EFFECTS OF HARVEST AND PACKING TECHNIQUES ON DOUGLAS-FIR SEEDLINGS

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INTRODUCTION

Foresters in the Pacific Northwest have shown that Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco] seedling survival ray be substantially improved by careful methodology during harvest, storage, and outplanting (Cleary and DeYoe 1982, Cleary et al. 1978, Hermann et al. 1972). Similarly, New Zealand workers have demonstrated increased survival and dramatically increased growth of Monterey pine (Pinus radiata D. Don) seedlings with careful handling (Trewin 1979).

This paper is a preliminary report of trials designed to determine if extreme care in harvesting and planting Douglas-fir seedlings will result in significantly improved growth.

MATERIALS AND METHODS

The experimental populations were 2-year-old bare-root seedlings and seedlings grown in *containers* the first growing season and as bare root stock the second--the latter to be referred to here as "container-grown" seedlings, for differentiation.

Bare-root seedlings were grown in the Dwight L. Phipps Forest Nursery, Elkton, Oregon from seeds collected at 1,000 feet in seed zone 042. Mean bed density was 25 seedlings per square foot. Part of the bed was thinned to 18 seedlings per square foot in the spring of the second growing season, therefore the Elkton populations will be referred to as unthinned and thinned seedlings (Table 1).

Container seedlings were grown in a U.S. Forest Service facility at Corvallis in Leach tubes (1 x 4.5 in., 100/ft^2) from seeds collected at 3,000 feet in seed zone 081 and 3,500 feet in seed zone 511. These seedlings generally responded to treatments in a similar manner, hence the seed sources will be considered together. The Corvallis seedlings were transplanted to the Phipps nursery and to a cold frame in Corvallis in the spring of 1981, and half of the cold-frame seedlings were fertilized with 50 pounds of phosphorus per acre in early September. These three transplant populations will be referred to as "nursery plugs," "cold-frame plugs" and "fertilized plugs." All were maintained under regimes designed to initiate dormancy by late July (Table 1).

TABLE 1. Experimental seedling populations and treatments.

	Bare-root seedlings (2 yrs old)		Container-grown seedlings (1st season in Leach tubes)		
	Unthinned	Thinned	Nursery plugs	Cold-frame plugs	Fertilized plugs
Seed zone	042 (1,000 ft)		081 (3,000 ft) and 511 (3,500 ft)		
Nursery location	Elkton, Oregon		Corvallis, Oregon		
Density	25/ft^2	18/ft^2	1" x 4.5" Leach tubes, 100/ft^2		
Transplanting	None		Spring 1981 to Elkton nursery	Spring 1981 to Corvallis cold frame	Spring 1981 to Corvallis cold frame
Fertilizer treatment	None		None	None	50 lb K:50 lb P per acre
Lifting (half November 1981; half January 1982)	Careful nursery standards	Very careful nursery standards	Very careful nursery standards	Extreme care	Extreme care
Storage	Half: storage; Half: 3 wks at 2°C		Half: storage; Half: 3 wks at 2°C		

All bare-root and container-grown seedlings received one of four treatments--combinations of lifting in November or January and dark storage for either 0 to 3 weeks at 2°C before planting.

In early November, half of both the bare-root and container-grown seedlings were lifted with three standards of care. Unthinned seedlings were handled according to "careful nursery standards" during lifting and sorting. Thinned seedlings were handled with "very careful nursery standards." Both unthinned and thinned seedlings were root-pruned to 8 inches. Cull rates were 17 percent and 10 percent, respectively. Nursery-plug seedlings were also handled with "very careful nursery standards." The two cold-frame populations were lifted and handled with "extreme care."

All populations were shovel-planted carefully in a cultivated area in the Northwest Forest Genetics Center north of Corvallis, half of each immediately after lifting, the other half after 3 weeks of dark storage at 2°C. Each of the three blocks, in a randomized block design, contained four 12-seedling replications of each seedling population-treatment combination.

The second half of each seedling population was lifted and planted in January with the same procedures as the first.

Seedlings selected at random were lifted in April. The number of active roots per seedling and seedling dry weights were recorded. Dates of seedling bud break and incidence of seedling mortality were also recorded from early April until late June, and at that time total current-year leader lengths of twelve randomly selected seedlings for each seedling-treatment combination were recorded.

RESULTS

Table 2 summarizes the observations on seedling root activity made during April. The sample size is admittedly small, four plants per population-treatment combination. Nonetheless, the data demonstrate that there were no differences between seedling populations, and they demonstrate, perhaps surprisingly, a superior new-root capacity for early lifted material. New-root numbers were lowest at later sampling dates, but there was no discernible evidence that new roots had been produced earlier in the spring and then suberized.

TABLE 2. Condition of seedling populations in April 1982.

Lifting date	Storage	Unthinned	Thinned	Nursery plugs	Cold-frame plugs	Fer-tilizer plugs	Mean
		Seedling population					
MEAN NUMBER ACTIVE ROOTS PER SEEDLING							
November	0	36	22	32	27	29	29
	3 wks	17	21	16	15	13	16
January	0	6	17	13	6	23	13
	3 wks	4	3	14	11	6	8
Mean		16	16	19	15	18	16
MEAN OVER-DRY WEIGHT (grams)							
November	0	14.28	11.34	7.10	6.52	6.41	9.13
	3 wks	6.74	9.23	6.78	5.11	6.01	6.77
January	0	15.16	9.29	7.48	4.40	7.63	8.79
	3 wks	9.58	7.51	7.43	4.92	5.05	6.90
Mean		11.44	9.34	7.19	5.24	6.28	

An analysis of variance of the data in the table demonstrated that the effects of lifting data and of storage were highly significant (p = 0.01) but that there was no significant interaction or effect of experimental population.

The data describing seedling dry weight (Table 2) again demonstrate a distinct trend, i.e., stored seedlings were lighter than nonstored seedlings. It is apparent, too, that the bareroot seedlings were larger than the plug seedlings.

An analysis of variance of seedling dry weight showed that the effects of both storage and of seedling type were insignificant (p = 0.05) but that the effects of lifting date were not significant and that there was no significant interaction.

Table 3 summarizes seedling survival late in June. No significant differences appeared between the effects of either populations or treatments upon seedling arrival.

Table 3. Survival of seedlings in late June.

		Seedling population					
Lifting date	Storage	Unthinned	Thinned	Nursery plugs	Cold-frame plugs	Fer-tilizer plugs	Mean
November	0	98	100	99	100	98	99-
	3 wks	99	96	93	100	99	97+
January	0	100	99	100	99	99	99+
	3 wks	98	98	98	100	100	99+
Mean		99-	98+	97+	100-	99+	99

Mean dates of seedling bud break are shown in Table 4. The effect of seedling genetics is clearly evident--seedlings grown from seeds collected at higher elevations broke bud more rapidly.

Table 4. Mean date of budbreak of Douglas-fir seedlings.

Lifting date	Storage	Unthinned	Thinned	Nursery plugs	Cold-frame plugs	Fer-tilizer plugs	Mean
		Seedling population					
November	0	5/6	5/3	4/21	4/24	4/26	4/28
	3 wks	5/5	5/7	4/23	4/24	4/25	4/29
January	0	4/29	4/25	4/16	4/17	4/17	4/20
	3 wks	4/30	4/29	4/21	4/20	4/20	4/24
Mean		5/3	5/2	4/22	4/21	4/21	4/26

An analysis of variance of the data describing date of bud break indicated that the effects of lifting date, storage, and seedling population were all highly significant (p = 0.10). The interaction between lifting date and storage was also highly significant, primarily because the storage after the second lifting date slowed bud break more than did the same treatment after the early lifting.

Table 5 gives data on leader elongation in 1982. Although measurements were made on June 22, all seedlings observed had set at least terminal bud primordia, so it is probable that no significant further shoot elongation may occur in 1982. The data are similar to those in the previous tables in that the degree of care in handling seedlings was not reflected in a growth response and in that storage reduced seedling growth slightly.

Table 5. Length of 1982 leader growth of Douglas-fir seedlings.[1]

Lifting date	Storage	Unthinned	Thinned	Nursery plugs	Cold-frame plugs	Fer-tilizer plugs	Mean
		Seedling population					
November	0	5.5	6.0	4.5	4.0	4.0	5.0
	3 wks	5.0	4.5	3.5	3.5	3.0	4.0
January	0	5.5	5.0	4.0	4.5	4.0	4.5
	3 wks	5.0	5.0	3.0	4.0	4.0	4.0
Mean		5.0	5.0	4.0	4.0	4.0	4.5

[1]Seedling measurements made to nearest 0.5 cm. Above data computed on same basis.

DISCUSSION

Although the data presented in this paper are preliminary, they suggest that Douglas-fir seedlings do not respond to extremely careful handling during harvest, storage, and planting with the strong growth response reported for Monterey pine. These results confirm earlier conclusions of Smith and Walters (1963). The pattern of seedling growth presented in this paper reflect several influences.

First, the difference between poor and good handling in the New Zealand study was probably greater than differences in handling care in this study, which compared good to excellent care, not poor to excellent care.

Second--and interestingly--regardless of the degree of care in seedling processing, "transplant shock" in 2-year-old plants may be more significant than for seedlings processed after one growing season. The New Zealand seedlings were only 1 year old, and other workers (Little & Somes, 1964; Rudolph, 1939) have suggested that 1-0 pine root systems are much more adaptable than those of older plants. Carlson and Preisig (1981) note that control plug seedlings grew much more after planting than did 2-year-old stock in previous trials.

Third, the outplanting site and post-planting weather may also have limited seedling response. However, growth-room data for the same seedling populations and treatments (to be reported elsewhere) generally support the responses noted here. The site, an old nursery seed bed, has not limited growth of previous seedling crops severely.

CONCLUSIONS

Early seedling mortality is generally related to nursery handling, to storage and shipping techniques, and to the quality of outplanting. Late season mortality is related more closely to current weather. It would appear that even the preliminary data reported here provide a fair estimate of effects of nursery practice upon seedling survival potential. If so, seedlings which have been maintained under a nursery regime prohibiting shoot elongation in August or September may be lifted and outplanted in early November with little reduction in survival and growth from that of the same stock lifted in January. These data are at variance with those reported earlier (Cleary et al. 1978, Lavender 1964) which described responses of seedlings that had elongated their leaders in late summer.

The data of the present study confirm those of previous trials (Lavender and Wareing 1972, Hermann et al. 1972) which show that cold dark storage is not beneficial to Douglas-fir seedlings.

REFERENCES

Carlson, W.C., and C.L. Preisig. 1981. Effects of controlledrelease fertilizers on the shoot and root development of Douglasfir seedlings. Canadian Journal of Forest Research 11:230-242.

Cleary, B.D., and D.R. DeYoe. 1982. Reforestation seedling care and handling. The Woodland Workbook. Extension Circular 1095. Oregon State Extension Service, Corvallis, Oregon. 4 p.

Cleary, B.D., R.D. Greaves, and R.K. Hermann. 1978. Regenerating Oregon's forests. Oregon State University Extension Service, Corvallis, Oregon. 287 p.

Hermann, R.K., D.P. Lavender, and J.B. Zaerr. 1972. Lifting and storing western conifer seedlings. Research Paper 17, Forest Research Laboratory, School of Forestry, Oregon State University, Corvallis, Oregon. 8 p.

Lavender, D.P. 1964. Date of lifting for survival of Douglasfir seedlings. Research Note 49, Forest Research Laboratory, Oregon State University, Corvallis, Oregon. 20 p.

Lavender, D.P., and P.F. Wareing. 1972. Effects of daylength and chilling on the responses of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) seedlings to root damage and storage. New Phytologist 71:1055-1067.

Little, S., and H.A. Somes. 1964. Root systems of direct-seeded and variously planted loblolly, shortleaf, and pitch pines. U.S.D.A. Forest Service Northeastern Forest Experiment Station Research Paper NE-26. Upper Darby, Pennsylvania. 13 p.

Rudolph, P.O. 1939. Why forest plantations fail. Journal of Forestry 37:377-383.

Smith, J.H.G., and J. Walters. 1963. Planting check (reduction in height growth) of planted Douglas-fir seedlings. Faculty of Forestry, University of British Columbia. Research Note No. 43. Vancouver, British Columbia. 4 p.

Trewin, A.R.D. 1979. Poor handling can upset forest plans. Forest Industries Review, July 1979:10.