# WHOLE-CANOPY GAS EXCHANGE AMONG FOUR ELITE LOBLOLLY PINE SEED SOURCES PLANTED IN THE WESTERN GULF REGION

Bradley S. Osbon, Michael A. Blazier, Michael C. Tyree, and Mary Anne Sword-Sayer

Planting of artificially selected, improved seedlings has led to large increases in productivity of intensively managed loblolly pine (*Pinus taeda* L.) forests in the southeastern United States. However, more data are needed to give a deeper understanding of how physiology and crown architecture affect productivity of diverse genotypes. The objective of this study was to gain an understanding of whole-canopy gas exchange and crown architecture characteristics that govern productivity of four rapid-growing loblolly pine seed sources.

Four seed sources of loblolly pine were planted in 0.15-acre plots at the LSU AgCenter Hill Farm Research Station in northwest Louisiana in January 2005. Each seed source was replicated 12 times in a randomized complete block design. Soil type was used as the blocking factor. The soils are USDA NCRS Sacul series, which is a very fine sandy loam with shallow clay subsoil, and Wolfpen series, which is a loamy fine sand with deep clay subsoil. All seed sources were from the eastern portion of the loblolly pine range. Two of the seed sources were of open-pollinated half-sib families (7-56 and 8-103), and two seed sources were clones (93 and 9).

Light compensation point (LCP), light saturated photosynthesis (Asat), and daytime dark respiration (Rd) were calculated from photosynthesis light response curves with a LI-6400 portable photosynthesis system (LI-COR, Lincoln, NE) between August 4 and September 9, 2009. These variables were measured on two needles sampled from the first foliage flushes of 2008 and 2009 in the upper-mid crown section from one tree per plot.

A destructive harvest was conducted in mid-September 2009 to obtain the crown architecture characteristics of each seed source. Six trees for each seed source were harvested, and the aboveground tissue was separated into stem, branch and foliage. Foliage was also separated by year of production. The variables measured for each seed source included: the ratio of foliage weight to branch weight, the ratio of branch weight to stem weight, and the average branch diameter (Table 1). Specific leaf area (SLA) was also measured on 4 subsamples per foliage flush on each destructively harvested tree. Site-specific non-linear regression equations that predicted foliage, branch, and stem dry weights from tree total height and dbh were created from the destructively harvested trees. Tree height and diameter at breast height (dbh) measurements of the trees on which LCP, Asat, and Rd were measured were used as inputs in the regression equations to estimate the trees' foliage weight. Crown leaf area (CLA) was then estimated for each of the trees by multiplying average SLA obtained for each seed source from the destructively harvested trees by foliage dry weight estimated from the regression equations. Crown-level Asat and Rd were estimated from multiplying CLA by the leaf level measurements.

Significant differences were found among seed sources in LCP, Asat, Rd, and crown leaf area (Figure 1). Light compensation point was higher for 93 than 9 in 2008 foliage, whereas no differences in LCP among families was found in 2009 foliage (Figure 1A). Crown-level Asat in 2008 foliage was greatest in 93, and Asat of 7-56 exceeded that of 9 and 8-103. In 2009 foliage 93 and 7-56 had the greatest crown Asat, and Asat of 9 was greater than that of 8-103 (Figure 1B). Trends among seed sources in crown-level Rd in 2008 and 2009 foliage were similar to those of Asat (Figure 1C). Crown leaf area in 2008 foliage of 93 and 7-56 were greater than that of 9 and 8-103; trends in leaf area of 2009 foliage among seed sources were identical to that observed for Asat in 2009 foliage (Figure 1D).

Clone 93 and family 7-56 have a higher crown-level leaf area and photosynthetic capacity than clone 9 and family 8-103 (Figure 1), but 93 and 7-56 have different presentations of leaf area (Table 1). Family 7-56 has a

Bradley S. Osbon, Research Associate, Hill Farm Research Station, LSU AgCenter, Homer, LA, 71040
Michael A. Blazier, Associate Professor, Hill Farm Research Station
Michael C. Tyree, Assistant Professor, School of Forestry, Louisiana Tech University, Ruston, LA
Mary Anne Sword-Sayer, Plant Physiologist, Southern Research Station, USDA Forest Service, Pineville, LA

higher proportion of branches to stem and larger branch diameter (Table 1). Meanwhile, clone 93 has a higher amount of foliage per branch, smaller branch diameter, and fewer branches per stem (Table 1). Thus, while 7-56 and 93 had the highest potential for biomass production as inferred by their relatively high Asat and CLA, the tendency of 93 to have a crown form with fewer branches and branches smaller in diameter would likely lead to greater yields of trees of top grade.

**Table 1—Crown architecture characteristics of four loblolly pine seed sources at the LSU AgCenter Hill Farm Research Station in northwest Louisiana**

| Seed Source | Foliage Weight : Branch Weight | Branch Weight : Stem Weight | Average Branch Diameter (cm) |
|---|---|---|---|
| 7-56 | 1.18 c | 0.78 a | 1.42 a |
| 8-103 | 1.23 bc | 0.55 bc | 1.24 ab |
| 9 | 1.56 ab | 0.59 ab | 1.22 ab |
| 93 | 1.66 a | 0.33 c | 1.02 b |

NOTE: Seed sources 7-56 and 8-103 are half-sib families, and 9 and 93 are clonal varieties. Means within columns differ at $P < 0.05$.

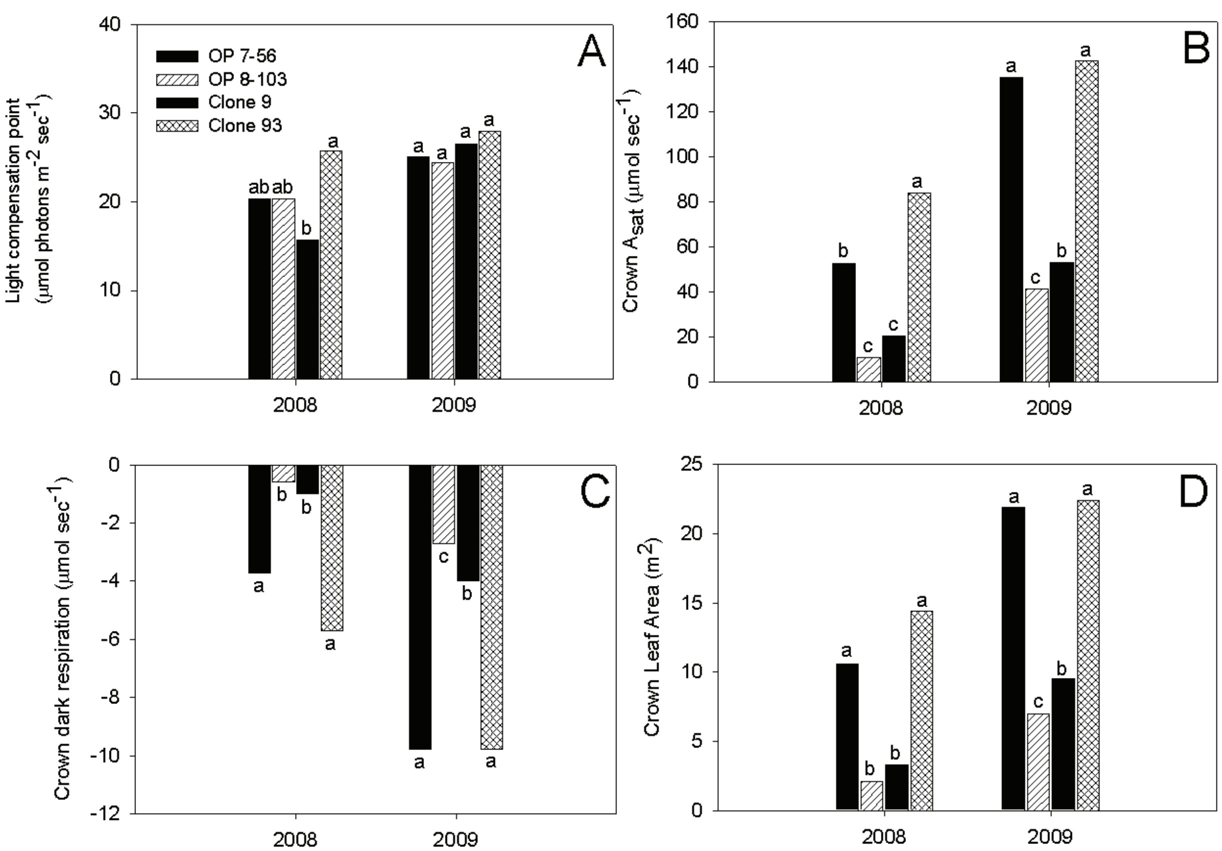


Figure 1—Leaf-level light compensation point (A) and crown-level Asat (B), daytime dark respiration (C), and leaf area (D) measured for first flushes of foliage produced in 2008 and 2009 of four loblolly pine seed sources at the LSU AgCenter Hill Farm Research Station in northwest Louisiana. Seed sources 7-56 and 8-103 are half-sib families, and 9 and 93 are clonal varieties. For each variable and foliage flush, bars headed by different letter differ at $P < 0.05$.