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An Innovative Method for Using the Day-Cent Model to Simulate Intercropping

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ABSTRACT

Croplands can have less detrimental environmental effects by combining various crops in intricate spatial and temporal configurations. Simulation models are helpful tools to investigate novel crop combinations and management techniques in various settings under various weather conditions. However, there aren't many models that can simulate the growth of two or more crops at once, such as intercropping or relay cropping systems. To simulate two crop kinds growing simultaneously, we modified Day-Cent; one of the most frequently used models for analyzing greenhouse gas emissions on croplands. The savanna scheme, which was intended to mimic a single crop and tree species growing concurrently and competing for light and nutrients, included various tree attributes that we altered. As a result, we were able to replicate the growth of two crop species simultaneously without changing the model code. Our findings were in good agreement with common single crop predictions of various important variables as well as with grain production and aboveground biomass measurements obtained from a lengthy intercropping experiment. According to a sensitivity analysis, the factors that affect the leaf-area-index are more crucial than those that affect crop competition. Day-Cent can now simulate a variety of crop combinations for intercropping and relay cropping methods, allowing researchers to examine the agronomic and environmental performance of cutting-edge agricultural systems.

Keywords: Plant growth, Plant resilience, Hybrid calcium mineral, Calcium silicate, Calcium carbonate

INTRODUCTION

A promising approach to guarantee crop output while minimizing the related detrimental environmental effects is multiple cropping systems. Agricultural practises such as intercropping, cover cropping, and margin cropping are examples of multiple cropping systems. These systems integrate various crop species in a variety of spatial or temporal configurations. Because it can help provide ecosystem services including lowering greenhouse gas emissions, preventing weed growth and soil erosion, increasing biodiversity, or improving yields and soil functioning, cover cropping is sometimes known as service cropping. Relay cropping is a specific type of cover cropping in which cover crops are planted in the same field as cash crops and harvested at the same time as the cash crops. There is growing interest in creating new management strategies utilizing multiple cropping systems and comprehending the ecological and agricultural ramifications because of their potential benefits.

Simulation models are useful tools for forecasting management practise results and comprehending how these activities affect agricultural systems. These models are often created to simulate single harvests. Several models have been modified to simulate the simultaneous growth of two crop species. These models are still hard to come by, though, and there aren't many models available right now that can replicate numerous crops. The lack of knowledge about the ecological interactions between two crop species that compete for resources or the difficulty of modeling species interactions in model algorithms might be blamed for the underrepresentation.

One of the most popular process-based simulation models, Day Cent examines the carbon and nitrogen cycles in many ecosystems, including croplands, with a particular focus on greenhouse gas emissions. As of right now, this model can only mimic one crop at a time because that is how it was intended to work. The so-called savanna approach, however, allows the model to replicate a herbaceous species coexisting and outcompeting a woody species. Without changing the original model code, we were able to easily simulate an herbaceous species through the Forest sub model, and as a result, two crops growing at the same time, as is the case in the intercropping or relay cropping systems.

The purpose of this work is to propose a straightforward and original method for simulating the growth of two crops simultaneously using the Day Cent model. To do this, we first outlined the process for simulating a herbaceous species using the Forest sub model before contrasting the results from the Crop and Forest sub models. The effectiveness of this new mechanism was then assessed by

contrasting simulation results with information obtained from an intercropping field experiment in Argentina. Finally, we conducted a sensitivity analysis to determine how five important model parameters affected the primary simulation outputs.

Description of the Mechanism

We took advantage of the model's ability to depict competing tree and grass vegetation types in order to design this mechanism. We specifically changed some of the parameter values in three input files for the Day Cent model. The model's code and structure didn't need to be altered. In order to change a tree species to resemble an herbaceous crop species, we first altered the parameters in the file that regulates tree growth. In this study, we only evaluated.

C-crop vs T-crop comparison

The tree sub model of Day Cent could precisely simulate most of the outputs we considered for annual herbaceous species by adjusting the required parameters in the tree.100, trem.100, and schedule input files. All 9 variables analyzed showed the same temporal patterns and were close to the absolute values when crops were run as C-crops or as T-crops. Soybean crop biomass showed some small differences in the maximum values achieved, mainly during the first and sixth year.

CONCLUSION

Although there aren't many models that can mimic the growth of two crops at once, emerging crop management techniques that aim to increase agricultural sustainability are increasingly including combinations of two or more crops in space and time. This paper demonstrates a straightforward method for modifying one of the most used ecosystem simulation models to accurately mimic the growth of two crops simultaneously.

Conflict of Interest Statement

The authors affirm that they have no known financial or interpersonal conflicts that might have appeared to have an impact on the research presented in this paper.