CHANGES IN CROP YIELDS, SOIL ORGANIC CARBON AND SOIL NITROGEN CONTENT UNDER CLIMATE CHANGE AND VARIABLE MANAGEMENT PRACTICES

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Introduction

The assessment of climate change impacts on global and local crop production is known to be inherently uncertain (Asseng et al. 2015). Crop simulations models are playing an increasing role in researches related to the soil-plant-atmosphere continuum and have proven to be useful tools in climate impact studies (Palosuo et al., 2011). Recent maize (Bassu et al., 2014) and wheat (Asseng et al., 2015) multi-modelling ensembles have predicted grain yield declines across the globe in response to global temperature increases. But none of these models have been used in continuous mode (Basso et al., 2015), rather annually re-initializing pre-seasons soil conditions. In an effort to evaluate the long-term impacts of soil modifications on crop production under climate change conditions, we present the largest multi-modelling ensemble exercise so far conducted with crop models run under sequential mode.

Materials and Methods

Five maize models and seven wheat models involved respectively in the maize- and wheat-pilot initiatives of the Agricultural Model Intercomparison and Improvement Project (AgMIP) were run under reinitialized and sequential running mode. The same respective factorial climatic modification protocols were followed (for methodology details, cfr Asseng et al. (2015) and Bassu et al. (2014)). Additionally, modelers were asked to simulate conventional tillage and no-tillage management. Modelling ensemble techniques were used to analyze the impacts of the interactions between soil, climate and management on soil organic carbon (SOC), soil nitrogen content (NO_3^-) and crop yields under the maize-fallow and wheat-fallow crop rotations.

Results and Discussion

Under continuous running mode, all models agreed in the direction of the changes. Model ensemble showed that N-NO_3^- would increase under increasing temperatures treatment, and SOC was found to decrease with temperature increases. However, important cumulated differences on simulated yields were observed between the pre-seasons reinitialized run and the continuous run of the model ensemble.

When models were run in continuous mode, model ensemble highlighted that yields were overall higher when CO_2 increased, whatever the temperature treatment. Soil N-NO_3^- was globally lower under higher CO_2 levels and was found to increase with temperature, while SOC modification rates were globally the same whatever the CO_2 treatment.

Regarding tillage management, simulated yields were slightly lower when practicing no-till compared to conventional tillage. The main effects when practicing no-till was observed under the maize-fallow rotation, with lower N-NO_3^- level and lower SOC decrease observed under no-tills system, leading thus to higher level of SOC remaining in the soil.

Conclusions

Continuous running mode of crop models appeared as a promising way to better understand the interactions between soil, climate and crop management. Ensemble of continuous modelling is a promising way to design crop and soil management strategies able to mitigate adverse climate change impacts.

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