Predicting evapotranspiration in crop rotations with a simple model: AqYield

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ESA2018

XV[e] European Society for Agronomy Congress

August 27-31, 2018 - Geneva, Switzerland

www.esa-congress-2018.ch

ABSTRACT BOOK

PoS2-37

Cropping Systems for Driving Biological Regulation of Weeds. A Simulation Study of Seed Predation by Carabids.

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Abstract: Weed seed predation by carabid beetles (*Coleoptera*, *Carabidae*) may contribute to weed control in crop fields but to date, evidence of weed regulation by carabids is scarce. Predation rates are driven by several factors (crop management techniques, habitat quality, pedoclimate, and carabids' seasonal dynamics). Models are needed to evaluate the impact of weed seed predation on multi-annual weed dynamics, and thus on crop production and weed biodiversity.

We developed a predation model which was added to an existing weed dynamics model (FlorSys, Colbach *et al.*, 2014). The model was built from available literature and experimental data. It simulates the effects on daily predation rates of management techniques, vegetation cover, climate, carabids' intra-annual abundance variation and in-field weed seed preferences of carabids. First, a sensitivity analysis of predation to model parameters was run to identify the parameters that have the most impact on predation rate and are thus required to be accurately estimated. Then, ten cropping systems were simulated over thirty years to evaluate the impact of weed seed predation on weed dynamics, crop production (weed biomass, yield loss due to weeds) and biodiversity (weed species richness, bee food resources). The systems were based on a rapeseed/wheat/barley rotation, differing in rotational crop diversity, herbicides use, ploughing and tillage frequency.

The sensitivity analysis revealed that predation rate was the most sensitive to cropping system. Management techniques must thus be set carefully in order to promote predation, regardless of parameters value. Predation rate varied greatly with parameters associated to effects of temperature and incident radiation whereas it varied little with parameters associated to carabid seasonal dynamics and effect of management techniques (insecticides, tillage, plough). The former parameters must be estimated precisely whereas current values can be kept for the latter.

The cropping system simulations showed that annual predation rates varied greatly among years, depending on the crops. Predation rates averaged over the thirty simulated years were higher in cropping systems including spring crops (pea or sunflower). Adding seed predation by carabids in the simulations only marginally changed multiannual weed dynamics. Effects of predation on crop production and weed biodiversity were rare and depended on the cropping system. Predation decreased weed species richness in all ten cropping systems because the model assumed that carabids predated their preferred weed species rather than the most frequent ones. Consequently, we plan to make seed predation also depend on seed density in a future model version. We will also simulate a wider range of cropping systems to conclude on the contribution of seed predation by carabids to the biological regulation of weeds.

Funding: INRA and the CoSAC project (ANR-15-CE18-0007).

Keywords: Predation, Biological Regulation, Model, Cropping System

PoS2-38

Predicting Evapotranspiration in Crop Rotations with a Simple Model: AqYield

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Abstract:

Introduction: Designing cropping systems that are well-adapted to water-limited conditions is one challenge of adapting agriculture to climate change. It requires estimating their impacts on crop water use and water resource availability in agricultural areas. Quantifying the evapotranspiration (ET) (plant transpiration + soil evaporation) according to their management is crucial because it has a direct impact on water availability in areas where water is scarce.

Crop models such as AqYield are useful tools for evaluating effects of climate, soil and agricultural practices that directly impact water balance. While extending evaluation of model performance to the rotation scale is a priority since it is the temporal scale that makes sense for environmental assessment of cropping systems such an evaluation is rarely performed; probably due to difficulty to access to data on ET. Our main objective was then to evaluate the ability of AqYield to predict water flux dynamic like ET at the field scale over crop rotations.

Materials and Methods: AqYield is a simple model with few input data. It only requires 4 soil properties, 3 daily climate features and dates for crop managements. The model simulates water balance components (soil available water, ET and drainage) at a daily time step, phenological stages and yield. It has already been satisfactory evaluated for spring crops in southwestern France.

Predictions from continuous run of AqYield were evaluated with data (7 years with continuous measurements of daily turbulent ET fluxes) coming from two crop rotations (FR-Aur: wheat/sunflower/wheat/rapeseed; FR-Lam: maize/wheat).

Results and Discussion: The simple equations and empirical processes in AqYield appears relevant enough to predict daily and monthly ET fluxes at the crop rotation scale on both sites. AqYield adequately reproduced intra- and inter-annual variability of observed ET fluxes, with accurate prediction of low and high ET for a variety of crops and contrasting climatic years. ET at the end of growing seasons, however, was slightly underpredicted. Moreover, daily ET predictions were as accurate or more accurate than those predicted with the spatially distributed and more complex TNT2 model, which was evaluated using the same dataset.

Conclusion: Whereas AqYield is simple and requires only a few input data, it allows accurate prediction of ET along cropping systems. It therefore could be useful as a module in more complex modeling approaches. For example, it can be used in the modeling platform MAELIA (http://maelia-platform.inra.fr/) for simulating cropping system scenarios at the watershed level.

Keywords: Evapotranspiration, Calibration, Evaluation, Model, Crop Rotation