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Impact of and adaptability to climate change of irrigated fruit crops in the Emilia Romagna region (Italy)

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Emilia Romagna region is the most important area for fruit crop production in Italy and the future sustainability of its actual agricultural system is an urgent question in view of climate change.

This work aims at the evaluation of the impact of the future water and thermal regime on the main fruit cultivations in an area of the Emilia Romagna region between Lugo, Faenza and Imola. We evaluated for several fruit tree cultivars the soil water deficit and the irrigation requirements taking into account the shift in phenological phases in response to air temperature. Then a probabilistic evaluation of cultivars adaptability was performed considering different irrigation management scenarios. We analyzed several cultivars with different ripening time for Peach, Apricot, Pear and Kiwi.

A reference (1961-90) and future (2021-2050) climate cases were considered. The reference climate data set has been produced applying a spatial statistic approach on ground observations. The future climate data set has been generated by statistical downscaling of predictions by general circulation models (AOGCM). The data sets consist of daily time series of maximum and minimum temperature, and daily rainfall on a 35 km $\times$ 35 km grid. Data on a grid node located near Ravenna were used, being representative of the climate within the study area.

The phenological development in the reference and future climate was modelled using phase – specific thermal times and thermal requirements for each cultivar. The requirements were estimated by means of phenological observations over several years in the Emilia Romagna region and data from scientific literature. We calculated the dates of start and end of the main phenological phases from late autumn through late summer.

Then, a mechanistic model of water flow in the soil-plant-atmosphere continuum was used to describe the hydrological conditions in response to climate and irrigation, taking into account the variations (i.e.time of occurrence and duration) of phenological phases due to climate change. Input data and model parameters were estimated on the basis of local experiments and of scientific literature. Soils' hydrological properties were determined from soil texture using the HYPRES pedo-transfer functions. Upper boundary conditions were derived from the two climate scenarios.

Adaptability has been determined by comparing hydrological and thermal indicators against cultivar- specific requirements. Hydrological requirements were determined by means of yield response functions to soil water availability, through the re-analysis of experimental data derived from local experiments and scienti?c literature. The standard error of the estimated requirements was determined. A probabilistic assessment of adaptability could thus be performed, since the inaccuracy of estimated hydrological requirements was accounted for by the error of estimate and its distribution. Phase-specific critical temperatures values were derived from scientific literature and used to determine the risk of yield loss due to extreme climate events.

For some species , i.e. Apricot and Peach the predicted future climate does not imply a reduction of the adaptability because of the advancement of phenological phases that places critical phases under optimal thermal and/or water regime. In other cases, i.e. kiwi and Pear species are more vulnerable. Thus, agricultural management, i.e. changing irrigation strategies or cultivars selection has a crucial role in maintaining sustainability of current agricultural system in a changing climate.