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Effects of defoliation intensity on the genetic and phenotypic composition of virtual ray-grass populations

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Highlights: A modeling approach to simulate a successive generation of plants submitted to defoliation cylcles was built upt using the L-Grass FSPM model coupled with a simple genetic model. The model allows analyzing the phenotype of simulated successive plant generation resulting from genetics and light competition processes.This study showed the use of the FSPM approach for analyzing evolution of plant population in grassland system

Keywords: L-GRASS model, selective pressure, phenotypic plasticity, genetic selection, *Lolium perenne* L.

Grasslands Biomass production and quality respond to multi-factor dynamics including management such as frequency of defoliation, climatic conditions, soil properties or the floristic composition of the grassland. One of the challenges is to understand the determinants implied in the perinnity of grassland productivity. These determinants are related to the fitness of plants that constitute the grassland and the fitness of plant depends on environmental conditions. Canopy structure, that is to say the pattern of the spatial distribution of the plant items, is equally a factor that shall be considered especially in interactions among individual plants such as light competition which are involved in the dynamics of plant population.

The aim of the present work was there to build up a modeling approach to simulate a successive generation of plants submitted to defoliation cylcles. This approach is based on the coupling of an existing FSPM L-Grass (Verdenal *et al.*, 2008) with a module dealing with genetic properties and reproduction.

The plant model L-Grass (Verdenal et al., 2008) consists in the realistic simulation of the 3D development of the aerial parts of plants in the vegetative phase. Grasses have the particularity, in the vegetative phase, of not elongating their internodes so that the plant is mainly constituted of tillers, which are themselves made of leaves emitted at the basis of the plant, by the apical meristems. Consequently, a realistic representation of the architecture can be obtained by a faithful description of the topology of the plant and of the leaf dynamics (e.g. growth kinetic, lifespan, geometry) at different levels of organization.

The estimation of the biomass production was based on the linear relationship between dry weight accumulation (DW) and intercepted PAR radiation cumulated over time (PARc), which is consistently observed for crop canopies in conditions where neither water nor mineral nutrients are limiting.

A generation G1 of plants originating from the G0 population was obtained using the harvest index principle which determine the number of seed per individual as a function of its total biomass through an empirical relationship parametrized from observed data. Genetic information for each seed was simulated with a bottom-up approach from genes to individual using a L-Grass parameter representing the phenotype of each individual. The simple genetic model is based on the additive hypothesis of quantitative effect of each gene contributing to the expression of the phenotype.

This modeling approach shows the capacity of the L-Grass model to simulate the virtual plant population submitted to cylcles of defoliations. The model allows analyzing the phenotype of simulated successive plant generation resulting from genetics and light competition processes. This study showed the use of the FSPM approach for analyzing evolution of plant population in grassland system.

LITERATURE CITED

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