The effect of branching on cotton plant growth and development

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Introduction

Cotton plant development is usually predicted through a function of thermal time either at a daily step (Hanan and Hearn, 2003) or at a growth cycle (de Reffye *et al*., 1999). The GREENLAB model fits well to the architecture of some simple structured plants, e.g. pruned cotton (de Reffye *et al*., 1999) and maize (Guo *et al*., 2006). In the model, it is assumed a constant developmental rate and also stable specific leaf weight (SLW) throughout all the plant developmental stages. We are interested to see whether and how the existence of branches will influence cotton growth and development in terms of metamer production rate, SLW, and blade area profiles.

Materials and methods

The cotton (*Gossypium hirsutum* L.) cultivar DP99B was used in the field experiments under non-limiting conditions in 2006. Three treatments were conducted: (1) the control cotton plants whose branches were removed immediately after initiation; (2) two-branch cotton that remains only two vegetative branches; (3) unpruned cotton plants. Plants were weekly measured on fresh weight and area for leaf blades, the fresh weight, length and diameter for internodes.

Results and discussion

Compared with the control plants, the two vegetative branches had little effect on the main stem development, while for the unpruned cotton the developmental rate of the main stem was slowed at later stage. The presence of branching caused distinct biomass partitioning patterns in terms of compartmental partitioning coefficients. The variation of SLW between and within treatments indicates that SLWs must be treated as developmental and leaf-specific variables. The maximum area of the fully expanded leaves was smaller for branched plants. All the results are being considered in the construction and validation of a new functional structural cotton model.

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Effect of the plants azimuth on light phylloclimate within a virtual maize canopy

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FSPMs have mainly focused on the growth and development of a single plant, even if its parameters were measured on plants sampled in a canopy. Usually, this virtual plant was duplicated and simply translated to simulate a canopy. Improved duplication processes have introduced the inter-plant variability by randomly sampling in-field measurements. Thus, the resulting inter-plant geometry may be far from reality. For example, an actual leaf never goes through another one, when a virtual leaf can do it. However, simulating an actual inter-plant geometry would require simulating how neighbor plants "interact" to colonize free space with their respective organs, thus modeling complex processes and interactions resulting from photomorphogenesis (Ballaré et al., 1997) and thigmorphogenesis (Jaffe and Forbes, 1993). Thus, the question of the effective need of an accurate inter-plant geometry raises. This effectiveness would partly be the ability to accurately simulate physical transfer within virtual canopies, and thus satisfyingly estimate phylloclimate (Chelle, 2005) and dispersion, *e.g.,* of pathogen spores and pollen grains. Among the numerous variables characterizing the inter-plant geometry, the presented study focused on the relative azimuth of maize plants. Indeed, the distribution of leaf azimuth for a given plant results from light-driven leaf reorientation (Girardin and Tollenaar, 1992; Maddonni et al., 2002). The effect of this leaf reorientation on light interception at canopy scale was found weak and significant by Drouet et al. (1999) and Maddonni et al. (2001), respectively. These contradictory results motivated this study, which consists in assessing the importance of taking into account actual plants azimuths in virtual maize canopies to correctly simulate the light interception at canopy but also at leaf scale, the FSPMs one.

The architecture of maize miniplot (3 x 8 plants) and associated light interception profiles were measured within a maize field at various development stages in 2002 at Grignon (France). Virtual plots were built from measurement following Drouet (2003). Artificial plots were generated from the actual ones by rotating plants 2, 5, 10, 20, 30, 45, 65, 90°. Light interception on this set of real and virtual plots was calculated using the nested radiosity model (Chelle et al., 1998). Three light sources were used: a daily suncourse, a standard overcast sky, and a parallel zenith one. Results showed that taking not into account inter-plant azimuth in maize FSPMs is acceptable regarding the light interception of a whole canopy and a leaf layer, but less regarding the one of an individual plant (maximum error of 15%). Moreover, errors on inter-plant azimuth led to erratic and significative errors on the light interception of individual leaves. Another result was that the high variability of the light interception by individual leaves, *e.g.,* the coefficient of variation for leaf 10 was around 60%. These preliminary results raise two questions: how reliable are FSPMs using leaf irradiance but taking not into account inter-plant geometry and how validates the canopy architecture component of FSPMs regarding leaf irradiance estimation, knowing that integrated light variables such as soil irradiance or ground cover, are not well suited?

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