# GEOGRAPHIC VARIABILITY IN GROWTH OF TEN-YEAR-OLD GREEN ASH FAMILIES WITHIN EAST TEXAS

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Abstract.--Open-pollinated progeny from 58 greeni sh selections in East Texas representing 15 counties were planted at three locations within East Texas. Seedlings representing five geographic areas in East Texas were planted in two locations, Northeast Texas and Southeast Texas. Survival was excellent across the five plantations, ranging from 95 to 98 percent with an average of 97 percent. Average volume estimates ranged from 6.6 $dm^3$ per tree to 17.5 $dm^3$ per tree across the plantings and averaged 10.0 $dm^3$ per tree. There were no significant differences for the variables measured due to the geographic area of seed collection within East Texas. The planting location effect was highly significant for height, diameter, and volume. The planting location by family interaction was significant only for survival and volume. Heritability estimates ranged from $h^2 = .51$ for volume to $h^2 = .66$ for height and diameter. Volume per tree can be increased about 1.40 $dm^3$ by selecting the ten best families in the combined analysis.

Additional keywords: Fraxinus pennsylvanica, progeny tests, heritability.

Green ash (Fraxinus pennsylvanica Marsh.) is a bottomland species and is the most widely distributed species of American ash (Harlow and Harrar 1969). The range of green ash extends from the East Coast of the United States and Canada westward into eastern Texas in the South, and eastern Alberta, Canada in the North. Its moderately high wood specific gravity and low wood moisture content make green ash a high valued species for solid wood products as well as for pulp and paper (Talbert and Heeren 1979). Both the North Carolina State University-Industry Hardwood Research Cooperative and the Western Gulf Forest Tree Improvement Program-Hardwood have active tree improvement programs underway with green ash and selected trees have been accepted for use in seed orchards and breeding arboretums (North Carolina State University 1982, Byram et al. 1982). Even though green ash performs best on moist bottomland sites, it is unusually versatile in site requirements and once established, will persist on droughty sterile soils.

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## METHODS

Open-pollinated seed from 58 green ash selections in East Texas representing 15 counties were collected in 1968 and 1970 (figure 1). The seedlings from these selections were grown in 1971 in three replications at Indian Mound Nursery located near Alto, Texas. Three progeny tests were established in early spring 1972: 1) Harrison County, 2) Burleson County, and 3) Montgomery County. Seedlings representing seven geographic areas of seed collection in East Texas were locations in East Texas, Harrison County and Montgomery County. Because of insufficient representation two of the areas, data from only five areas were used in the analysis. These provenance studies were planted adjacent to the progeny tests. With the exception of the test at Burleson County which was four replications, the field design was a six-replicate, randomized complete block with four-tree-row family plots. Spacing was 10 by 10 feet in each planting. A single border row was used at each location to offset edge effects. All seedlings were root-pruned to eight inches and top-pruned to a height of five inches.

The Harrison County planting was cleared previously forested land of silty loam soil. The Burleson County plot was alluvial soil of the Brazos River which had been under intensive agriculture for many years. The planting at Montgomery County was an old forested area previously planted in a plantation which was abandoned one year after planting. All sites were disced prior to planting.

Weeds and sprouts were controlled in all tests by discing during the first three years and mowing thereafter. Chemical weed control was used at the Burleson County planting. The four tests at Harrison and Montgomery Counties were fertilized in 1973 and 1974 respectively.

Provenance and family variation were examined by a least squares regression approach using the General Linear Model (GLM) procedure of Statistical Analysis Systems (SAS) (Barr et al. 1979). Plot means were used in each of the combined analyses. The geographic area of seed collection was considered as a fixed effect, while locations, replications and families were considered as random effects. Dead trees were assigned a volume of 0 $dm^3$ to account for survival differences. A Satterthwaite-F (pseudo-F) test was used in the absence of valid tests (Hicks 1973). Family heritability and gain estimates were calculated for height, diameter and volume.

## RESULTS AND DISCUSSION

Survival was excellent across the five plantations, ranging from a low of 95 percent at Burleson County to a high of 98 percent at Harrison and Montgomery Counties, and averaging 97 percent at all locations (table 1). At age 10 average plantation height for all plantings was 6.6 meters and diameter averaged 6.9 cm. The planting in Burleson County had the best tree growth while the Montgomery County plantings had the slowest growth.

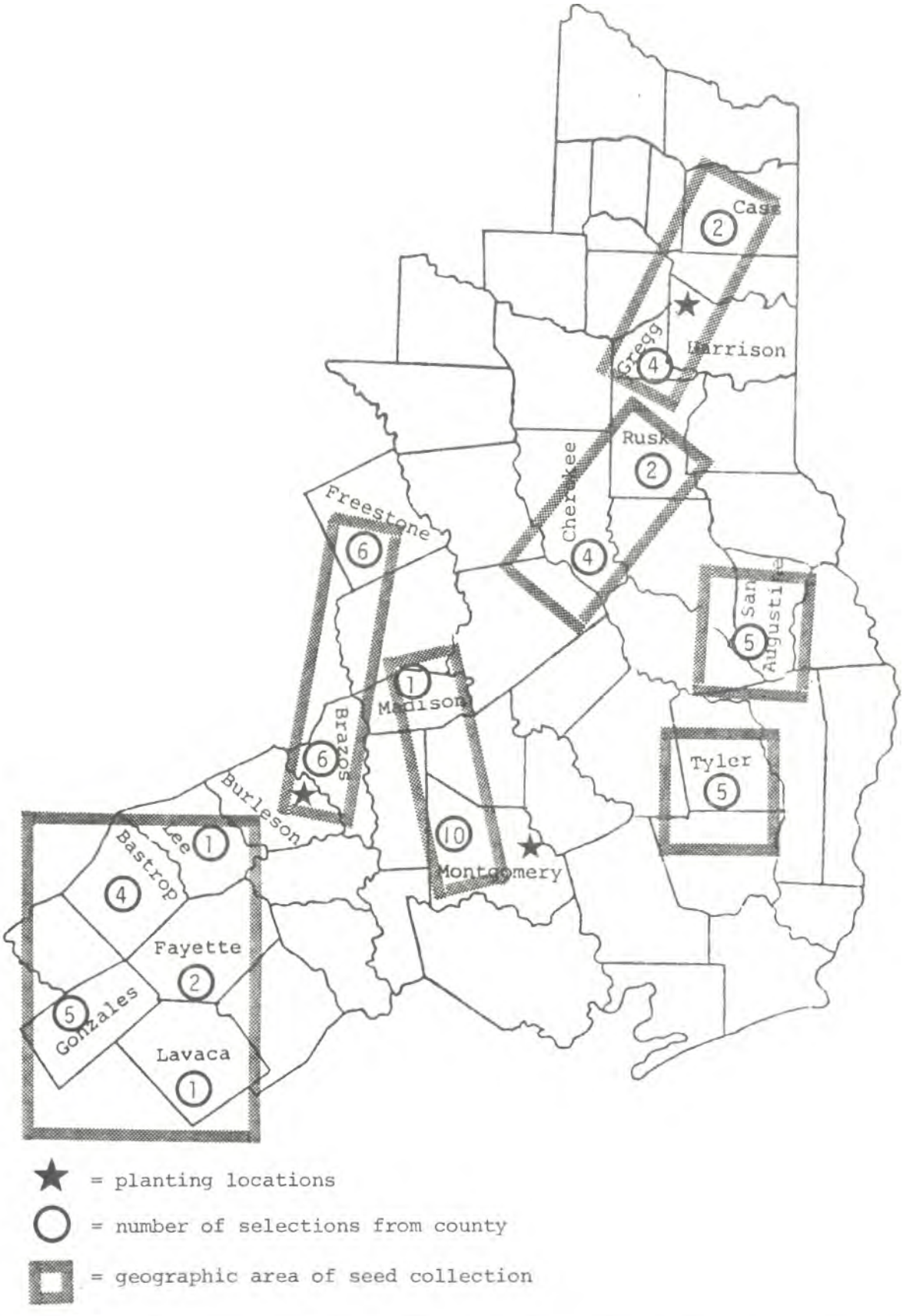


Figure 1. Seed collection locations and plantation locations in East Texas for the 1972 green ash study.

Table 1.--Plantation means for green ash tests at 10 years

| Plantation | Survival | Height | Diameter | Volume |
|---|---|---|---|---|
| | (%) | (m) | (cm) | ($dm^3$) |
| Burleson County | 95 | 7.6 | 9.2 | 17.5 |
| Harrison County | 98 | 7.1 | 7.0 | 10.6 |
| Harrison County (Provenance) | 97 | 6.4 | 6.5 | 8.2 |
| Montgomery County | 98 | 5.8 | 5.8 | 6.6 |
| Montgomery County (Provenance) | 98 | 6.2 | 5.8 | 7.1 |

Green Ash Provenance Studies

There were no significant differences (0.05 level of significance) for survival, height, diameter or volume growth among the geographic areas of seed collection for the combined analysis (table 2). The planting location by provenance interaction was also non-significant for the measured traits. Therefore, these bulk collection studies indicate that there is not any differences between the sampled geographic areas of seed collection. Green ash seed can be collected from any area within this study's boundaries and plant& in East Texas without a loss in survival or growth.

Table 2.--Analysis of variance for survival (Sur.), height (Ht.), diameter, (Dia.), and volume (Vol.) for the combined location provenance green ash analysis

| Source of | df | Mean Square for | | | |
|---|---|---|---|---|---|
| | | Sur. | Ht. | Dia. | Vol. |
| Location | 1 | 0.86 | 2.88 | 11.06 | 31.20 |
| Replication (Loc.) | 10 | 24.09 | 2.47** | 2.42** | 24.05** |
| Provenance | 4 | 10.60 | 1.74 | 1.72 | 16.06 |
| Location x Provenance | 4 | 17.88 | 0.45 | 0.46 | 4.36 |
| Error | 40 | 11.72 | 0.24 | 0.38 | 3.48 |

**significant at the 0.01

Green Ash Progeny Tests

An analysis of variance was performed on the data from 42 families that were planted in at least two locations. Location, geographic source, and family effects were included in the model. The provenance and location by provenance terms were non-significant for survival, height, diameter, and volume. This supports the conclusions from the provenance analysis in that there were no significant differences due to the geographic area of seed collection within East Texas.

Because the geographic area of seed collection was non-significant an analysis was performed deleting the provenance effects from the model (table 3). The location effect was non-significant for survival (mean=, 97 percent), but was highly significant for height, diameter, and volume. As shown in Table 1 the trees at the Burleson County site were the largest. There were highly significant differences among families for height, diameter, and volume growth, but not for survival. The planting location by family interaction was significant only for survival and volume. The range of family survival was 92 percent to 100 percent, and it is doubtful that this small a difference in survival is important in an operational breeding program.

Table 3.--Analysis of variance of survival (Sur.), height (Ht.), diameter (Dia.) and volume (Vol.) for the combined analysis of three green ash progeny tests

| Source of Variation | df | Mean Square for | | | |
|---|---|---|---|---|---|
| | | Sur. | Ht. | Dia. | Vol. |
| Location | 2 | 269.95 | 146.18** | 364.29** | 3946.14** |
| Replication (Loc.) | 13 | 139.28* | 8.47** | 9.52** | 152.73** |
| Family | 41 | 74.36 | 3.45** | 5.23** | 65.12** |
| Location x Family | 66 | 110.51** | 1.17 | 1.79 | 32.16** |
| Error | 480 | 65.35 | 0.93 | 1.63 | 19.12 |

*significant at 0.05 level of significance
**significant at 0.01 level of significance

Because the planting location by family interaction was highly significant for volume, Spearman Rank correlation coefficients were calculated among the plantings. Correlation coefficients for the Burleson County planting with the plantings at Harrison County and Montgomery County were not significant (0.20 and 0.01 respectively). The coefficient between the Harrison and Montgomery County plantings was highly significant (r = 0.56), indicating that much more consistent family rankings occurred between these two plantings. One reason for the differences in family rankings may be because the Burleson County planting was previously under intensive agriculture, while the other plantings

were previously forested land. The Burleson County planting also contained the fewest number of families. Selected families performed well at all three planting locations and a breeding program can be developed utilizing these families. The need for multi-location testing is stressed however, because of the significant family by planting location interaction for volume growth.

Family heritability and gain estimates were calculated for height, diameter, and volume (table 4). These indicate that these traits are strongly inherited in green ash. Estimates ranged from $h^2$ = .51 for volume to $h^2$ = .66 for both height and diameter. Gain in growth traits by selecting the best ten families out of 42 for height, diameter, and volume were 0.33 m (5 percent), 0.48 cm (6 percent), and 1.40 $dm^3$ (12 percent) respectively. These gains for growth traits appear to be large enough for use in a tree improvement program.

Table 4.--Family lieritabilities ($h^2$), standard error (SE) of heritability, and estimated genetic gains for the combined analysis of three green ash progeny tests

| Variable | Family $h^2$ | SE $h^2$ | Gain |
|---|---|---|---|
| Height | 0.66 | 0.22 | 0.33 m |
| Diameter | 0.66 | 0.22 | 0.48 cm |
| Volume | 0.51 | 0.21 | 1.40 $dm^3$ |

## CONCLUSIONS

The geographic area of seed collection within East Texas had no effect on survival or growth; therefore, green ash seed can be collected from any area within the boundaries of this study and planted in East Texas without a loss in survival or growth. Family differences were important in height, diameter and volume growth but not for survival. The planting location by family interaction was highly significant for survival and volume. Well adapted families can be identified with multiple location testing. Growth traits appear to be strongly inherited in green ash (height and diameter $h^2$ = 0.66, volume $h^2$ = 0.51). By selecting the 10 best families expected genetic gains were 5 percent for height, 6 percent for diameter, and 12 percent for volume growth.

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