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Crown architecture in relation to productivity of *Populus* clones in the Pacific Northwest, U.S.A.

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Introduction

Productivity is intimately related, in addition to process-related aspects, to crown architecture and canopy density. Therefore, it is important to adequately describe and quantifiy different components of crown architecture to better understand and optimize productivity in tree plantations, particularly in plantations grown under short-rotation intensive culture (SRIC). The present communication briefly summarizes the various crown architectural productivity components that were determined for a number of *Populus* clones, grown under SRIC, and reports some preliminary data on leaf area distribution and leaf area density. The relationship between light interception and leaf area of the same clones has been described elsewhere in this volume by Scarascia-Mugnozza *et al.* (1989).

Materials and Methods

Twelve different *Populus* clones were grown at a 1 x 1 m spacing in a 0.36 ha plantation, established in February 1985 at Puyallup, Washington (47°12' N, 122°19' W), as part of a joint University of Washington/Washington State University Poplar Project. Lay-out, description and management of the plantation have previously been described (Ceulemans *et al.*, 1989).

Five of these 12 clones were more intensively studied, *i.e.*, 1 *Populus deltoides* (eastern cottonwood) clone from IL (III-005), 2 *P. trichocarpa* (black cottonwood) clones (clones 1-12 from Chilliwack, B.C., and clone 12-106 from central OR) and 2 hybrid clones between both species, clones 11-11 and 44-136, obtained by Heilman and Stettler (1985).

Besides growth and productivity, different physiological, morphological and structural characteristics were studied during the first 3 (of a total of 4) yr of the experimental field plantation. At the beginning (May–June), middle (July–August) and end (September–October) of the third growing season (1987), detailed information on branching patterns and branch

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characteristics was collected on representative trees of each of the 5 clones. Number of branches, branch length and diameter, and the angles of origin and termination were determined for both proleptic and first-order sylleptic branches. All branches on a given year's height growth increment *(HGI)* were counted and measured. Dry weight (DW) of proleptic and sylleptic branches, current terminal and the remainder of the stem were determined, as well as DW and leaf area *(LA)* of leaves of current terminal, proleptic and sylleptic branches. Leaf areas of large, representative samples were measured with a Lambda (LiCor Inc., U.S.A.) leaf area meter.

Results and Discussion

Significant clonal differences in number of branches, branch length and diameter, and branch angles caused striking differences in form. Although clone III-005 had the lowest number of branches overall, its branchiness index (*i.e.,* the ratio of total branch DW to total stem DW) was highest as compared to the other clones. Branch length and branch diameter were

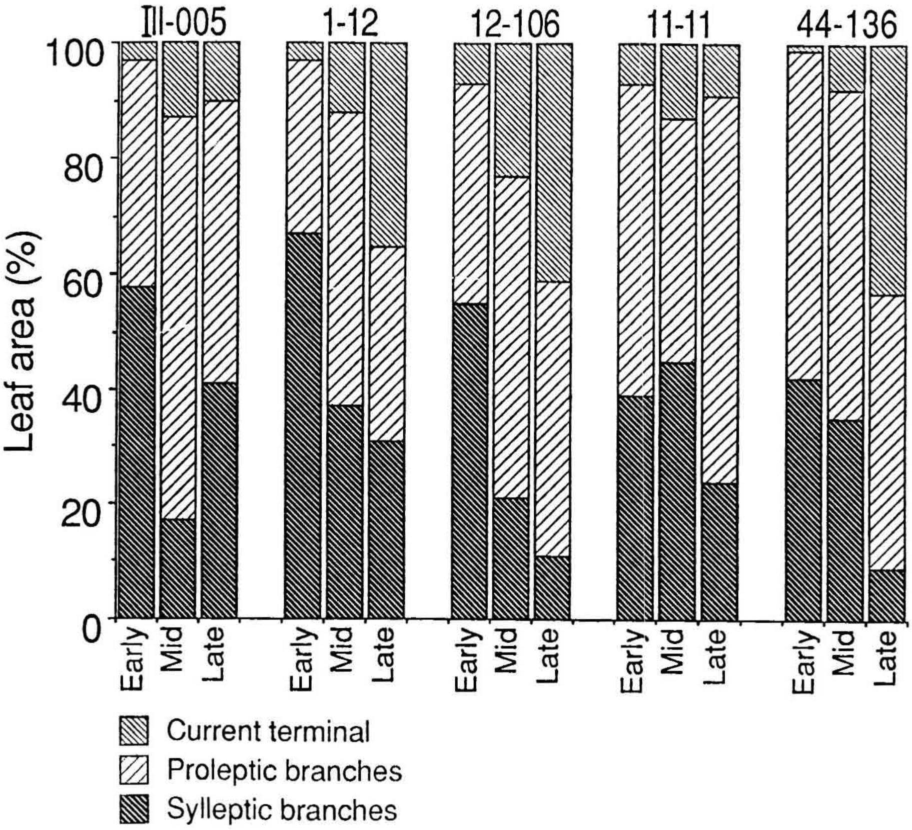

Fig. 1. Leaf area of current terminal, proleptic and sylleptic branches of *Populus deltoides* clone III-005, *P. trichocarpa* clones 1-12 and 12-106 and hybrid clones 11-11 and 44-136 at 3 different times during the growing season. All leaf areas are expressed as the percentage of the total leaf area per tree. Early = May–June; Mid = July–August; late = September–October.

highly correlated within all clones, as were leaf and branch surface areas, which confirms observations by Burk *et al.*, (1983). For all clones, sylleptic branches were smaller (both in length and diameter) than proleptic branches, and had less *LA* per branch.

Except for *P. trichocarpa* clone 1-12, which had nearly the same amount of sylleptic and proleptic branches in each *HGI*, all clones had significantly more sylleptic than proleptic branches. However, total biomass of sylleptic branches was about the same as that of proleptic branches for the *P. trichocarpa* and hybrid clones in the middle of the season, but was only 1/5 the biomass of proleptic branches in clone III-005. The ratio of total *LA* on sylleptic branches to *LA* on proleptic branches was lower in the hybrid clones when compared to the 2 parental species, early and late in the growing season (Fig. 1). However, in the middle of the growing season, the ratio was highest in the hybrid clones. In clone III-005 total *LA* on proleptic branches was always higher than that of their sylleptic counterparts.

The relative proportion of *LA* on sylleptic branches to *LA* on proleptic branches in the hybrid clones was intermediate between that of the 2 parental species at both the beginning and end of the growing season, but exceeded them throughout July and August (Fig. 1). In the middle of the growing season, 35–40% of the total *LA* were carried on sylleptic branches in hybrid clones 44-136 and 11-11, respectively. The *LA* on the current terminal of each of the 5 clones remains a minor part of the total *LA* of the tree, until the end of the growing season. These clonal differences in leaf area distribution and leaf area density help explain the substantial differences in light interception and biomass production of these poplar clones (Scarascia-Mugnozza *et al.*, 1989).

Conclusion

Data on other growth determinants (canopy density, rates of photosynthesis and respiration, patterns of translocation and growth analysis) have meanwhile been collected for the same clones and will be integrated with the information on crown architecture and leaf area distribution, in order to provide a stronger basis for understanding and optimizing yields in SRIC of *Populus*. This information on functional and structural productivity components of poplar will be published in the open literature in the near future.

Acknowledgments

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