Simulating perennial ryegrass cutting

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Perennial ryegrass is one of the most commonly cultivated forage species in Europe, where grazing and mowing (cutting) are used to manage this resource. Cutting can be characterized by its intensity (height) and its frequency. Combinations of these two factors affect mono-species grasslands productivity and could also modify the genotypic composition of heterogeneous populations. Indeed, the hierarchy of genotypes in a mixture is affected by cutting regimes in terms, for instance, of tillers relative frequency in the sward (Hazard and Ghesquiere, 1995).

It has been suggested that these observations could be explained by the modification of the structure and function of the individual plant induced by the removal of a part of the leaves, and by the subsequent modification of the light resource accessibility for shaded plants/organs. However, it is difficult to assess whether, and to what extent, these phenomena are due to reactions of the plant to the defoliation *per se* (e.g. reduction of the leaf area) or to the changes that occur in the physical environment in which the plant is growing.

The aim of our work is to better understand how cutting regimes affect the productivity and the genotypic composition of grasslands, and thus their use-value, via the modification of the canopy structure. To this end, an individual-based FS model enabling to simulate a mini-sward canopy and its cutting seems to be an appropriate and valuable tool. To our knowledge, the L-system-based approach has still not been used in the case of cutting/mowing. Indeed, when testing "alternative canopy structures" (Vos *et al.*, 2007) for plants with FS models, attention has rather focused on pruning.

Pruning often consists in the selective removal of entire phytomers (including lateral buds and the terminal apex) in order to modify the shape or the functioning of the plant. On the other hand, in the case of mowing, apex are not removed as they are situated at the bottom of the leaves, close to the ground, and cutting itself only consists in the removal of every tissues situated above a given height (Fig.1), independently of their age, physiological role or any other property.

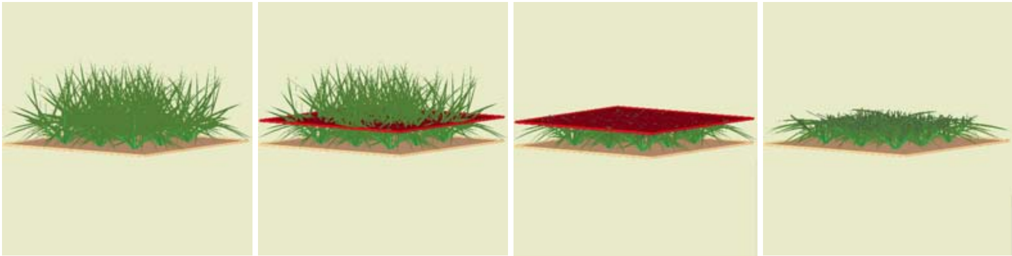

Fig. 1. Sequence of 4 images illustrating a simulated defoliation of a rye-grass mini-sward.

Ultimately, cutting could be compared with hedge-pruning (Prusinkiewicz *et al.*, 1994) which is also based on a purely spatial criterion. However, in our particular case, it is not possible to simulate the truncation by simply removing unwanted modules as they are dedicated to the representation of whole leaves. Consequently, it is necessary to develop the algorithms allowing to determine, for each leaf, the length of the remnant after a cutting event (Fig. 1.).

We explored several algorithmic options for L-system-based models. For example: i) the use of query modules in order to make the leaves “remember” their length when they first cross the defined cutting plane, ii) decomposition/reconstruction of the plant using LPFG’s feature enabling to create several groups of production, and iii) vector-based calculations. We will present and discuss them in relation with the structure of the plant.

References

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