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Assessing the adaptive capacity of maize hybrids to climate change in an irrigated district of Southern Italy

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Climate change will cause significant changes in water distribution and availability; as a consequence the water resources in some areas (like Mediterranean regions) will be limiting factors to the cultivation of some species, included cereals. So the perspective of climate change requires an analysis of the adaptation possibilities of food and fiber species currently cultivated. A powerful tool for adaptation is the relevant intra-specific biodiversity of crops. The knowledge, for different crop cultivars, of the responses to different environmental conditions (e.g. yield response functions to water regime) can be a tool to identify adaptation options to future climate. Moreover, simulation models of water flow in the soil-plant-atmosphere system can be coupled with future climate scenarios to predict the soil water regime also accounting for different irrigation scheduling options.
In this work the adaptive capacity of maize hybrids (Zea mays L.) was evaluated in an irrigated district of Southern Italy (the "Destra Sele" plain, an area of about 18.000 ha), where maize is extensively grown for water buffalo feeding. Horticultural crops (tomato, fennel, artichoke) are grown, as well.
The methodology applied is based on two complementary elements:
- a database on climatic requirements of 30 maize hybrids: the yield response functions to water availability were determined from experimental data derived both from scientific literature and from field trials carried out by ISAFOM-CNR. These functions were applied to describe the behaviour of the hybrids with respect to the relative evapotranspiration deficit;
- the simulation performed by the agro-hydrological model SWAP (soil-water-plant and atmosphere), to determine the future soil water regime at landscape scale.
Two climate scenarios were studied: "past" (1961-1990) and "future" (2021-2050). Future climate scenarios were generated within the Italian National Project AGROSCENARI. Climate scenarios at low spatial resolution generated with general circulation models (AOGCMs) were down-scaled by means of a statistical model (Tomozeiu et al., 2007). The downscaled climate scenario includes 50 realizations of daily minimum, maximum temperature and precipitation data, on a regular grid with a spatial resolution of 35 km. The hydraulic properties of 25 representative soils of the "Destra Sele" area were estimated with HYPRES pedo-transfer function previously tested in the area.
The model SWAP was run to determine the soil water balance with different irrigation strategies: optimal irrigation, no irrigation, and deficit irrigation, in both climate periods. Deficit irrigation was scheduled applying water volumes equal to 20%, 40%, 60% and 80% of optimal ones.
From the outputs of the model runs the relative evapotranspiration deficit (or Crop Water Stress Index - CWSI) was calculated and compared with the yield response functions of the hybrids. By means of these functions, for each hybrid a critical value of CWSI was identified, namely a CWSI value corresponding to a relative yield of 0.9. By comparing the CWSI of soil units with hybrid's critical values, cultivar's adaptability to future water regime was determined, both as a function of irrigation scheduling and of soils' physical properties.
The case study shows how, in the future climate scenario, with limited water resources, the intra-specific variability will allow to maintain current crop production system.
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