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## Calibration of LgrassFlo, a new model of perennial grass phenology in response to temperature and photoperiod.

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In perennial grasses, the reproductive development encompasses several phenological events, such as apex induction, floral transition, heading and flowering, that deeply affect biomass production, forage quality and plant perenniality. Despite the importance of perennial grasses in agricultural systems and natural ecosystems, we still lack accurate models predicting the reproductive development and its consequences on plant growth and grassland management. Most of available models implements a fixed scheduling of the reproductive development expressed either in thermal time or in calendar time. The progressive completion of floral induction and the effects of environmental factors are generally poorly described. In addition, the vegetative and reproductive developments are represented as independent and successive phases. In the present work, we introduce the new model LgrassFlo, which simulates the reproductive development of perennial grasses in interaction with plant vegetative development and considering the effects of environmental conditions on floral induction.

LgrassFlo simulates the canopy as the dynamics of a collection of individual plants, each being composed of one or more tillers. The 3D description of leaf growth and tillering is based on a functional-structural plant model of perennial ryegrass (Lgrass). We developed a new model of floral induction describing the progression of the primary and secondary induction of each apex of the plant according to (i) the daily temperature, (ii) photoperiod and (iii) plant architecture. This model was coupled to Lgrass, the model ensemble being called LgrassFlo. During apex induction, LgrassFlo accounts for an increase in the rates of leaf primordia initiation and leaf elongation. After floral transition, we assume that the apex only initiates spikelet primordia and that internodes start to elongate. LgrassFlo simulates the date of floral transition, the final number of leaves and the heading date based on a 3D representation of plant architecture.

A specific experiment was carried out in order to calibrate LgrassFlo on data describing the vegetative and reproductive development of three *Lolium perenne* cultivars contrasted for their precocity and exposed to four inductive conditions in growth chambers. The first three conditions consisted in a period allowing for primary induction (low temperature – short day) followed by a period allowing for secondary induction (high temperature – long day), the two periods being spaced by a non-inductive period (high temperature - short day) of 0, 3 or 6 weeks. In the fourth condition, plants were not exposed to conditions allowing for the primary induction. A set of

vegetative and reproductive parameters were estimated for each individual plant of the experiment. The parameter values were independent of the experimental treatment but showed a large genetic diversity both between and within varieties. Using this calibration, LgrassFlo satisfactorily predicted the observed diversity in final leaf number and heading date.

The present model is a step forward towards a better prediction of perennial grass phenology in actual and future climatic conditions. In this respect, the model is being currently used to simulate the observed genetic diversity in the heading date of several *Lolium perenne* cultivars grown in contrasted temperate climates over the last 15 years.