



Rising nutrient availability may have much more impact than climate change on pearl millet in Senegal

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► To cite this version:

Léo Garcia, Francois Affholder, Benjamin Sultan, Bertrand Müller, Patrice Kouakou. Rising nutrient availability may have much more impact than climate change on pearl millet in Senegal. 2nd Agriculture and Climate Change Conference, Mar 2017, Sitges, Spain. , 2017, 10.13140/RG.2.2.21666.32965 . hal-03329839

HAL Id: hal-03329839

<https://hal.science/hal-03329839>

Submitted on 19 Sep 2022

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Rising nutrient availability may have much more impact than climate change on pearl millet in Senegal

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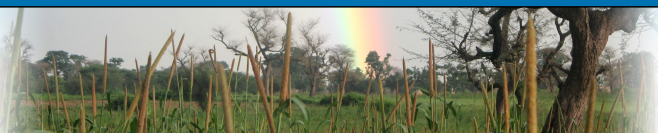
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Context and objectives

- Semi-arid Africa (Senegal)
- Traditional food crops productions low and far from attainable yields
- Assessing the impact of climate change on millet yield
- Comparing climate change impact with crop intensification (*i.e.* increased fertilization)



Methods

Climate modelling

- CIMP5 ensemble
- 3 time horizons (1985, 2050, 2080), 30-years time spans, 2 radiative forcing (RCP 2.6, RCP 8.5)
- Future scenarios = projected changes applied to observed local weather data

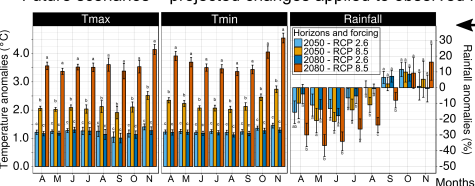


Figure 1 - Temperature and rainfall anomalies, standard errors and significant differences between projections (CIMP5 ensemble)

MIROC models better fit with observed rainfall and predict rainfall increase in all scenarios (not shown)

6 future scenarios :

- RCP 2.6 (MIROC / All Models)
- RCP 8.5 2050 (MIROC / All Models)
- RCP 8.5 2080 (MIROC / All Models)

High standard errors for rainfall anomalies compared with temperature increase projections

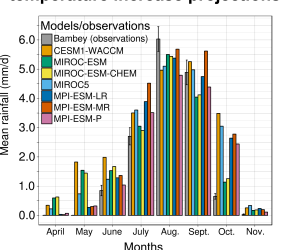


Figure 2 - Comparison between observed and simulated rainfall for 7 closest models

Crop modelling

- CELSIUS crop model
- Calibrated against observed data under varying weather, soil and nutrient management
- Millet crop simulations:
 - Present and future climate, 30-years time spans
 - Severe and moderate nutrient limitations.

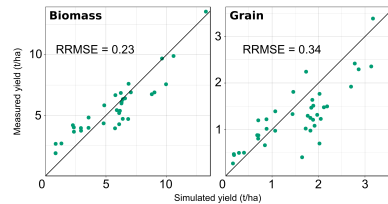


Figure 3 - CELSIUS performances for biomass and grain yield over varying observed situations

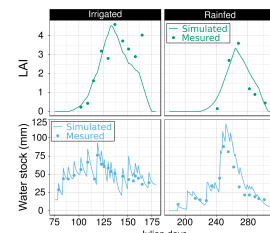


Figure 4 - Comparison between observed and simulated values for millet LAI and soil water content in two contrasted situations

4 nutrient limitation levels :

- F0 : 25% of potential yield (Yp)
= current representative yield level
- F1 : 50% of Yp
- F2 : 75% of Yp
- F3 : 100% of Yp

Results

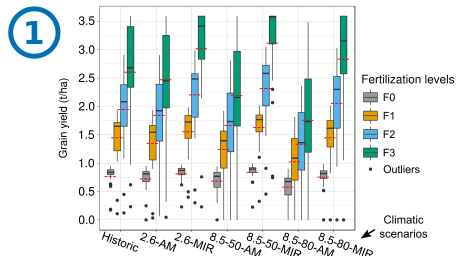


Figure 5 - Grain yield distribution per climatic scenario and fertilization level. MIR = MIROC models; AM = CIMP5 ensemble.

- Yield interannual variability increases in the future, under CIMP5 ensemble projections
- Contrasting trends depending on climate models

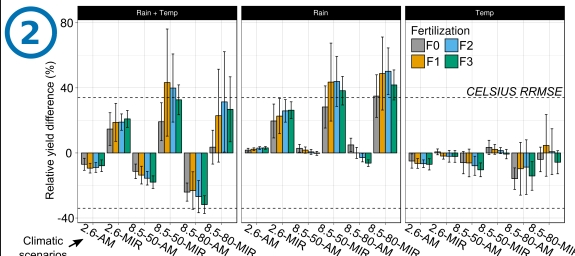


Figure 6 - Relative yield differences under 6 climatic scenarios with unchanged fertilization between present and future

- Relative yield differences lower than model RRMSE, especially for temperature impact
- Strong differences depending on rainfall projections

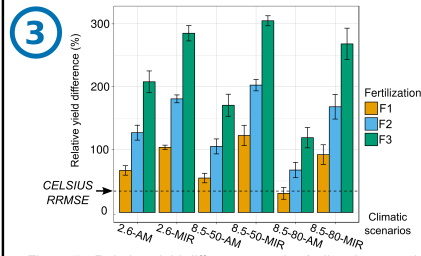


Figure 7 - Relative yield differences under 6 climatic scenarios with increased fertilization between present (F0) and future (F1, F2, F3)

- The lowest tested level of nutrient supply (F1=35 kg.ha⁻¹) is sufficient to provoke a substantial increase in yield
- Relative yield differences significantly higher than CELSIUS RRMSE

Discussion

- In our simulations, climate change impact on yield differences depends above all on rainfall. However, rainfall scenarios still remain uncertain.
- Millet currently grown under severe nutrient limitations (continuous cropping, insufficient recycling and external supply)
- Our simulations suggest that fertilization have more impact on millet yield compared to climate change scenarios.
- Strong yield increase could be expected from increasing organic or inorganic fertilization.