RELATIONSHIPS OF SEED SIZE, NUMBER OF COTYLEDONS, AND INITIAL GROWTH OF SOUTHERN PINES

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Significant correlations between seed weight and number of cotyledons were found in four of eight seed lots (two each of loblolly, slash, shortleaf, and Virginia pines).

The high cost of producing seed from orchards and impending increases in the use of containerized seedlings for artificial regeneration have renewed interest in sizing southern pine seeds. Past research has not shown sizing to have any consistent advantage except that it facilitates uniform sowing in nurseries *(1)*. Findings have been contradictory. Some investigators report superior germination and faster early growth from large seed, while others detected no differences *(4, 5, 6)*. Differences among species or methods of sizing (by weight or screening) may account for some of the conflict in results.

This study explored the interrelationships among seed size, number of cotyledons, and early growth. It was theorized that large seed are apt to have a greater number of cotyledons. Since cotyledons carry on photosynthesis after the seedcoat is shed *(3)*, it was also theorized that seedlings with the greatest number would grow fastest in early months of development.

Procedures

Seeds of slash (*Pinus elliottii* Engelm.), loblolly (*P. taeda* L.), and shortleaf (*P. echinata* Mill.) pines were each collected from two plantation trees in central Louisiana. Virginia pine (*P. virginiana* M.) seed came from two clones in a Hiawassee Land Company orchard in Tennessee. Seeds from each tree were kept separate, and the eight lots were cleaned to remove all empties. Moisture contents were under 10 percent.

Fifty seeds were drawn at random from each lot. Individual seeds were weighed to the nearest 0.1 mg. Seeds were then stratified at 3.5° C for 30 days. They were sown in plastic molds that contained a horticultural potting mix of peat, vermiculite, perlite, and starter nutrients. The capacity of each mold was about 67 cm^3 (4 cubic inches).

Molds, each containing one seed, were placed under a misting system in the greenhouse where controlled temperature ranged from 24° to 26° C. After germination, seedlings were kept in the greenhouse and watered normally.

Cotyledons of each seedling were counted when the seedcoat was shed. The height of each seedling was measured to the nearest centimeter 60 and 120 days after germination. Correlation coefficients were computed to evaluate all combinations of relationships between seed size, number of cotyledons, and seedling heights at 60 and 120 days after germination.

Results

The 50 sound seeds drawn from each seed lot provided a broad range in weights (table 1). For example, lot 1 of loblolly pine had seeds ranging from 18.0 to 32.1 milligrams or from 6,409 to 11,454 seeds per kilogram. Similarly, ranges in number of cotyledons were typical for each species *(2)*.

Four of the eight seed lots had significant correlations between seed weight and number of cotyledons (table 2), including both shortleaf lots. Loblolly was the only species for which these two variables were unrelated to each other. The significant correlation coefficients (r) ranged from 0.328 to 0.506.

The number of cotyledons was significantly correlated with 60day heights only in lot 1 of shortleaf pine, and this relationship did not continue through 120 days. When seedlings were 120 days old no correlations were significant except that number of cotyledons and average heights were negatively related in lot 1 of Virginia pine. Length and number of cotyledons were not related with any species.

Seed weights and seedling heights at 60 and 120 days were unrelated, except for one lot each of Virginia and shortleaf pine. Both correlation coefficients were low.

Three of the four r values for number of cotyledons and seedling heights of Virginia pine had negative signs, and the other value was close to zero.

Table 1.—*Summary of seed and seedling data, for two lots of each species*

Species and seed lot		Seed per kg	Seed weight Avg.	Seed weight Range	Cotyledons Avg.	Cotyledons Range	Height -60 days Avg.	Height -60 days Range	Height -120 days Avg.	Height -120 days Range
		number	*milligrams*		*number*		*centimeters*			
Slash	1	28,736 (13,032)[1]	34.8	21.2-45.1	6.6	4-8	8.3	5-12	13.9	10-17
	2	27,174 (12,324)	36.8	23.7-56.8	7.5	5-9	9.4	6-11	15.6	11-20
Loblolly	1	40,486 (18,361)	24.7	18.0-32.1	7.5	6-9	8.3	5-12	13.6	8-18
	2	30,960 (14,041)	32.3	22.9-41.6	7.8	5-9	10.7	7-13	16.3	9-20
Shortleaf	1	114,943 (52,128)	8.7	4.7-12.4	5.8	4-7	7.3	4-10	13.5	9-20
	2	136,986 (62,125)	7.3	3.9- 9.8	5.4	4-7	7.4	5-10	14.9	10-20
Virginia	1	92,593 (41,992)	10.8	8.5-12.9	5.9	4-7	8.6	6-13	12.6	9-16
	2	89,286 (40,493)	11.2	8.8-14.0	5.6	4-7	8.9	7-12	14.6	10-20

[1]Seeds per pound.

Table 2.—*Correlation coefficients of various relationships of seed weights, numbers of cotyledons, and seedling heights*

Species and seed lot		Seed weight: No. of cotyledons	Seed weight: 60-day	Seed weight: 120-day	Number of cotyledons: 60-day	Number of cotyledons: 120-day
		----------*heights*----------				
Slash	1	0.506[1]	0.073	0.152	0.225	0.078
	2	.205	.007	.110	.047	.301
Loblolly	1	.072	.017	.082	.159	.030
	2	.067	.009	.060	.034	.076
Shortleaf	1	.492[1]	.298[1]	.270	.319[1]	.146
	2	.328[1]	.202	-.101	.164	.001
Virginia	1	.218	.060	.369[1]	-.181	-.342[1]
	2	.400[1]	.278	.251	.017	-.006

[1]Significant at 5 percent level.

Discussion

This study failed to show any benefits from sizing seed. Four significant correlations were found between seed weight and number of cotyledons, but this by itself has no value, especially when number of cotyledons and heights were largely unrelated. In the few instances where seedling heights were correlated with one of the other factors, the r values were low, indicating weak relationships. We have no explanation of the negative correlation between number of cotyledons and 120-day heights of Virginia pine seedlings.

If seedlings with the greatest number of cotyledons had the shortest cotyledons, lack of correlation with height might be explained. Since cotyledons of seedlings from an individual seed lot were the same length, it is difficult to understand why heights were not related to number of cotyledons because the amounts of photosynthetic area differed appreciably.

All of the significant correlations between heights, seed weights, and number of cotyledons were found in shortleaf and Virginia pine lots. Seedcoats of these two species comprise a smaller proportion of total seed weights than those of loblolly and slash pine.' This suggests that

[1] Unpublished data provided by Dr. James P. Barnett.

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four progeny groups, respectively. Thus, the frequency of flowering trees appears to have been lower in the progenies from S_1 X S_1 crosses and in the S_2 progenies than in the two types of open-pollinated progenies, but the numbers are too small to demonstrate statistical significance. However, S_2 seedlings were significantly shorter than the other progeny groups (6).

Only three of the 22 ovulate strobili remained after the first growing season. The high abortion and/or abscission rate may be at least partially attributed to the lack of pollen-bearing jack pine in the immediate vicinity of the plots in this study, and to the earlier receptivity of female strobili on the small trees due to higher temperatures near the ground. Thus, most strobili would no longer be receptive when wind-blown pollen from more distant pollen sources would be available. Controlled pollinations on young seedlings have been shown to result in good cone set and seed yields *(5)*.

Conclusions

Jack pine seedlings grown for 10 weeks under favorable greenhouse conditions and transplanted to the nursery in early July produced female strobili on a small percentage of trees the following spring or at about 12 months of age. With improved growing conditions to promote more rapid early vegetative growth, and a different transplanting time than that in this study, the percentage of trees flowering can undoubtedly be increased greatly for practical use in jack pine breeding programs. Studies of the influence of these factors on early flowering are underway.

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embryo or megagametophyte weights might be more closely related to seedling growth than seed weight.

A literature search did not reveal any reason for the variation in number of cotyledons or any advantages that might result from larger or smaller number of cotyledons. This phenomenon is probably due to evolutionary processes.

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