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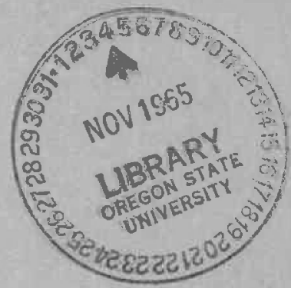
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# Early Growth of Douglas-Fir in a Reciprocal Planting

By Kim K. Ching

Research Paper 3

August 1965



**Forest Management Research  
FOREST RESEARCH LABORATORY  
OREGON STATE UNIVERSITY  
Corvallis**

## FOREST RESEARCH LABORATORY

The Forest Research Laboratory, Oregon State University, is part of the Forest Research Division of the Agricultural Experiment Station. The industry-supported program of the Laboratory is aimed at improving and expanding values from timberlands of the State.

A team of forest scientists is investigating problems of growing and protecting the timberland crop, while wood scientists endeavor to make the most of the material produced.

The current report stems from studies of forest management.

### **PURPOSE . . .**

Develop the full potential of Oregon's timber resource by:

increasing productiveness of forest lands with improved practices.

improving timber quality through intensified management and selection of superior trees.

reducing losses from fire, insects, and diseases--thus saving timber for products and jobs.

Keep development of the forest resource in harmony with development of other Oregon resources.

### **PROGRAM . . .**

**REGENERATION** through studies of producing, collecting, extracting, cleaning, storing, and germinating seed, and growing, establishing, and protecting seedlings for new forests.

**YOUNG-GROWTH MANAGEMENT** through studies of growth and development of trees, quality of growth, relationship of soils to growth, methods of thinning, and ways of harvesting to grow improved trees.

**FOREST PROTECTION** through studies of weather and forest fire behavior to prevent fires, of diseases and insects to save trees, and of animals to control damage to regrowth.

**TREE IMPROVEMENT** through studies of variation, selection, inheritance, and breeding.

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## SUMMARY

Survival and growth during three years at 8 out-planting areas are reported for Douglas-fir from 14 sources of seed.

Early survival was highest near Nimpkish on Vancouver Island. At most plantations, trees from the local seed source grew as well as did those from the best three sources. Trees from seed collected at northern and southern extremes of the study grew least in the three years.

## ACKNOWLEDGMENTS

Cooperators with Oregon State University in furnishing land, seed, labor, and supervision of plantations include:

British Columbia Forest Service  
Canadian Forest Products, Ltd.  
Crown Zellerbach Corporation  
Washington Dept. of Natural Resources  
Crown Zellerbach Canada Ltd.  
Jack Stump and Kenneth McCrae  
MacMillan, Bloedel, and Powell River, Ltd.  
Medford Corporation  
Oregon State Board of Forestry  
Simpson Olympic Tree Farm  
University of British Columbia  
United States Forest Service  
Weyerhaeuser Company

# Early Growth of Douglas-Fir in a Reciprocal Planting

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## INTRODUCTION

Out-plantings of Douglas-fir at various locations in northwestern United States and British Columbia will allow comparisons among trees grown from seed collected near each location. Such comparisons may demonstrate advantages of planting seed from certain sources in some areas. Growth and survival after three years at selected plantations are related here.

The importance of selecting the proper seed source for reforestation has been known to foresters for many years. Systematic experiments dealing with such a subject began as early as the nineteenth century (1)\*. Studies of seed source in Douglas-fir have attracted a great deal of attention since European countries began to introduce this timber species. Information accumulated rapidly through the years from Douglas-fir plantations established in Europe and the southern hemisphere as well as in the United States (3, 4, 5, 6, 7, 12) has provided a wealth of knowledge to guide planting.

In the Northwest, private as well as public agencies have participated enthusiastically in this particular field of study. In 1954, staff of the Research Division of the Oregon State Board of Forestry (now in the Forest Research Laboratory, Oregon State University) began to plan a region-wide provenance study of Douglas-fir in the Pacific Northwest. Information on seed collection and results of growth of various groups of Douglas-fir seedlings in the nursery were reported in *Silvae Genetica* (3), January 1960. The current report deals with growth of these seedlings after they were out-planted.

### Design of experimental plots

A reciprocal design for planting was adopted in this experiment. Plantations were established at, or near, each seed-collection site (Figure 1) so that seedlings of local provenance could be compared with stock from other provenances.

Each out-planting area has two plantations, usually situated from 1/4 to 1/2 mile apart (Figure 2). A plantation occupies 5.69 acres and consists of two blocks. Each block has 121 trees of each seed source

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\*Numbers in parentheses refer to similarly numbered references cited.

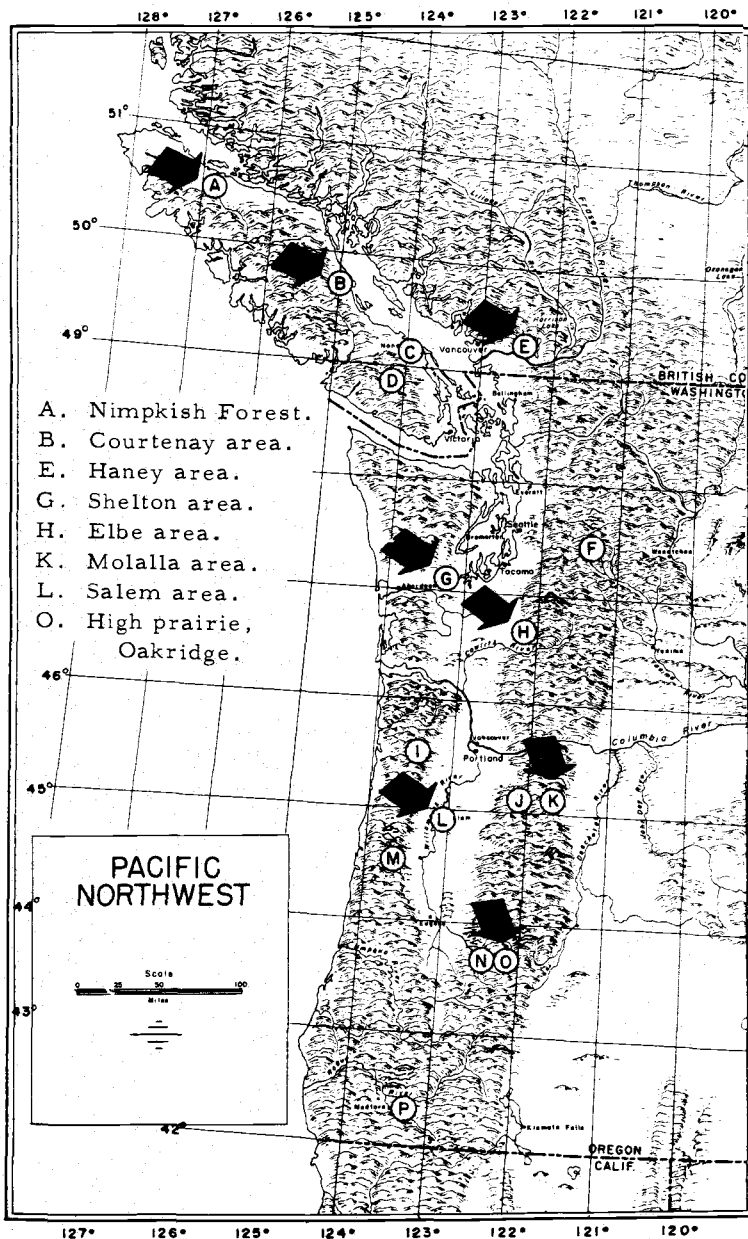


Figure 1. Locations of plantations in provenance study of Douglas-fir. Arrows indicate those reported here.

13A	8A	14A	7A	4B	10B	1B	13B
6A	1A	4A	12A	9B	15B	5B	2B
15A	5A	11A	16A	7B	8B	11B	14B
9A	3A	10A	2A	12B	3B	6B	16B

Plantation 1

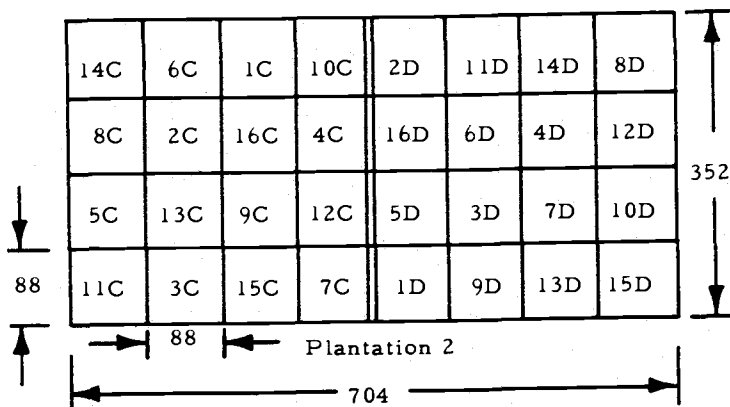


Figure 2. Arrangement of plots in plantations for provenance study of Douglas-fir.

Dimensions shown are in feet.

with a spacing of 8 by 8 feet. Only the innermost 49 trees of each seed provenance within the block were selected for measurement.

#### Assessment

First measurements in the field were made at the end of the first growing season following out-planting in the spring of 1959. Subsequent data were collected in the field in 1960 and 1961.

Examinations made on various plantations included the following data: 1, survival; 2, current growth in height of terminals on each living tree; 3, total height of each living tree; 4, damage to trees by animal clipping, grouse nipping, or frost.

All these data were sent by each cooperator to the Forest Research Laboratory to be assembled, summarized, and analyzed.

## RESULTS AND OBSERVATION

This progress report is restricted to information collected on growth of seedlings of 14 seed sources in 8 of the original 16 out-planting areas. Selection of these planting sites for this report is based on availability of data for at least two seasons in the field. Seedlings in those areas that have been excluded were damaged heavily by mammals, birds, or adverse climatic conditions. Damage by rabbits was found in plantations supposedly with rabbit-proof fencing. In the Tillamook area, 27 percent of the provenance stock treated with animal repellent (Zag) was destroyed two days after planting.

### Survival

For three seasons, survival of trees of different provenances at each plantation was recorded, whether or not they had been damaged by animals or other environmental factors (Table 1). Where there were dead trees in the first-year tally, the replaced trees were not tallied in subsequent years; therefore, the percentage of surviving trees refers to the originally planted trees.

There is no doubt that the plantation in the Nimpkish area on Vancouver Island (area A) has the best planting site for establishment of seedlings based on survival in early stages, regardless of the origin of seed sources. In the Willamette valley of Oregon, the plantation in area L showed much mortality the first year, and the trend continued in following years. Only seedlings originating from three seed sources (B, D, and P) maintained a fair amount of stock of the original planting at area L. The other plantation on Vancouver Island (area B) had a high rate of survival during the first and second years in the field, but was damaged severely by deer in the third year. The plantation (area E) maintained by the University of British Columbia at Haney, Canada, suffered some damages by hares in the first year, but surviving trees did very well subsequently. As for the plantations in areas K and O in Oregon (high-elevation sites at Molalla and Oakridge), only the former had more than half of the originally planted materials still growing vigorously after three years in the field.

### Growth in height

In all plantations, damage to trees either by animals or by adverse climatic conditions was recorded. To assess the amount of damage that would retard growth of a tree, separate measurements of total height were compiled for those trees that had never been damaged and for those that suffered damage, but were alive when measured. Surprisingly, in most instances, "never damaged" trees were no more than slightly different from those that had been damaged previously.



Trees that never were damaged are compared for 14 provenances in Table 2 with damaged trees at areas A, B, E, K, L, and O. So few trees were undamaged at areas G and H that values given apply to all living trees, damaged and undamaged together. Trees at each area were ranked in height by seed source. Seed sources that produced seedlings not significantly different in height when analyzed statistically are grouped by brackets.

Significant differences in height existed among seedlings of different geographical origins at the end of the second growing season in the Oregon State nursery. Seedlings from seed sources B, C, and D on Vancouver Island and G near Shelton, Washington, were taller (at the 1 percent level of significance) than seedlings from other sources. Trees from seed sources A and P (northernmost and southernmost) were shortest of all the groups.

At the end of the third season in the field, trees from two Canadian seed sources, B and C, and from one near Shelton, Washington, G, had grown outstandingly in height. In most plantations, trees of seed sources A and P had grown least. Local seed sources at some plantations produced seedlings that grew about as well in their own locale as did seedlings B, C, and G, which were among the tallest at most plantations. Such relationships are illustrated in Figures 3-10, except that local seed source is not shown for location E because these seedlings were a year younger than the other trees. To avoid cluttering the graphs, not all 14 seed sources are shown.

Table 1. Yearly Survival of Trees Planted in 1959 at Eight Locations. Percent, Based on Number Planted.

Seed source	A. Nimpkish Forest.			B. Courtenay area.			E. Haney area.			G. Shelton area.		
	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
A	95	95	91	92	89	-- <sup>1</sup>	86	86	81	78	62	58
B	98	96	95	99	97	--	85	85	82	84	61	58
C	95	95	95	98	97	--	95	93	91	96	94	93
D	96	94	93	95	88	--	87	87	87	93	67	59
G	94	94	94	96	96	--	89	88	86	92	78	75
H	94	93	92	92	90	--	93	93	92	88	67	62
I	94	94	94	93	93	--	94	94	92	85	73	71
J	96	96	95	98	96	--	91	90	88	91	59	56
K	97	96	96	96	95	--	91	88	85	81	64	61
L	97	95	94	95	95	--	89	88	83	82	65	63
M	92	92	91	89	87	--	90	87	85	95	77	68
N	93	91	90	90	87	--	87	86	83	82	62	54
O	96	94	94	91	90	--	90	88	83	91	84	81
P	92	91	91	96	96	--	94	94	92	91	82	81

Seed source	H. Elbe area.			K. Molalla area.			L. Salem area.			O. Oakridge.		
	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
A	43	34	32	77	69	66	32	19	17	54	39	32
B	75	70	68	88	84	78	75	67	61	78	62	57
C	68	60	58	89	82	79	59	56	55	68	53	41
D	71	64	60	92	81	77	80	72	68	82	68	65
G	54	48	45	85	74	71	47	41	36	74	57	49
H	41	36	30	80	74	73	57	45	42	63	54	45
I	51	45	40	79	71	69	57	52	47	65	51	45
J	40	33	28	78	69	67	45	33	31	71	58	55
K	64	53	51	80	69	65	51	45	43	68	52	44
L	46	41	35	74	67	63	24	16	14	58	42	39
M	50	44	38	83	77	76	63	58	51	70	52	50
N	42	37	34	74	66	64	32	26	23	61	40	37
O	45	40	38	81	70	66	59	47	45	71	64	62
P	50	47	46	71	65	62	79	68	61	59	47	43

<sup>1</sup> Trees at area B, near Courtenay, were damaged extensively by deer in 1961, and survival was not recorded that year.

Table 2. Growth in Height, in Centimeters, of Douglas-Fir of 14 Provenances at 8 Locations.  
Seed Sources Not Significantly Different at Level Shown Are Bracketed.

Rank	1959			1960			1961		
	Seed source	Height		Seed source	Height		Seed source	Height	
		Un-damaged	Damaged		Un-damaged	Damaged		Un-damaged	Damaged
<u>Location A</u> Nimpkish Forest.									
1	G	23.8	23.7	G	34.9	35.1	G	58.8	59.0
2	C	22.6	21.4	C	32.2	31.7	C	52.6	52.3
3	I	21.8	21.6	H	30.5	30.4	M	51.0	50.3
4	H	21.5	21.3	O	30.4	30.3	O	51.0	51.1
5	D	20.9	20.5	M	30.1	29.4	H	50.8	50.7
6	K	20.8	20.3	B	29.8	28.9	B	48.5	47.4
7	J	20.8	20.6	J	28.4	27.9	D	48.4	46.9
8	B	20.8	20.5	I	28.4	28.2	J	46.3	45.3
9	M	19.6	19.2	K	28.2	27.2	I	44.7	44.4
10	O	19.1	18.7	D	27.7	27.3	K	44.0	42.6
11	A	18.2	17.8	A	26.4	26.0	A	43.9	43.5
12	L	17.4	16.7	L	25.0	24.4	L	43.5	42.0
13	P	16.9	16.4	P	24.0	23.5	P	40.6	40.4
14	N	16.5	16.1	N	22.2	21.9	N	35.4	35.4
LSD		2.57 (1% level)			4.51 (1% level)			10.43 (1% level)	
<u>Location B</u> Courtenay area.									
1				C	28.1	25.5	C	41.2	39.5
2				G	27.8	26.2	G	40.1	39.0
3				J	27.1	24.7	J	39.2	37.2
4				D	26.5	22.4	I	38.4	36.2

5	B	25.7	23.7	D	38.4	34.9
6	H	25.5	24.4	B	37.4	36.3
7	I	25.4	24.0	K	37.0	36.1
8	M	25.2	22.6	M	36.7	35.0
9	K	24.7	23.7	H	35.8	36.0
10	O	22.6	21.0	L	33.9	32.9
11	L	22.0	20.3	O	32.6	31.9
12	N	21.6	20.2	P	30.9	29.8
13	A	21.4	20.6	A	30.8	29.3
14	P	20.6	19.8	N	30.0	29.0
LSD		5.01 (1% level)			6.89 (5% level)	

Location E Haney area.

1	C	41.7	38.3	C	71.2	64.9
2	G	40.5	39.0	G	66.9	64.6
3	B	39.6	37.0	B	64.6	59.7
4	I	38.9	35.7	I	64.4	59.1
5	K	38.7	36.7	H	63.6	61.0
6	H	38.5	37.3	K	62.4	59.2
7	J	35.4	33.5	A	59.0	52.5
8	D	35.1	33.3	M	58.0	53.8
9	M	34.8	32.0	J	57.0	52.9
10	A	34.3	31.6	D	54.7	51.4
11	P	31.9	31.1	P	53.8	52.4
12	N	31.8	29.3	L	52.2	49.0
13	O	30.6	28.6	O	51.0	48.1
14	L	30.2	27.8	N	50.1	46.5
LSD		No differences (5% level)				

Table 2. (Continued)

Rank	1959			1960			1961		
	Seed source	Height		Seed source	Height		Seed source	Height	
		Un-damaged	Damaged		Un-damaged	Damaged		Un-damaged	Damaged
<u>Location G</u> (damaged and undamaged live seedlings grouped together) Shelton area.									
1	C	25.1		C	42.2		C	64.8	
2	G	24.4		B	41.9		G	54.5	
3	B	23.9		G	38.7		M	53.3	
4	H	23.9		J	36.3		H	50.9	
5	O	22.3		D	35.8		B	50.3	
6	I	21.2		H	35.1		O	49.7	
7	D	20.6		O	33.2		K	48.8	
8	J	20.5		I	32.4		I	45.4	
9	K	20.0		K	32.0		D	45.2	
10	L	19.8		L	31.0		J	44.3	
11	N	19.3		M	28.9		L	42.2	
12	M	19.2		A	28.4		A	36.1	
13	A	18.6		N	27.5		P	35.9	
14	P	17.2		P	26.6		N	32.6	
LSD		3.35 (1% level)			No difference (5% level)			14.48 (1% level)	
<u>Location H</u> (damaged and undamaged live seedlings grouped together) Elbe area.									
1				C	26.8		H	36.8	
2				G	26.6		C	33.2	
3				B	26.4		G	32.3	
4				H	24.3		B	31.6	

5	O	23.1	O	28.1
6	I	22.5	D	27.8
7	D	22.5	K	27.4
8	J	22.0	I	26.7
9	N	21.9	A	26.1
10	K	21.7	N	25.2
11	L	21.5	L	25.1
12	A	21.2	M	24.9
13	M	20.2	J	22.6
14	P	19.0	P	22.0
LSD		No difference (5% level)		9.63 (1% level)

Location K Molalla area.

1	H	22.7	22.1	H	25.5	25.0	I	31.7	31.8
2	G	22.0	21.8	I	23.9	24.0	H	31.7	30.7
3	C	21.4	20.8	G	23.7	23.5	G	30.7	30.5
4	I	20.5	20.2	C	23.4	23.2	C	30.6	30.2
5	B	20.1	20.0	N	22.5	22.3	D	29.3	29.4
6	N	19.2	18.6	J	22.1	21.6	B	28.3	28.2
7	L	18.8	18.0	B	21.5	21.3	M	27.2	26.9
8	D	18.4	18.2	D	21.2	21.0	O	26.8	26.7
9	O	18.3	18.1	O	20.7	20.7	K	26.0	26.0
10	J	17.5	17.0	L	20.4	19.8	J	25.9	25.3
11	M	16.8	16.3	A	20.0	20.3	N	25.9	25.7
12	A	16.7	16.4	M	20.0	20.2	L	25.3	24.4
13	K	16.5	16.2	K	19.8	19.9	A	24.9	24.7
14	P	16.5	16.4	P	18.0	18.0	P	22.7	22.5
LSD		2.83 (1% level)			4.54 (1% level)			6.93 (1% level)	

Table 2. (Continued)

Rank	1959			1960			1961		
	Seed source	Height		Seed source	Height		Seed source	Height	
		Un-damaged	Damaged		Un-damaged	Damaged		Un-damaged	Damaged
Location L Salem area.									
1	D	26.3	25.7	D	44.0	44.0	D	74.2	74.1
2	C	25.7	25.9	C	40.7	40.7	C	67.6	67.3
3	B	25.4	25.3	B	38.5	39.3	B	62.4	62.7
4	G	23.0	24.6	I	35.7	34.9	G	60.1	59.8
5	L	22.3	18.8	G	34.9	34.2	I	59.3	59.1
6	H	21.8	21.7	O	34.4	34.1	M	57.6	57.1
7	I	21.6	21.1	M	34.0	33.1	H	57.0	56.9
8	O	21.4	20.8	H	33.6	34.8	O	53.8	53.3
9	K	20.7	20.3	K	32.8	32.7	K	53.7	54.3
10	N	19.4	18.2	L	30.9	31.7	J	51.5	51.1
11	J	19.2	18.5	J	29.9	30.2	P	44.0	44.1
12	M	19.2	19.1	P	27.5	26.9	L	42.4	41.6
13	A	17.8	17.5	A	26.7	25.8	A	42.2	41.2
14	P	17.4	16.9	N	26.0	25.1	N	41.7	40.6
LSD		5.62 (1% level)			11.64 (1% level)			18.22 (1% level)	



Location O High prairie, Oakridge.

1	C	28.6	26.4	D	42.7	42.3
2	G	28.3	25.2	B	41.5	39.7
3	D	28.3	27.5	C	40.1	39.0
4	B	28.1	26.3	G	39.9	36.9
5	H	26.1	25.8	H	38.9	38.6
6	O	24.9	23.8	J	37.3	37.0
7	J	24.3	23.6	M	37.2	36.7
8	L	23.9	22.9	O	37.0	35.9
9	M	23.3	22.7	A	36.0	35.2
10	K	22.3	21.8	L	35.4	34.5
11	N	21.6	21.4	I	35.2	35.0
12	I	21.4	20.9	K	34.4	34.4
13	P	20.3	20.5	N	32.6	32.5
14	A	18.9	18.4	P	30.1	29.7
LSD		6.94 (1% level)			No difference (5% level)	

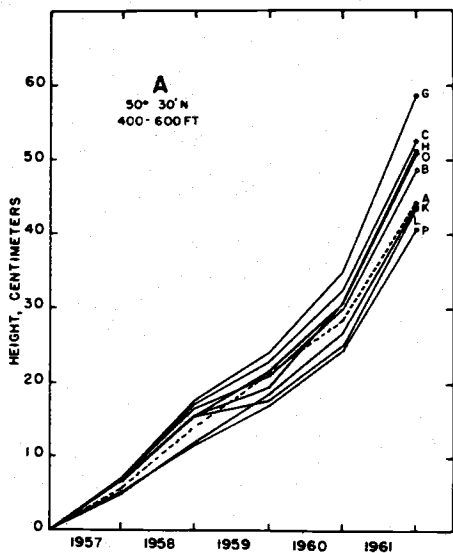


Figure 3. Nimpkish Forest.

ANNUAL GROWTH  
AT PLANTATIONS  
IN BRITISH COLUMBIA

Dotted lines indicate  
local seed source

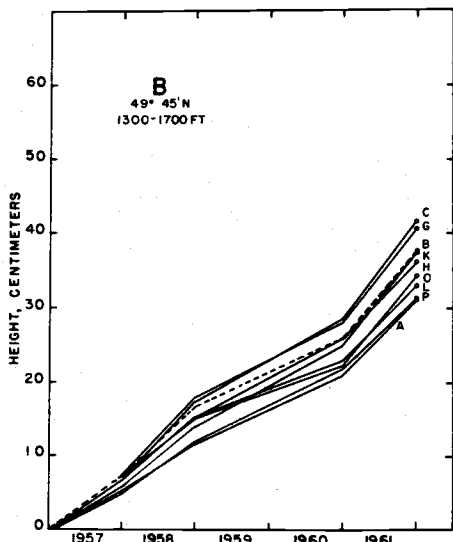


Figure 4. Courtenay area.

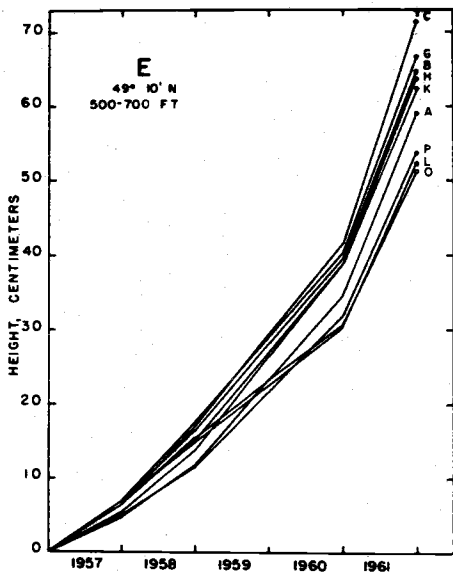


Figure 5. Haney area.

# ANNUAL GROWTH AT PLANTATIONS IN WASHINGTON

Dotted lines indicate local seed source

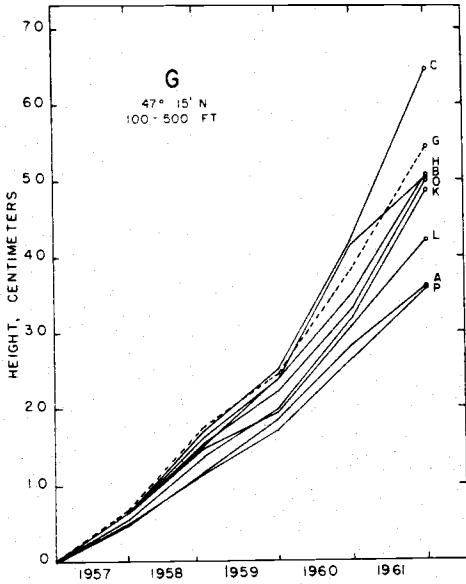


Figure 6. Shelton area.

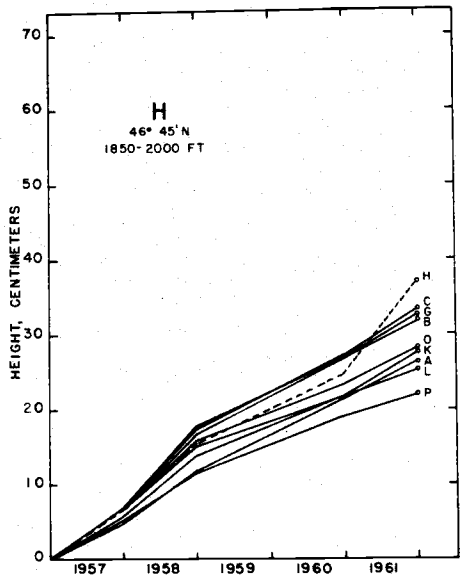


Figure 7. Elbe area.

ANNUAL GROWTH  
AT PLANTATIONS  
IN OREGON

Dotted lines indicate  
local seed source

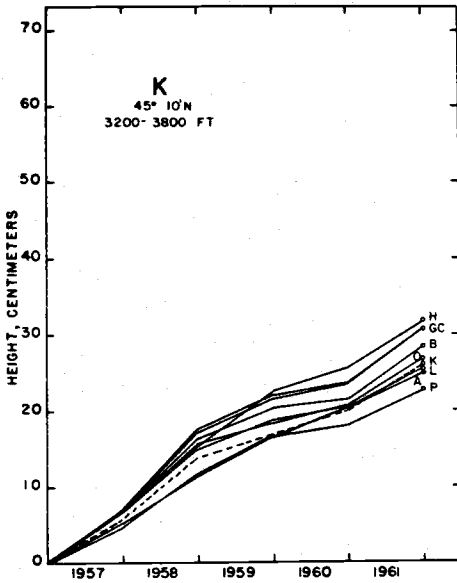


Figure 8. Molalla area.

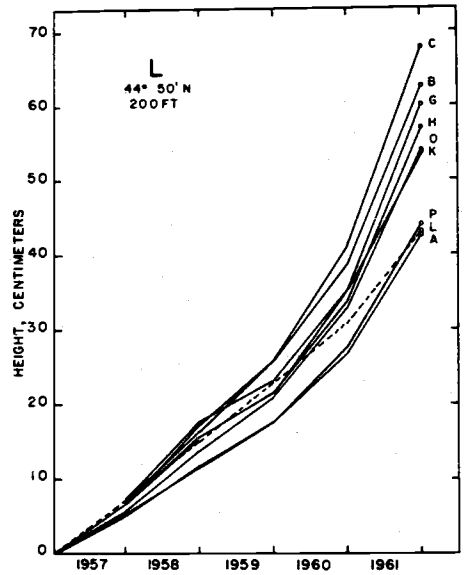


Figure 9. Salem area.

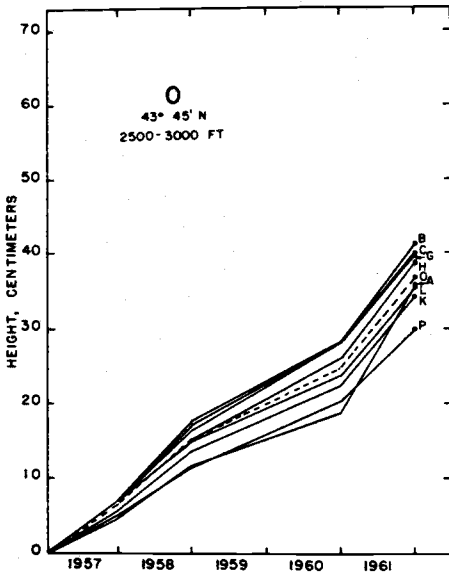


Figure 10. High prairie, Oakridge.

## DISCUSSION

Wakeley (10) pointed out that many contradictory results of seed-source studies could be related to raising planting stock of various provenances in different nurseries. Their survival and rate of growth were reflected in a different degree of significance. Stone and his co-worker (8) found the same phenomenon in their study of ponderosa pine. In the present study, all seedlings were raised in one nursery, so the effect of a differential selective force by nurseries was avoided.

Few provenance tests have included seed from trees near the plantings, and this circumstance made difficult comparing the growth rates and adaptability of local and nonlocal races from early establishment to maturity. The present study provides such an opportunity, because more than half of the plantations were able to survive and furnish valuable information for making such a comparison. Caution should be exercised in interpreting results at this early stage, as these preliminary observations are based on only a few years' growth, and were not derived from all provenance stocks from all plantations represented in this study. Other experiments (9, 11) have indicated that a pattern of early growth may be altered as trees under observation grow, although study of growth in height of wind-pollinated progenies of ponderosa pine (2) has shown that data on early growth can be useful in predicting future growth.

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