

IMPACT OF DIFFERENT CLIMATE CHANGE SCENARIOS ON RAINFED CROPPING SYSTEMS IN CENTRAL ITALY

IMPATTO DI DIFFERENTI SCENARI DI CAMBIAMENTO CLIMATICO SU SISTEMI COLTURALI IN ASCIUTTO DEL CENTRO ITALIA

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Abstract

The rainfed cropping system based on the durum wheat-sunflower rotation is very common in Central Italy, to the point of being the almost exclusive system in some areas. The predominance of the system, and the suboptimal environmental conditions in which such system is implemented make it at risk in scenarios of possible worsening of weather patterns as estimated by weather change scenarios. The objectives of this paper were: 1) to estimate the impact of climate change on the agronomic performance and long term soil fertility; 2) to explore adaptation strategies and to identify research needs. Three years of field data on current cropping system practices were collected at two microcatchments of the Marche (Central Italy) to calibrate the cropping systems simulation model CropSyst. Crops yield and soil organic matter dynamics were analyzed in relation to increased air temperature and CO₂ concentration, as forecasted by different future climate scenarios.

To assess the impact of climatic change on mean crop yields and variability, two fifty-years *equilibrium* climate datasets were generated from a local 20-years daily temperature and rainfall dataset assuming for each scenario constant climate at different atmospheric CO₂ concentration: "baseline" [CO₂] = 350 ppm; 2040 *equilibrium* [CO₂] = 450 ppm. To assess the long term impact of climatic change on soil organic matter content, three 100-years *transient* climatic scenarios were generated from a 20-years daily temperature and rainfall dataset of a neighbouring station: *transient* "baseline" scenarios with current [CO₂] = 350 ppm; *transient* "A2" and "B2" scenarios, characterised by an yearly increase of [CO₂] starting from current conditions to final values of 840 and 620 ppm respectively.

Under 2040 *equilibrium* scenario, sunflower showed a slight increase of mean grain yield +12%, while durum wheat grain yield was not significantly different from "baseline". Under "baseline" *transient* scenarios and starting from a current soil organic matter content of 0.9%, CropSyst simulated a progressive decrease of soil organic matter down to 0.6% after 100 years. Under "B2" and "A2" scenarios, increased soil temperature simulated by CropSyst resulted in a sharper decrease of the soil organic matter, leading respectively 0.5% and 0.4% after 100 years. Results suggest that while climate change impacts on current rainfed cropping systems of central Italy may not be visible in the short term on crop yields, long term sustainability is expected to decline noticeably, even under "baseline" climatic scenarios. In terms of bio-physical research, further efforts should be addressed on the relationships between agronomic practices and seasonal dynamics of soil organic matter mineralization due to soil temperature.

Keywords: CropSyst, durum wheat, sunflower, adaptation, cropping system, sustainability.

Riassunto

Il sistema colturale asciutto basato sull'avvicendamento frumento duro-girasole è molto comune in Italia centrale, al punto di essere quasi esclusivo in alcune aree. La predominanza del sistema e le condizioni ambientali subottimali in cui esso è adottato, lo rendono vulnerabile nell'ipotesi di peggioramento delle tendenze climatiche, secondo quanto previsto dagli scenari di cambiamento climatico. Gli obiettivi di questo lavoro sono stati: 1) stimare l'impatto dei cambiamenti climatici su rese colturali, bilancio idrico e fertilità del suolo a lungo termine; 2) esplorare strategie di mitigazione e indirizzare ulteriori ricerche. Sono stati raccolti tre anni di dati sulle pratiche colturali adottate in due microbacini delle Marche per calibrare il modello di simulazione dei sistemi colturali CropSyst. Rese colturali e dinamica della sostanza organica sono state analizzate in relazione alla dinamica di temperatura dell'aria e concentrazione di CO₂ prevista da differenti scenari climatici futuri.

Per valutare l'impatto dei cambiamenti climatici su medie e variabilità delle rese colturali, sono stati generati due scenari climatici *equilibrium* di cinquanta anni a partire da una serie reale di dati giornalieri di temperatura e precipitazione, assumendo per ogni scenario clima costante e differenti concentrazioni atmosferiche di CO₂: "baseline" [CO₂] = 350 ppm; 2040 *equilibrium* [CO₂] = 450 ppm.