THE EFFECT OF HORIZONTAL AND VERTICAL ROOT PRUNING ON 2-0 AUSTRIAN PINE (Pinus nigra Arnold)

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The need for vigorous, rapid growing planting stock leads to the question of which to use: seedlings or transplants. On the basis of size and vigor, transplants are normally favored over seedlings. However, with today's methods of nursery transplanting production costs may run as high as $26 to $28 per thousand, compared with $19 to $21 for seedling stock.[2] In an attempt to compromise between high costs and low vigor some nurserymen have turned to root pruning. To answer the question, "Will root pruning in place produce seedlings comparable to transplants at a comparative cost,"the authors initiated the study described herein.

A review of literature (Clifford, 1956; Foster, 1932a, 1932b; Hastings, 1923; Huberman, 1940; Janouch, 1929; Rudolf and Gevorkiantz, 1935; Stone, 1955; Stone and Schubert, 1956; and Wycoff, 1959) indicated that root pruning could be used to retard top growth, stimulate root development, and improve root-top ratios.

Procedures

A split plot design was established according to Cochran and Cox (1957). Three treatments, horizontal and vertical root pruning, transplanting, and check, where the seedlings were allowed to develop to normal 3-0 stock, were assigned to plots on three different dates, April 18, April 27, and May 8. Horizontal pruning was done with a lifting bar (fig. 1) and vertical pruning with a rolling coulter root-pruner, equipped with nine coulters,

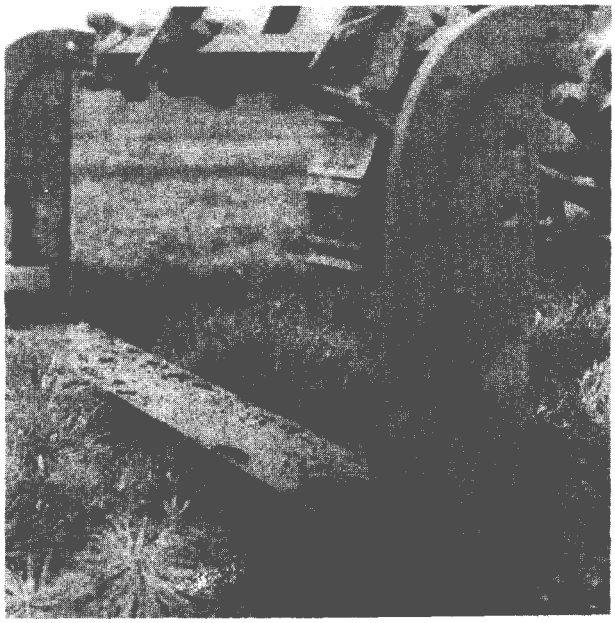

Figure 1.--Lifting bar in the horizontal position for pruning.

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[2]Based on current costs at the Iowa State Conservation Commission Nursery, Ames, Iowa.

one to run between each row in the bed (fig. 2). Seedling samples were selected randomly from each treatment at the beginning and end of the growing season and tested for total weight, top weight, root weight, and root-top ratio. Any measure of root development was confined to within 6 inches of the ground line as this was considered the only recoverable part of the roots with a mechanical lifting operation.

Figure 2.--Coulter root pruner with the nine coulters in the pruning position.

Results

Differences among treatments at the beginning of the growing season were not significant; bed uniformity was thus verified. At the end of the growing season the total weight, top weight, and root-top ratio of root-pruned seedlings and transplants varied significantly from the check seedlings (table 1 and fig. 3). Differences among planting dates were not significant.

TABLE 1.--Summary of treatment averages at the end of the growing season

Treatment	Total weight	Root weight	Top weight	Root-top ratio
	Grams	*Grams*	*Grams*	
Root pruned	23.36	3.22	20.14	6.26
Transplanted	20.20	2.71	17.48	6.38
Check	34.23	3.24	30.99	8.65

Total weights: Total weights of the root-pruned seedlings and transplants were reduced significantly. The checks were 32 percent heavier than the root-pruned seedlings and 59 percent heavier than the transplants. Differences were significant at the 5 percent probability level (table 2 and fig. 3).

Top weights: Top weights of the root-pruned seedlings and transplants varied by only 2.66 grams. The checks were 35 percent heavier than the root-pruned seedlings and 44 percent heavier than the transplants (table 3). Differences were significant at the 1 percent probability level.

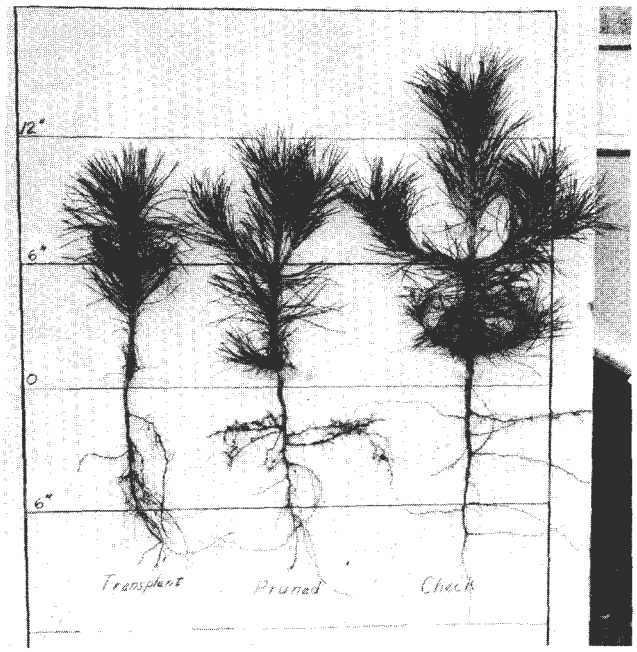

Figure 3.--Representative seedlings showing differences among treatments.

TABLE 2.--Total mean weight differences per plant among treatments

a. Total mean weight (grams)

Replication	Root pruned	Transplanted	Checks
1	21.18	19.64	32.92
2	22.02	18.77	37.09
3	26.89	22.19	32.69
Mean	23.36	20.20	34.23

b. Analysis of variance

Source of error	D.F.	Mean square	F
Date	2	9.76	0.12
Treatment	2	271.99	4.65*
DxT	4	97.24	1.67

*Significant at the 5 percent level.

TABLE 3.--Top mean weight differences per plant among treatments

a. Top mean weight (grams)

Replication	Root pruned	Transplanted	Checks
1	23.14	19.22	30.52
2	19.14	16.28	33.15
3	18.13	16.95	29.31
Mean	20.14	17.48	30.99

b. Analysis of variance

Source of error	D.F.	Mean square	F
Date	2	8.67	0.14
Treatment	2	250.69	91.83**
DxT	4	72.66	26.62**

** Significant at the 1 percent level.

Root weights: Root weights were nearly the same for all treatments and not significant. However root form and ramification were appreciably different. The recoverable roots of the upper 6 inches of the root-pruned seedlings were more numerous and finer than the roots of the seedlings and transplants (fig. 3). Lifting normal seedlings or transplants at deeper depths would not result in a major increase in root weight.

TABLE 4.--Root mean weight differences per plant among treatments

a. Root mean weight (grams)

Replication	Root pruned	Transplanted	Check
1	3.73	2.96	2.17
2	2.88	2.49	3.94
3	3.05	2.69	3.61
Mean	3.22	2.71	3.24

b. Analysis of variance

Source of error	D.F.	Mean square	F
Date	2	0.56	0.06
Treatment	2	0.80	1.21
DxT	4	1.41	2.14

Root-top ratio: Root-top ratios of the root-pruned seedlings and transplants were significantly greater than the checks at the 1 percent level, thus resulting in better toproot balance. The difference between the root-pruned seedlings and transplants was not significant (table 5 and fig. 3).

TABLE 5.--Root-top mean ratio differences per plant among treatments

a. Root-top mean ratio

Replication	Root pruned	Transplants	Checks
1	6.16	6.30	9.04
2	6.63	6.46	8.73
3	6.00	6.38	8.18
Mean	6.26	6.38	8.65

b. Analysis of variance

Source of error	D.F.	Mean square	F
Date	2	0.42	1.56
Treatment	2	16.41	65.64**
DxT	4	0.20	0.80

**Significant at the 1 percent level.

Discussion

On the basis of top weight, total weight, root weight, and root-top ratio, transplants and root-pruned seedlings are more. vigorous and exhibit greater top-root balance than seedlings. Moreover, neither varies significantly from the other. With no major physical differences between transplants and root-pruned seedlings, the choice for planting should be based on production costs and space requirements. Consequently the higher costs and greater space requirements of transplants apparently justify the substitution of rootpruned seedlings for the former.

Possible refinements in the commercial production of root-pruned seedlings may be these: (1) Reduce seedbed densities as suggested by Foster (1932b). (2) Prune between the first and second growing season. (3) Prune before bud break; otherwise timing seems to have little effect. (4) Use a knife-type lateral root pruner (Baker, 1961) in place of the rolling coulter to give a sharper cut, less injury, and less compression and lifting of seedlings from the bed by the coulter action.

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