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Assessing the adaptive capacity of some olive cultivars to future climate

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The intra-specific biodiversity of agricultural crops is very significant and likely to provide the single major opportunity to cope with the effects of the changing climate on agricultural ecosystems. Appraisal of the adaptive capacity is particularly relevant for long-life crops, since their substitution will be slow if future climate conditions threaten their sustainability. Assessment of adaptive capacity must rely on quantitative descriptions of plant responses to environmental factors (e.g. soil water availability, temperature). Moreover climate scenario needs to be downscaled to the spatial scale relevant to crop and farm management. Distributed models of crop response to environmental forcing might be used for this purpose, but severely constrained by the very scarce knowledge on variety-specific values of model parameters, thus limiting the potential exploitation of intra-specific biodiversity towards adaptation.

We have developed an approach towards this objective that relies on two complementary elements:

a) a distributed model of the soil – plant – atmosphere system to downscale climate scenarios to landscape units, where generic model parameters for each species are used;

b) a data base on climatic requirements of as many varieties as feasible for each species relevant to the agricultural production system of a given region.

The case-study presented here shows how the yield response of olive cultivars to soil water availability can be defined by means of variety-specific threshold values of soil water (or evapotranspiration) deficit. The soil water regime calculated by the distributed model is compared with the threshold values to identify varieties compatible with expected climate. The operation is repeated for a set of realizations of each climate scenario. This analysis is performed in a distributed manner, i.e. using the time series for each model grid to assess possible variations in the extent and spatial distribution of cultivated area of olive cultivars.

The selected study area is a hilly region of about 20.000 ha in Southern Italy (Valle Telesina, Campania Region), characterized by a complex geomorphology with a large soil (five soil systems) and climate variability. Future climate scenarios in the area were generated within the Italian National Project AGROSCENARI. Climate scenarios at low spatial resolution generated with general circulation models (AOGCM) 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, for the 2021-2050 period. The down-scaled climate scenario was further refined by using the distributed model which describes the soil water regime in 67 soil units.

The analysis of climate scenarios showed that significant increases in summer maximum daily temperature could be expected in 2021-2050 period.

Response to soil water availability of 30 cultivars was evaluated qualitatively as high, medium, low based on FAO data base (2006). Moreover the variety-specific threshold values of soil water and evapotranspiration deficit of 10 olive cultivars were estimated through the re-analysis of experimental data (unpublished or derived from scientific literature).

Spatial pattern of soil water and evapotranspiration deficit was determined for the 50 realizations of the daily time series, taking into account the 67 soil units, and was compared with threshold values to evaluate cultivars' adaptation options.