Geophysical Research Abstracts
Vol. 16, EGU2014-14719, 2014
EGU General Assembly 2014

How can crop intra-specific biodiversity mitigate the vulnerability of agricultural systems to climate change? A case study on durum wheat in Southern Italy

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Climate evolution may lead to changes in the amount and distribution of precipitations and to reduced water availability, with constraints on the cultivation of some crops. Recently, foreseen crop responses to climate change raise a crucial question for the agricultural stakeholders: are the current production systems resilient to this change?
An active debate is in progress about the definition of adaptation of agricultural systems, particularly about the integrated assessment of climate stressors, vulnerability and resilece towards the evaluation of climate impact on agricultural systems.
Climate change represents a risk for rain-fed agricultural systems, where irrigations cannot compensate reductions in precipitations. The intra-specific biodiversity of crops can be a resource towards adaptation. The knowledge of the responses to environmental conditions (temperature and water availability) of different cultivars can allow to identify options for adaptation to future climate. Simulation models of water flow in the soil-plant-atmosphere system, driven by different climate scenarios, can describe present and foreseen soil water regime.
The present work deals with a case-study on the adaptive capacity of durum wheat to climate change. The selected study area is a hilly region in Southern Italy (Fortore Beneventano, Campania Region). Two climate cases were studied: "reference" (1961-1990) and "future" (2021-2050). A mechanistic model of water flow in the soil-plant-atmosphere system (SWAP) was run to determine the water regime in some soil units, representative of the soil variability in the study area. From model output, the Relative Evapotranspiration Deficit (RETD) was determined as an indicator of hydrological conditions during the crop growing period for each year and climate case; and periods with higher frequencies of soil water deficits were identified. The timing of main crop development stages was calculated. The occurrence of water deficit at different development stages was thus assessed.
Moreover, the yield response functions to water availability of several durum wheat cultivars were determined; cultivars' hydrologic requirements were thus defined and compared with the simulated values of RETD. The latter was evaluated against requirements for each soil unit, cultivar and year in both climate cases to assess adaptability. In the future climate scenario a significant reduction (about 80 mm) of rainfall is foreseen.
The analyses of inter- and intra-annual courses of the indicator (RETD) showed higher RETD in one soil unit, which resulted less suitable for durum wheat cultivation.
According to the soils' water regime and to the cultivar-specific yield responses, the adaptability of durum wheat cultivars was assessed. The difference between the two climate cases was significant; the adaptability of the cultivars was strongly influenced by the different rainfall regime and by the soil physical properties, which strongly affected the soil water balance.
The case study showed how in the future climate case, for rainfed durum wheat, the intra-specific variability will allow to maintain the current crop production system.
The work was carried out within the Italian national project AGROSCENARI funded by the Ministry for Agricultural, Food and Forest Policies (MIPAAF, D.M. 8608/7303/2008)