Architectural modeling of two poplar cultivars

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Abstract

Poplar 'Jing 2' and Poplar '107' (Populus euramericana clone'74/76') are fast-growth cultivars widely cultivated in China. The aim of this study is (1) comparing the architectural properties of these two cultivars through a modeling approach; (2) rebuilding dynamically the tree structures, which can serve to visualization of tree stand. Two destructive measurements were conducted in year 2009. In both measurements, the obtained data included the organ dimensions of each growth unit (GU) in the trunk and the number of leaf scars in each growth unit; a growth unit of poplar tree corresponds to the part of an axis that is born in one year. According to the previous research work of de Reffye et al., the number of leaf scars (NoLs) in a GU of poplar tree follows a compound law of a binomial and a negative binomial distribution. Based on the probability distribution function of NoLs, we made fitting on the histogram of NoLs in GUs with different PA for both cultivars by using particle swarm algorithm. The unknown parameters which are used to simulate tree topology were estimated for each PA of each cultivar. To reconstruct properly the organ size (including the internodes length, diameter, and leaf area), the measured organ sizes were fitted using an empirical function. Using the parameters, QingYuan software simulated the tree architectures.

The results show that two trees of the same cultivar, although simulated using the same parameters, differ in topological structure as they are generated by different random seeds. It is visually obvious that cultivar 'Jing 2' has more trigs than cultivar '107'. The current work focuses on the architectural modeling of two poplar cultivars, taking into account the distribution of NoLs in preformation and neoformation part. The distribution was in accordance with previous work on poplar tree. Such work is useful to understand the development features of fast-growth cultivars, e.g., the number of leaves in the bud, the neo-formation probability, the mean and variance of NoLs in an annual shoot. What's interesting is that the theoretical mean and variance of NoLs in whole plant can be computed for comparison. The simulated 3D tree architectures can be used for estimating light capture by the canopy, or for pure visualization purpose.