INTRASPECIFIC VARIATION IN GROWTH AND WOOD CHARACTERISTICS OF TWO SLASH PINE VARIETIES GROWN IN SOUTH FLORIDA

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Nearly two million acres of south Florida is cut-over pine land. Some of it has been converted to range land, but much of it is still unproductive. These forest lands are capable of producing valuable forest products, but to do so will require large-scale reforestation. A question often asked by landowners of this region is which variety of slash pine is bested suited for planting, the native South Florida slash pine, Pinus elliottii var. densa, or the typical slash pine, Pinus elliottii var. elliottii .

Each variety has distinct advantages and disadvantages as a commercial forest species. Variety densa is more fire resistant, less susceptible to tip moth attack, and reportedly has greater wood density. On the other hand, planted stock of variety elliottii has greater survival, initiates early growth more rapidly, and is less susceptible to brown spot needle blight.

Growth and other data for our comparison of the two slash pine varieties were obtained from plantations near Fort Myers, Florida. Descriptions of the stands and a comparison of average growth and wood characteristics were published in TAPPI from a paper presented at the third Forest Biology Conference in 1965 (White and Saucier, 1966).

Briefly, our results are based on wood disks cut from 40 trees, 11 years old, of each variety that were planted in a randomized block field test design. At the time of our study, variety elliottii had a superiority over densa of 9 percent in d.b.h., 27 percent in height, and 37 percent in cubic foot volume. Variety elliottii also had 10 percent higher extracted wood specific gravity, 47 percent greater dry weight per tree, 33 percent more latewood, and 52 percent higher field survival. However, variety elliottii had a low percent of wood extractives (2.9 percent) compared with variety densa (4.1 percent).

In this paper we will discuss tree-to-tree differences in variety densa because the data, although limited, are the first available. Brief mention will he made of similarities to, or contrasts with, typical slash pine, which has been more thoroughly studied. In general, our data show that fairly large differences occur among trees in rate of growth, wood specific gravity, tree dry weight, and percentage of latewood. The patterns of variation seem similar to those for other southern pines.

Studies of intraspecific variation help to establish the range in traits within which phenotypic selection of plus trees is possible. Computation of correlations between traits helps guide the tree breeder in selecting for good combinations of good traits. Mating trees with special traits has given striking

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genetic gains in oleoresin yield, tree form, wood quality, volume growth, resistance to fusiform rust, and other less important traits. Thus, results reported here may be of considerable importance in south Florida, although they are not definitive, but they seldom are from such studies because of the large number of variables involved. It is not our purpose to set up requirements for selecting plus trees, but merely to point out some of the possibilities.

RESULTS

Variation in Specific Gravity

Without regard to other factors, the frequency distribution curves for extracted specific gravity seemed to be about normal (Figure 1).

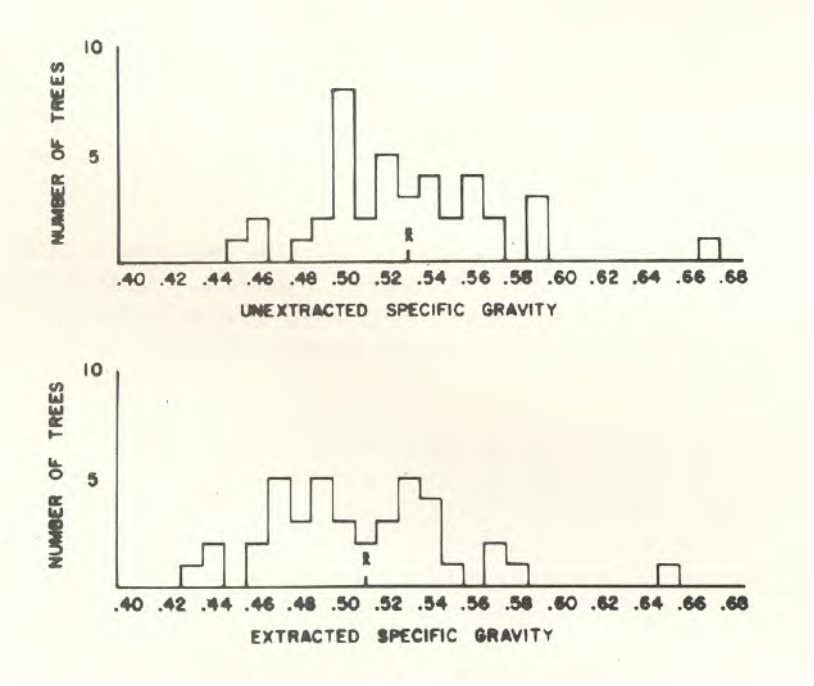

Figure 1.--In South Florida slash pine the frequency distribution curve of wood specific gravity shows that phenotypes with relatively high density could be selected. The extracted specific gravity value is also lower than the unextracted value, but the effect of extraction is uniform throughout the range of density among trees. Thus, extraction of wood of high density trees did not lower their values disproportionately.

With a sample of only 40 trees it can he expected that the curve would not be very smooth and the data for the tail ends would he rough. Specific gravity for individual trees ranged from 0.43 to 0.65. The average was 0.51, so the maximum value of 0.65 was 27 percent greater than average. The maximum value was about 50 percent greater than the minimum.

Extraction of wood samples lowered average wood specific gravity 0.02 points. The shape of the frequency distribution curve remained essentially unchanged. Extraction seemed to lower the specific gravity uniformly throughout the range among trees, but there was a slight tendency for it to have more effect on trees with low values than on those with high values. However, the correlation between extractive content and specific gravity was not significant (r = -0.235). The same general relationships held true for typical slash pine.

The low extractive content of trees of high specific gravity would have an important bearing on the amount of genetic gain possible in a selection program for this trait. The wood specific gravity values are high for trees of this age.

Diameter at Breast Height

Tree diameter at breast height ranged from slightly over 2 inches to 5 inches and averaged 3.3 inches (Figure 2).

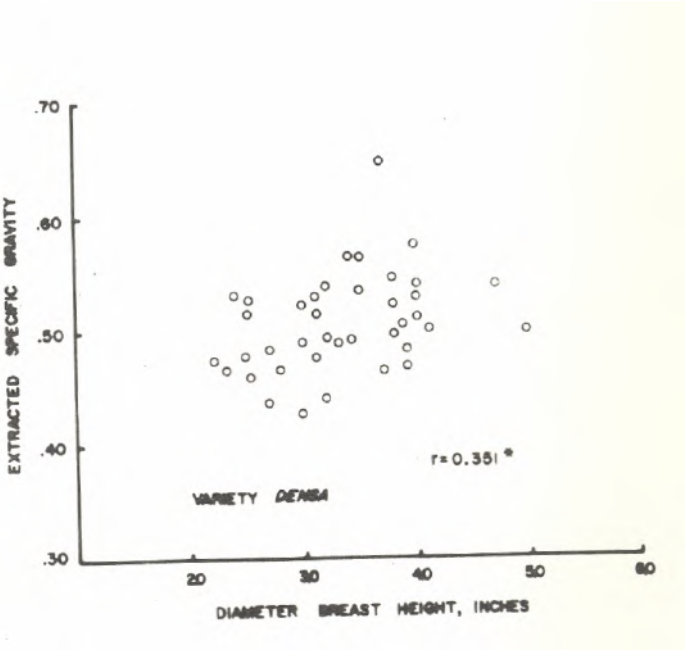

Figure 2.--Inasmuch as wood specific gravity is positively correlated with d.b.h., selection of fast-growing phenotypes is possible without loss in wood density, but trees of the same d.b.h. may vary as much as 0.10 in extracted specific gravity.

Extracted specific gravity increased with diameter. The correlation coefficient was rather low (r = 0.351), but it was statistically significant. The range in specific gravity for trees of the same diameter was

approximately 0.10 and was relatively constant throughout the range of tree sizes. The two trees of maximum diameter had specific gravity of about average for the group or slightly higher. Tree diameters in typical slash pine varied the same amount among trees, but the correlation of specific gravity with diameter was negative (r = -0.222), although very low and nonsignificant.

Tree Height

Height of individual trees ranged from 11 feet to 24 feet and averaged 17.1 feet (Figure 3).

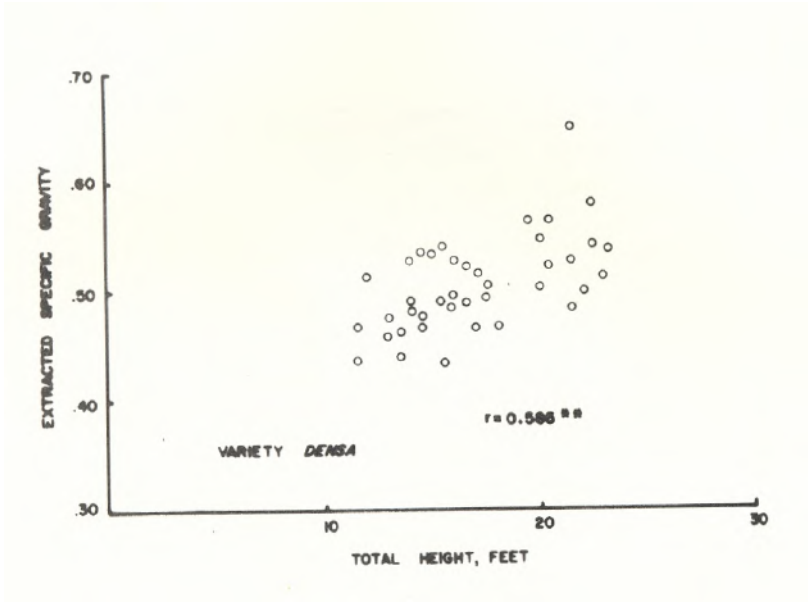

Figure 3.--Selection of phenotypes outstanding in height would result in trees of above average specific gravity, although certain individual trees might be about average because of the variation in wood density among trees of the same height.

Extracted specific gravity increased with tree height, and the correlation coefficient of r = 0.585 was highly significant. The range in specific gravity among trees of the same height was about the same as for diameter, and was uniform throughout the range of tree sizes. One tree near the maximum in height had the highest specific gravity of all trees, 0.66, but was only average in diameter at breast height. In typical slash pine, the height varied the same amount as in variety densa, but the correlation of specific gravity with height was negative and nonsignificant (r = -0.043).

Tree Volume

Total wood volume per tree reflects both diameter and height growth, and had a wide range in this study (Figures 4 and 5).

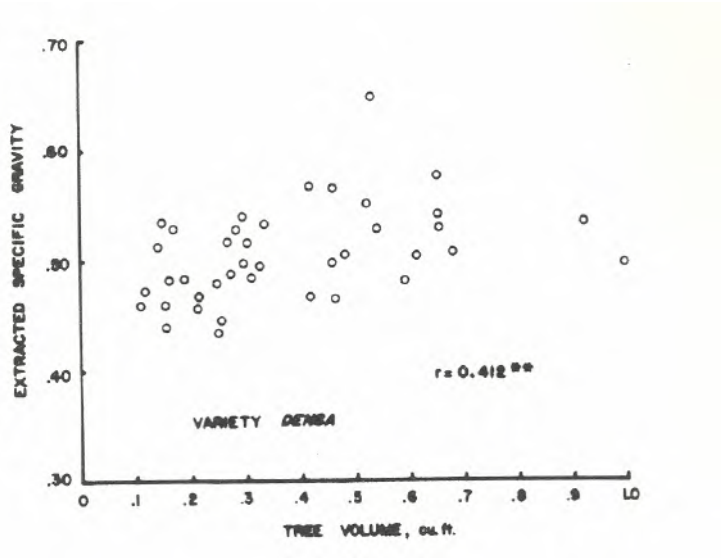

Figure 4.--Selection of fast-growing phenotypes in variety densa would yield trees of average or above average in extracted wood specific gravity.

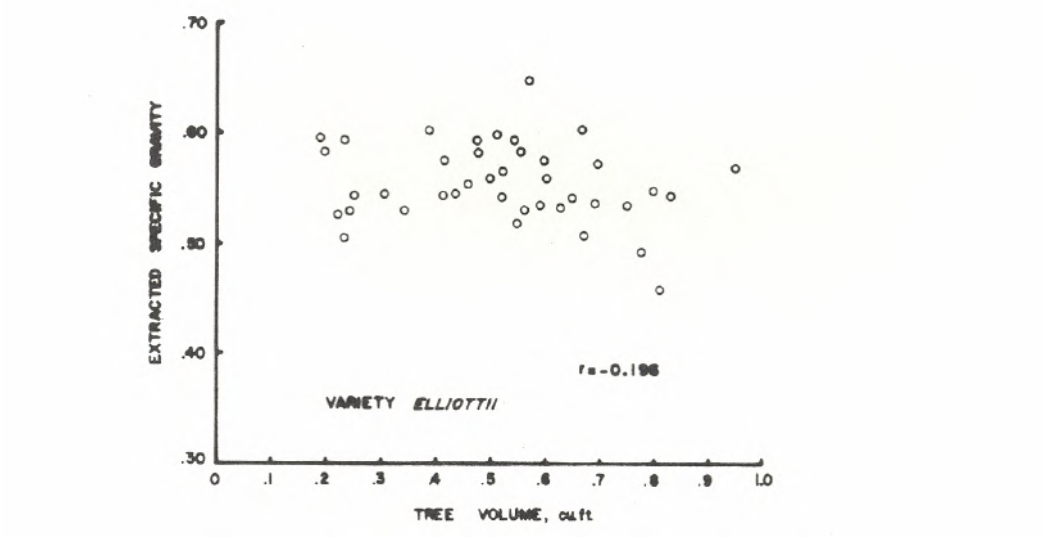

Figure 5.--Unlike variety densa, extracted specific gravity of variety elliottii decreased as tree volume increased.

Individual trees of variety densa varied from 0.1 cubic feet to 1.0; the largest tree had 10 times the volume of the smaller trees and about 2.6 times that of the average tree (Figure 4). Average volume was 0.381 cubic feet. Extracted wood specific gravity increased with tree volume, and had a highly significant correlation coefficient of r = 0.412. This is contrary to the specific gravity and volume growth relationships found in certain studies with other southern pines. The two trees with the largest volume were average or slightly above average in specific gravity. The tree with the highest specific gravity had about 35 percent greater volume than the average tree. If trees with 0.65 cubic-foot volume were selected, they would be about 70 percent larger in size, and from average (0.51) to 14 percent higher in specific gravity. The yield of pulp would be materially increased on a per-acre basis if the traits were inherited, the scatter of points for tree volume in typical slash pine is about the same as for variety densa, except that there were fewer trees in the smaller diameter classes (Figure 5). This may reflect the habit of typical slash pine of making rapid height growth at a younger age than variety densa. Also, the correlation of specific gravity with tree volume differs typical slash because it is negatively correlated and nonsignificant (r = -0.196). Our data for typical slash pine are in agreement with other studies that show specific gravity decreases as volume growth increases, but the rate of change may be small.

Latewood Percent

Percentage of latewood in the 11-year-old trees averaged 45, but ranged from about 30 to 60 (Figure 6).

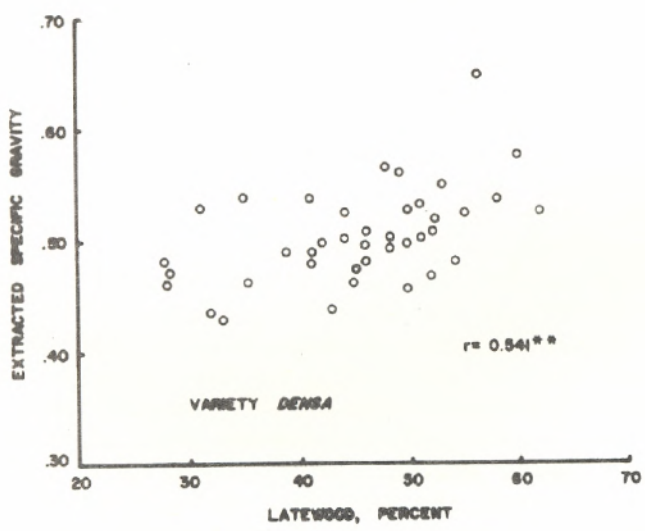

Figure 6.--Latewood percentage values in variety densa ranged from 30 to 60 among the 11-year-old trees, and this contributed to the wide range in specific gravity variation among trees. The relationship of specific gravity to latewood percent was similar to that for typical slash pine, and this was the only trait measured where this was true.

Thus, certain trees had twice the amount of latewood as others, and the highest values were over 30 percent greater than average. Wood specific gravity increased with latewood percent, which is similar to the relationship found in other studies. The correlation coefficient was highly significant ($r = 0.541$). Specific gravity of individual trees varied somewhat among trees with the same percentage of latewood and the range in variation was relatively constant throughout different values. In typical slash pine the scatter of points for latewood percent was similar to that for variety densa. However, instead of being low and negative as for d.b.h., height, and volume, the correlation of specific gravity with latewood was positive ($r = 0.482$) and highly significant. Thus, the relationship of wood specific gravity to latewood percent was similar to that in variety densa.

The percentage of latewood in these young trees did not vary significantly with tree volume for either variety densa ($r = 0.251$) or variety elliottii ($r = -0.120$). This is the main reason why most of the large trees had high dry weight.

DISCUSSION

Applied tree breeding is a creative process. The rate of progress depends on the success with which the breeder selects his parental stock and estimates the gains from the mating scheme used. For breeding stock, the breeder draws on his knowledge of species, races, varieties, and--in many cases--individual plants. In forest tree breeding the choice of the proper individual parent is of great importance because the large size of the plants and great expense of progeny testing make it nearly impossible to use large numbers of trees or base selection of parents upon a very high percentage of populations or families.

Because of the importance of the individual tree, information on intra-specific variation under relatively constant environmental conditions is of considerable value. The range in variation of traits indicates the selection differentials that may be chosen and which rank equally in importance with heritability percent when they are multiplied to give an estimate of genetic gain. Highly accurate information is not easy to obtain because of the extremely wide range of conditions, plus the interactions of ages, stand conditions, and site factors under which trees grow. The alternative is to acquire information from small studies under known conditions such as are reported here.

The trees used in our study were fairly young and certain relationships may change with age, but they are the first figures available for a relatively little-known-but-locally-important tree variety. It was not possible to estimate microsite effects, but broad factors were held constant that have been shown to be important in tree growth and quality, such as age, stocking, and all the complex of temperature, moisture, and soils associated with geographic location.

Tree breeders have pointed out the importance of evaluating trees as a whole rather than becoming involved only in individual traits (Dorman, 1967). Thus, it is necessary to learn the range in each trait and, in addition, the relationship among traits, so that the net effect of all traits on the individual trees can be estimated. This information can best be obtained for

trees grown under the same environment, such as planted stands.

This study, which compares growth rate, wood specific gravity, and survival of the two slash pine varieties when planted at one location in south Florida, is a good example for tree breeders of the additive effects of several rather small differences on total wood produced on an area basis. It will he recalled from our introductory statement that typical slash not only grew faster than variety densa but also had higher wood specific gravity, latewood percent, and plantation survival. For typical slash, a superiority of 9 percent in d.h.h. and 27 percent in height gave a cubic-foot volume superiority of 37 percent. Extracted specific gravity of the wood was 10 percent higher, which brought average tree dry weight to 47 percent more than variety densa trees. Furthermore, survival of typical slash pine was 52 percent higher than variety densa so that total dry weight of wood produced per acre was about 2.2 times that of variety densa. Thus, survival was a large factor in total yield, but might vary from year to year.

Although the differences in performance of the two varieties was quite large, we want to point out, as did White and Saucier (1966), that this is not a definitive study, and foresters should await results of additional studies before revising or completing forest management plans in south Florida.

Assuming that changes in relationships with age will not be very large, which seems to hold fairly well for other southern pines, selection of trees with greatly increased growth rate but normal or improved wood quality characteristics--whichever are desirable--is possible in South Florida slash pine. The positive correlation of specific gravity and volume growth indicates that improvement in yield of dry wood per acre would be striking and prompt if this is a desirable objective.

Inheritance studies with southern pines have shown in many instances that the genotype and the phenotype are highly correlated. This is particularly true if the selection of plus trees was carefully done. This is the reason some slash pine families of superior parents produced nearly twice as much oleoresin as other families (Squillace and Harrington, 1968), or specific chemical composition (Squillace and Fisher, 1966), or high yield of dry wood (Goddard and Cole, 1966), to cite but a few of the important results published to date.

Our study, although small, has given us our first indications of the kind and range of tree-to-tree variations in South Florida slash pine, particularly in the important traits of volume growth and certain wood characteristics. This will make easier the next step of determining the inheritance of important traits and then breeding better trees for the grower and user of South Florida slash pine.

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