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SEEDBED TREATMENTS INFLUENCE SEEDLING DEVELOPMENT IN WESTERN LARCH FORESTS

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ABSTRACT

Studies in 12- to 15-year-old western larch stands at Coram Experimental Forest in northwestern Montana show that condition of the seedbed at the time of seedling establishment strongly influences seedling development. Larch regenerates abundantly, grows rapidly, and becomes dominant where prescribed burning or mechanical scarification has reduced the amount of competing vegetation. In contrast, Douglas-fir is less sensitive to seedbed conditions for both establishment and growth. With reduced competition from larch, it subsequently dominates stands where seedbeds had little or no preparation.

Seedling and sapling stands are steadily replacing harvested old-growth western larch (Larix occidentalis Nutt.) in the northern Rocky Mountains.[2] Condition of seedbeds after harvesting is a key factor influencing initial establishment of these young stands in terms of species composition and distribution. Treatments that expose mineral soil and reduce competing vegetation favor natural regeneration of all species represented here but particularly favor western larch and Engelmann spruce. Conversely, site treatments that expose little or no mineral soil and do not destroy other vegetation discriminate against these two species and result in establishing a greater proportion of Douglas-fir and subalpine fir.

Do these initial differences expressed on various seedbeds during regeneration persist and influence the subsequent development of the new seedlings? Young stands that started on a variety of seedbeds in larch forests of northwestern Montana provided opportunity to answer this question.

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[2]Western larch grows in association with a wide variety of species. In this study primary associates were Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.)), Engelmann spruce (Picea engelmannii Parry), subalpine fir (Abies lasiocarpa Hook.), lodgepole pine (Pinus contorta Dougl.), and western white pine (Pinus monticola Dougl.).

STUDY AREAS AND PROCEDURES

Two stand development studies--one called Terrace Hill, the other Coram--were conducted on the Coram Experimental Forest on plots originally established to study effects of different types of seedbed on natural regeneration. Seed tree cuttings, made about 1945, were used for the original seedbed tests.[3] Seedling stands became established on all of the different seedbeds and now furnish the information used in this stand development report. Analyses here are based primarily upon data for a 5-year period in each stand--age 10 to 15 on the Terrace Hill study and age 7 to 12 on the Coram study.

TERRACE HILL

The Terrace Hill plots were on the lower half of a northeast slope and have a larch site index of 58 feet at 50 years--a medium site. Individual records were kept of all trees 1 foot and taller on 60 systematically located milacre quadrats. Initial seedbed conditions were:

Previous treatment	Initial seedbed conditions
Scarification plus removal of remaining understory	Mineral soil exposed by heavy tractor skidding; plus practically all remaining understory vegetation removed.
Scarification only	Mineral soil exposed by heavy tractor skidding; some major shrubs and residual understory trees left intact.
Removal of understory vegetation only	Litter and duff left intact; major shrubs and residual understory trees cut.
None	Litter, duff, and understory vegetation left intact.

CORAM

Plots for the Coram study were on middle north and lower south slopes. The average larch site index was 46 feet at 50 years. On the Coram study site, all trees 6 feet and taller were measured individually on 109 randomly located 4-milacre quadrats. The initial seedbed conditions were as follows:

Previous treatment	Initial seedbed conditions
Burning	Mineral soil exposed by prescribed burning; most understory vegetation killed.
Disking	Mineral soil exposed by light disking; some shrubs and grass killed.
Removal of understory vegetation only	Litter and duff left intact; major shrubs and understory trees cut.
None	Litter, duff, and understory vegetation left intact.

[3]These studies were planned and installed by K. N. Boe, A. L. Roe, R. C. Shearer, and A. E. Squillace.

RESULTS

The seed tree overstory and small understory trees left after logging produced enough seed during the 12- to 15-year study periods to stock all of the areas adequately--regardless of seedbed. However, there were important differences in seedling growth, species composition, and dominance on the different seedbeds.

GROWTH

Larch seedlings grew best on intensively prepared seedbeds. The more thoroughly vegetative competition was destroyed, the faster the trees on those areas grew in height. Dominant larch at Terrace Hill grew more than twice as fast on the scarified seedbeds as they did on plots that had had no seedbed treatment (table 1). The Coram study indicated the same relation--trees on plots that had been burned grew the fastest. McNamara and Reigner[4] reported similar results with Japanese larch (Larix leptolepis (Sieb. and Zucc.) Gord.). Height growth was significantly greater where seedbed preparation had been intensive.

Trees with rapid initial growth improved their relative position in the stand as they grew older. At Terrace Hill, for example, dominant larch that were 10 feet tall at age 10 grew 8 feet in the next 5 years while those that were only 5 feet tall at age 10 added only 5 feet in height during the same period.

Tree vigor can also be a good indicator of future performance. All trees at Terrace Hill, including all species and crown classes, were classified into three broad categories of vigor[5] when the study was started (fig. 1). Good vigor larch trees grew about six times faster than the poor vigor trees. Lodgepole pine, Douglas-fir, and subalpine fir showed the same relation as larch, but the characteristically slow growing spruce seedlings did not demonstrate as much growth difference between trees of different vigor classes as the other species. Good vigor spruce trees grew only twice as fast as the poor vigor trees.

Table 1.--Heights of dominant larch, 10 and 15 years old, on seedbeds at Terrace Hill

Treatment	Average height		Average 5-year height growth[1]
	10 years old	15 years old	
	Feet		
Scarification, and understory removed	4.9	10.4	5.5
Scarification only	5.1	10.9	5.8
Understory removed	4.1	8.7	4.6
None	3.2	5.5	2.3

[1]Means bracketed by a single line do not differ significantly (1% confidence level).

[4]McNamara, E. F., and I. C. Reigner. Effect of competition on height growth and survival of planted Japanese larch. U.S. Forest Serv., Northeastern Forest Exp. Sta. Forest Res. Note 103, 4 pp. 1960.

[5]The vigor classification was based upon observations of such tree characteristics as crown length and density, needle color and length, and prior growth performance.

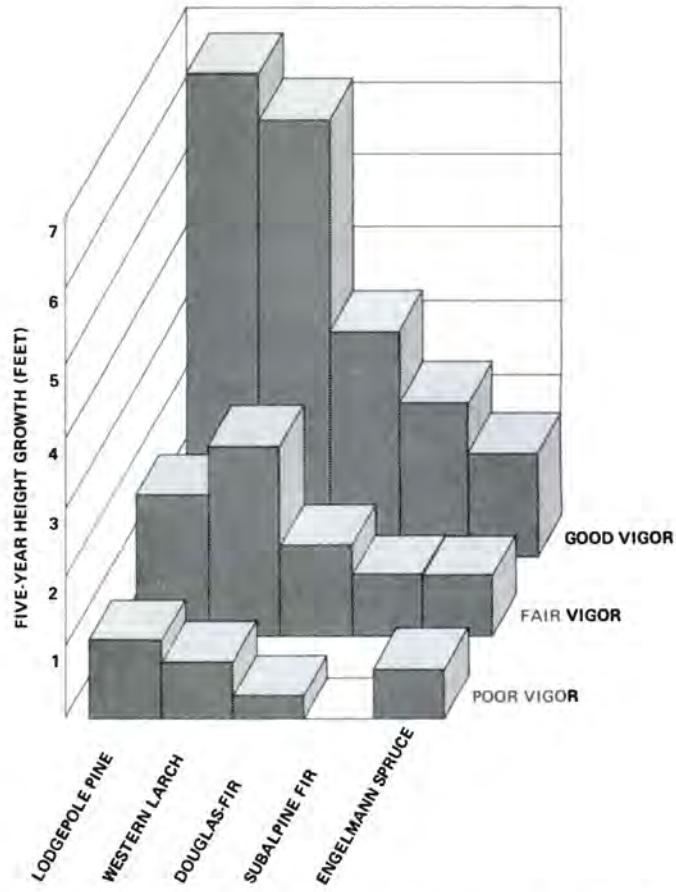

Figure 1.--Height growth from age 10 to 15 at Terrace Hill.

Western larch and lodgepole pine grew much faster than any other species (fig. 1). A comparison of height growth of all good vigor trees showed that during the last 5 years these two pioneers grew at least twice as fast as Douglas-fir, subalpine fir, and spruce. Similar comparisons of fair and poor vigor trees showed the same general relation.

COMPOSITION AND DOMINANCE

Western larch and spruce comprised two-thirds or more of the large number of trees per acre occupying seedbeds that had been scarified on the Terrace Hill plots and broadcast burned on the Coram plots. Conversely, Douglas-fir and subalpine fir were about two-thirds of the trees stocking areas where the forest floor was largely undisturbed. The undisturbed forest floor of the untreated plots not only hindered establishment of larch and spruce seedlings, but it supported a heavy stand of shrubs and other vegetation that competed with the seedlings and reduced their growth.

Larch trees were distributed uniformly and dominated[6] the young stand on 50 percent or more of the area where mineral soil had been exposed by scarification on the Terrace Hill plots and by broadcast burning on the Coram plots (tables 2 and 3). Spruce was well distributed only where mineral soil had been exposed. Because it characteristically grows slowly in the juvenile stage, it was overtopped and dominated by its associates, particularly larch. Douglas-fir, showing little preference for any particular seedbed, was evenly distributed throughout the study area irrespective of the treatments, but it dominated more of the plots where there had been no seedbed treatment and where larch was not a strong competitor.

[6]The tallest tree per quadrat was considered the dominant tree.

Table 2.--Stocking and composition of dominant seedlings by seedbed conditions at Terrace Hill

Seedbed treatment	Stand age	Western larch	Douglas-fir	Other species[1]	Total	Total trees per acre (all species)
	Years	Percent				
Scarification, understory removed	10	73	13	14	100	10,470
	15	66	7	20	93	12,800
Scarification only	10	93	0	7	100	13,390
	15	93	0	7	100	17,330
Understory removed	10	47	53	0	100	3,270
	15	46	47	7	100	4,410
None	10	33	53	14	100	3,140
	15	40	40	20	100	4,210

[1]Includes Engelmann spruce, subalpine fir, and lodgepole pine.

Douglas-fir gained a comparative advantage over larch during the last 5 years on the Coram disked plots (table 3). The two species shared about an equal dominant position on these plots at age 7, but larch declined rapidly, while Douglas-fir stayed about the same. Even though disking exposed enough mineral soil to permit seedlings to become established, it did not suppress the grass and shrubs enough to give larch the competitive advantage it needed to stay in the dominant position.

DISCUSSION

The effects of different methods of site preparation on initial seedling establishment in larch forests have been well documented.[7] [8]

The results reported here demonstrate that seedbed influences the new seedling stand well beyond the initial 5-year regeneration period. Methods that favor successful establishment of young tree seedlings also favor their subsequent development. These two studies of stand development demonstrate that scarification and prescribed burning result in:

1. Greater height growth in larch; it grows nearly twice as fast on prepared sites as on untreated areas.

2. The formation of young stands composed of several species but dominated by larch.

3. Good distribution and survival of all seedlings.

[7]Roe, A. L. Larch--Douglas-fir regeneration studies in Montana. Northwest Sci. 26: 95-102. 1951.

[8]Roe, A. L. A seedbed preparation test in the larch--Douglas-fir timber type in northwestern Montana. M.S. thesis, Sch. Forest., Univ. Mont., Missoula. 1955.

Table 3.--Stocking and composition of dominant seedlings by seedbed conditions at Coram

Seedbed treatment	Stand age	Western larch	Douglas-fir	Other species[1]	Total	Total trees per acre (all species)
	Years	Percent				
Burning	7	61	19	8	88	5,117
	12	54	15	19	88	6,468
Disking	7	35	40	7	82	3,381
	12	21	38	18	77	2,803
Understory removed	7	35	21	32	88	5,669
	12	39	18	31	88	5,203
None	7	20	33	22	75	3,923
	12	14	39	19	72	3,349

[1]Includes Engelmann spruce, subalpine fir, lodgepole pine, and western white pine.

Prescribed burning and scarification not only expose enough mineral soil for good seedling establishment but, perhaps even more important, they also destroy or delay the regrowth of much of the grass and shrub vegetation, which hinders tree growth. As a result, seedlings of intolerant species have adequate time to develop good crowns above the general tree and shrub canopy.

Removal of major shrubs and residual understory trees without additional site preparation results in only a slight advantage over no treatment. The low layer of small shrubs and grass remains as a competition barrier that precludes good seedling establishment and growth.

Complete lack of seedbed preparation discriminates against larch. Larch seedlings that do become established on natural forest floor cannot compete successfully. Residual understory trees of other species, shrubs, and grasses compete vigorously with the newly established tree seedlings. Some of the more shade-tolerant species, particularly Douglas-fir, are better adapted to cope with this competition and consequently have a relative advantage over larch and other intolerant species on natural forest floor.

These two studies included no direct comparison of seedling development on burned and dozer-scarified seedbeds--the two methods most commonly used in larch forests. However, another study comparing these two methods indicated that larch trees up to

13 years old grew about one-third faster on broadcast-burned areas than they did on dozer-scarified seedbed.[9] This growth difference is probably due to better reduction of vegetative competition, less soil compaction, and the availability of more nutrients on the burned seedbeds. How long these differences persist is still unknown.

The overstocking on all the seedbeds in these studies--most severe on the burned and scarified areas--demonstrates that the seed source should be removed when sufficient seedlings have become established to fulfill the manager's minimum stocking objectives. Natural variation in seed production, germination, and seedling survival makes precise regulation of stocking difficult when using natural regeneration systems. Some overstocking is practically inevitable following especially favorable years or if seed trees are inadvertently left too long, as occurred in these studies. Under these conditions, even untreated seedbeds can overstock, particularly with the more tolerant species.

Even though seedling growth, particularly on burned and scarified areas, has been good up to this point, these heavy stand densities will suppress future growth.[10] To maintain a vigorous stand and to capitalize on the rapid juvenile growth characteristic of larch, cleaning is necessary. On good mineral soil seedbeds, species composition and tree vigor are always good, and cleaning can produce a thrifty, well distributed stand composed of several species including larch, spruce, lodgepole pine, Douglas-fir, and subalpine fir. Conversely, where there has been little or no seedbed treatment, the intolerant trees--particularly larch--are in the minority, have already declined in vigor, and appear to be poor prospects for future management. As a result, the alternatives available for selection of species to favor in cleaning are limited to the more tolerant trees.

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[9]Roe, A. L., R. C. Shearer, and W. C. Schmidt. Management of western larch. (Manuscript in preparation)

[10]Schmidt, Wyman C. Growth opportunities for young western larch. U.S. Forest Serv. Res. Note INT-50, 4 pp. 1966.

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