GENOTYPIC STABILITY COMPARISONS IN LOBLOLLY PINE

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Abstract.--Phenotypic regressions with coefficients of about 1.2 were calculated for height growth four years after planting loblolly pine in nine diverse locations in five southeastern states. The heterogeneity of the coefficients of all 18 sets of families was shown to be statistically nonsignificant and therefore that wide-cross, local-cross, and open-pollinated progeny do not differ in stability.

Additional keywords: Adaptation analysis, Pinus taeda

Wide adaptability is a highly desirable character for the breeding genotypes to possess for most tree breeding objectives. A technique for assessing genotypic stability, first described by Finlay and Wilkinson (1963), consists of growing a number of genotypes in a number of environments, quantifying the environmental quality by the average expression of all the genotypes at the particular environments and then estimating the linear regression of the value of each genotype on the mean values for the environments. According to this technique, a perfectly stable genotype (b=0) is completely unresponsive to changing environments. Such genotypes are undesirable in most tree breeding situations because they cannot take advantage of silvicultural improvements. A genotype of average genotypic stability (b=1) shows added performance in the better environments in proportion to the added improvement in environmental quality. A genotype with b>1 will perform better than average in the better environments but less than average in the poor environments. Conversely, a genotype with b<1 will perform better than average in the poor environments but less than average on the better environments. Selecting for genotypes with appropriate stabilities for specific breeding objectives can therefore result in increased yields. The investigations reported here were aimed at comparing genotypic stabilities of intra- and interregional crosses of loblolly pine.

METHODS

The crosses on which the study is based were made by Dr. R. Woessner in 1964 and 1965. Four seed orchard trees indigenous to the North Carolina Piedmont (Hoerner-Waldorf seed orchard) and four seed orchard trees indigenous to the North Carolina Coastal Plain (Weyerhaeuser seed orchard) were crossed with pollen of seed orchard trees from ten widely separated geographic areas. Also, open-pollinated seed of 32 pollen and seed parents were included in the study.

The seedlings were outplanted at twelve locations in five southeastern states in spring 1968. Randomized complete-block design with 10-tree row plots planted at 9' x 9' spacing was used at all locations assessed except for the planting in Tyrrell County which had 2-tree row plots.

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RESULTS

Of the four characters assessed (height growth, fusiform rust score, crown score, and stem straightness), it was found that height growth is most sensitive to environmental changes. Height growth of trees on the best site was over twice that of those on the poorest site. Such large differences would be expected because the test locations were purposely chosen to sample extreme environments as well as intermediate ones. There were also great differences in the degree of rust infection from location to location, but such variability was indifferent to site quality.

Table 1. Mean height growth of single crosses of loblolly pine grown in six locations

	Locations[1/]					
Crosses	1	2	3	4	5	7
6-9 x 10-37	19.56	12.71	13.74	12.09	12.44	10.66
6-9 x 11-504	18.39	13.47	12.48	12.97	11.74	11.22
8-33 x 11-30	17.35	11.60	10.19	9.64	10.14	8.31
6-9 x GRI-2	-	12.74	-	10.48	10.70	10.90
Commercial Check	-	11.16	-	10.52	10.75	9.56
6-9 x 11-9	19.26	13.24	-	-	-	14.08
6-20 x 1-9	-	-	9.62	10.47	-	8.05
6-7 x 8-30	17.00	-	-	-	11.89	8.25
Average	17.65	12.06	11.39	11.11	10.61	9.85

[1/] Legend for Table 1

Location	County	State	Company
1	Jackson	La.	Continental Can
2	Shelby	Ala.	Kimberly-Clark
3	Bullock	Ga.	Continental Can
4	Rhea	Tenn.	Bowaters
5	Halifax	N. C.	Hoerner-Waldorf
7	Murray	Ga.	Bowaters

Table 2. Mean rust scores for single crosses at four locations in the Southeast

	Location (County and State)			
Crosses	Jackson, La.	Bullock, Ga.	Columbus, N. C.	Kershaw, S. C.
6-9 x H-2	3.46	1.90	1.71	1.65
8-33 x GRI-12	1.46	1.18	1.00	1.05
8-68 x GRI-16	1.03	1.28	1.21	1.15
6-20 x 11-510	3.79	2.30	2.77	2.43
Average	2.54	1.49	1.56	1.49

It was evident that single crosses tend to retain the same relative ranks from location to location--an indication that genotype x environment interaction may not be very important (Tables 1 and 2). The performances of three sets of families were shown to be linearly related to the environmental quality (Figure 1). These three sets of families were chosen to represent open-pollinated progeny, local crosses, and wide crosses. A general analysis for eighteen sets of open-pollinated progeny, local and wide crosses resulted in a rather homogenous set of regression coefficients with average value of about 1.20 (Table 3).

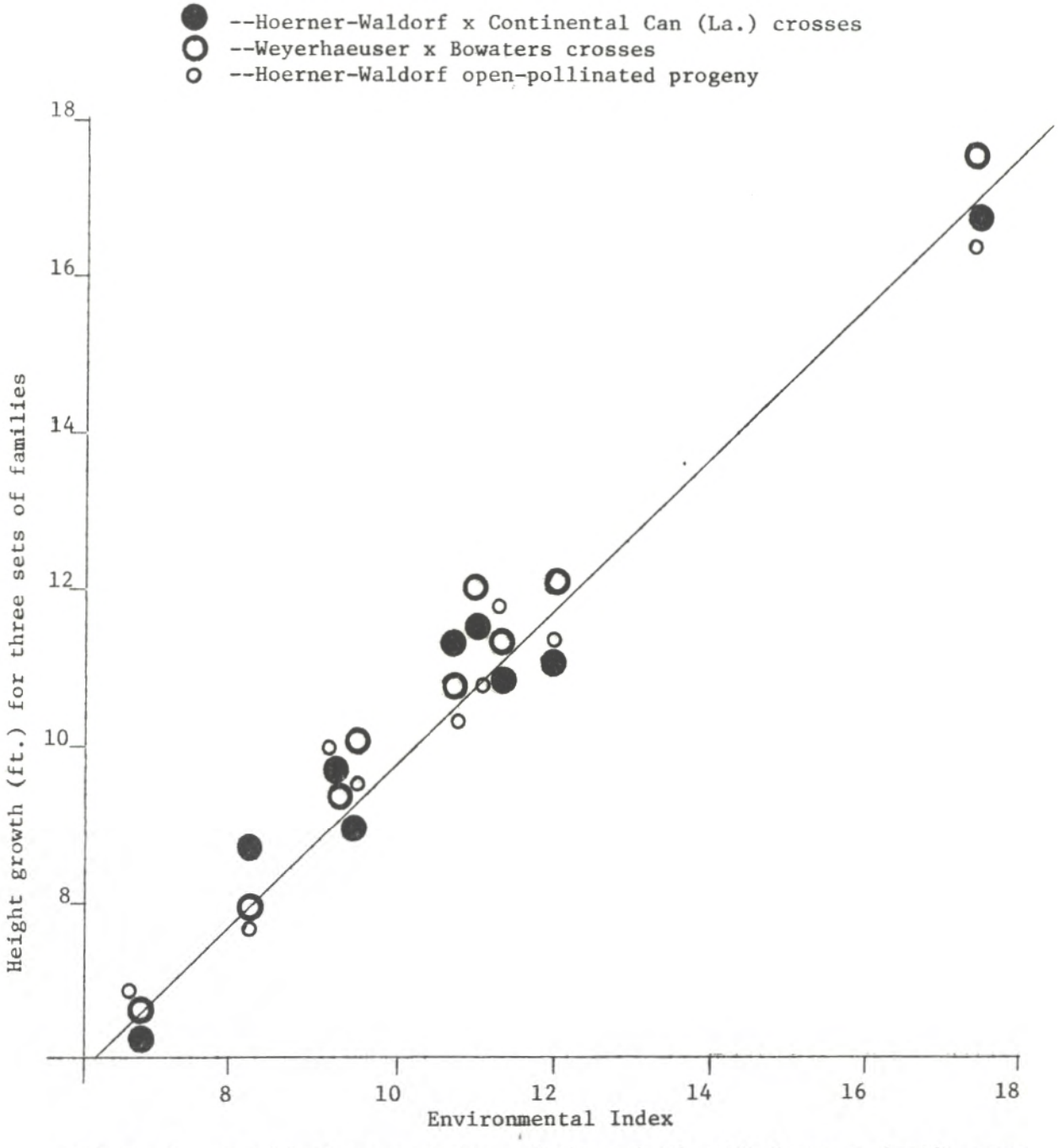

Figure 1. Graphical presentation of the relationship between family means and environmental index (mean of all genotypes at the particular environment)

Table 3. Mean height over all locations for family groups and genotypic stabilities calculated by the regression coefficient (Finlay and Wilkinson, 1963)

Family	Mean Height (ft.)	Regression Coefficient
Commercial check	10.26	1.244
Westvaco O.P.	10.12	1.302
Weyerhaeuser O.P.	10.46	1.230
Hoerner-Waldorf O.P.	10.38	1.134
Weyerhaeuser x Weyerhaeuser	10.53	1.290
Hoerner-Waldorf x Hoerner-Waldorf	10.71	1.122
Hoerner-Waldorf x Weyerhaeuser	10.19	1.226
Hoerner-Waldorf x Union Camp	10.53	1.204
Hoerner-Waldorf x Kimberly-Clark	10.29	1.302
Hoerner-Waldorf x Westvaco	10.82	1.234
Hoerner-Waldorf x Continental Can (East)	10.11	1.073
Weyerhaeuser x Bowaters	10.90	1.283
Weyerhaeuser x Continental Can (La.)	10.34	1.201
Weyerhaeuser x Champion	10.32'	1.214
Weyerhaeuser x Continental Can (East)	10.06	1.179
Weyerhaeuser x Texas	10.52	1.352
Hoerner-Waldorf x Texas	10.81	1.285
Hoerner-Waldorf x Continental Can (La.)	10.56	1.374

DISCUSSION

Judged by the regression coefficients, all 18 sets of families show genotypic stabilities well below the average stability of b=1.0, with the only exception being the Hoerner-Waldorf x Continental Can (East) set of crosses (Table 3). Such a trend indicates that forest productivity can be increased by using the best genetic stock coupled with optimal cultural practice, as compared to the contribution from genetic improvement and silvicultural improvements singly. The response observed also implies that a disparity can be expected between predicted and realized gain when the progeny are raised in the better environments.

CONCLUSIONS

These stability analyses have shown that the selected loblolly pine families have below average genotypic stabilities and therefore that they are better adapted to the more favorable environments. This adds justification

for improved plantation practices, including intensive site preparation and fertilization. These and other analyses (Owino, 1975) also show that the different sets of families do not differ much in their stabilities, indicating that stability assessment should play only a secondary role in plus-tree selection.

LITERATURE CITED

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