Field Performance of Undercut Coastal and Rocky Mountain Douglas-Fir 2+0 Seedlings

James W. Edgren
Pacific Northwest Region, USDA Forest Service, Portland, Oreg.

Coastal and Rocky Mountain varieties of Douglas-fir seedlings were either not undercut or undercut in the nursery once in spring as 1 +0. Three years after outplanting on native sites as 2+0, undercutting had significantly improved survival of coastal seedlings, but did not improve growth of either variety.

In the Pacific Northwest, nursery-grown Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) seedlings are customarily undercut during May just before their second season by drawing a thin, flat blade 10 to 15 centimeters (4 to 6 in) beneath the surface of nurserybeds. This cultural operation is thought to stimulate root development and retard top growth.

In Canada, undercutting white spruce (*Picea glauca* (Moench) Voss) and eastern white pine (*Pinus strobus* L.) after the spring growth flush increased field survival and growth of spruce, but none of the treatments improved field performance of the pine (*5*).

Undercutting southern pines once in October or November-1 month before lifting—increased field survival of longleaf pine (*Pinus palustria* Mill.), but not of slash (*Pinus elliottii* Engelm.) or loblolly (*Pinus taeda* L.) pine (*7*).

Experiments have been conducted in Great Britain (2) with Douglas-fir, Scotch pine (*Pinus sylvestris* L.), Sitka spruce (*Picea sitchensis* (Bong.) Carr.), Japanese larch (*Larix leptolepis* (Sieb. and Zucc.) Gord., Corsican pine (*Pinus nigra* var. *calabrica* Arnold), English oak (*Quercus robur* L.), beech (*Fagus sylvatica* L.), and sycamore maple (*Acer pseudoplatanus* L.). Only Corsican pine showed improved field performance because of undercutting.

The possibility exists that varieties, as well as species, may respond differently to undercutting. This paper reports the effects of a single undercutting on 1+0 stock in spring—the standard practice at Oregon and Washington forest nurseries—on field survival and growth of coastal and Rocky Mountain varieties of Douglas-fir, var. *menziesii* and var. *glauca* (Beissn.) Franco, respectively.

Methods

Seedlings from one seed source of each variety were grown in adjacent beds under the production regime at the U.S. Department of Agriculture, Forest Service, Wind River Nursery near Carson, Wash. In mid-May, when seedlings were beginning their second-season growth flush, one-half of a single nurserybed of each variety was undercut at approximately 15 centimeters (6 in) using a sled-type undercutter. Control seedlings were taken from adjacent portions of the beds that were not undercut.

Seedlings were lifted, graded, and packed in March for planting in the conventional manner to assess the effects of undercutting on field performance. The coastal variety of Douglas-fir was planted in south-western Oregon approximately 16 kilometers (10 mi) south of Cave junction. The Rocky Mountain variety was planted in northeast Oregon approximately 13 kilometers (8 mi) west of Ukiah. At each location, the planting design consisted of six fully randomized blocks with 32 undercut and 32 control seedlings planted at 2.4- by 2.4-meter (8- by 8-ft) intervals.

Seedlings were planted in areas for which they were originally intended. Rocky Mountain seedlings were planted in a clearcut with gently irregular topography and overstory shade. Coastal seedlings were planted in the open in an older clearcut on a moderate south slope in the dry interior of the Siskiyou Mountains; this was an area with high growing-season temperatures and severe plant moisture stress where past plantings had failed. Rocky Mountain seedlings were subject to grazing pressure and competition from seeded range grasses; coastal seedlings suffered browse damage and competition from native grass and brush. These conditions were assumed to be unique to each area and to impinge randomly on planted seedlings; they were ignored during data analysis.

Initial seedlings heights were recorded at planting time. Leader growth was recorded after each of three growing seasons. If the leader was missing, growth of the lateral branch assuming dominance was recorded. Growth was recorded as zero if no dominant leader was apparent. Analyses of variance were performed on field survival and growth data.

Results

Nursery plots were not replicated, thus seedling morphology data were not analyzed statistically. Data (table 1) are furnished to provide an indication of average stem length and diameter and shoot and root ovendry weight.

Three years after planting, survival of undercut coastal seedlings (36%) was significantly better than survival of controls (22%). Conversely, survival of undercut Rocky Mountain seedlings (64%) was less than that of controls (73%); but the difference was not significant (fig. 1). Control seedlings of both seed sources grew significantly better during their first season than undercut seedlings. Undercutting did not significantly influence 2d- or 3d-year growth or total 3-year growth for either variety.

Table 1.—*Morphology of* untreated *and undercut 2+0 Douglas-fir seedlings of two varieties at nursery lifting time*

		Shoot		Mean ovendry weight	
	Number of trees	Mean length	Mean diameter at root collar	Shoot	Root
		cm	*mm*	*g*	*g*
Coastal variety:					
Untreated	100	37.3	4.2	3.58	1.24
Undercut	100	30.5	3.8	2.68	1.23
Rocky Mountain variety:					
Untreated	100	18.5	3.5	2.02	1.03
Undercut	100	13.3	3.2	1.36	0.93

Discussion and Conclusions

Survival and growth of planted stock. Conclusions concerning field survival and growth of undercut Douglas-fir nursery stock are that undercutting significantly improved the survival of outplanted coastal seedlings and that undercutting did not improve the growth of either variety after outplanting. Based on this study, we must conclude that undercutting, as practiced in the past, is not a satisfactory procedure for production of all Douglas-fir seedlings. Field performance of the Rocky Mountain variety was not improved in any way.

Future undercutting practice. Generally unimpressive performance by undercut seedlings does not mean that nursery personnel should abandon undercutting—seedling roots become too long and coarse when not undercut. Rather, different cutting dates and depths should be tested for different varieties of Douglas-fir.

The area of the root system stimulated by undercutting may differ by seedling variety. For instance, Aldhous (*1*) and Davey (*3*) mentioned the tendency toward lateral root extension following undercutting. Trappe (*10*) noted that coastal seedlings appeared to respond to undercutting with new root growth on existing laterals. This growth was retained at lifting time. Rocky Mountain seedlings responded by replacing deep, roots, which break off in lifting. Incidental root measurements made during this study tend to support Trappe's interpretation—lateral root extension appeared to occur with the coast-

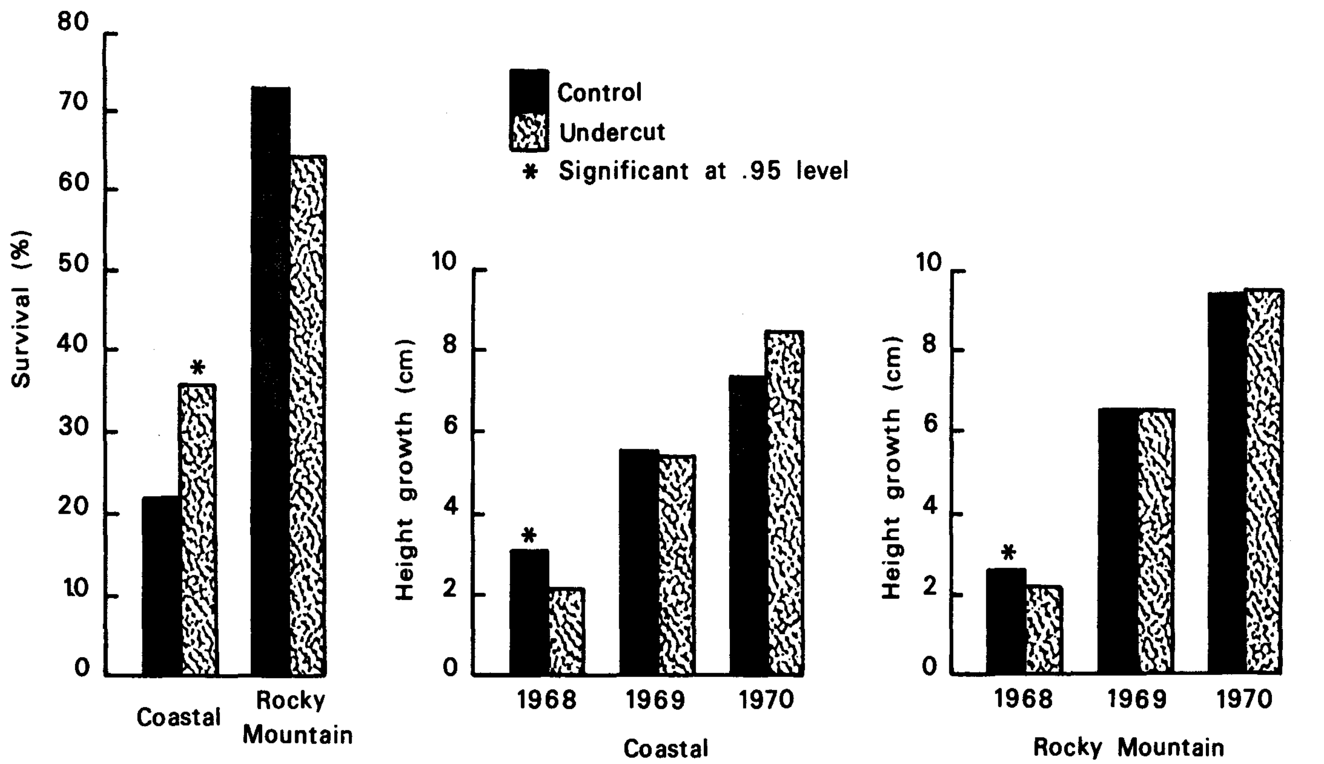

Figure 1.—*Field performance of control and undercut coastal and Rocky Mountain Douglas-fir 2+0 seedlings three growing seasons after outplanting in their native environments.*

al, but not with the Rocky Mountain, variety. Different undercutting timing and depth may influence these root growth patterns in different ways.

Becaus e Rocky Mountain seedlings appeared to send a higher percentage of their root system deep, undercutting may have reduced their root mass below a minimum level from which they could not recover. Humphries (*4*), working with tomato, a taprooted plant with laterals, found that removal of 40 percent or more of the root Sys tem (dry weight basis) reduced the growth rate of the re maining portion; removing less than 40 percent did not. Sutton (*8*) reported that "low root capi tal" contributed to poor root elongation performance in pruned root systems of white spruce and Norway spruce (*P. abies* (L.) Karst.).

Undercutting at this depth may also have removed a greater proportion of younger, metabolically more active root tips of the Rocky Mountain variety. This would impair the ability of the root system to produce growth hormones and also to absorb water and nutrients and thereby renew itself. In either event, deeper undercutting of Rocky Mountain seedlings should be tried.

Incorporation of the practice of wrenching, a series of undercuttings using a tilted blade, into undercutting schedules should also be examined. New Zealand nursery researchers have found that wrenching can be effectively used to produce Monterey pine *(Pines radiata* D. Don) seedlings of improved quality and specified size (*6*). In addition, to reduce top growth, repeated wrenching of Monterey pine prevents deep root replacement and promotes root growth higher on the system where it will not be lost during lifting operations. Soil aeration caused by wrenching is also believed to stimulate root growth. Tanaka and others (9) have demonstrated that the technique can be useful on Douglas-fir and loblolly pine *(Pines* taeda L.). Their data indicate that undercutting followed by repeated wrenching stimulated development of fiberous roots in the coastal variety of Douglas-fir.

Seedling cultural practices used and resulting size relationships are particularly important because producers and users of nursery stock are currently initiating efforts to classify stock by size as well as by age. The next step may be the ordering of stock by specific size classes. It therefore behooves researchers to examine and perfect cultural methods to influence seedling size in specific, predictable ways. Nursery personnel must know how to produce the desired size. This is especially difficult when methods may influence subsequent field performance depending on variety or seed lot.

Literature Cited

1. Aldhous, J. R. 1972. Nursery practice. For. Comm. Bull. 42. HMSO, London.
2. Atterson, J. 1964. Survival and growth of undercut seedlings in the nursery and forest. *In* Report on Forest Research for the Year Ended March, 1963. For. Comm. (Lond.), p. 147-156.
3. Davey, C. G. 1964. Root pruning in forest nursery management. *In* Proc. For. Nurserymen's Conf. Reg. 8, U.S. Dep. Agric., For. Serv., p. 38-42.
4. Humphries, E. C. 1958. Effect of removal of a part of the root system of the subsequent growth of the root and shoot. Ann. Bot. 22:251-257.
5. Mullin, R. E. 1966. Root pruning of nursery stock. For. Chron. 42:256-264.
6. Rook, D.A. 1971. Effect of undercutting and wrenching on growth of *Pinus radiata* D. Don Seedling. J. Appl. Ecol. 8:477-490.
7. Shoulders, E. 1963. Root pruning southern pine in the nursery. U.S. For. Serv. Res. Pap. SO-5, 6 p. South. For. Exp. Stn.
8. Sutton, R. F. 1969. Form and development of conifer root systems. Commonwealth For. Bur. (Oxford) Tech. Comm. 7, 131 p.
9. Tanaka, Y., J. D. Walstad, and J. E. Borrecco. 1976. The effect of wrenching on morphology and field performance of Douglas-fir and loblolly pine seedlings. Can. J. For. Res. 6:453-458.
10. Trappe, J. M. 1971. Root pruning conifers in nursery beds: does it increase survival potential? Tree Planters' Notes 22(3):13.