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INTRODUCTION

The purpose of this experiment was to obtain basic information on regional variation in the natural population of ponderosa pine as a basis of selection for genetic improvement (Wang 1967). The wide range of among-stand and among-progeny variations in the first 5-year period indicates that substantial improvement could be expected from the first generation selection.

The region of this study includes six counties in southern Idaho, viz., Adams, Boise, Elmore, Gem, Idaho, and Valley. The materials were 271 half-sib families from 37 natural stands. Each stand was represented by 1 to 10 seed trees, selected at random from the dominant class, with the restrictions that the sample trees were no less than 61 m (200 ft) apart, and that all trees in a stand were within a 1.609 km (1-mile) radius. Their geographic sources were tabulated in Appendix 1. The 1-year and 2-year growth and their relationship with seed characteristics were analyzed (Wang and Patee 1974). The progenies were tested in four sites from 1127.8 m (3700 ft) to 1630.7 m (5350 ft) within the natural range of ponderosa pine of this region. The 12-acre plantation at each site includes 10 randomized complete blocks of all the progenies in 4-tree plots at 5 ft x 10 ft spacing.

The four sites were located at (1) Boise County, 1219.2 m (4000 ft), Idaho City, U.S. Bureau of Land Management plantation (2) Adams County, 1447.8 m (4750 ft), Boulder Creek, New Meadows, Payette National Forest plantation (3) Valley County, 1630.7 m (5350 ft), Jack's Creek, Idaho State Department of Public Lands, plantation and (4) Ada County, 1127.8 m (3700 ft), Holcomb, Boise National Forest plantation. This is a report of the 5-year progeny variations, their correlation with seed, seed-tree and seedling characteristics, and the progeny x site interaction.

This study was conducted in cooperation with the Idaho Department of Public Lands, U.S. Bureau of Land Management, U.S. Forest Service, and the Southern Idaho Forestry Association. It was partially supported by the McIntire-Stennis fund, and was published with approval of the Director, Forest, Wildlife and Range Experiment Station, as Contribution No. 21, University of Idaho, Moscow.

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COVER PHOTO: This Ponderosa pine progeny test seed orchard is located at the low elevation 1127.8 m (3700 ft) Boise National Forest plantation at Holcomb.

AMONG-STAND AND WITHIN-STAND VARIATION

The analysis of variance in the four sites showed that the among-stand and among-progeny 5-year height differences are highly significant (Table 1). The five fastest growing stands as indicated by the average 5-year height on the four sites were (a) stand no. 47, Garden Valley, BNF, 79.58 cm (31.33 inch), (b) 21 A, Hazard Creek, BLM, 79.22 cm (31.19 inch), (c) 42, Trail Creek, BNF, 77.65 cm (30.57 inch), (d) 54, Zena Creek, PNF, 76.61 cm (30.16 inch), and (e) 21 B, Scriver Creek, BLM, 75.09 cm (29.56 inch).

Table 1. Analysis of Variance of 5-year Ponderosa Pine height at four test sites.

S.O.V.	D.F.	F.	S.O.V.	D.F.	F.
SITE	3	238.62**	SITE	3	424.96**
BLOCK	36	44.57**	BLOCK	36	66.16**
STAND	36	3.75**	PROGENY	270	3.87**
SXS	108	2.84**	SXP	810	2.45**
ERROR	1296		ERROR	5906	
TOTAL	1479		TOTAL	7025	

The five slowest growing stands by four-site mean height were (a) stand no. 5, 58.83 cm (23.16 inch), (b) 50, 62.62 cm (24.65 inch), (c) 26, 62.84 cm (24.74 inch), (d) 16, 62.87 cm (24.75 inch), and (e) 18, 63.73 cm (25.09 inch).

For the analysis of within-stand variation, sample trees within each stand are divided into substands according to age at 10-year intervals. Age of parent trees is given in Appendix 2. The within-stand among-substand differences in 5-year height are not significant (Table 2). Variance components attributable to within-stand among-substand variations are mostly negligible (Table 3).

VARIANCE COMPONENTS AND POPULATION STRUCTURE

At site 1, 48.65 percent of total variance and site 4, 58.19 percent of total variance in 5-year hei were associated with stands; 25.20 percent (site and 19.51 percent (site 4) of the total variance w associated with progeny families. The among-proge differences were highly significant (Tables 2, 3).

However, the analysis of variance of 5-year p genies within each individual stand indicated that within-stand among-progeny differences were sign cant only in 3 to 8 of the 35 multi-progeny star (Table 4). This was a drastic change by comparison w the 1-year and 2-year seedlings. At the 1-year stage, within-stand among-progeny differences were sign cant in 31 of the 35 multi-progeny stands, and at 2-year stage the among-progeny differences were sig ficant in 32 stands. (Table 2, Wang and Patee 197

At this early stage of 5-year seedling height develo ment, a distinct pattern of population structure came evident. There was more variation among star than there was variation among mother trees with stand (Table 3). There was no significant differer among progenies from different age classes of tr superimposed upon the same stand by natural reg eration (Table 2). And in a relative sense, the progen from a common stand, i.e., a small panmictic popu tion, were essentially uniform (Table 4). Simi results were obtained from among physiographic regic and within-stand studies of loblolly pine (LaFarge 19 Barber 1966, and Wells and Switzer 1971).

CORRELATION WITH SEEDLING, SEED, AND SEED TREE

Partial correlation analysis of 5-year proge height was made with 1-year seedling height, se characteristics, and seed tree sources (Table 5). T partial correlation with 1-year seedling height w

Table 2: Analysis of variance of 5-year Ponderosa Pine Height at Each of the Four Test Sites.

	Site 1		Site 2		Site 3		Site 4	
S.O.V.	D.F.	F.	D.F.	F.	D.F.	F.	D.F.	F.
STAND	36	2.14*	36	2.47**	35	1.03	36	1.25
SUBSTAND	73	0.71	73	0.89	70	1.40	72	1.12
PROGENY	152	1.96**	158	1.85**	153	1.42**	155	1.67**
INDIVIDUAL	1875		1891		712		1462	
TOTAL	2136		2158		970		1725	

7.10

und to be highly significant, but it was not significant ith seed characteristics, including seed size, seed eight, and germination capacity. The 5-year seedling eight was found to be inversely correlated with seed ee age, but not correlated with mother tree height.

able 3. Percentage of Variance Components Attributable o the Variance of Progeny Mean 5-Year Height at the Four est Sites.

.O.V.	Site 1	Site 2	Site 3	Site 4
TAND	48.65	58.19	0	14.79
UBSTAND	0	0	32.22	9.00
ROGENY	25.20	19.51	20.54	30.81
NDIVIDUAL	26.15	22.30	47.24	45.40
OTAL	100.00	100.00	100.00	100.00

The geographic origin of the seed trees has an ltitudinal range of 1005.84 m (3300 ft) from stand No. 32 (New Meadows), 975.36 m (3200 ft), to stand No. 41 (Cottonwood, Boise), 1981.2 m (6500 ft), and latitudinal range of 200 miles from stand No. 11 Mountain Home) to stand No. 43 A (White Bird). The 5-year seedling height, as that of the 2-year seedling, vas inversely correlated with altitude and not ignificantly correlated with latitude.

The four sites for the progeny tests plantations vere in the granitic region of average site quality. They vere selected to represent the altitudinal range in vhich ponderosa pine was to be planted. The nvironmental influence of the test sites was reflected n progeny growth and the plantation means. The rogeny site interaction of the 271 half-sib families vas highly significant(Table 1). The plantation mean eight of the four sites were (1) 65.76 cm (25.89 nch), elevation 1219.2 m (4000 ft); (2) 77.95 cm 30.68 inch) at 1447.8 m (4750 ft); (3) 70.03 cm 27.57 inch) at 1630.7 m (5350 ft); and (4) 64.74 cm 25.49 inch) at 1127.8 m (3700 ft).

In addition to their altitudinal range, there were other distinct differences between the four sites. Sites 3 and 4 were seriously affected by severe site condition, and site 2 by heavy snow. In view of the strong site influence, both the over-all performance of their progenies at the four sites and their site interaction should be taken into consideration in the selection of superior seed trees.

DISCUSSION

Theoretically speaking it is logical to infer that greater genetic gain can be expected from among-stand selection than from within-stand among-progeny selection. The 5-year result proved the veracity of this approach.

Mean height growth was used as an indication of vigor and general adaptability of the progeny families. The 5-year result indicated that this desirable character was not distributed at random. In the natural population, desirable parent trees were found to be concentrated in certain local populations. Of the 20 best half-sib families, 8 families were from the best two stands, and 14 families from the best five stands.

Table 4. Analysis of Variance of 5-Year Progeny Height of Each Stand at the Four Test Sites.

Stand	Site 1 F	Site 2 F	Site 3 F	Site 4 F
1	2.02*	1.76	0.94	1.26
2	1.35	1.29	1.70	0.42
5	1.68	1.95	0.98	1.73
6	1.07	1.97	2.09	4.35**
9	1.74	1.65	2.14	4.10**
11	1.37	1.71	1.41	1.32
14	1.70	1.38	1.40	0.73
15	1.06	1.68	1.76	1.88
16	1.77	5.35**	0.71	1.31
17	(a)	(a)	(a)	(a)
18	1.09	1.51	2.39	1.31
19	3.14**	2.61*	1.25	1.41
20A	1.83	1.28	0.99	1.45
20B	2.67*	1.38	0.20	2.22
21A	0.98	1.28	0.72	1.70
21B	6.27**	0.09	0.26	0.81
22	0.10	0.81	0.05	0.59
23	3.62*	1.78	0.85	0.70
24	1.33	1.41	1.39	0.47
25	0.28	1.75	0.98	1.22
26	0.30	0.66	1.11	3.74*
27	1.35	1.80	5.50*	0.31
28	1.88	3.66**	1.42	0.77
29	1.25	0.41	3.92**	2.43*
35	1.35	1.58	0.66	0.96
38	2.80**	1.47	2.16	2.03
39	0.28	1.72	1.04	0.51
41	1.65	2.31*	4.85**	0.72
42	0.63	3.12*	1.56	1.00
43A	1.46	1.07	0.47	1.98
43B	2.74*	1.98	0.59	2.05
46	1.08	1.47	1.33	1.29
47	2.44*	2.30*	2.67	0.56
50	2.43	0.15	1.96	0.91
51	(b)	(b)	(b)	(b)
53	2.17	0.73	0.27	1.42
54	1.58	1.05	1.47	2.70*

(a) Bulked seed (b) 1-tree stand

The best progenies and their stand origin are: (a) Stand No. 47, (progeny 244, 246, 250, 251), (b) 21A (112, 113, 114, 132), (c) 42 (215, 216), (d) 54 (265, 266, 270), and (e) 21B (166).

The slow growing progenies showed a similar pattern. Of the 20 worst progeny families of the four sites, 8 families were from the four most slow-growing stands. The worst progenies and their stand origin are: (a) Stand No. 5 (progeny 21, 25, 27), (b) 26 (143, 144), (c) 16 (73), and (d) 1 (1, 8). Stand and family means at the four sites are tabulated in Appendix 2.

Table 5. Partial correlation of 2-year and 5-year height with 1-year height, seed characteristics and seed tree sources.

	2-Year Height	5-Year
1-Year Height	0.31506**	0.25474**
Seed Length	0.00242	-0.10032
Seed Width	-0.01728	-0.00421
Seed Weight	0.07948	0.09689
Germination Capacity	0.39600**	0.07548
Mother Height	-0.03273	0.03554
Mother Age	-0.02204	-0.16825**
Altitude	-0.24874**	-0.16905**
Latitude	0.06736	0.00005
Multiple Correlation Coefficient	0.67496**	0.48464**

From the practical point of view, natural sta are better units for initial field selection t individual trees, especially in the case of ponde pine, which generally regenerates in group-wise pat and mostly in site conditions of great topograph diversity. The naturally regenerated stand is in fa natural progeny test stand of nearby seed sour Furthermore, the seed trees included in the prog test were sample trees of the natural stand; they w pollinated mostly by neighboring trees. Results of progeny test confirmed the essential uniformity of progeny parents, including the seed parents and pollen parents, within each natural stand. For purpose of early production of superior seed, c crops can be readily collected from the superior tr and from other trees of the superior stands immediate use in bushel quantities.

The results further indicated that parent trees desirable characters were concentrated in certain stan and possibly in the general areas where the super stands were located. For the second generation s orchard, additional sample trees from the super stands and from additional phenotypically desira stands in their vicinity were included in the t materials for further evaluation and selection.

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APPENDIX I

Stand (1)	Tree (2)	Alt. (3)	Soil (4)	Lat. N. (5)	Land (6)	RD (7)	County (8)	T (9)	R (10)	S (11)	Note (12)
1	10	5000	B	44:33	P	Council	Adams	14N	2E	16	Anderson
2	10	4500	B	44:26	P	Council	Adams	13N	2E	13,23	Mill Creek
5	7	6000	G	44:36	B	Cascade	Valley	15N	7E	30	Camp Creek
8	10	4800	G	44:32	B	Cascade	Valley	14N	4E	21	Crawford
9	10	5000	G	43:51	B	Idaho City	Boise	6N	5E	20	Warm Springs
11	10	6000	G	43:36	B	Mt. Home	Elmore	3N	9E	4,9	Lester Cr
14	10	5200	B	44:21	B	Emmett	Gem	12N	2E	33	Sagehen
15	10	4100	B	44:24	B	Emmett	Gem	12N	1E	14	Third Fork
16	6	5800	G	44:47	P	McCall	Valley	17N	5E	20	Powellson Cr.
17	(a)	4200	G	45:03	P	New Meadows	Adams	20N	2E	19	
18	6	6000	G	43:55	B	Lowman	Boise	7N	8E	14	Bear Creek
19	10	4800	G	43:46	State	Idaho City	Boise	5N	6E		
20A	8	4200	G	43:46	State	Idaho City	Boise	6N	6E		
20B	8	4200	G	43:52	State	Idaho City	Boise	6N	5E		
21A	7	3500	B	45:09	BLM	Riggins	Idaho	21N	1E	1	Hazard Creek
21B	3	4300	G	44:09	BLM	Crouch	Boise	10N	4E	29	Scriver Creek
22	4	4000	G	44:05	B	Lowman	Boise	9N	8E	33	S. Fk. Payette
23	5	4100	B	44:40	P	Weiser	Valley	15N	4W	6	Mill Creek
24	7	3800	B	44:41	P	Weiser	Valley	16N	4W	20	Pine Creek
25	10	6400	G	43:49	B	Idaho City	Boise	5N	6E	3	Rabbit Creek
26	5	5000	B	44:36	BC	Weiser	Adams	15N	2E	17	Mica Creek
27	4	4500	B	44:38	BC	Weiser	Adams	15N	2E	7	Cabin Creek
28	10	5000	B	45:03	P	New Meadows	Adams	20N	1E	19	Mud Creek
29	9	3200	B	44:53	P	New Meadows	Adams	18N	1W	8	Ralph Creek
35	9	5000	G	43:48	B	Boise	Elmore	6N	9E		Dutch Creek
38	9	4000	G	45:03	P	New Meadows	Adams	20N	2E	19	Circle C
39	4	4000	B	44:49	P	New Meadows	Adams	19N	2E	16	3-Mile Creek
41	8	6500	G	43:44	B	Boise	Elmore	5N	8E	25	Dutch Creek
42	6	3900	G	43:37	B	Boise	Elmore	3N	6E	9	Trail Creek
43A	9	4700	B	45:47	State	WhiteBird	Idaho	28N	1W	12	Rice Creek
43B	8	4300	G	44:03	State	Horseshoe Bend	Boise	8N	3E	16	Fleming Creek
46	10	4480	G	44:18	B	Emmett	Boise	11N	5E	4,5	West Fork Rd.
47	8	3400	G	44:04	B	Emmett	Boise	8N	4E	1	Garden Valley
50	5	4300	G	43:37	S	Shake Creek	Elmore	3N	11E	13,18	Baumgartner
51	1	4300	G	43:37	S	Shake Creek	Elmore	3N	10E	11	Barker Gulch
53	6	4000	G	44:52	P	Krassel	Valley	18N	6E	15	Camp Creek
54	8	5000	G	45:05	P	Krassel	Valley	20N	6E	21	Zena Creek

Geographic Sources of the Progeny Test Parent Trees

Column: (1) stand number, (2) parent trees, (3) altitude, ft , (4) soil types: B-basaltic, G-Granitic, (5) approximate latitude, (6) Land: B-Boise National Forest, BC-Boise Cascade Corp., BLM-Bureau of Land Management, P-Payette National Forest, S-Sawtooth National Forest, State-Idaho State Department of Public Lands, (7) RD: Ranger District of National Forest or location, (8) County, (9) Township, (10) Range, (11) Section, (12) note, (a) stand 17 seed source is bulked seed from Circle C seed production area adjacent to stand 38.

APPENDIX 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	1	10	250	60	43.75	18.29	20.60	25.50	23.40	22.24
	2	20	70	20	56.25	26.30	25.00	25.33	30.80	26.90
	3	40	220	55	28.75	21.44	24.43	22.00	28.17	23.63
	4	65	230	70	68.33	27.80	27.25	21.00	31.50	27.19
	5	40	270	70	37.50	21.89	28.50	25.10	32.70	27.11
	6	10	250	50	41.25	26.25	23.00	27.50	34.30	28.11
	7	25	80	25	26.25	28.33	21.00	17.67	31.13	25.72
	8	45	250	50	32.50	22.44	21.33	20.00	22.50	21.56
	9	60	320	75	46.25	24.25	24.90	31.38	27.40	26.89
	10	70	330	75	29.50	26.33	23.67	26.44	30.29	26.47
					40.33	24.33	23.97	24.22	29.22	25.58
2	11	70	350	60	34.50	32.89	30.11	27.90	27.25	29.56
	12	70	300	60	33.75	22.63	21.44	24.22	27.40	24.06
	13	60	280	60	43.75	25.44	23.38	27.56	29.22	26.49
	14	50	220	50	19.75	28.75	27.71	22.25	24.60	25.89
	15	50	210	50	62.50	21.40	19.88	20.60	28.60	22.76
	16	50	220	50	34.50	23.44	23.13	24.88	37.67	27.47
	17	45	170	40	41.25	24.50	31.78	21.90	32.30	27.51
	18	45	180	40	50.00	29.20	24.88	26.90	28.40	27.47
	19	45	180	40	38.75	31.22	22.50	28.00	33.20	29.03
	20	50	200	50	51.25	26.00	24.13	0.00	29.10	26.57
					41.00	26.55	24.89	24.91	29.77	26.68
5	21	95	177	90	15.25	12.00	18.00	23.57	26.00	20.39
	22	91	179	90	37.00	26.00	18.56	23.89	29.20	24.54
	23	114	200	110	25.25	29.17	18.89	28.80	25.00	25.26
	24	81	199	75	16.25	26.50	24.75	22.33	36.75	26.36
	25	61	150	55	19.00	21.00	19.63	18.29	13.33	18.79
	26	81	191	75	33.75	23.00	24.88	22.90	23.70	23.58
	27	62	153	55	30.25	24.78	23.88	21.90	22.14	23.18
					25.25	23.21	21.22	23.10	25.16	23.16
6	28	115	217	110	45.00	25.80	31.29	26.67	33.10	29.11
	29	100	206	90	72.50	28.00	26.71	26.67	26.10	26.89
	30	95	210	80	73.25	31.50	28.70	32.75	28.30	30.18
	31	79	172	70	72.50	17.89	20.00	20.86	29.00	22.20
	32	106	208	90	72.50	23.30	29.22	26.50	28.50	26.84
	33	92	228	80	40.00	25.89	17.22	27.11	34.70	26.46
	34	107	190	90	43.75	23.25	27.25	19.25	33.89	26.00
	35	95	204	80	38.75	23.20	24.63	28.11	26.50	25.59
	36	106	211	90	71.25	23.50	24.60	25.00	30.40	26.03
	37	64	138	60	51.25	26.10	29.56	29.10	33.80	29.64
					58.07	24.84	25.92	26.20	30.43	26.89
9	38	88	130	45	35.75	32.17	29.78	22.57	26.88	27.80
	39	96	190	45	34.25	28.50	32.00	25.30	27.14	28.21
	40	95	170	45	49.25	31.33	34.56	24.30	36.22	31.41
	41	72	120	47	57.50	26.33	26.86	23.80	33.50	27.72
	42	87	170	48	55.00	25.00	23.43	24.44	27.10	25.14
	134	64	120	40	34.25	25.71	20.78	27.86	37.40	26.75
	135	70	160	45	29.25	0.00	28.67	29.00	27.00	28.43
	208	104	280	55	26.75	23.67	22.13	29.56	28.14	25.85
	209	86	180	45	26.00	26.40	30.63	24.89	35.86	28.94
	210	80	190	45	22.25	29.00	26.13	21.86	30.60	26.59
					37.02	27.57	27.49	25.36	30.98	27.68
11	43	50	120	50	37.50	20.86	21.88	21.70	24.60	22.40
	44	30	80	30	33.75	30.10	25.88	27.78	34.00	29.29
	45	32	100	30	37.50	18.43	24.63	26.20	35.30	26.89
	46	130	340	110	14.50	0.00	23.13	0.00	23.00	23.10
	47	90	280	90	36.50	27.00	21 38	23.29	26.67	24.04
	48	100	300	120	26.25	23.43	25.89	26.44	27.67	25.84
	49	90	220	80	48.25	24.90	24.56	27.40	31.70	27.21
	50	85	220	80	60.00	25.90	28.56	28.89	30.20	28.37
	51	90	220	80	58.75	19.89	25.13	26.10	24.80	24.03
	52	80	200	80	35.75	19.00	25.67	23.63	35.25	25.68
					38.88	23.28	24.67	25.71	29.32	25.68
14	53	55	120	40	42.50	32.60	23.89	26.56	31.30	28.76
	54	70	200	65	67.50	26.90	26.10	25.00	30.00	27.00
	55	85	120	60	51.50	23.00	27.63	33.67	35.20	30.29
	56	55	160	60	34.50	21.29	24.67	26.44	26.00	24.76
	57	70	200	65	30.00	31.90	29.71	29.22	32.00	30.73
	58	70	160	65	44.00	25.20	26.11	36.33	31.60	29.74
	59	60	120	40	47.50	25.11	28.38	27.50	33.20	28.71
	60	50	140	40	38.75	27.33	24.60	25.50	27.60	26.27
	61	50	120	40	46.00	24.00	28.00	27.11	30.50	27.38
	62	80	160	40	60.00	29.43	28.20	26.25	38.00	30.80
					46.22	26.68	26.73	28.36	31.54	28.44
15	63	65	140	40	53.75	24.00	31.22	30.78	35.20	30.61
	64	65	120	40	50.00	19.33	25.00	29.11	31.30	27.00
	65	100	240	75	46.25	23.70	29.33	28.50	33.40	28.76
	66	80	160	50	50.00	21.88	23.00	23.90	26.30	23.89
	67	70	160	50	38.75	25.60	20.00	19.71	29.90	24.25
	68	55	160	40	43.75	20.56	28.14	28.00	35.78	28.12
	69	80	180	50	44.00	25.00	25.80	27.30	34.40	28.13
	70	70	160	40	37.50	24.88	0.00	36.75	39.00	30.29
	71	55	100	30	16.00	26.00	0.00	40.00	35.00	35.25
	72	100	220	75	32.50	24.10	24.43	25.11	29.90	26.03
					43.63	23.50	25.87	28.92	33.02	28.23

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
16	73	73	170	63	10.00	19.56	22.90	25.88	24.70	22.41
	74	81	180	63	26.25	24.30	21.50	0.00	27.14	24.20
	75	83	170	63	29.50	23.33	23.56	30.80	29.71	26.80
	76	66	120	38	21.00	22.71	25.38	21.71	28.00	23.57
	77	57	120	38	58.75	24.67	24.33	23.63	35.40	27.61
	78	84	200	63	33.25	0.00	17.20	28.00	26.90	23.90
					34.79	22.91	22.48	26.00	28.14	24.75
17	79				55.00	31.33	28.10	22.20	32.70	28.51
					55.00	31.33	28.10	22.20	32.70	28.51
18	80	98	291	180	57.50	24.00	21.33	26.43	30.70	25.76
	81	92	228	150	46.25	29.44	25.25	22.90	31.40	27.30
	82	88	211	150	47.50	19.89	21.88	24.50	25.80	23.16
	83	74	176	140	31.25	20.75	22.86	24.25	26.88	23.71
	84	98	241	180	42.50	22.80	26.86	24.00	22.63	23.91
	85	77	194	140	4.75	23.50	29.33	24.00	20.00	26.70
					38.29	23.40	24.58	24.35	26.23	25.09
19	86	40	142	30	40.00	25.00	21.25	29.75	32.30	27.31
	87	70	169	60	38.75	30.00	26.00	32.50	27.78	29.08
	88	77	161	60	38.75	23.44	28.33	25.22	24.44	25.09
	89	50	156	45	28.00	22.75	22.38	30.30	31.50	26.66
	90	94	175	80	53.75	24.22	26.13	26.50	22.80	24.86
	91	58	108	50	27.50	28.38	21.63	28.60	31.50	27.59
	92	111	284	100	42.50	30.89	23.00	25.40	27.90	26.89
	93	41	87	40	71.25	21.50	23.00	23.57	29.70	24.56
	94	59	138	50	66.25	25.56	27.56	28.78	24.90	26.65
	95	48	166	40	71.25	26.60	25.33	25.11	29.60	26.74
					47.80	25.83	24.46	27.57	28.24	26.54
20A	96					29.50	30.33	30.00	43.00	31.86
	97				68.75	25.71	29.80	18.56	35.60	27.81
	98				41.25	24.30	26.40	26.11	31.90	27.21
	99				50.00	24.80	26.63	24.00	23.33	24.66
	100				63.33	29.90	23.38	28.33	31.20	28.46
	101				9.33	21.33	21.75	20.00	26.00	21.85
	102				32.50	19.22	21.44	27.67	28.20	23.63
	103				11.75	20.00	22.00	30.20	29.00	24.65
					39.81	24.35	25.22	25.61	31.03	26.26
20B	104				37.50	24.00	21.50	29.00	31.71	28.91
	105				30.00	22.50	24.20	19.60	33.44	24.72
	106				22.50	21.44	15.00	24.60	21.10	20.81
	107				41.25	24.71	25.67	28.11	29.00	26.93
	108				31.25	27.56	28.50	29.89	37.20	31.03
	109				57.50	24.40	24.56	31.75	28.50	27.06
	110				60.75	9.00	22.33	26.00	30.20	25.73
	111				40.11	21.50	27.88	25.33	31.00	26.66
						21.89	23.70	26.79	30.27	26.48
21A	112	63	128	60	65.00	31.22	35.67	30.50	37.50	33.76
	113	28	75	40	53.75	36.50	29.67	32.38	35.30	33.97
	114	88	207	80	65.00	32.78	29.71	31.89	35.80	32.80
	115	58	148	55	80.00	26.00	27.83	30.30	31.80	30.15
	131	70	169	60	48.75	20.90	24.63	27.80	31.70	26.34
	132	94	179	80	53.75	32.44	29.25	32.22	34.30	32.19
	165	91	197	60	30.75	32.40	25.22	29.60	28.75	29.11
					56.71	30.32	28.85	30.67	33.59	31.19
21B	116	25	123	30	44.50	29.40	22.22	31.30	35.00	29.38
	133	39	129	45	55.00	25.30	28.00	24.38	24.80	25.62
	166	95	340	200	66.25	35.67	33.89	31.50	33.89	33.68
					55.25	30.12	28.04	29.06	31.23	29.56
22	117	100	187	120	32.50	25.14	25.50	25.00	33.22	27.44
	118	90	238	140	53.00	29.11	29.44	27.90	0.00	28.79
	119	98	223	140	65.00	30.50	29.86	29.80	33.10	30.89
	120	71	171	90	61.25	24.33	28.50	30.60	31.50	28.86
					52.94	27.27	28.33	28.32	32.61	28.99
23	121				60.00	26.22	28.25	26.50	31.50	28.16
	122				60.00	27.00	27.25	27.40	28.10	27.46
	127				28.50	29.22	26.89	31.83	29.30	29.09
	128				73.75	27.67	32.00	24.22	33.40	29.50
	129				28.00	23.75	28.71	29.17	29.11	27.60
					50.05	26.77	28.62	27.82	30.28	28.36
24	123				60.00	26.44	29.75	32.30	38.40	31.97
	124				58.75	24.70	25.22	27.78	35.00	28.26
	125				53.75	31.80	28.00	32.00	29.80	30.42
	126				70.00	27.00	23.89	26.22	35.20	28.31
	130				43.75	26.40	26.25	33.11	29.20	28.76
	167				45.00	28.89	32.44	26.78	35.30	30.97
	168				53.75	22.38	24.56	27.63	27.00	25.46
					55.00	26.80	27.16	29.40	32.84	29.16

Five-Year Progeny and Stand Performance

Column: (1) stand number, (2) progeny number, (3) mother tree height, ft, (4) DBH, 0.1 inch, (5) age, (6) germination capacity, percent (7) site 1, 5-year progeny and stand mean height, cm, (8) site 2, (9) site 3, (10) site 4, (11) four-site mean

APPENDIX 2 Cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
25	136	32	90	35	18.75	24.83	26.57	32.25	35.50	29.40
	137	50	140	45	40.50	0.00	23.00	24.80	26.71	24.76
	138	45	120	45	17.50	26.57	25.20	29.33	26.50	27.00
	139	70	150	55	7.00	30.50	20.33	33.00	37.33	30.27
	169	35	130	35	40.00	33.83	26.00	26.13	28.40	28.40
	170	50	110	45	12.00	26.00	23.25	29.00	36.33	26.71
	171	60	120	50	37.50	23.11	24.38	29.88	34.00	28.06
	172	70	210	60	42.75	24.00	21.25	28.20	34.33	26.56
	173	45	110	45	22.50	20.90	25.89	28.20	22.60	24.62
	174	45	150	35	28.50	30.56	31.29	33.13	36.57	32.74
					26.70	26.70	24.72	29.39	31.83	27.85
26	140	121	270	138	10.25	20.33	25.75	33.00	24.00	26.29
	141	126	297	119	13.75	22.86	20.88	33.50	29.00	25.48
	142	110	230	134	2.75	35.00	20.33	31.50	28.00	27.75
	143	113	210	130	9.00	23.33	18.33	27.80	18.00	22.47
	144	122	257	139	13.75	19.17	20.50	23.33	26.00	21.71
					9.90	24.14	21.16	29.83	25.00	24.74
27	145	102	155	57	25.75	26.29	28.50	34.56	28.80	29.90
	146	112	160	51	11.25	29.00	21.67	37.60	28.67	28.88
	147	94	173	66	20.50	22.00	23.00	26.00	36.20	25.77
	148	110	215	76	4.75	0.00	23.00	20.00	32.00	23.75
					15.56	25.76	24.04	29.54	31.42	27.07
28	149	60	170	56	51.25	29.80	32.88	24.78	30.00	29.30
	150	60	170	59	43.75	21.40	28.13	27.60	29.30	26.53
	151	61	145	53	68.75	30.38	24.70	32.67	38.20	31.51
	152	54	140	53	60.00	24.30	27.33	30.00	26.50	26.95
	153	91	180	95	35.00	26.11	26.89	23.00	27.50	25.84
	182	52	120	36	2.75	28.67	8.00	19.00	29.00	23.67
	183	59	110	51	22.50	28.83	25.29	34.14	30.75	29.67
	184	73	155	61	41.25	24.44	26.00	27.90	30.90	27.38
	185	83	150	60	43.75	26.00	25.50	24.40	29.70	26.41
	186	62	160	67	39.75	0.00	27.78	30.90	30.30	29.72
					40.88	26.66	25.25	27.44	30.21	27.70
29	154	62	140	50	46.25	25.33	28.11	29.11	34.60	29.43
	155	60	140	58	45.75	25.50	26.38	30.89	38.00	30.27
	175	76	165	50	40.00	27.44	24.89	29.50	36.00	29.63
	176	72	150	58	33.00	23.50	26.00	27.86	31.25	26.88
	177	41	130	50	30.00	25.71	0.00	34.75	36.33	30.57
	178	72	150	48	45.50	32.60	27.00	31.10	34.33	31.18
	179	78	180	52	51.67	32.13	24.44	24.20	34.67	28.64
	180	63	130	47	66.25	27.20	27.75	25.40	26.50	26.66
	181	61	180	53	32.00	25.88	29.44	29.88	31.40	29.29
					44.38	27.25	26.75	29.19	33.68	29.17
35	156	70	180	60	17.50	25.40	29.86	30.40	32.60	29.54
	157	60	180	65	50.00	25.56	30.89	30.44	37.30	31.22
	158	65	200	80	24.25	18.78	24.63	23.60	27.38	23.46
	159	40	140	35	26.25	29.22	24.33	22.13	28.00	26.07
	160	60	170	60	47.50	28.60	26.13	24.60	28.70	27.05
	161	55	180	50	41.50	25.40	26.10	25.70	30.40	26.90
	162	50	160	40	45.00	27.75	28.50	28.80	27.40	28.11
	163	50	160	45	35.75	20.89	13.75	21.10	31.78	23.13
	164	55	170	55	25.00	27.50	21.57	19.71	25.80	23.63
					38.08	25.45	25.08	25.16	29.93	26.57
38	187	88	164	48	53.75	31.50	29.00	35.90	35.50	33.53
	188	78	137	49	41.25	26.50	26.00	30.00	0.00	27.67
	189	90	180	44	44.50	24.33	27.78	30.20	30.20	28.24
	190	85	165	49	68.75	25.60	25.00	29.70	30.10	27.74
	191	71	129	54	58.75	28.80	28.86	31.50	32.00	30.41
	192	88	160	54	55.00	30.44	30.44	26.56	32.50	30.05
	193	72	175	53	45.00	21.63	28.25	30.33	37.70	29.97
	194	71	141	51	10.50	21.50	27.86	28.00	27.00	25.74
	195	86	169	52	57.50	22.70	28.22	25.78	27.60	26.03
					48.33	25.89	27.93	29.77	31.57	28.82
39	196	65	124	47	56.25	25.30	26.44	29.20	30.80	27.97
	197	77	118	55	48.00	27.86	22.33	11.33	35.50	30.47
	198	68	122	54	43.75	24.89	23.11	27.20	35.40	27.74
	199	47	94	34	30.25	30.20	29.11	33.00	35.63	31.80
					45.62	27.04	25.25	32.68	34.33	29.50
41	200	65	210	65	40.25	22.30	20.30	35.33	28.70	26.44
	201	60	220	60	30.00	20.00	21.78	23.22	26.75	22.91
	202	55	200	60	15.75	29.71	21.88	35.33	26.00	27.05
	203	60	210	60	33.50	25.00	19.29	22.33	31.63	24.65
	204	60	200	50	11.25	24.00	29.25	22.33	30.30	26.59
	205	60	180	50	50.00	31.20	24.50	32.80	35.90	32.05
	206	50	180	40	41.25	21.50	28.25	26.46	31.40	27.17
	207	35	110	35	12.50	21.89	17.88	21.80	26.80	23.14
					36.81	24.90	22.30	27.81	29.68	26.25

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
42	211	88	163	80	60.00	34.00	26.11	24.33	36.00	30.27
	212	94	180	80	65.00	28.11	31.43	25.44	39.20	31.19
	213	89	174	75	48.75	26.20	24.89	29.10	28.80	27.31
	214	78	154	70	52.50	27.00	27.00	31.78	31.00	29.44
	215	84	151	70	39.25	29.13	25.67	36.11	38.00	32.47
	216	89	154	70	18.50	30.14	29.38	37.80	37.75	32.75
					47.33	29.10	27.36	30.76	35.13	30.57
43A	217	92	181	68	25.00	26.50	23.11	21.50	26.20	24.93
	218	86	172	72	24.25	25.00	24.33	31.63	31.80	27.53
	219	80	166	58	22.25	30.67	23.13	25.00	29.25	26.71
	220	88	171	61	14.00	27.00	28.00	33.17	34.50	30.00
	221	86	166	70	5.00	0.00	20.00	50.00	16.00	31.20
	222	85	173	72	14.25	28.88	22.56	27.33	29.75	26.56
	223	91	203	75	13.25	25.80	26.63	34.33	37.50	28.89
	224	90	145	75	36.25	23.40	23.11	27.75	31.78	26.39
	225	84	186	76	67.50	30.22	32.29	29.44	29.00	30.09
					25.79	27.18	24.79	31.46	29.53	28.03
43B	226	80	152	45	5.25	33.20	33.00	31.50	29.00	32.45
	227	80	153	53	30.00	30.13	30.86	23.56	0.00	27.88
	228	90	208	90	13.75	0.00	27.50	35.00	30.00	28.93
	229	90	164	57	60.00	35.89	27.78	36.89	33.70	33.57
	230	97	187	90	57.50	25.38	26.29	28.16	33.40	28.63
	231	86	176	77	45.25	22.11	27.00	25.11	25.20	24.86
	232	78	160	51	21.50	19.14	25.50	25.56	20.20	22.47
	233	76	149	59	43.75	24.44	22.22	26.56	30.80	26.14
					34.63	27.18	27.52	29.03	28.90	28.12
46	234	99	194	115	51.25	25.63	23.13	29.00	30.40	27.33
	235	86	196	115	70.00	26.30	27.89	28.80	27.50	27.62
	236	100	200	110	24.75	23.00	21.57	23.89	29.14	24.32
	237	96	216	125	36.50	23.38	24.50	26.22	26.89	25.32
	238	76	133	100	71.25	25.00	24.80	25.33	34.11	27.18
	239	110	181	115	48.75	18.63	23.75	19.88	30.40	23.59
	240	100	173	140	63.75	24.70	31.13	26.50	29.90	27.89
	241	90	190	85	42.50	20.13	24.75	25.10	20.10	22.53
	242	60	146	100	55.00	26.80	23.75	23.50	30.20	26.18
	243	78	136	80	46.25	29.00	25.10	23.88	31.00	27.38
					51.00	24.25	25.04	25.21	28.96	25.94
47	244	65	95	70		24.00	0.00	34.00	40.00	32.67
	245	75	140	80	58.75	28.89	26.90	22.10	31.50	27.31
	246	85	145	85	43.75	28.10	26.38	30.56	45.20	32.95
	247	110	158	90	12.50	29.60	0.00	26.00	32.50	29.10
	248	80	150	90	53.75	25.56	28.71	33.44	33.30	30.43
	249	50	100	40	72.50	27.90	31.30	28.70	30.30	29.55
	250	60	125	60	24.50	33.63	0.00	37.29	35.00	35.26
	251	60	155	70	57.50	37.63	27.00	27.60	41.00	33.42
					50.79	29.41	28.06	29.96	36.10	31.33
50	252	130	680	225	19.25	24.00	21.86	19.20	28.11	21.01
	253	80	300	110	23.25	18.57	23.88	24.29	29.00	23.56
	254	96	320	110	32.50	26.80	21.00	25.44	26.86	25.34
	255	112	400	200	47.50	24.60	25.00	23.30	29.90	25.74
	256	80	380	150	45.00	20.70	22.44	25.00	29.90	24.56
					33.50	22.93	22.84	23.45	28.82	24.65
51	257	80	320	90	18.75	25.57	23.63	32.50	37.00	28.74
					18.75	25.57	23.63	32.50	37.00	28.74
53	258	50	150	70	42.50	24.40	12.50	32.44	33.20	27.96
	259	85	160	90	47.50	26.40	26.22	31.00	27.80	27.82
	260	70	180	60	30.00	27.86	24.00	16.29	31.00	24.54
	261	70	120	75	43.75	29.00	27.00	30.00	27.90	28.54
	262	80	180	90	61.67	0.00	26.25	28.11	31.90	28.96
	263	65	160	70	50.00	31.11	24.50	27.50	26.70	27.36
					45.48	27.75	23.41	27.56	29.75	27.53
54	264	65	95	70	72.50	27.50	25.25	27.30	29.10	27.39
	265	75	140	80	51.25	28.75	27.75	34.10	36.00	32.03
	266	100	145	90	55.00	30.70	30.33	32.40	38.50	33.05
	267	80	150	90	41.25	22.56	29.00	30.11	31.70	28.43
	268	50	115	50	52.50	28.80	27.38	28.00	35.00	29.78
	269	50	100	40	58.75	24.10	30.30	25.67	35.11	28.79
	270	60	125	60	57.50	34.11	29.88	30.50	37.90	33.24
	271	60	155	70	56.25	27.00	29.44	26.60	31.44	28.53
					55.63	27.98	28.67	29.33	34.34	30.16

Column: (1) stand number, (2) progeny number, (3) mother tree height, ft, (4) DBH, 0.1 inch, (5) age, (6) germination capacity, percent, (7) site 1, 5-year progeny and stand mean height, cm, (8) site 2, (9) site 3, (10) site 4, (11) four-site mean.

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The 5-year progeny height was significantly correlated with 1-year seedling height and inversely correlated with age and altitude of mother tree, but not correlated with seed characteristics including seed weight, seed size, and germination capacity.

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