot radius	4.2a	18.4a	14.2a	438
Partially cleared to 12-foot radius	5.8a	25.1ab	19.3ab	433
Totally cleared to 4-foot radius	4.8a	25.6ab	20.8abc	533
Totally cleared to 8-foot radius	5.1a	30.2b	25.1bc	592
Totally cleared to 12-foot radius	4.3a	31.9b	27.6c	742
Average	4.9	24.7	19.8	508

[a]Means followed by the same letter in each column are not significant from each other at the 5-percent probability level (Duncan's multiple range test).

[b]Analysis of variance shows highly significant treatment differences in diameters of Douglas-fir. F=3.402 (probability level < 0.001).

[c]Analysis of variance shows highly significant treatment differences in diameter growth response of Douglas-fir. F=3.836 (probability level < 0.01).

Nonconifer vegetation likely plays an important role in soil moisture depletion. Hallin (1967) found that soil moisture depletion rates are similar in clearcuts and adjacent forest stands. He concluded that vegetation that invaded a clearcut is as effective in depleting soil moisture as the conifers in an adjacent old-growth stand. Conard (1986) observed that soil moisture depletion is more rapid under oceanspray (*Holodiscus* Maxim.) and redstem ceanothus (*Ceanothus sanguineus* Pursh) than under greenleaf manzanita (*Arctostaphylos patula* Greene). She reports that this moisture depletion difference is most likely to occur early in the growing season when conifers are growing in height. Conard's data suggest that deciduous species may be stronger competitors than evergreen species; however, both evergreen and deciduous species can deplete soil moisture to the same level by the end of the growing season. Soil moisture depletion becomes an important factor because conifers can increase in diameter in late summer and early fall if temperature and moisture are adequate.

Although lower in elevation than the Squaw unit, Bybee is steeper (45-percent slope compared with 30-percent on Squaw), and the soils are shallower. Manzanita, snowbrush, and poison oak were more abundant on Bybee than on Squaw, where Pacific madrone and tanoak were more numerous. Deerbrush is abundant on both units and showed the largest percentage increases per acre over time.

Conclusions

Three years of measurements clearly indicate that complete elimination or reduction of nonconifer plant species from around a Douglas-fir crop tree can contribute significantly to the growth of that tree (figs. 3 and 4). Removal of vegetation greatly enhanced the height and diameter growth of Douglas-fir on the Bybee unit and the diameter growth of Douglas-fir on the Squaw unit. Complete removal of vegetation to 8- and 12-foot radii around crop trees can significantly increase conifer growth. Test trees in the 4-foot, totally cleared plots were not shaded by other vegetation; however, the proximity and extension into the plots of roots from vegetation at the perimeter may have had an impact on soil moisture availability over time. Fine root production of nonconifer species was reduced considerably by clearing vegetation to greater distances from the test trees. Eliminating or reducing the number of roots of competing vegetation could increase moisture resources for the conifers, an important factor when moisture is limited by hot, dry growing seasons. These moisture and seasonal factors, in addition to differences in site characteristics and in competing vegetation between the Bybee and Squaw units, probably account for the differences in the height growth responses of Douglas-fir to vegetation removal.

Although this study was not intended to provide management guidelines for removal of nonconifer vegetation from Douglas-fir plantations (to clear monthly is impractical), results do indicate that even partial removal of some vegetation can enhance conifer growth. The data reported here substantiate some of the information already known about competitive interactions between conifers and other woody plant species.

Figure 3—Douglas-fir tree in plot cleared to 8-foot radius: A. Fall 1981. B. Fall 1983.

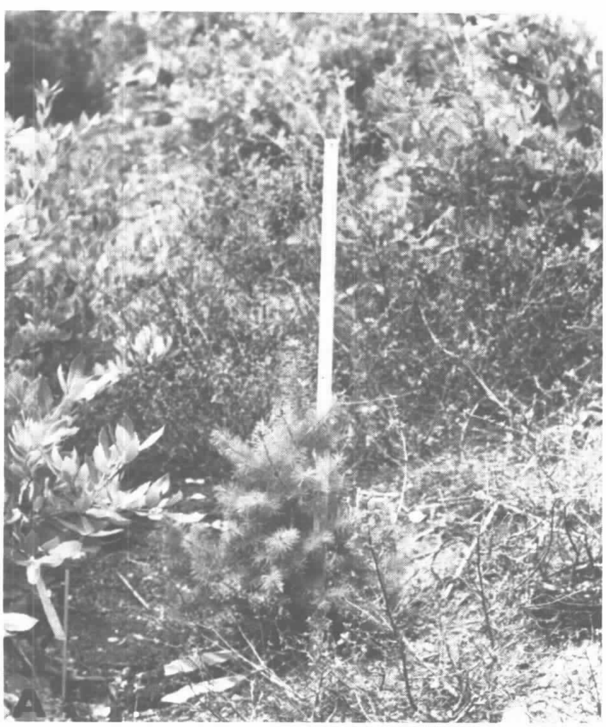

Figure 4—Douglas-fir tree in control plot: A. Fall 1981. B. Fall 1983.

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