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Assessing the potential of intra-specific biodiversity towards adaptation of irrigated and rain-fed Italian production systems to future climate

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Abstract

The study addresses the biophysical dimension of adaptation. It illustrates and applies a framework to evaluate options for adaptation by identifying cultivars optimally adapted to expected climate conditions, building on existing crops intra-specific biodiversity. The aim is to reduce the vulnerability of current production systems without altering the pattern of current species and cultivation systems.

Adaptability is assessed through a three-step approach that involves: 1) evaluation of indicators of expected thermal and hydrological conditions within the specific landscape and production system; 2) determination, for a set of cultivars, of cultivar-specific thermal and hydrological requirements to attain the desirable yield; 3) identification, as options for adaptation, of the cultivars for which expected climate conditions match the climatic requirements. The approach relies on a process-based simulation model of water flow in the soil-plant-atmosphere system for the calculation of hydrological indicators. Thermal indicators are derived by means of phenological models. Empirical functions of cultivars yield response to water availability are used to determine cultivar-specific hydrological requirements, whereas cultivars thermal requirements are estimated through phenological observations.

In a future climate case (2021-2050) three case-studies are analyzed: 1) a system dominated by rain-fed crops (olive, winegrapes, durum wheat) in a hilly area of southern Italy; 2) irrigated fruit crops (peach, pear) in the Po Valley; 3) maize and tomato crop in an irrigated plain of southern Italy.

Cultivars adapted to the future climate have been identified for rain-fed crops (e.g. 5 olive cvs). For irrigated crops we have evaluated adaptability for optimal and deficit irrigation schedules, accounting for site-specific soils hydrological properties. Options for adaptations have been identified as a combination of cultivars, soils and irrigation schedules (e.g 2 tomato cvs and 3 maize hybrids have been identified as options for adaptation at scarce water availability). Moreover, in the case of fruit crops,

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accounting for phenological changes highlighted the impact on irrigation water requirements of the interaction between phenology and the intra-annual distribution of precipitation.

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Keywords: hydrological requirements; thermal requirements; cultivars; simulation models