GROWTH THROUGH AGE FIVE OF LOBLOLLY PINE CUTTINGS AND SEEDLINGS ORIGINALLY MATCHED USING THREE CRITERIA GROUPS

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If clonal forestry is to be practiced in the southeastern U.S. with rooted stem cuttings of native pines, it will be important to know how their growth compares with growth of similar seedlings. Procedural shortcomings that may have skewed results in comparison tests with other species have been summarized by Frampton and Foster (1993). Prominent among these shortcomings are unequal genetic backgrounds of the two propagule types and different sizes of the two types at planting. For example, Norway spruce *(Picea abies (L.)* Karst) cuttings were larger than seedlings at age 13, but the propagule types were from different families and the ortets that originally furnished the cuttings had been selected for vigor while the seedlings had not (Rouland et al. 1985). Alternately, Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) seedlings were larger than cuttings after five years, but the seedlings also had been about 50% taller at planting (Ritchie et al. 1994). In addition, some seedlings had been derived from families that were not represented by cuttings, and the cuttings were composed of one-fifth the number of genotypes, or fewer. Of the few tests comparing cuttings and seedlings of loblolly pine *(Pinus taeda L.),* Foster (1988) found them to posses many similar size characters at age three. Although sizes were similar at planting and both propagule types were generated from the same five families, there were only ten total seedlings in the final comparison versus 121 cuttings.

The objective of this test was to compare rooted stem cuttings and seedlings of equivalent genetic background and initial size. Since the appropriate criterion for matching the initial size of seedlings with that of cuttings was not known, the test also examined five different criteria. Beginning December 17, 1991, dormant cuttings were rooted from 33-month-old seedling hedges that had been generated from four control-pollinated families of loblolly pine. Seven sets of seedlings were germinated at two-week intervals using the same seed lots, and were grown in tandem with the rooting of cuttings. The first set was germinated four weeks before cuttings were collected. All sets were produced in Hillsons Rootrainers containing a medium of peat moss, perlite, and vermiculite that had been mixed and loaded at one time. Cuttings were rooted and seedlings were grown in the same greenhouse, although the cuttings were within a shaded polyethylene mist chamber above a root-zone heating system and the seedlings were not. Twelve weeks after rooting was initiated on cuttings, all plants were gradually acclimated to outdoor conditions. Beginning three days before the test was to be field-planted, twelve cuttings were sampled from each family of rooted cuttings, and were evaluated for five criteria: stem height, stem diameter at 1 cm above the soil, stem dry weight, root dry weight, and total dry weight. The seven seedling sets were sampled similarly. For each family of rooted cuttings, a seedling set from the same family was then identified that most closely matched it based on one measured criterion. The process was repeated for each of the remaining four criteria. Since the seedling sets identified by some

criteria overlapped completely for all families, measured criteria clustered into three groups: (1) stem height and root dry weight, (2) stem diameter, and (3) shoot and total dry weight. Seedlings from these three criteria groups and the rooted cuttings were field planted as single-tree plots on April 10 and 13, 1992, using a randomized complete block design with 20 blocks. To maintain equal representation of the two propagule types, only one cutting was planted from any ortet since a seedling can represent only one genotype.

Trees were assessed annually for total height, diameter at breast height (DBH), diameter 15 cm above the soil (D15), lower stem taper, average crown diameter, number of stem growth cycles, and number of primary lateral branches produced. Diameter of the largest branch l.8 to 2.4 m above the soil was measured at age five only. Data within each year were analyzed as a series of three 4 X 2 factorials (4 families X 2 propagule types); one analysis of variance for each of the three criteria groups. Family was considered to be a random effect and propagule type was a fixed effect.

In general, the family-by-propagule-type interaction was statistically significant only infrequently. For the 99 total analyses of variance conducted for all measured characters over five years, this interaction was significant at the 5% or 1% level in only five instances. Three of these occurred at age one and none occurred at age five. Therefore propagule types generally reacted similarly across the four families tested, and only their main effects will be presented.

Cuttings generally grew similar to seedlings that had been matched by at least one criteria group. For seedlings matched to cuttings based on initial height or root dry weight, tree height was similar for cuttings and seedlings by age four. These seedlings had been, however, significantly taller than cuttings at ages two and three. Seedlings originally matched by other criteria were taller than cuttings at all ages. DBH was similar for cuttings and seedlings matched by initial height and root dry weight by age three. DBH of seedlings matched by other criteria--including initial stem diameters 1 cm above the container's soil--were larger than those of cuttings through age five. D15 was always larger for seedlings than cuttings regardless of initial matching criteria. For all three groups of initial matching criteria, rooted cuttings exhibited less taper, or more cylindrically shaped trunks, than seedlings by age four. This was mostly due to lower stem diameters (D15) remaining larger in seedlings while DBH became more similar, especially with seedlings originally matched by height and root dry weight. By age three, crown diameters for cuttings were similar to those for seedlings that had been matched initially by height and root dry weight. Seedlings matched by initial shoot and total dry weights had crown diameters equivalent to those of cuttings at age five only; seedling crowns had been broader in earlier years. Seedlings originally matched to cuttings based on stem diameter had broader crowns for all years through age five. The number of annual growth cycles and the number of lateral branches produced annually on the main stem were generally similar for cuttings and seedlings matched by all groups of size criteria after age one. Diameter of the largest lower branch at age five was also similar between cuttings and seedlings from all criteria groups.

In summary, height, DBH, and crown diameter were statistically similar after five years for cuttings and seedlings matched to them by initial height and root dry weight. For this same group of matching criteria, however, D15 was larger and stem taper was greater for seedlings. Seedlings originally matched by initial stem diameter, or by initial shoot and total dry weights, were taller and had larger stem and crown diameters than cuttings. Number of growth cycles, number of primary laterals, and diameter of the largest lower branch were generally equivalent between cuttings and seedlings at age five regardless of matching criteria.

The general absence of significant family-by-propagule-type interactions suggests that good families identified by seedling progeny tests should perform equally well as rooted cuttings. Therefore these results support the testing and selecting of clones from any superior family. The test further indicates that rooted loblolly pine cuttings can grow similar to seedlings from the same families when they are matched by stem height or root dry weight, although stem diameters near ground level may be narrower for cuttings. If this difference results in measurable reductions in wood volume at rotation age, then genetic gains from clonal selections may be not be realized fully. Seedlings matched by other criteria were larger by several measures throughout the test, so this test also confirms that small differences in initial age or size may persist for at least five years.

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