Exploring modeling concepts to deal with carbon source-sink relationships in EcoMeristem: implications for analyzing the phenotypic variability of biomass-sorghum

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The sorghum plant can produce great amount of stem biomass due to the elaboration of one main stem made of thick and large internodes possibly associated with few tillers, depending on the genotype and the environment (GxE). Depending on GxE as well, Carbon (C) is differentially allocated to stem internode structural (lignocellulosic) and non-structural (sugar) components, making stem biomass appropriate to diverse end-uses (feed, energy, bioproducts...). Then optimizing C resource acquisition and allocation to stem component sinks is a major challenge for sorghum breeding toward the conception of plant ideotypes. By accounting for traits involved in C source-sink relations in a dynamic way and at the organ level, FSPM can be of major interest to support the analysis of biomass sorghum phenotypes. EcoMeristem model is designed for this purpose. It simulates plant and crop performance (biomass, sugar, grain) as the result of GxE acting on C sink activity (organ size and number, dynamically set-up in plant topology) and their regulation by their competition for a common pool of C resource within the plant, computed in a simple way at crop level (Beer-Lambert for light interception, Monteith for its conversion into C). This model, initially developed for rice, was recently tested for its ability to capture the phenotypic variability met across eight contrasted genotypes of biomass sorghum. Whereas tiller number, stem and leaf biomass at whole plant level were correctly modelled, biomass partitioning between the main stem and tiller(s) was unreliable: nonstructural (C stored) and a minor extent structural biomass of the main stem was reduced to the benefit of tiller stem growth, suggesting some limits in the way C source acquisition and/or C sink rules of dominance among culms. The aim of the present study was to evaluate concepts for representing C source-sink relationships in EcoMeristem and better capturing the phenotypic variability of biomass sorghum. For this purpose, the current concepts used in this model were compared to more detailed approaches enabling to differentiate the culms with respect to C source and/or sink activity. Regarding C source acquisition, a light interception model taking into account canopy closure dynamics (from isolated plant to row and closed canopy) and horizontal canopy layers defined by leaf age, temperature and sunlit/shaded ratio, was implemented. It was combined with a photosynthesis model inspired from Farquhar-von Caemmerer-Berry's model to compute C assimilation at leaf level. These modules together enable to compute C supply either at whole plant or culm level. Regarding C sink activity, an exploratory formalism was implemented that prioritized C sinks (i.e. growing organs and C storage in internodes) for their access to C resource, according to the age of the culm they belong to (proxy of apical dominance). These different C source and sink related concepts are currently compared to a dedicated field data set. This data set deals with two genotypes and tiller pruning treatments to evaluate the competition between main stem and tiller growth. Accordingly, these source-sink concepts are being benchmarked regarding their ecophysiological relevance and computation time efficiency. Results will be presented and discussed with respect to the added value of each approach for analyzing biomass-sorghum phenotypes.