Yields and Water-use Efficiency of Maize and Sorghum under the Impacts of Climate Change in West Africa

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1. Background

Climate change and climate-driven changes in soil, water, and nutrients will put at risk the resilience of the agricultural production systems in the West Africa dry savanna region, although one remains uncertain about the magnitude of the impact.

2. Objective

(i) To examine the responses of maize and sorghum to three soil fertility management options under the historic climate (1986 – 2005) and
(ii) compare these to the performance of the same options under bias-corrected ensemble predictions of future climate (2080-2099) for three Representative Concentration Pathways (RCPs 2.6, 4.5, and 8.5).

3. Materials and Methods

Study region: northern Benin dry savanna, West Africa

Climate change scenarios:

- Bias-corrected ensemble mean predictions (BNU-ESM, CanESM2, and MPI-ESM-MR models) of future climate (2080-99) under RCPs 2.6, 4.5, and 8.5.
- Baseline (Bas.): historical climate over 1986-2005

Cropping system models: CERES-Maize and CERES-Sorghum

Test crops: Maize (cv. EVDT-97 STR) and Sorghum (cv. local)

Soil fertility management options: Un-amended soil (**CONT**), Integrated soil-crop management (**ISC**: recommended fertilizer rates with return of crop residues), and high use of mineral fertilizer (**HMF**)

Parameters simulated: Biomass accrual, water use efficiency, and grain yields.

5. Conclusions

Although carbon dioxide-fertilization will enhance biomass production during early-season growth, the projected climate change for the dry savanna in North Benin will likely reduce water- and nitrogen- use efficiencies as well as grain yields of maize and sorghum considerably, threatening food security in the region.

4. Scientific highlights

- Early-season increases in biomass of maize and sorghum due to projected climate change (CC) (Fig. 3), but overall yields will be reduced due to haying-off (Fig. 2).
- Integrated soil-crop management options enhance grain yields and water use efficiency, but could not offset overall yield loss of CC (Fig. 1,2).
- Projected temperature increases drive CC impact, irrespective of carbon dioxide-fertilization effects in the West African dry savanna.

Water use efficiency

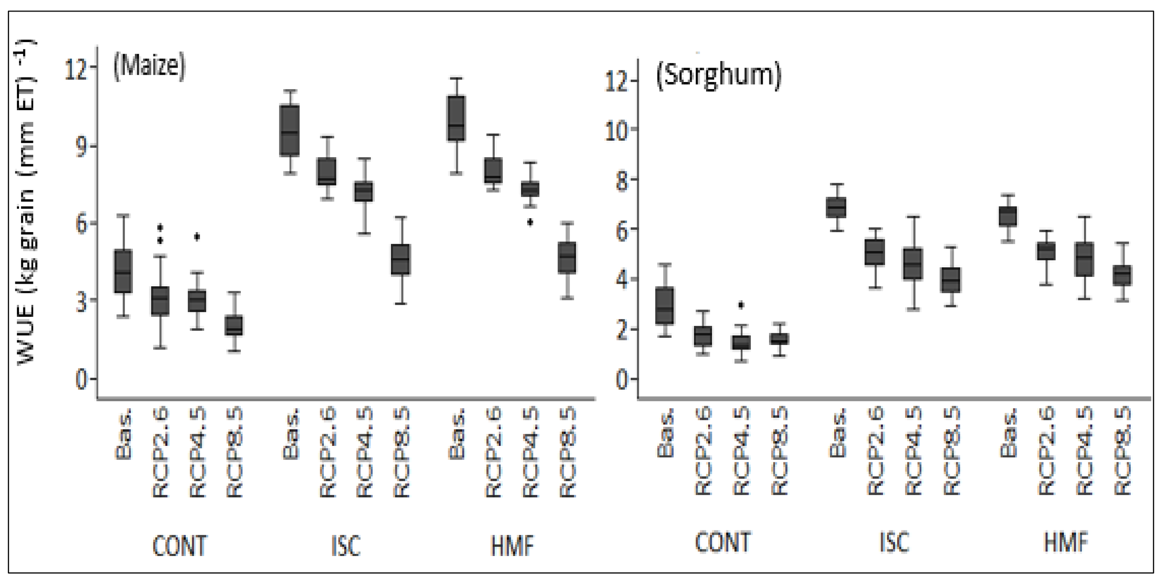

Fig. 1 Predicted water use efficiency of maize and sorghum as impacted by CONT, ISC, and HMF assuming the historic (Bas., 1986-2005) and future climate (2080-2099) and considering RCPs 2.6, 4.5, and 8.5

Grain yields

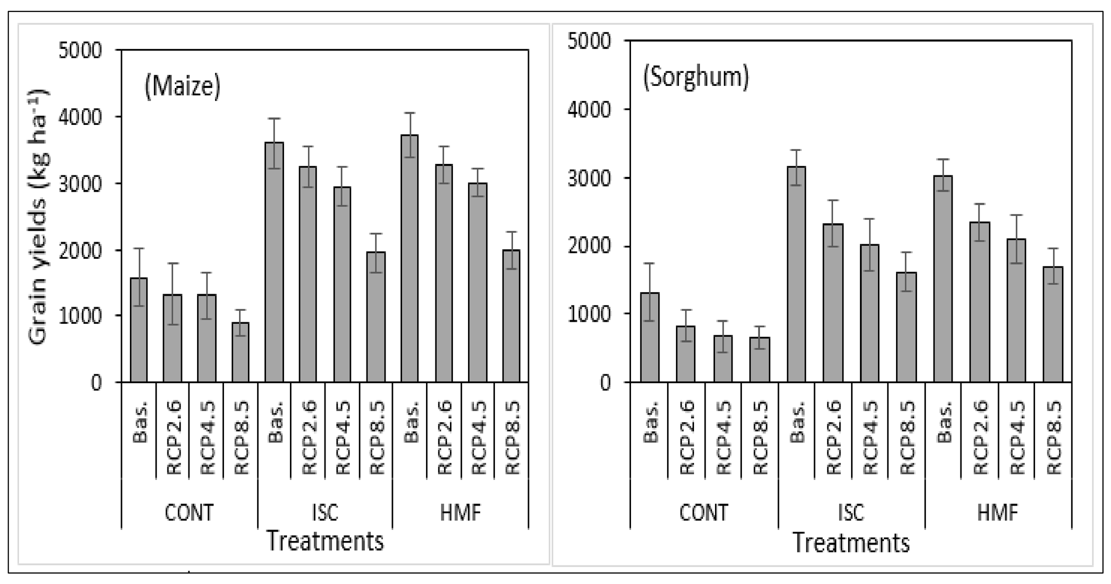

Fig. 2 Predicted grain yields of maize and sorghum as impacted by CONT, ISC, and HMF assuming a historic (Bas., 1986-2005) and future climate (2080-99) and considering RCPs 2.6, 4.5, and 8.5

Aboveground biomass accrual

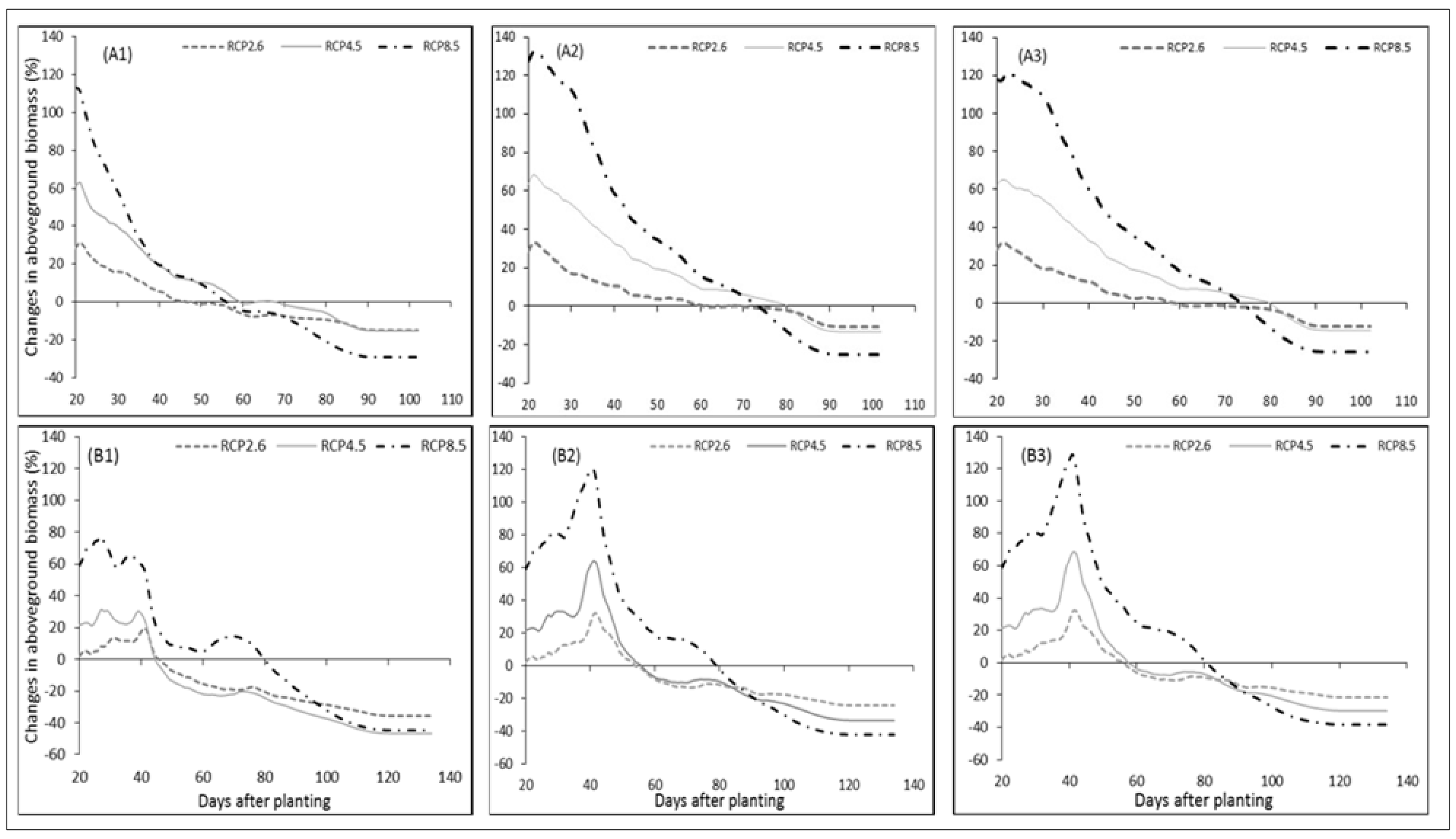

Fig. 3 Changes in cumulative aboveground biomass responses of maize (A1, A2, A3) and sorghum (B1, B2, B3) under future climate (2080-99) relative to their historical means (1986-2005) assuming CONT(A1, B1), ISC (A2, B2), and HMF (A3, B3) but also three RCPs 2.6, 4.5, and 8.5

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