EFFECTS OF SEVERAL LEVELS OF INBREEDING ON GROWTH AND OLEORESIN YIELD IN SLASH PINE

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Effects of selfing on seed set, germination, and early growth for many species of trees have been summarized by Franklin (1970). Many tree breeders are now making second generation selections and are becoming more interested in the inbreeding effects of backcrossing and sib mating.

One selection method employed in establishment of second-generation orchards is combined selection in the progeny tests. If more than one individual is selected from a family, full-sib or half-sib matings can result. If the best original selections are also added to the new orchard, then backcrossing becomes possible. Knowledge of the effects of these different levels of inbreeding is needed in order to predict seed production and subsequent tree growth. This paper presents data on the effects of selfing, sib mating, and backcrossing on growth and oleoresin yield of slash pine (Pinus elliottii Engelm.). Earlier results from this study on effects of inbreeding in slash pine were reported by Squillace and Kraus (1962).

EXPERIMENTAL PLOTS

The main study plot (Study G-38A) was outplanted near Olustee, Florida, in January 1962. It consisted of 17 full-sib families planted in 2-tree plots replicated 10 times. Five mating types were represented: outcross, half-sib, full-sib, backcross, and self. Study G-38B is a supplement to G-38A. It contains 4 blocks with 1 to 14 trees per family per block and was planted the same time as G-38A. Study G-38C was planted 1 year later and contains single tree plots with 10 replications. Wind and polycross progeny of the selfed selections are compared with self progeny.

In addition, data obtained from two other studies are also included. From short-term progeny tests (Studies G-58 and G-62), height growth, stem diameter, and -oleoresin yield of progenies resulting from two levels of inbreeding were compared with outcrossed progenies. Both studies contained 3-tree family plots with 12 and 8 replications, respectively. Data are from third year measurements. Trees varied from 5 to 15 feet and averaged 10 feet in height. Special care was taken of these outplantings so very few seedlings were lost. Those with depressed growth were still present at the time of final measurement. Study G-58 was a diallel cross of eight selections but lacked most reciprocal crosses. A mean was determined for the progeny of each self as was a mean for the outcrossings of that self. They were then combined for comparison (Table 1). Study G-62, compares 35 backcrosses with a like number of outcrosses. Both studies received intensive care including cultivation, fertilization, and irrigation. Insect damage was kept to a minimum by chemical control.

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Table 1.--Progeny means for height, stem diameter, volume, and oleoresin yield for different types of matings when compared with outcrossing.

Type of mating	Number of Families	Theoretical Inbreeding Coefficient	Height	Stem[1/] Diameter	Volume	Oleoresin Yield[2/]
			Feet	Inches	Cu. ft.	Grams
			Study G-38A (9th year measurements)			
Outcross	3	0	34.5	5.7	2.37	329
Half-sib	4	0.125	31.8	5.1	1.85	323
Full-sib	2	0.25	30.5	4.7	1.51	298
Backcross	6	0.25	30.8	4.9	1.69	299
Self	2	0.5	32.5	5.5	2.32	360
			Study G-38B (9th year measurements)			
Outcross	3	0	31.5	5.4	2.12	285
Self	4	0.5	25.5	4.2	1.00	233
			Study G-38C (8th year measurements)			
Outcross	5	0	25.7	4.7	1.05	
Self	3	0.5	13.3	2.1	.21	
			Study G-58 (3rd year measurements			
Outcross	34	0	9.9	2.0		4.5
Self	8	0.5	7.1	1.4		2.6
			Study G-62 (3rd year measurements)			
Outcross	35	0	10.4	2.1		4.3
Backcross	35	0.25	8.9	1.8		3.8

1/ Stem diameter in Studies G-38A, B and C was measured at breast height but in studies G-58 and G-62, it was measured 6 inches above ground line.

2/ Oleoresin yields for Studies G-38A and B are based on flow from 4 one-inch square microchips made at two week intervals and treated with a 50% sulfuric acid solution to prolong flow. Yields from Studies G-58 and G-62 are from a triangular mini-chip (.95 sq. cm) treated with a small bead of sulfuric acid paste along the top side and left for one week.

RESULTS

Inbreeding depression in height, d.b.h., and volume is evident in the 9-year-old plantation and is proportional to the degree of inbreeding (Table 1). Oleoresin yield shows considerable variation in inbreeding depression.

Inbreeding depression in height, stem diameter, volume and oleoresin yield compared to outcrosses for the different degrees of inbreeding is presented in Figure 1. For height growth, this is in close agreement with the previous results by Squillace and Kraus (1962), who reported an approximate 4% decrease for each 0.1 increase in inbreeding coefficient. These findings were also in agreement with what Langner 2/ found in studying Japanese larch; that is, a 5% decrease for each 0.1 increase in inbreeding coefficient.

Figure 1 indicates little change in inbreeding depression with age for height or diameter growth. The younger and older plantation data follow the same pattern. A report by Snyder (1968) and subsequent studies conducted at Gulfport, Mississippi (personal communication with Snyder, May 1971) expressed the possibility of a severe change in inbreeding depression with age. However, there are too few selfed individuals in this study to resolve this question.

CONCLUSIONS

Inbreeding caused a significant and predictable depression on tree growth in these studies. Effects of backcrossing, full-sib and half-sib matings may be of more importance in a plantation than selfing. The reason for this is that fewer seedlings are produced from selfs (Snyder, 1968 and Franklin, 1970) and of those planted, many do not compete in the stand due to the severe inbreeding depression. Seedlings produced from backcrossing and full- and half-sib matings are more numerous and less depressed in growth than are self seedlings, so more remain in the stand longer and can result in decreased fiber production.

Oleoresin yield and growth are positively correlated so when growth is adversely affected so is oleoresin yield. Ideally, there should be no inbreeding in seed orchards. However, from a practical standpoint, this is not possible so the next best thing is to minimize inbreeding.

2/ A 10-page mimeographed reproduction of a report prepared for Sec. 22, IUFRO, 13th Congress at Vienna, 1961: "Einige Versuchsergebnisse zum Inzucht-problem bei der forstlichen Saatgutgewinnung," by W. Langner, Institut fur Forstgenetik and Forstpflenzenzuchtung in Schmalenbeck.

RECOMMENDATIONS

The following suggestions are offered to seed orchard managers as ways to minimize inbreeding when establishing new seed orchards:

Know the parentage or origin of all selections in the orchard.

Use at least 20 clones, preferably 50 to 100, for establishment of seed orchards.

Use seed orchard designs which maximize distance between ramets of the same clone and/or related clones.

Avoid using related clones in the orchard whenever possible.

When establishing your new seed orchards, don't underestimate the adverse effects of inbreeding.

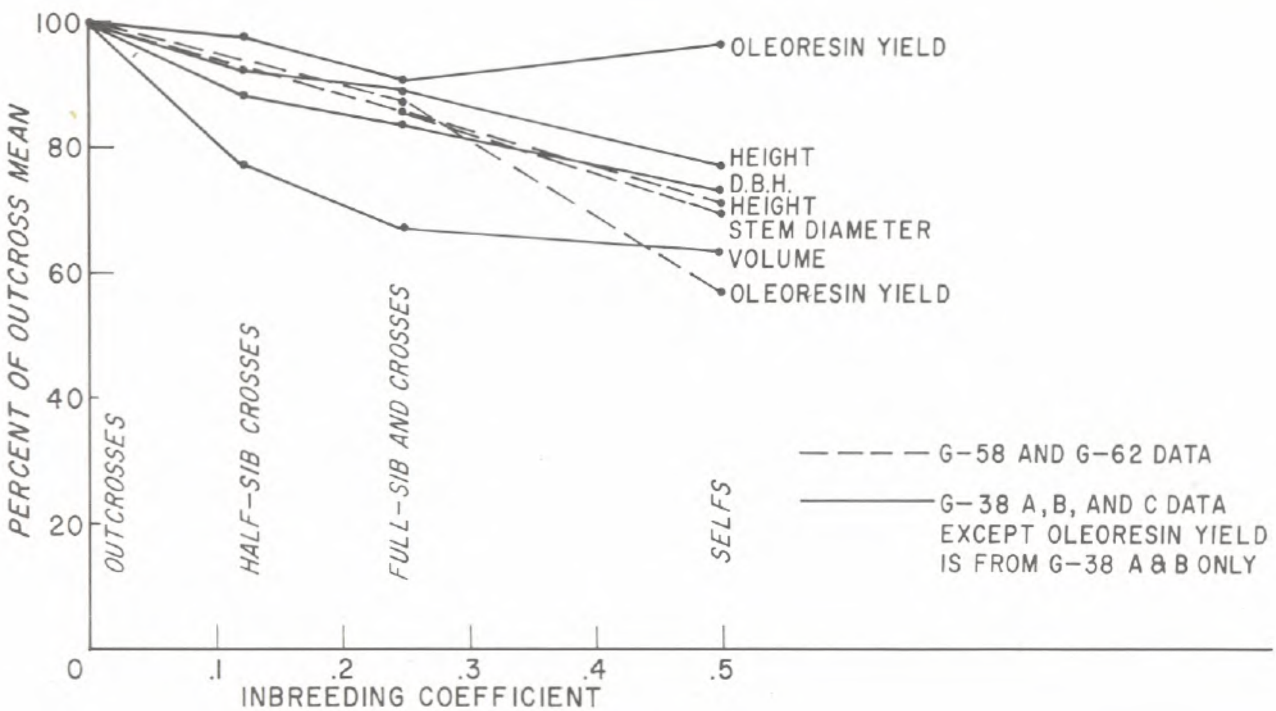

Figure 1.--Effect of inbreeding on growth and oleoresin relative to outcrosses means.

LITERATURE CITED

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