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Predicting olive phenology in Portugal in a warming climate

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Introduction

Prediction of flowering of olive trees should account for chilling requirements, using an appropriate chilling unit for the accounting of chilling accumulation. After chilling requirements are satisfied, dormancy break takes place. Thereafter, the trees enter the forcing phase, in which the thermal time approach is used, but an appropriate base temperature must be determined. Such a model was developed, calibrated and validated for many olive cultivars (De Melo-Abreu et al., 2004).

After flowering, the occurrence of developmental stages may be predicted using a thermal time approach, but for warm regions a saw-tooth model, which is a model that reduces the effect of supra-optimal temperatures, is mandatory (Garcia-Huidobro et al., 1982).

According to the simulations of the model HadCM3, developed by the Hadley Centre, global climate warming will result in average temperature anomalies in winter, in Continental Portugal, of about 2ºC, in SRES scenarios B1 and B2, 3ºC in scenario A2, and 4ºC in scenario A1FI, by the end of XXI century. (Miranda et al., 2006).

In this study, we discuss the prediction of flowering and subsequent phenological stages and calculate and map the times of occurrence of flowering under three warming scenarios. No flowering or abnormal flowering events are also predicted.

Methodology

The model used in the simulations of the dates of flowering and is presented in De Melo-Abreu et al., 2004. This model was included in an application, programmed in Visual Basic for Applications, that reads the temperature data and computes the date of dormancy break and full flowering.

Maximum and minimum daily temperatures for a 30 year period (1981-2010) and 32 locations scattered around the continental part of Portugal were used as a control period (Sco). Global change scenarios compatible with SRES scenarios B1/B2, A2 and A1FI for winter in Continental Portugal (Miranda et al., 2006) were obtained by adding 2ºC (Sc1), 3ºC (Sc2) and 4 ºC (Sc3) to both maximum and minimum daily temperatures, respectively. In Portugal, the daily temperature range has increased only in the last years (Miranda et al., 2006), and is almost undetectable in the simulations downloaded from the Ensembles Project. Also, the six 25 km-boxes that include Portugal show little differences both in maximum and minimum daily temperatures, within each scenario, in relation to longitude.

Results and Discussion

The effects of global warming on olive trees in the continental part of Portugal, for full flowering and under contrasting scenarios were presented and mapped.

The simulations show that warming, in general, results in advances of the date of flowering in all cultivars. However, responses are different for different cultivars and latitudes. In southern latitudes, for the warmest scenarios, the effect of global warming upon certain cultivars is higher than on other cultivars, and in some years no or abnormal flowering is likely to occur. 'Arbequina', 'Picual', 'Cobrançosa' and 'Galega' are likely to have an increasing number of years without flowering or with abnormal flowering. The last two cultivars are likely to have abnormal or no flowering events in more than half of the years, under Sc2 and Sc3, in most locations within the traditional olive tree growing areas.

Conclusion

In some years and scenarios, abnormal flowering or no flowering is likely to occur. 'Arbequina' and 'Picual' are likely to have less of these unfavorable events.

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