

EFFECTS OF WRENCHING DOUGLAS-FIR SEEDLINGS IN AUGUST¹

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ABSTRACT: Effects of wrenching Douglas-fir seedlings in August of their second season in the D. L. Phipps State Forest Nursery, Elkton, Oregon, were determined by periodic samplings to learn of changes in phenological, morphological, and growth characteristics. Initial effects of wrenching moderated by January when seedlings were lifted; both unwrenched and wrenched seedlings had grown substantially larger. Survival and growth of seedlings were good during the first 5 years after outplanting, and no significant differences were found between unwrenched and wrenched seedlings.

INTRODUCTION

Some years ago, a study was started to determine what effect a single wrenching in August would have on Douglas-fir seedlings. At the time, wrenching was getting particular attention as a means of conditioning seedlings better for outplanting. By wrenching in early August, it appeared possible to avoid the drastic growth reductions that can result from earlier wrenching, yet favorably influence the root morphology and conditioning of Douglas-fir. Final results of that study, including a 5-year field test, are now available.

METHODS

A production bed of 2+0 Douglas-fir seedlings in the D. L. Phipps State Forest Nursery, Elkton, Oregon, was chosen for this test. The nursery's usual production practices, including undercutting at 15 centimeters (6 in) in late

Paper presented at combined meeting of the Western Forest Nursery Council and Intermountain Nurseryman's Association, Coeur d'Alene, ID, August 14-16, 1984.

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¹ This paper is based on data presented in greater detail in: Stein, William I. Wrenching Douglas-fir seedlings in August: immediate but no lasting effects. Res. Pap. PNW-317. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 12 p.

April and vertical root pruning in early June, had been applied to this bed of seedlings. Bed density was about 323 per square meter (30/ft²).

On August 2, 1976, 15.2 lineal meters (50 lineal ft) of the bed were wrenched at 18-centimeter (7-in) depth with an oscillating wrenching blade. A 15.2-meter segment of the same bed with seedlings of similar size and density was left unwrenched as a control. Before dawn the next day, moisture stress in the wrenched seedlings averaged 12.25 bars, so the entire bed of seedlings was irrigated for 2 hours on August 3.

Unwrenched and wrenched seedlings were sampled on August 26, September 14, October 5, and October 29, 1976. Another sample was taken when the entire bed of seedlings was lifted on January 18, 1977. At each sampling, trees were taken from four well-spaced points in the unwrenched and four well-spaced points in the wrenched part of the bed and systematically allotted to 10-tree subsamples (bundles). Roots of bundled trees were pruned to 25-centimeter (10-in) length. Bundles of seedlings were then randomly allocated for size determination and growth tests. Following the January lifting, 100 unwrenched and 100 wrenched seedlings were planted the same day on two droughty sites near Days Creek, Oregon.

RESULTS

Development After Wrenching

Phenological and size observations were made on 40 unwrenched and 40 wrenched seedlings of each sampling. Similarities, but also some significant differences, were found between unwrenched and wrenched seedlings.

Judging from phenological appearance, growth of seedlings slowed after wrenching, then resumed more actively than did growth of unwrenched seedlings (table 1). By late August, most wrenched seedlings had developed a terminal bud compared to only one-third of the unwrenched seedlings. By early October, however, only 60 percent of the wrenched seedlings had terminal buds whereas 95 percent of the unwrenched seedlings had terminal buds. Light-green needles on more terminal shoots of wrenched than unwrenched seedlings also indicated they were more active in October. Wrenched seedlings showed a high level of root activity at every sampling date

Table 1.--Phenological status of unwrenched and wrenched seedlings at each sampling date

Phenological observation	Sampling date				
	8/26	9/14	10/5	10/29	1/18/77
Percent occurrence (N=40)					
Terminal bud present:					
Unwrenched	35	98	95	100	100
Wrenched	93	100	60	100	100
Terminal foliage light green:					
Unwrenched	38	10	8	8	8
Wrenched	25	3	48	0	8
Active root growth:					
Unwrenched	35	45	65	73	80
Wrenched	78	100	43	93	80

except early October, whereas root activity of unwrenched seedlings increased from August onwards.

Unwrenched and wrenched seedlings differed significantly in size in late August, 24 days after wrenching (fig. 1). Shoot length of wrenched seedlings was shorter, shoots and roots were lighter, and the number of lateral roots over 1 centimeter (0.4 in) long was less. Shoot:root ratio of wrenched seedlings was significantly larger. When lifted for planting 145 days later, however, size of unwrenched and wrenched seedlings was similar in most respects. Wrenched seedlings tended to be larger, particularly in shoot length, and have a lower shoot:root ratio.

Both unwrenched and wrenched seedlings grew substantially larger between late August and mid-January (fig. 1). For example, the oven-dry weight of roots of wrenched seedlings increased fivefold; for unwrenched seedlings, about half that much. Shoot dry weight of wrenched seedlings increased by a factor of 2.4, of unwrenched seedlings by 1.6. These size changes appear to be more than random variation among successive destructive samplings. Regression analyses showed that there was a significant change with time in each observed attribute for both wrenched and unwrenched seedlings with one exception--shoot length of unwrenched seedlings.

Growth of Tended Seedlings

Survival and growth observations were made on 20 unwrenched and 20 wrenched seedlings potted promptly after each lifting and an equal number that were planted in raised outdoor

beds. Potted seedlings were initially placed in a greenhouse and later outdoors, and both sets of seedlings were tended for more than a year.

Time of lifting as well as wrenching influenced subsequent phenology and growth of tended seedlings (table 2). Survival of wrenched seedlings was generally slightly higher. In outdoor beds, unwrenched seedlings from the August, September, and October liftings were darker green the following March than were wrenched seedlings lifted in the same 3 months. Among potted seedlings, only unwrenched and wrenched seedlings lifted in January flushed and started growing promptly. Potted seedlings of the other four liftings needed a chill period before most of their terminal buds would flush. In the outdoor beds, seedlings of the January lifting also flushed earliest and most vigorously.

Table 2.--Survival and shoot growth of unwrenched and wrenched seedlings lifted at different dates and transplanted to pots and outdoor beds

Seedling response	Date lifted				
	8/26	9/14	10/5	10/29	1/18/77
IN POTS					
Seedlings alive (%):					
Unwrenched	95	90	90	89	95
Wrenched	85	100	100	100	100
Average shoot growth (cm):					
Unwrenched	3.1	3.6	3.5	5.9	10.3
Wrenched	2.4	2.6	3.0	4.3	9.4
Increment gained (%):					
Unwrenched	14	14	18	24	41
Wrenched	11	10	13	18	37
IN OUTDOOR BEDS					
Seedlings alive (%):					
Unwrenched	80	80	95	90	95
Wrenched	100	100	90	100	100
Average shoot growth (cm):					
Unwrenched	8.8	9.2	9.4	9.7	10.1
Wrenched	7.1	7.7	8.0	10.0	11.5
Increment gained (%):					
Unwrenched	46	39	39	48	47
Wrenched	31	32	31	50	44

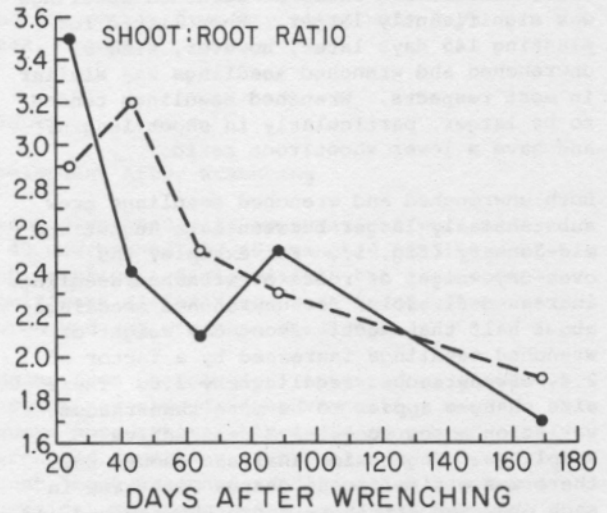
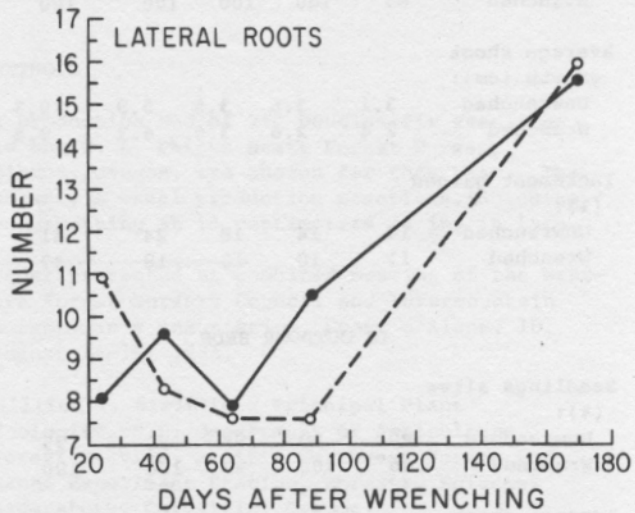
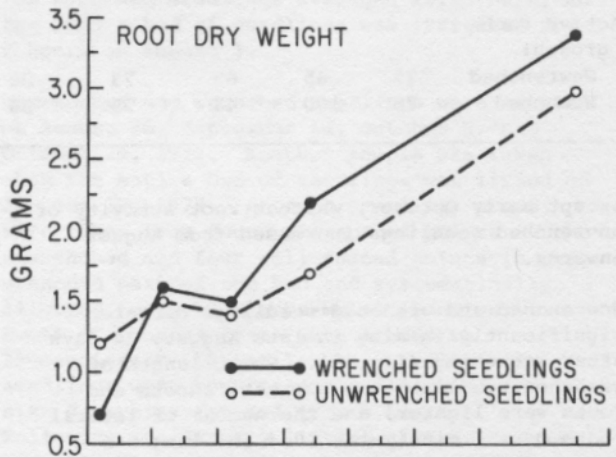
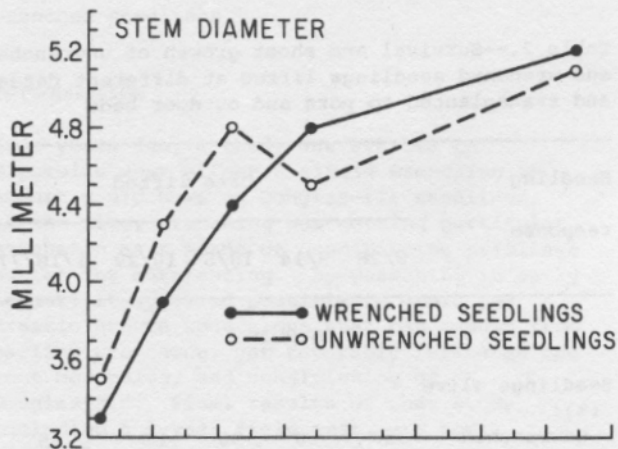
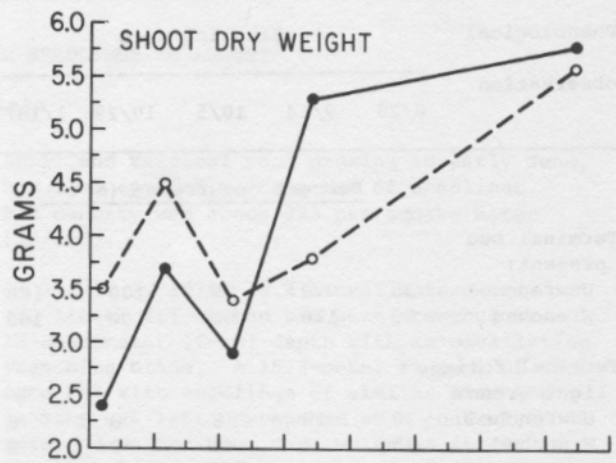
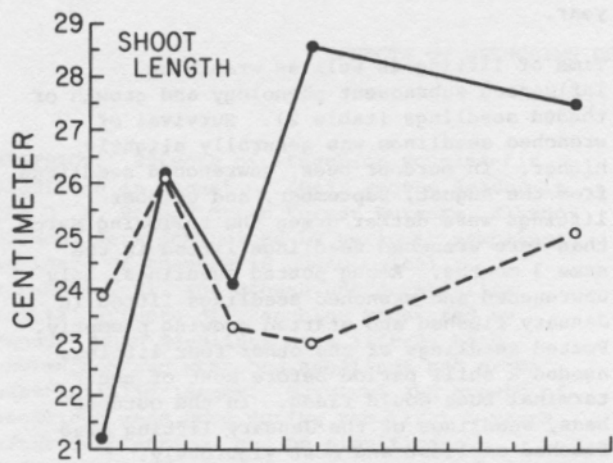


Figure 1.--Size and weight of unwrenched and wrenched seedlings at successive samplings from August to January.

The later that both wrenched and unwrenched seedlings were lifted, the greater their subsequent height growth (probability greater than 99 percent). An adverse effect of wrenching on height growth was indicated for the earlier liftings, but growth differences for unwrenched and wrenched seedlings later narrowed.

Growth in the Field

Two hundred seedlings from the January lifting were planted the same day on a steep southeast and northeast site located southeast of Roseburg, Oregon. On each site, 100 trees were planted at 2.4-meter (8-ft) spacing in a 10x10 grid. Wrenched trees were planted at half the planting spots and unwrenched trees at the rest as randomly designated in advance. Survival and total height of trees were determined periodically.

Field survival and total height of unwrenched and wrenched seedlings did not differ significantly after 5 years (table 3 and fig. 2). Survival of wrenched seedlings averaged 89 percent; of unwrenched seedlings, 86 percent. Total height averaged 97.8 centimeters (38.5 in) and was identical for unwrenched and wrenched seedlings. Stem diameter 30 centimeters (12 in) above ground level averaged 14.1 millimeters (0.6 in) for unwrenched seedlings and 13.1 millimeters (0.5 in) for wrenched seedlings; the difference was not significant at the 90-percent probability level.

Table 3.--Survival and stem diameter of unwrenched and wrenched seedlings 5 years after planting

Seedling attribute	Slope		
	Southeast	Northeast	All
Survival (%):			
Unwrenched	88	84	86
Wrenched	92	86	89
Average	90	85	87.5
Stem diameter (mm):			
Unwrenched	14.7	13.5	14.1
Wrenched	13.1	13.1	13.1
Average	13.9	13.3	13.6

DISCUSSION AND CONCLUSIONS

Results of this study add some insight to the debate on the merits of wrenching for improving field survival and growth of

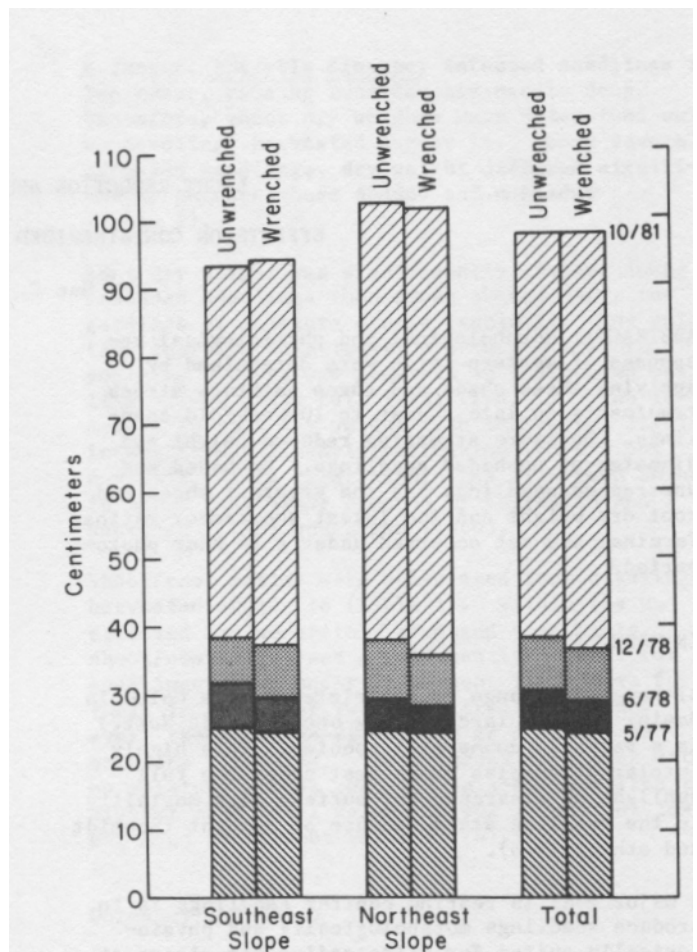


Figure 2.--Total height of unwrenched and wrenched Douglas-fir seedlings at intervals after planting.

Douglas-fir. Even a single wrenching late in the season curtailed seedling growth and altered the size and physiology of Douglas-fir seedlings, a finding consistent with those from other, generally more drastic, wrenching regimes. The effects of wrenching did not improve field survival or growth of seedlings, a finding consistent with those of some investigators but not of others.

The interwoven effects of lifting date and wrenching deserve particular attention for several reasons:

1. The more time that elapses between wrenching and lifting, the more likely wrenching effects will be diminished because of growth and physiological changes occurring in both wrenched and unwrenched seedlings.
2. Lifting seedlings too early interrupts their development and may affect their subsequent performance more than wrenching does.
3. Instead of conditioning seedlings for lifting, wrenching in August appeared to have had the opposite effect; it stimulated late growth under the prevailing conditions.