THE EFFECT OF SEED ORIGIN ON SEED WING MORPHOLOGY AND JUVENILE GROWTH OF EAST TEXAS GREEN ASH

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Abstract.--Morphological measurements were made of green ash seed wing characteristics on a sample of seeds collected from 185 trees growing in the Pine-Hardwood and the Post-Oak forest regions of Eastern Texas. Seed wing width of seeds of the middle and southern areas of the Post-Oak forest was greater than that found in other regions of East Texas. The widest seeds were collected near the "Lost Pines" forests of Eastern Texas. Seedlings were grown from the same seedlots and then used to establish plantations of half-sibs in northern and southern East Texas. One-year height measurements made in four different plantations indicated that there was a trend for growth to increase as the source of the seed moved south and west. These preliminary results indicate that further research is warranted to determine if other hardwood species from the "Lost Pines" area possess growth or other physiological characteristics such as drought resistance which could be exploited in a tree improvement program.

The seed wing morphology and one-year height of green ash *Fraxinus pennsylvanica* Marsh. collected from 41 seed origins in Eastern Texas were examined in this study. Many previous authors have studied variation patterns in phenotypic morphological characteristics since they may indicate the existence of genetically controlled characteristics that can be exploited in a tree breeding program. Thorbjornsen (1961) studied the variation patterns in natural stands of loblolly pine *Pinus taeda* L. throughout most of its natural range and found good evidence of regional variation patterns in fruit, seed, and needle characteristics. Wells and Wakeley (1966) found geographic variation in survival, growth, and fusiform-rust infection of loblolly pine. A North Carolina study of yellow-poplar *Liriodendron tulipifera* L. by Kellison (1967) revealed the existence of a distinct acid soil ecotype which differed from other populations in foliage, seed, and wood properties. The seeds were distinctive in that the samaras were long and narrow. A later study with the same species (Kellison, 1970) showed that the acid soil ecotype also had distinctive growth and survival properties. Seed origin was shown to have an effect on the drought resistance of green ash by Meuli and Shirley in 1937. Drought resistance in the Prairie-Plains states increased from south to north and from east to west. Foliage color, seed germination rate, growth rate, and tree dormancy were found to be associated with the drought resistant characteristic.

MATERIALS AND METHODS

The seeds used in this study were collected from individual trees from

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stands located throughout the East Texas Pine-Hardwood forest (31 stands) and the Post-Oak forests (10 stands) during the fall season of 1970 and 1971. The outline map (fig. 1) shows the approximate location of the 41 stands. From th

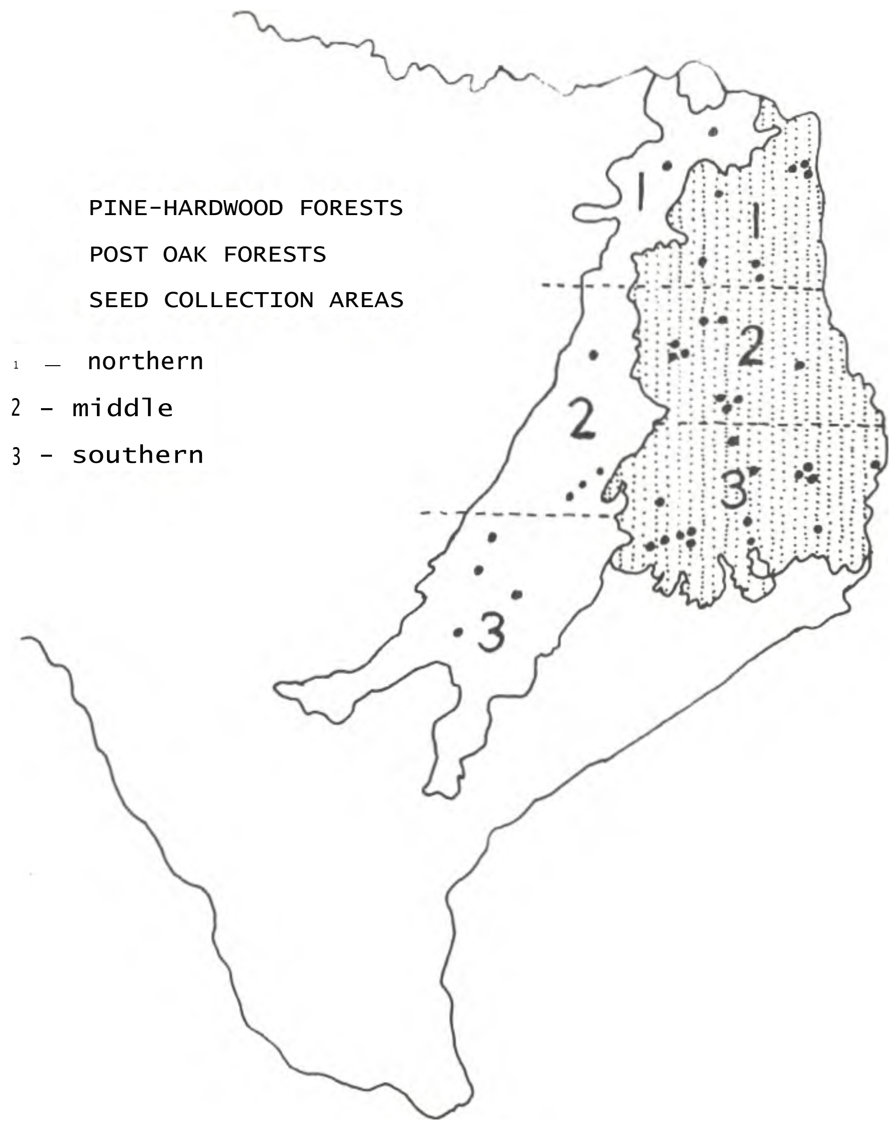


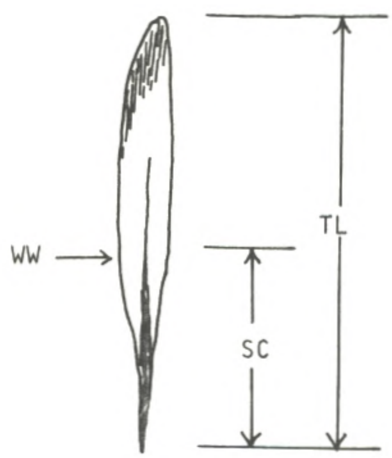
Figure I.--Green ash seed collection areas
in Eastern Texas.

to seven individual trees per stand were collected with five trees per stand being most frequent. Forty-five trees were collected in the Post-Oak forest region and 140 trees were collected in the Pine-Hardwood forest region (table 0, From 250 to 900 grams of seed were collected per tree. The seeds were air dried at room temperature. A ten seed random sample of unbroken seeds were selected to be measured for each of the 185 trees. Three linear measurements were made on the 10 seed sample to the nearest hundredth of an inch. The measurement variables were total samara length, samara width at the distal end of the seed cavity, and seed cavity length (fig. 2). A fourth variable was derived by dividing samara width by total length since ratios may be better than the actual measurements in indicating relative differences.

Table 1.--The number of stands and trees sampled

	Pine-Hardwood				Post-Oak			
	North	Middle	South	total	North	Middle	South	total
number of stands	7	9	15	31	2	4	4	10
number of trees	33	42	65	140	8	20	17	45

Seedlings were raised from the seedlots and four half-sib plantations were established in East Texas in a northern and southern location in 1972 and 1973. In 1972, duplicate plantations were planted in Harrison and Montgomery counties. In 1973, duplicate plantations were planted in Cherokee and Montgomery counties. Sufficient seedlings were not obtained from all seedlots to establish outplantings of all the trees that were collected. Some families were also common to the 1972 and i973 plantations. The basic planting design was a randomized complete block of six replications. Four tree plots were used and the spacing was 3 meters by 3 meters. The plantations were disked to control competing vegetation. Height measurements were made after the first growing season.



TL - TOTAL LENGTH

SC - SEED CAVITY LENGTH

WW - WING WIDTH

Figure 2.--Illustration of the seed wing measurements

The mean of the 10 seed sample and the mean of the four tree plots were subjected to an analysis of variance. A nested analysis was used assuming a random model. Areas, stands within areas, and trees within stands were the sources of variation for the seed characteristics. The sources of variation for the height analysis were replications, areas, and trees within areas. Several stands had only one collection tree represented. Because of this, trees within areas was used as a source of variation rather than stands within areas and trees within stands within areas.

Means were computed for the three areas of the Pine-Hardwood and the three areas of the Post-Oak forests as shown in fig. 1.

RESULTS

Analysis of variance results for the seed wing characteristics (table 2) indicate significant differences among areas for wing width and the ratio of

Table 2.--Analysis of variance results for the four seed characteristics and one-year height growth[a]

Source	df	Seed Characteristics 'F' Test Results: total seed length	seed cavity length	wing width	wing width/ total length
areas	5	ns	ns	.05	.05
stands in area	35	.05	.05	.05	ns
trees in stands	144				

Height Growth

1972 Plantations

Source	Harrison County df	Harrison County 'F'	Montgomery County df	Montgomery County 'F'
areas	4	.10	4	.10
trees in areas	46	ns	45	ns
error	194		203	

1973 Plantations

Source	Cherokee County df	Cherokee County 'F'	Montgomery County df	Montgomery County 'F'
areas	5	.05	5	.10
trees in areas	113	ns	108	ns
error	423		394	

[a] ns not statistically significant at the .05 level.
.05 statistically significant at the .05 level.
.10 statistically significant at the .10 level.

wing width to total seed length. Examination of the area means (table 3) of wing width and the ratio of wing width to total seed length for the northern, middle, and southern areas of the Pine-Hardwood and the Post-Oak forest regions

Table 3.--Mean values in cm of the green ash seed characteristics and mean values for height in cm by areas of the Pine-Hardwood and Post-Oak forests of East Texas

	Pine-Hardwood			Post-Oak		
	North	Middle	South	North	Middle	South
total seed length	3.4	3.4	3.5	3.7	3.5	3.5
seed cavity length	1.6	1.6	1.6	1.7	1.6	1.7
wing width	.37	.40	.40	.39	.47	.51
wing width/ total length	.28	.30	.30	.27	.35	.37
			Height Growth			
1972 Plantations						
Harrison County	52	63	67	-	59	79
Montgomery County	60	69	66	-	68	84
1973 Plantations						
Cherokee County	85	87	94	73	104	94
Montgomery County	66	80	90	66	73	74

of East Texas reveals an interesting pattern of variation. The middle and southern areas of the Post-Oak forest have seeds with much wider samaras. Wing width averages .49 cm in the middle and southern areas of the Post-Oak forest and .39 cm in the rest of Eastern Texas. The trend within the Post-Oak forest region is for an increase in wing width from north to south, .39 to .51 cm. A similar trend exists in the Pine-Hardwood forests although the differences among the area means are not nearly so large, .37 to .40 cm. A better appreciation of the distinctive appearance of these seeds from the middle and southern Post-Oak forests can be obtained from figures 3 and 4. One representative seed from each of 5 trees from each area of both forest regions is pictured.

Analysis of variance results for one year height (table 2) indicate significant differences among areas in all four plantations. Examination of the area means (table 3) indicates that tree height has a tendency to increase as you go south in either the Pine-Hardwood or the Post-Oak forests. The trend for height is not as clear cut as for wing width since the middle and southern areas change ranks several times. The mean height of the two northern areas do average 16 percent less than the average for the two middle and southern areas.

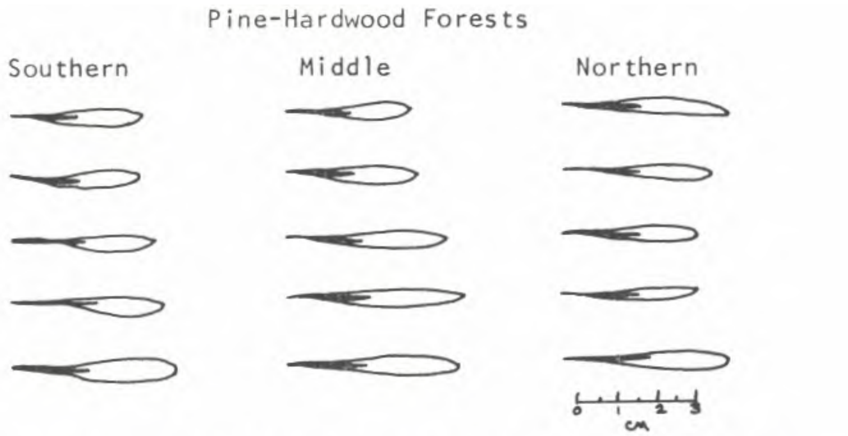


Figure 3.--Sample of seeds from the Pine-Hardwood forests. One seed from each of 5 trees from each area.

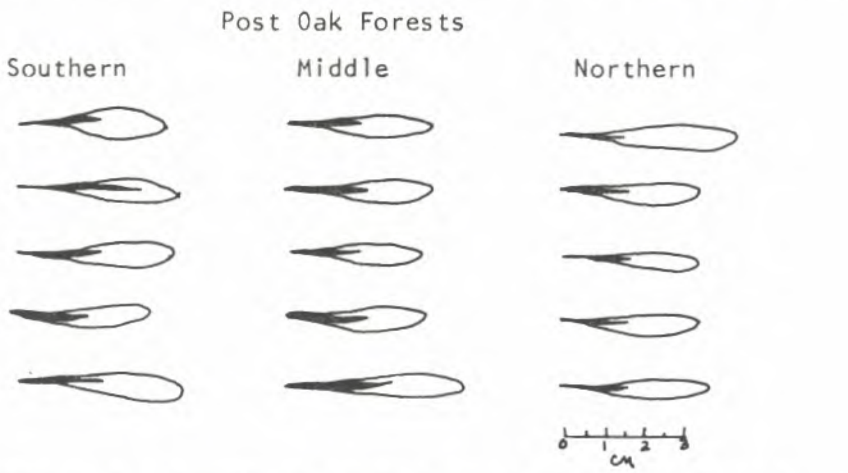


Figure 4.--Sample of seeds from the Post-Oak forests. One seed from each of 5 trees from each area.

Stand differences in areas are indicated for total seed length, seed cavity length, and wing width (table 2). However, differences among trees within areas were not shown to be significantly different in the analysis of the one-year height data. There could be significant stand-to-stand differences for height. The inadequacies of this data precluded making such an analysis. Stand-to-stand differences have frequently been found in hardwood species. Schmitt and Webb (1970) in reviewing studies of natural variation in hardwood species stated that a significant portion of the variation of hardwood species is associated with st

DISCUSSION

These results with green ash indicate genetic differences among populations just as did the work of Meuli and Shirley in 1937. The distinctive appearance of the seeds from the southern portion of the Post-Oak forests and the possibility that such populations may possess other desirable characteristics is particularly interesting because they were collected near the "Lost Pines" forests of Texas. These "Lost Pines" consist of several islands of loblolly pine growing between 100 miles and 130 miles west of the western edge of the southern pine belt under conditions of low rainfall. The morphological structure of their needles differs from other loblolly pines (Thames, 1963). The Texas Forest Service has found the "Lost Pines" superior to other loblolly pines in drought resistance (Zobel and Goddard, 1955). McClurkin, et al. (1971) found the potassium-calcium ATPase system in the "Lost Pines" to be completely different than that found in root tips of other loblolly pines. The factors which have led to the formation of genetic seed source differences in loblolly pine in the "Lost Pines" area could have had the same effect on other Texas tree species. For example, one-year heights of water oak families indicated that oak originating from the southern parts of East Texas will grow faster than those from the northern part of East Texas. Sycamore growth results did not indicate a clear cut north-south or east-west gradient, but source was important (22nd Progress Report of Cooperative Forest Tree Improvement, 1974). Nurserymen have noticed a tendency for sycamore that is collected from the Post-Oak belt to be more resistant to leaf scorch during the summer months as compared to other sources.[2] Of the Texas species studied so far, sweetgum is the only one which does not show source differences. It is also the only species so far studied that does not extend its range into the Post-Oak belt. Ideal conditions for genetic differentiation exist since the populations growing in the Post-Oak belt tend to be scattered and isolated. However, they are not completely isolated. Desirable gene combinations stabilized here could on occasion be transferred to populations in the Pine-Hardwood area. The results with green ash certainly indicate that more intensive research is warranted in order to better determine if hardwood species from the "Lost Pines" area or areas adjacent to it possess characteristics which could be useful in a tree improvement program.

LITERATURE CITED

Kellison, R.C. 1967. A geographic variation study of yellow-poplar (*Liriodendron tulipifera* L.) within North Carolina. Tech. Rept. No. 33, School of Forest Resources, N.C. State Univ., Raleigh.

. 1970. Phenotypic and genotypic variation of yellow-poplar (*Liriodendron tulipifera* L.). Ph.D. Thesis, North Carolina State University, Raleigh, N.C.

McClurkin, D.C., I.T. McClurkin, and T.J. Culpepper. 1971. Cytochemical and tissue homogenate analysis of adenosine triphosphatase in root tips of Texas "Lost Pines." Forest Sci. 17:446-451.

euli, L.J., and H.L. Shirley. 1937. The effect of seed origin on drought

2/ Personal communication, Mr. Richard Aldridge, Jr., Van Ormy, Texas.

resistance of green ash in the Prairie-Plains states. J. Forest. 35:1060-1062.

Schmitt, D.M., and C.D. Webb. 1970. The relation of forest genetics research to southern hardwood tree improvement programs. 11th Annual Forestry Symposium. L.S.U., Baton Rouge, 89-100.

Thames, J.L. 1963. Needle variation in loblolly pine from four geographic seed sources. Ecology 44:168-169.

Thorbjornsen, E. 1961. Variation patterns in natural stands of loblolly pine. Proc. Sixth South. Conf. on For. Tree Impr., Gainsville, Fla., 25-44.

Wells, O.O., and P.C. Wakeley. 1966. Geographic variation in survival, growth, and fusiform-rust infection of planted loblolly pine. Forest Sci. Monograph 11:1-40.

Zobel, B.J., and R.E. Goddard. 1955. Preliminary results on tests of drought hardy strains of loblolly pine (*Pinus taeda* L.) Texas Forest Serv. Res. Note 14, 23 p.

22nd Progress Report of Cooperative Forest Tree Improvement Program. 1974. Texas Forest Service. Cir. 221. pp. 24.