# VARIATION OF SLASH PINE WOOD SPECIFIC GRAVITY IN DIFFERENT PROGENY TEST ENVIRONMENTS

G.A. Lowerts and M.H. Zoerb, Jr.1/

Abstract.--In 1973, 28 open-pollinated first generation seed orchard slash pine families originating from Florida and Georgia wild stand selections were planted in progeny tests at two locations; Effingham County, Georgia and Putnam County, Florida. Eight families were selected for wood specific gravity analysis in 1987 (age 15). All families displayed significantly higher specific gravity at the Florida location than at Georgia location. The average specific gravity of families originating from Florida selections was significantly greater than that of families originating from Georgia selections at both locations. Family specific gravity appeared to be stable across locations.

Keywords: *Pinus elliottii*, wood specific gravity, geographic variation.

## INTRODUCTION

Open- (o.p.) and control-pollinated slash pine (*Pinus elliottii* var *elliottii* Engelm.) progeny tests have been established by many forest products companies. The inheritance of slash pine wood specific gravity has been shown to be under strong genetic control with narrow sense heritabilities (h ) ranging from 0.43 to 0.68 (Squillace, et al. 1962; Goddard and Cole 1966; Sohn and Goddard 1975). Although several studies have estimated the heritability of specific gravity, the trends in specific gravity among geographic sources and the stability of family mean specific gravity at different progeny test locations has not been explored to any great extent. In natural stands, slash pine specific gravity increases from north to south (Zobel and Talbert 1984; Megraw 1985); however, Goddard and Cole (1966) determined that no trend in specific gravity variation was apparent among geographic sources in one six-year-old progeny test.

The objective of this study was to determine the variation and stability of specific gravity in open-pollinated progeny of high and low gravity first generation seed orchard ortets at two different locations within the species range.

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1/ Seed Orchard Manager and Tree Improvement Project Leader, respectively, Woodlands Research, Union Camp Corporation, Savannah, Georgia.

## METHODS

In 1973, 28 open-pollinated families, from a first generation seed orchard, and two unimproved bulk seedlots were planted in four replications of ten tree row plots at two locations. Location one (poorly drained Olustee soil type) is in Effingham County, Georgia and location two (poorly drained Leon soil type) is approximately 150 miles south in Putnam County, Florida. Site preparation of the Georgia and Florida locations consisted of disk and bed and chop and bed, respectively, in 1972. No other cultural treatment other than mowing prior to measurement has been applied to either site.

Ideally, 20-30 individuals per family should be used for specific gravity analysis (Jett, 1989). Due to the poor survival (<55%) and high incidence of stem fusiform rust (Cronartium quercuum Miyabe ex Shirai f. sp. fusiforme (Cumm.) Burds et Snow) (>80%) infection at the Georgia test location (age 12 data), only eight individuals with rust free stems per family were available for specific gravity analysis. Based upon geographic source and the constrictions of survival and stem rust incidence, four families from Florida selections with relatively high specific gravity (mean 0.64) and four families from Georgia selections with lower specific gravity (mean 0.53) were available for analysis at both locations. Specific gravity of the original select tree was previously determined at the time of selection for seed orchard use by various agencies using the water displacement method (Smith 1954).

Regardless of the replication, the best (i.e. dominant or codominant) eight trees per family (n=8) were felled at each location (64 trees/location). Total height and breast height diameter were measured on each tree prior to felling. A wood disk, approximately 1" thick, was cut at breast height from each tree. Two wedges (usually 180° apart) of clear wood were cut from the pith to the bark. The unextracted specific gravity of the whole wedge was determined using the water displacement method. The specific gravity value at breast height for each tree was determined by mean of the two wedges.

### Statistical Analysis

Family mean, and standard deviation of specific gravity, height, and diameter were calculated using individual tree data. Location, geographic source, location X source, and family within source are the only sources of variation present in this study. Since a true replication effect was not available, individual trees cannot be used as a source of variation.

Analysis of variance procedures using family mean values were performed on a mixed model with the following main effects: location, source, location X source, and family within source. Location and source were considered to be fixed effects while family was considered to be a random effect.

## RESULTS

At age fifteen (1987), total tree height was significantly ($p<0.01$) different between locations (Table 1). The mean height of the eight families at the Florida location (48.4 ft) was greater than the Georgia location (43.9 ft). Diameter (DBH) was not significantly different between locations (Table 1). There was no significant difference between sources, and among families within source for height and diameter (Table 1). Also, the location X source interaction was not significant (Table 1). In comparison with the Florida location, the poor growth and high incidence of rust infection (80% at age 12) of the slash pine families at the Georgia location strongly suggests that slash pine is poorly suited for operational plantations near the northern limit of the species range.

Mean specific gravity of all families was significantly greater ($p< 0.01$) at the Florida location (0.552) than at the Georgia location, (0.510). At both locations, the families from the Florida source possessed a significantly ($p<0.05$) greater mean specific gravity than the families from the Georgia source (Table 1). The mean specific gravity of Florida source families exceeded that of Georgia source families by 4% at the Georgia and by 3% at the Florida locations (Table 2). Without exception, individual family mean specific gravity was greater at the Florida location than at the Georgia location (Table 2). Small rank order changes were evident between locations. For example, family 10-287 (Florida source) displayed the highest mean specific gravity (0.539) at the Georgia location but only the fourth largest mean value (0.555) at the Florida location (Table 2). However, extreme rank order change, such as moving from first to last place, was not evident. The location X source interaction was not significant, and there was no significant difference among families within source (Table 2). The results of this study were strongly influenced by the small test size.

## DISCUSSION

Over all families, total tree height, diameter, and specific gravity were greater at the Florida than at the Georgia location. Since specific gravity is influenced by various hormones produced by the crown, most environmental factors that impinge on crown vigor will affect specific gravity (Megraw 1985). Favorable environmental conditions such as increased summer rainfall, a longer growing season, etc., have been suggested as possible reasons for natural stands of Pinus spp. to display increasing specific gravity from north to south and west to east (Megraw 1985; Zobel and Talbert 1984). Environmental conditions apparently favor

Table 1. Age fifteen combined location analysis of variance for specific gravity (S.G.), total tree height, and diameter (DBH).

| Source | DF | S.G. | Height | DBH |
|---|---|---|---|---|
| | | - - - - - Prob. F - | | |
| | | ** | ** | |
| Location | 1 | 0.0004 | 0.0009 | 0.6251 |
| Source | 1 | 0.0331* | 0.2035 | 0.4145 |
| L X S | 1 | 0.8333 | 0.8367 | 0.5895 |
| Family(S) | 6 | 0.9364 | 0.5937 | 0.4607 |
| Error | 6 | | | |

Where = ** significant at the 0.01 level of probability
= * significant at the 0.05 level of probability

Table 2. Age fifteen (1987) mean specific gravity, total tree height, and diameter (DBH) by location, family, and source within location.

| Family | Source | Specific Gravity | DBH (in.) | Ht (ft.) |
|---|---|---|---|---|
| **Effingham County. Georgia** | | | | |
| 10-279 | Florida | 0.504 | 5.5 | 41.4 |
| 10-286 | Florida | 0.521 | 6.9 | 45.9 |
| 10-287 | Florida | 0.539 | 6.7 | 43.8 |
| 10-373 | Florida | 0.512 | 7.0 | 46.3 |
| 10-223 | Georgia | 0.504 | 6.5 | 42.9 |
| 10-227 | Georgia | 0.494 | 6.4 | 43.9 |
| 10-264 | Georgia | 0.510 | 6.0 | 43.3 |
| 18-29 | Georgia | 0.498 | 6.2 | 43.8 |
| | Location Mean | 0.510 | 6.4 | 43.9 |
| Florida | Source Mean | 0.519 | 6.5 | 44.3 |
| Georgia | Source Mean | 0.501 | 6.3 | 43.4 |
| **Putnam County. Florida** | | | | |
| 10-279 | Florida | 0.562 | 6.5 | 49.3 |
| 10-286 | Florida | 0.559 | 6.5 | 47.9 |
| 10-287 | Florida | 0.555 | 6.4 | 49.3 |
| 10-373 | Florida | 0.563 | 6.7 | 49.3 |
| 10-223 | Georgia | 0.538 | 6.3 | 46.4 |
| 10-227 | Georgia | 0.550 | 6.5 | 49.1 |
| 10-264 | Georgia | 0.537 | 6.6 | 48.6 |
| 18-29 | Georgia | 0.554 | 6.5 | 47.0 |
| | Location Mean | 0.552 | 6.5 | 48.4 |
| Florida | Source Mean | 0.560 | 6.5 | 48.9 |
| Georgia | Source Mean | 0.544 | 6.5 | 47.8 |

[1/] Family Means N = 8
Source Means N = 4
Location Means N = 8

the development of higher specific gravity slash pine at the Florida location. The greater specific gravity of all families at the Florida location agrees with the observed trend in natural stands.

The families originating from the Florida source displayed a greater mean specific gravity at both locations. Source effects were consistent between locations and followed the specific gravity trend observed in natural stands. In contrast, Goddard and Cole (1966) did not observe a trend among geographic sources of slash pine in a six-year-old progeny test. However, their study was conducted at one location using young trees. Perhaps, the presence of mature wood in this study allowed for the expression of the geographic trend in specific gravity. Several studies in loblolly pine have shown natural stand geographic trends are not always repeated in provenance tests at various locations (Byram and Lowe 1988; Saucier and Taras 1967), but other studies (Jackson and Strickland 1962) did observe increased specific gravity from southern loblolly sources in a provenance test of several sources in Georgia. Further examination of specific gravity trends among geographic sources of slash and loblolly pine at multiple locations is needed.

Individual family specific gravity of both sources was consistently greater at the Florida location and appeared to relatively stable with minor rank order changes. The stable performance of progeny from high specific gravity parents across many locations has also been reported in loblolly pine (Anonymous 1989; Byram and Lowe 1988). Of all the characteristics studied in Pinus spp., specific gravity is under the strongest degree of genetic control and offers the greatest opportunity for manipulation (Zobel and Talbert 1984). The stability of progeny from high specific gravity sources at different locations is a reflection of strong genetic control. Since environmental factors were not examined and because of the small sample size in this study, additional testing with an increased number of locations, families, and individuals within family will be necessary to confirm the consistency of source effects and the stability of families across locations.

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