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VARIATION IN SEED CHARACTERISTICS, AND SEEDLING GROWTH OF OPEN POLLINATED PONDEROSA PINE PROGENIES

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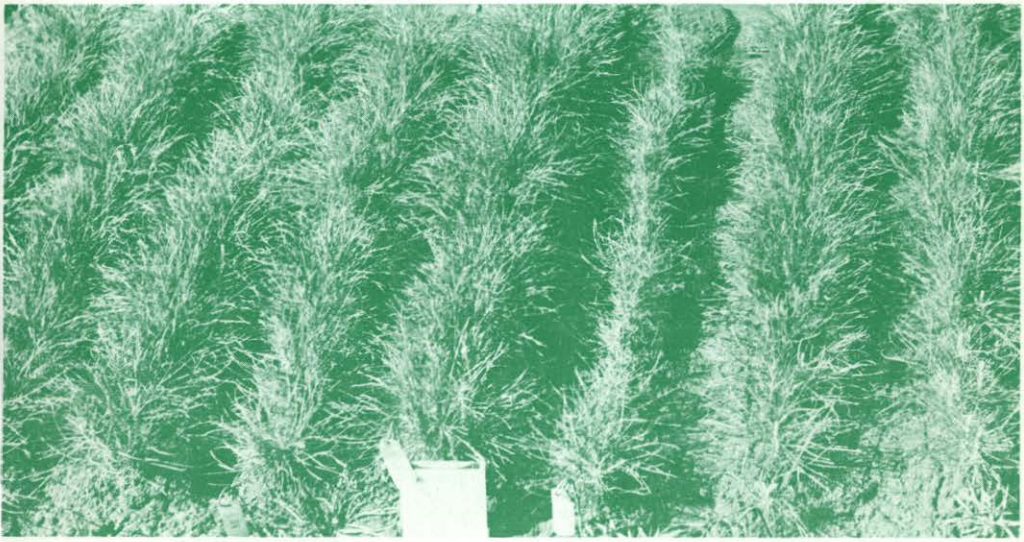

Fig. 1. 2-year seedlings of 271 open-pollinated progeny families showed that the differences among mother trees and among stands were highly significant.

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VARIATION IN SEED CHARACTERISTICS AND SEEDLING GROWTH OF OPEN POLLINATED PONDEROSA PINE PROGENIES (1)

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INTRODUCTION

The correlation between seedling characteristics and later performance is of great importance in selective breeding of forest trees. Observation of 271 open-pollinated progeny families of ponderosa pine showed that the 1-year and 2-year seedling height was positively correlated with their 8-year height (Wang and Patee 1973). However, 1-year and 2-year seedling height was found to be correlated with seed size, seed weight and germination capacity.

This report presents an analysis of seed and seedling characteristics of the open-pollinated progeny families and their interrelationship. The factors examined included their among-stand and among-progeny differences, the latitude, altitude, soil types of seed origin, and height and age of the seed trees.

MATERIALS AND METHOD

Seeds of 271 open-pollinated trees were collected in the same year from 37 natural stands in six counties of southern Idaho, viz., Adams, Boise, Elmore, Gem, Idaho, and Valley. Each stand was represented by 1 to 10 trees. The seedlings were raised in regular nursery seed bed. The progeny families were arranged in the seed bed according to the randomized complete-block design with 4 replicates.

In the analysis of variance the among-progeny differences was analysed at both the within-stand and the within-substand levels. The substands within each stand were separated according to the age of mother trees at 10-year intervals. Thus the mathematical model is as follows:

$$X_{ijklm} = U + B_i + S_j + T_{jk} + P_{jkl} + R_{ijklm}$$

$$i = 1, \ldots 4, j = 1 \ldots 37, k = 1, \ldots k_j, l = 1, \ldots l_{jk}$$

Where B_i is the block effect, S_j is the stand effect, T_{jk} is the effect of substand within stand, P_{jkl} is the effect of progeny within substand.

$$P'_{jkl} = T_{jk} + P_{jkl}$$

where P'_{jkl} is the within-stand progeny effect. Among the 37 stands studied 2 stands (nos. 17 and 51) are 1-tree stands, and 5 stands (nos. 20A, 20B, 23, 24, and 38) are even-aged.

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VARIATION IN 1-YEAR AND 2-YEAR SEEDLING HEIGHT

The analysis of seedling height included 268 progeny families from 37 natural stands. The progeny family means of 1-year and 2-year seedling height are listed in Table 9 (p. 9) and the stand means together with their relative ranking in comparison with the 8-year values in Table 1. The range of height between the shortest 2-year progeny family and the tallest was 7.25 - 14.78 cm (coeficient of variation 10.71, mean 10.65 cm) and that of 1-year progeny families 3.30-6.47 cm (C = 10.41, mean 4.66 cm).

The major sources of variation at the 1-year and 2-year stages were among stands and among progeny families within each stand. (Table 2)

The within-stand variance was further partitioned into substands according to age of the mother trees. At the 1-year stage the within-stand seedling height differences attributable to differences among age groups of mother trees were negligible, and the differences were non-significant at the 2-year stage (Table 2). This suggests that the succession of populations superimposed upon the same stand were not significantly different so far as observed in the seedling stage.

The general trend toward the 5-year and 8-year stage was that the difference in height between stands became increasingly distinct, and that the difference within stand among progeny families became increasingly uniform (Wang and Patee 1973).

THE VARIATION IN SEED CHARACTERISTICS

The seed characteristics analyzed included seed length, seed width, seed weight, and germination capacity. For seed size data length and width measurements were made with 10 individual random seeds for each progeny family, for seed weight data one measurement of a 40-seed sample was made for each progeny family. Equal amount of seed was sowed for each progeny family. The number of seedlings produced at the end of the first growing season was used as a measure of germination capacity.

The seed characteristics had a wide range of variation. The tree means are listed in Table 9. The range of seed length was 6.51 - 10.33 mm (coefficient of variation 7.58, mean 8.15 mm), seed width 4.01 - 5.92 mm (C = 6.38, mean 5.02 mm), and 40-seed weight 1.05 - 3.09 gram (C = 17.24, mean 2.09 gram). The major source of seed size variation was in the among-progeny differences within the natural stands (Table 3). There were no significant among-stand differences in seed length. The among-stand differences in seed width is significant at the 5% level.

In seed weight and germanation capacity the among-stand difference was one of the major sources of variation. (Tables 4-5). Furthermore, seed weight was the most variable of seed characters. It was positively correlated with germination capacity and seed size (Table 6). But there was no significant correlation between germination capacity and seed size (Table 6).

This divergent pattern of variation in seed characteristics confirmed the distinct embryogeny and seed development of the genus **Pinus**. At the time of fertilization about the end of June to early July over a year after pollination, the seed were fully grown in size though somewhat succulent. The seed coat hardened in a few days after fertilization but there was no appreciable increase in seed size. The seed developed rapidly during the period

of embryonic differentiation in which the embryo enlarged rapidly and differentiated its organs in a 10 to 12-day period. (Buchholz 1946, Buchholz and Stiemert 1946).

Control pollination of reciprocal crosses of ponderosa pine made by the senior author indicated that the inheritance of seed size was maternal. The seed weight, however, was obviously influenced by the environmental condition of the critical 2-week period of embryonic differentiation after fertilization and the subsequent period of seed maturation. The among-stand differences in seed weight and germination capacity reflected the essentially more uniform environmental conditions exposed to seed trees within the same stand in the same year in comparison with those among different stands at different localities.

Table 1. 1-year and 2-year stand mean seedling height and the ranking of 1-year, 2-year and 8-year stand mean height of ponderosa pine open-pollinated progenies

Stand (1) Number	1-year and 2-year Stand Mean Height (cm) and Ranking				8-year Stand Mean Height Ranking
1	4.44	(30)	10.14	(27)	25
2	4.47	(28)	10.97	(13)	23
5	3.93	(34)	9.11	(34)	33
6	4.60	(21)	11.02	(11)	21
9	4.91	(8)	10.84	(14)	17
11	4.54	(27)	10.27	(24)	31
14	4.81	(13)	10.67	(19)	9
15	4.45	(29)	11.00	(12)	22
16	3.93	(33)	9.84	(31)	30
18	4.59	(22)	9.91	(30)	32
19	4.66	(18)	10.72	(18)	19
20A	4.76	(16)	10.49	(20)	27
20B	4.63	(20)	10.19	(26)	26
21A	5.04	(4)	11.85	(3)	**1**
21B	4.93	(7)	11.38	(9)	8
22	5.44	(2)	**12.78**	**(1)**	15
23	4.79	(14)	10.77	(15)	12
24	4.72	(17)	12.18	(2)	7
25	4.85	(11)	9.69	(32)	24
26	**3.75**	**(35)**	**8.49**	**(35)**	**35**
27	4.35	(31)	9.43	(33)	16
28	4.58	(24)	10.75	(16)	14
29	4.86	(10)	11.55	(6)	6
35	4.23	(32)	10.40	(21)	20
38	4.55	(26)	10.74	(17)	5
39	4.95	(6)	11.44	(7)	2
41	4.83	(12)	10.07	(28)	28
42	4.86	(9)	11.42	(8)	11
43A	4.65	(19)	9.97	(29)	18
43B	4.96	(5)	10.38	(22)	13
46	4.55	(25)	10.35	(23)	29
47	**5.59**	**(1)**	11.79	(4)	3
50	4.59	(23)	10.24	(25)	34
53	4.78	(15)	11.16	(10)	10
54	5.06	(3)	11.58	(5)	4

(1): Two 1-tree stands (nos. 17, and 51) not included.

Table 2. Analysis of variance of 1-year and 2-year seedling height.

Sources of Variation	D. F.	F-Value 1-year	2-year
Block	3	27.1475**	169.5124**
Stand	36	2.2128**	2.787**
Substand	(73)	1.2999*	**1.1211 ns**
Progeny (1)	(158)	4.5725**	5.3236**
Residual	1821		

Within-Stand Among-Substand

Stand (2) Number	D. F.	F-Value 1-year	2-year
1	2	3.6783*	1.3522
2	2	0.2489	0.8164
5	3	0.7636	0.3431
6	4	0.6663	0.6923
9	1	0.6255	0.6173
11	4	2.4393*	0.9251
14	1	0.1929	0.1907
15	3	2.2611	2,5822
16	1	0.0911	0.0223
18	2	0.2755	0.4194
19	4	2.4784*	0.3521
21A	2	0.0168	0.4744
21B	2	0.2846	0.2945
22	2	2.8343	4.6525*
25	3	0.3441	0.2965
26	1	1.3809	0.3102
27	2	0.8674	1.7110
28	3	2.9788*	3.1946*
29	1	1.3926	1.0986
35	3	0.5526	1.4887
39	1	0.0319	2.7520
41	3	2.0889	2.3804
42	1	7.0988**	1.8790
43A	1	0.0100	0.9881
43B	3	0.3214	1.9127
46	4	0.5643	0.4780
47	4	1.0610	0.6185
50	3	0.2947	0.8502
53	2	0.8995	0.5365
54	5	1.6442	0.4120
Total: 30	73		

(1) Within-substand among-progeny. (2) Two 1-tree stands (nos. 17 & 51) and five even-aged stands (nos. 20A, 20B, 23, 24, & 38) not included. (3) stand nos. 17 & 51 not included.

* significant at the 5% level, ** significant at the 1% level, ns non-significant

Table 2 (cont.)

Within-Stand Among-Progeny

Stand (3) Number	D. F.	F-Value 1-year	2-year
1	9	5.88**	3.61**
2	9	3.49**	8.95**
5	6	4.71**	3.10**
6	9	3.02**	4.44**
9	9	5.53**	6.81**
11	9	5.94**	3.77**
14	9	2.32*	1.89*
15	9	4.27**	11.67**
16	5	0.52	3.97**
18	5	7.73**	8.17**
19	9	8.67**	2.71**
20A	6	5.66**	7.98**
20B	6	6.19**	5.42**
21A	6	5.16**	9.37**
21B	2	1.29	1.57
22	3	12.24**	16.85**
23	4	2.58*	1.06
24	6	5.15**	10.83**
25	9	3.13**	2.56**
26	4	7.31**	2.25
27	3	5.35**	6.09**
28	9	8.75**	8.92**
29	8	4.64**	3.05**
35	8	2.41*	4.40**
38	8	2.71**	4.02**
39	3	0.73	7.28**
41	7	6.91**	8.48**
42	5	10.72**	4.44**
43A	8	6.61**	5.78**
43B	7	4.69**	12.55**
46	9	4.28**	2.43*
47	6	6.59**	3.04**
50	4	1.05	4.53**
53	5	2.72*	3.06**
54	7	5.35**	2.08*
Total: 35	231		

CORRELATIONS BETWEEN SEED AND SEEDLING HEIGHT

The 1-year and 2-year seedling height was found to be positively correlated with seed length, seed width and seed weight in increasing degree of correlation. The seedling height was also positively correlated with germination capacity. Their interrelationships are tabulated in Table 6.

Table 3. Analysis of variance of seed length and seed width (1)

S.O.V.	D.F.	F-Value	
		seed length	seed width
stand	35	1.2691 ns	1.6852*
substand	60	1.1209 ns	0.8814 ns
progeny	112	36.5926**	14.4104**
residual	1840		

(1) The seed size analysis included 208 families from 36 stands. * significant at the 5% level. ** significant at the 1% level. ns non-significant

Table 4. Analysis of variance of seed weight (1)

S.O.V.	D. F.	F-Value
stand	36	2.0992**
substand	73	1.1273 ns
progeny	157	

(1) The seed weight analysis included 267 progeny families from 37 stands.

** significant at the 1% level. ns non-significant

Table 5. Analysis of variance of germination capacity (1)

S.O.V.	D. F.	F-Value
block	3	5.9358**
stand	36	3.5102**
substand	73	0.8760 ns
progeny	158	3.3730**
residual	774	

(1) The germination capacity analysis included 268 progeny families from 37 natural stands.

** significant at the 1% level. ns non-significant

Table 6. Correlations between seed length, seed width, seed weight, germination capacity, and seedling height.

	1-year Seedling Height	2-year Seedling Height	Germination Capacity	Seed Weight	Seed Width
Seed Length	0.3304**	0.1505*	**-0.0268 ns**	0.4790**	0.4528**
Seed Width	0.3649**	0.1970**	**0.0776 ns**	0.5559**	
Seed Weight	0.5528**	0.3760**	0.2447**		
Germination Capacity	0.4113**	0.5091**			
2-year Seedling Height	0.5019**				

* significant at the 5% level, **significant at the 1% level, ns non-significant.

RELATIONS BETWEEN SEED, SEEDLING AND THE MOTHER TREE

We then examined the relations between the variation in seed and seedling, and the geographical and morphological differences of the mother trees. The factors examined included the age and height of the mother trees, the soil types and the latitude and altitude of the original stands.

(1) AGE AND HEIGHT OF THE MOTHER TREES

The age of the mother trees varied from 20 to 200 years and the height from 20 to 130 ft.

Correlation analysis indicated that age of the mother trees was not significantly correlated with seed length, seed width, seed weight, germination capacity, and 1-year and 2-year seedling height. Height of the mother tree was not significantly correlated with the 2-year seedling height and the germination capacity. But the analysis based on this limited regional material suggested that taller trees produced smaller and lighter seeds, and shorter 1-year seedlings (Table 7).

Table 7. Correlation between seed, seedling and mother tree.

	1-year Seedling Height	2-year Seedling Height	Germination Capacity	Seed Weight	Seed Length	Seed Width
Mother Tree Age	-0.0698 ns	-0.0782 ns	0.0384 ns	-0.1060 ns	-0.1118 ns	-0.0987 ns
Mother Tree Height	-0.1462*	-0.1097 ns	-0.0710 ns	-0.1413*	-0.1672*	-0.1462*
Latitude of See Origin	-0.0377 ns	0.0949 ns	0.0759 ns	-0.0176 ns	0.0345 ns	-0.0292 ns
Altitude of Seed Origin	**-0.1948****	**-0.3725****	**-0.2424****	-0.1686*	0.0994 ns	-0.0032 ns

ns. non-significant, * significant at the 5% level, ** significant at the 1% level.

(2) SOIL TYPE

This progeny study was made for the genetic improvement of ponderosa pine (Wang 1967). In the planning of this program one of the major concerns of the cooperators was the differences in soil types of this 6-county area.

Among the 271 seed trees selected, 113 trees in 15 natural stands were from the "basaltic" bed rock soil regions and 158 trees in 22 natural stands from the "granitic" region. No significant difference was found between trees of these two regions in seed length, seed width, seed weight, germination capacity, and 1-year and 2-year seedling height (Table 8).

Table 8. Analysis of variance of seed and seedling characteristics from the basaltic and granitic regions.

Observation	D.F. Error	t-Value
Seed length	206	0.5109 ns
Seed width	206	0.2636 ns
Seed weight	265	1.8484 ns
Germination Capacity	266	1.2987 ns
1-year height	266	1.2494 ns
2-year height	266	1.1006 ns

ns. non-significant

Table 9. Seedling height, seed size and seed weight of 271 open-pollinated Ponderosa Pine progeny families.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1	3.70	8.72	7.04	4.59	1.05
	2	4.95	10.16	9.83	5.00	2.03
	3	4.20	10.27	9.29	5.12	1.86
	4	4.97	12.42	7.68	5.14	1.21
	5	4.64	10.72	9.10	5.75	1.93
	6	3.95	9.19	7.40	4.70	1.87
	7	4.27	9.25	7.77	4.90	1.91
	8	3.95	10.47	8.00	5.06	1.67
	9	5.44	10.47	8.68	5.37	2.07
	10	4.42	10.38	8.35	4.98	2.16
2	11	4.57	11.22	8.56	5.26	1.55
	12	4.26	8.94	6.60	4.10	1.44
	13	4.17	10.91	7.99	4.81	1.75
	14	4.61	9.53			1.52
	15	4.32	10.00	6.51	4.01	1.66
	16	3.94	10.31			1.71
	17	4.92	11.63	8.22	4.61	1.71
	18	3.90	11.00	7.86	4.67	1.76
	19	5.14	12.03	8.84	5.40	1.58
	20	4.84	14.16	7.64	4.56	
5	21	3.77	7.41	8.25	5.30	1.59
	22	3.50	9.84	6.71	4.54	1.08
	23	4.16	9.06	9.26	4.92	1.78
	24	4.91	8.89	9.80	5.22	2.29
	25	3.60	9.47			1.44
	26	3.64	9.09	7.87	4.26	1.46
	27	3.91	10.03	8.46	4.98	1.90
6	28	4.21	11.09	7.73	4.78	1.55
	29	5.29	12.69	8.33	5.18	2.56
	30	4.36	12.09	7.95	4.76	2.01
	31	4.12	9.28	7.54	4.57	1.64
	32	5.19	10.94	8.53	5.12	2.43
	33	4.69	11.44	7.49	4.50	1.31
	34	4.51	11.53			2.48
	35	4.56	10.63	7.92	5.23	2.24
	36	4.31	9.59	7.63	4.75	1.79
	37	4.74	10.94	8.93	5.59	2.68
9	38	4.10	11.66	7.65	4.71	1.94
	39	4.46	11.53	8.39	5.18	2.28
	40	5.77	13.91	7.98	5.39	2.63
	41	5.11	9.88	7.98	5.17	2.15
	42	4.39	9.91	7.92	5.13	2.05
	134	4.92	10.63	8.11	5.00	1.96
	135	5.50	10.38	8.84	5.46	2.62
	208	4.55	10.00	7.86	5.22	2.03
	209	5.12	10.91	8.57	5.59	2.87
	210	5.15	9.66	8.59	4.80	2.18
11	43	3.86	10.63	8.37	5.15	1.97
	44	4.80	10.69			2.27
	45	5.25	10.34	8.96	5.49	2.24
	46	4.11	9.16			1.74
	47	3.67	9.39	7.76	4.96	1.76
	48	4.35	9.16	8.11	5.07	1.62
	49	4.42	11.00			1.74
	50	5.19	11.25	9.10	5.71	2.80
	51	5.00	11.75	8.85	5.00	2.29
	52	4.75	9.31	8.77	5.17	2.19
14	53	4.99	10.24	8.25	5.22	2.90
	54	5.12	11.25	8.49	5.72	2.84
	55	5.32	9.97			2.13
	56	4.89	10.09	8.07	5.05	2.15
	57	4.30	11.00	7.84	4.89	2.05
	58	4.74	10.27	8.01	5.04	1.95
	59	4.25	11.09	7.58	5.22	2.22
	60	4.94	11.03	8.28	5.25	2.60
	61	4.92	9.88	8.43	5.00	2.32
	62	4.61	11.91			2.46
15	63	5.10	14.41	8.72	5.58	3.09
	64	5.24	10.34	8.67	5.32	2.93
	65	4.36	8.88	7.63	4.66	1.83
	66	4.02	10.06	7.23	4.96	1.87
	67	4.15	9.56	8.90	5.27	2.64
	68	4.84	12.91	7.94	5.65	2.43
	69	3.89	11.31	6.75	4.74	1.61
	70	4.35	10.94			2.12
	71	4.55	9.13			1.75
	72	4.10	11.38	7.33	5.19	2.03
16	73	3.76	10.31	7.54	4.53	1.59
	74	3.91	10.69	8.63	5.27	2.29
	75	4.20	9.69	8.40	4.77	2.08
	76	3.91	8.55	8.25	4.87	2.14
	77	3.79	10.94	7.71	4.95	2.12
	78	4.02	8.88	7.98	4.72	1.64
17	79	5.17	11.00	8.05	4.82	1.93
18	80	3.84	9.53	7.98	5.16	1.97
	81	5.09	11.88	8.90	5.00	2.89
	82	3.81	8.19	7.59	4.91	1.74
	83	4.71	9.88	8.34	4.89	1.94
	84	5.25	11.19	8.04	5.02	2.06
	85	4.93	8.81			2.35
19	86	4.72	12.66	8.39	5.06	2.33
	87	3.40	10.34	7.25	4.57	1.56
	88	4.44	10.69	7.94	5.13	2.20
	89	5.67	10.25	7.40	4.86	1.95
	90	4.24	10.38	7.89	5.15	1.76
	91	4.44	10.16	8.22	4.73	1.78
	92	4.61	9.97	7.41	4.81	1.62
	93	5.02	10.88	8.15	5.13	2.13
	94	5.57	11.50	9.07	5.46	2.72
	95	4.44	10.38	7.99	4.82	1.88
20A	96		(7.25)*			(1.27)*
	97	5.70	11.63	8.28	5.09	2.19
	98	4.90	12.69	9.47	5.06	2.08
	99	4.47	10.31			1.87
	100	5.07	10.63	7.83	5.30	1.93
	101	4.22	9.42			1.84
	102	4.74	10.07	10.33	5.92	2.16
	103	4.14	8.56	7.31	4.74	1.45
20B	104		(8.66)*			(1.47)*
	105	3.96	11.47	8.49	5.15	1.92
	106	4.24	9.03	7.87	4.73	1.87
	107	4.96	9.09	8.43	5.58	2.05
	108	5.62	10.16	9.27	5.47	2.58
	109	4.42	9.94	9.11	5.33	2.72
	110	4.82	9.66	7.44	5.01	2.08
	111	4.34	12.00	8.16	5.00	1.86
21A	112	5.36	14.38	8.20	4.88	2.12
	113	5.11	11.00	7.82	5.11	1.88
	114	5.32	12.44	8.78	5.07	2.20
	115	5.81	12.47	8.56	5.60	2.79
	131	4.59	10.41	7.76	4.88	2.03
	132	4.69	12.25	7.92	4.94	1.78
	165	4.37	10.00	6.83	4.36	1.45
21B	116	4.71	10.69	8.68	5.46	2.95
	133	5.21	11.84	7.98	4.89	2.49
	166	4.87	11.63	8.40	5.03	2.82
22	117	4.57	10.50	7.19	5.31	1.80
	118	5.42	14.78	8.34	5.21	2.41
	119	6.47	14.13			2.40
	120	5.27	11.72	9.09	5.87	2.88

Note: (1) stand, (2) progeny, (3) 1-year height (cm), (4) 2-year height (cm), (5) seed length (mm), (6) seed width (mm), (7) 40-seed weight (gram).
( )* Not included in the analysis.

Table 9. (Continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
23	121	4.31	10.66	8.32	4.91	1.92
	122	5.24	10.41			1.93
	127	4.62	10.22	8.48	5.05	1.99
	128	5.04	11.22	7.74	5.25	1.99
	129	4.75	11.38	8.72	5.66	2.22
24	123	5.24	12.84	8.39	4.96	2.33
	124	4.26	13.47	8.24	4.99	2.27
	125	5.17	13.09	8.81	5.46	2.39
	126	5.17	10.63	8.62	5.31	2.44
	130	4.39	11.16	8.03	5.00	2.21
	167	4.84	14.19	8.56	5.12	2.14
	168	3.99	9.91	8.36	4.69	2.21
25	136	4.66	8.94	8.12	5.41	2.03
	137	5.39	9.47	9.18	6.05	2.07
	138	5.26	9.38	7.84	5.11	2.03
	139	4.62	8.81	8.40	5.34	2.23
	169	4.22	10.38	8.02	5.12	2.26
	170	4.74	9.47	8.67	5.15	2.60
	171	4.64	10.78	8.18	5.12	1.97
	172	4.75	9.78	8.56	5.13	2.39
	173	4.70	8.91	8.02	4.88	2.58
	174	5.47	11.00	8.46	5.39	2.25
26	140	3.76	9.22	8.40	5.21	1.84
	141	4.25	9.06			1.38
	142	3.30	7.41			1.89
	143	4.42	8.63	8.50	5.25	1.61
	144	3.00	8.16	7.44	5.01	1.56
27	145	5.04	10.47	8.96	4.92	2.30
	146	4.09	10.44			1.65
	147	4.17	8.72	7.82	4.93	1.82
	148	3.30	8.09	6.95	4.31	1.07
28	149	4.42	12.50	8.11	4.89	1.80
	150	4.14	11.19	8.29	4.73	1.90
	151	5.85	12.50	8.73	4.92	2.23
	152	4.90	10.63	8.06	5.05	1.98
	153	3.66	8.91	7.45	4.91	1.88
	182	3.69	8.22			2.31
	183	4.70	9.97	8.00	4.54	1.71
	184	5.12	11.25	8.65	4.97	1.98
	185	4.47	10.22			1.78
	186	4.82	12.16	8.19	5.00	2.25
29	154	4.91	10.94	7.95	5.13	2.54
	155	4.55	10.47	7.94	4.86	1.95
	175	4.44	11.06	8.75	5.62	2.77
	176	4.25	11.00	7.90	5.03	2.13
	177	4.75	13.50			2.34
	178	4.91	12.25	8.44	5.26	3.01
	179	5.63	13.38			2.41
	180	5.49	12.38			2.31
	181	4.72	11.19			2.42
35	156	4.70	11.56	7.96	4.82	2.14
	157	4.26	12.19	7.18	4.40	1.58
	158	3.90	9.84	6.94	4.63	1.53
	159	3.80	9.28	7.07	4.51	1.47
	160	4.26	10.97	8.08	4.84	1.99
	161	3.80	9.72	7.48	4.91	1.86
	162	4.72	10.50	8.24	4.86	2.20
	163	4.37	9.16	8.05	5.00	2.17
	164	4.22	10.38	8.41	5.00	2.26
38	187	5.01	12.25	8.07	5.05	2.26
	188	4.72	11.16	8.77	5.10	2.73
	189	5.00	10.75	8.35	4.95	2.53
	190	3.84	9.59			1.56
	191	4.70	12.03	9.08	5.12	2.91
	192	4.29	10.78	7.99	4.69	1.81
	193	4135	10.69	8.87	5.10	2.43
	194	4.50	9.44			2.24
	195	4.55	9.97	7.97	4.77	2.19
39	196	4.75	9.94			2.29
	197	4.70	11.13			1.87
	198	5.15	11.59	7.73	4.97	2.14
	199	5.02	13.06			2.08

(1)	(2)	(3)	(4)	(5)	(6)	(7)
41	200	5.16	11.97	8.30	4.89	2.23
	201	4.04	9.75	8.24	4.93	2.08
	202	4.00	9.41	7.03	4.49	1.14
	203	4.69	9.09	7.67	4.61	1.63
	204	5.31	11.44	8.76	4.92	1.90
	205	5.67	11.44			3.18
	206	5.01	9.66	8.91	5.30	2.40
	207	4.76	7.78	8.63	4.92	2.21
42	211	3.97	12.84	7.20	4.76	1.59
	212	4.27	11.78	7.97	4.59	1.59
	213	5.02	10.69	8.43	4.94	2.25
	214	5.44	11.06			2.30
	215	4.54	10.00	7.29	4.40	1.84
	216	5.91	12.13			3.36
43A	217	4.34	10.03			1.88
	218	5.82	10.31			2.02
	219	4.84	10.97			1.70
	220	4.41	10.44			1.94
	221	4.78	8.69			1.96
	222	3.76	8.13			1.82
	223	4.69	9.03	8.28	4.98	2.02
	224	5.01	9.94			2.01
	225	4.25	11.88			2.59
43B	226	5.09	8.06	7.66	4.59	1.74
	227	5.10	11.03			2.42
	228	4.89	8.78			2.03
	229	5.51	13.19			2.20
	230	5.50	11.41	7.22	4.81	1.58
	231	4.95	11.34	7.61	4.58	1.87
	232	4.02	8.69			2.07
	233	4.59	10.50	7.77	4.96	2.07
46	234	5.41	11.16	8.21	5.57	2.48
	235	4.50	10.56	7.07	5.20	1.90
	236	4.26	9.38	8.46	5.02	1.96
	237	4.32	11.41	7.84	4.95	2.19
	238	5.10	10.00	8.17	4.09	2.19
	239	3.87	9.94	7.30	4.28	1.80
	240	4.36	9.25	7.83	4.59	1.95
	241	4.22	10.78	7.48	4.41	1.83
	242	4.79	11.13	8.41	5.29	2.43
	243	4.59	9.91	8.05	4.72	1.95
47	244		(8.75)*			
	245	5.46	12.25	8.00	5.44	2.87
	246	6.39	10.94			2.91
	247	4.25	10.31			2.70
	248	5.35	11.41			2.17
	249	5.57	11.97	8.29	5.12	2.49
	250	5.47	13.75			2.26
	251	6.02	12.34	7.64	5.06	2.20
50	252	4.54	9.41			1.66
	253	4.45	9.00			2.38
	254	4.59	10.47			2.36
	255	4.97	10.72			2.29
	256	4.39	11.59	7.72	4.73	1.75
51	257	4.70	10.66			2.53
53	258	5.87	13.19			2.41
	259	4.52	11.34	8.38	4.95	1.69
	260	4.57	10.28			2.13
	261	4.79	10.69			1.98
	262	4.42	12.29	7.11	4.79	1.81
	263	4.95	10.66	8.76	5.57	2.86
54	264	5.12	11.41	8.16	4.84	2.37
	265	5.19	11.25			2.47
	266	5.66	11.94	8.84	4.89	2.03
	267	5.60	12.22			2.89
	268	4.91	11.44			2.46
	269	4.75	11.97	8.83	8.46	2.54
	270	4.02	12.31	8.23	4.98	2.30
	271	5.20	10.13	8.57	4.92	2.44

(3) LATITUDE AND ALTITUDE

The 37 stands of seed trees covered a north-south range of approximately 200 miles from White Bird to Mountain Home. The seed characteristics, and the seedling heights were not siginificantly correlated with the latitude of seed origin (Table 7).

Of all the factors examined the correlation between the altitude of seed origin and seed and seedling variation was the most significant. The seed trees had a wide altitudinal range of 3200 to 6500 feet. The seed germination capacity and the 1-year and 2-year seedling height were inversely correlated with the altitude of seed origin. This general trend was found to be highly significant (Table 7). But elevations alone was not a reliable criterion for the selection of best progenies. As indicated by the 1-year, 2-year and 8-year height growth, the tallest and the shortest progeny families and stands were all from the broad zone of intermediate elevations.

SUMMARY

The among-stand difference was one of the major sources of variation in seed weight and germination capacity, but in seed length, seed width, the primary sources of variation was in the among-progeny difference within the natural stands.

The major sources of variation of seedling height were among stands, and among progeny families within each stand. The within-stand variance was further partitioned into substands according to the age of mother trees. The within-stand among-substand height differences were not significant in 2-year seedlings.

Seedling height growth was found to be positively correlated with seed length, seed width, seed weight and germination capacity, but there was no significant correlation between germination capacity and seed size. Age and height of mother trees were not significantly correlated with germination capacity, and 2-year seedling height. No significant differences were found between progeny families from the basaltic and the granitic regions in seed length, seed width, seed weight, germination capacity and 1-year and 2-year seedling height. Seed and seedling characteristics were not significantly correlated with the latitude of seed origin.

The inverse correlation between seedling height and altitude of seed origin was found to be highly significant, but the fastest and the slowest growing progeny families and stands were all from the broad belt of middle elevations.

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ABSTRACT

WANG, Chi-Wu and PATEE, Robert K. (1974)
Variation in Seed Characteristics and Seedling Growth of Open Pollinated Ponderosa Pine Progenies.
University of Idaho, Forest, Wildlife and Range Experiment Station, Station Paper No. 15, April 1974. 12pp.

The within-stand and among-stand variation of seed and seedling, and the correlations between seed, seedling and mother tree were analyzed.

The factors examined included seed length, seed width, seed weight, germination capacity, 1-year seedling height, 2-year seedling height, latitude, altitude, and soil types of seed origin, and height and age of mother trees.

KEY WORDS: Progeny test, Seed variation, *Pinus ponderosa*.