EXPECTED FLOWERING OF THREE OLIVE CULTIVARS UNDER GLOBAL TEMPERATURE INCREASE

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Introduction

Crop performance under global warming scenarios cannot be predicted or analyzed without the use of advanced crop models. In the case of olive, the increased temperatures expected in the future may prevent some cultivar to satisfy the chilling requirements which stop the endodormancy; this may lead to failures in flowering during some years, even inside the actual cultivation area. In the present work we use the model of De Melo e Abreu et al. (2004) - included into the olive model OliveCan 2.0 - to simulate the flowering dynamics of three olive cultivars under increased temperature regimes.

Materials and Methods

The model accumulates chilling units (*U*) during the cold season as a saw-teeth function of air temperature. In this phase, high temperatures can reverse the accumulation of *U*. When a cultivar-specific threshold (*TU*) is crossed, the chilling requirements are satisfied, the endodormancy ends and the forcing phase begins, accumulating thermal time above a temperature threshold *Tb* until the flowering occurs at threshold *TT*. The common parameters used and their meaning are listed in Table 1; the cultivar specific parameters were: *TU* = 339, 494 and 722 *U* for the cvs. Arbequina, Hojiblanca and Moraiolo; *TT* = 490, 510 and 509 ºC $days^{-1}$ in the same order. The base meteorological datasets used in the simulations was 1965-2004 actual measured temperatures registered in Córdoba, (37.8N, 4.8W), Southern Spain. The full base weather series was artificially altered maintaining the same distribution.

Parameter	Value	Meaning
To	7.3 (ºC)	Temperature for max. accumulation of chilling units
Tx	20.7 (ºC)	Temperature above which chilling is = *a*
a	-0.56 (chill units)	Fixed (negative) chilling accumulated at temperature above *Tx*
Tb	9.1 (ºC)	Lower temp. for thermal time accumulation in the forcing phase
TU	Cv. specific (ºC $days^{-1}$)	Number of chilling units to end the endodormancy
TT	Cv. specific (ºC $days^{-1}$)	Number of thermal units to reach flowering in the forcing phase

Table 1. common parameters.

Results and Discussion

Figure 1 shows the probability of successful flowering if the average temperature would increase until 6 ºC above the average measured from 1965-2004. The model correctly predicts no failure for the three cultivars over the 40 years of actual weather. Arbequina is less sensitive to the temperature increase, still flowering 100% at +2 ºC; Moraiolo is much more affected, expecting successful flowering only on 57% of the years if the average temperature rises 3 ºC above the actual. Hojiblanca shows an intermediate response.

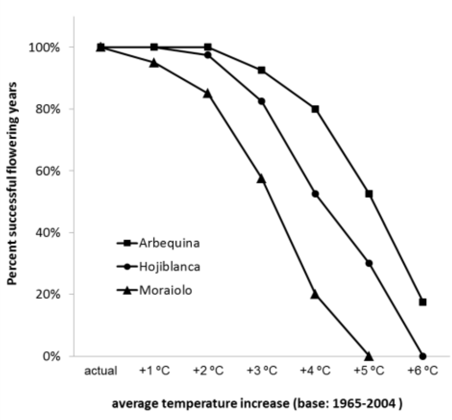

Figure 1. Cumulated probability functions of flowering success for the three cultivars in the climate of Cordoba vs. expected temperature increase

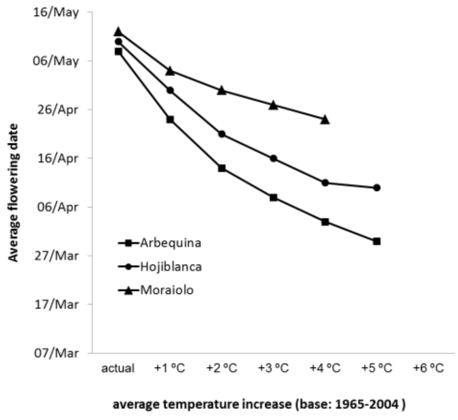

Figure 2. Average flowering date of the three cultivars in the climate of Cordoba vs. expected temperature increase

Figure 2 shows the expected average change in the flowering date for the three cultivars in response of a temperature increase. The average flowering dates predicted by the model for the actual weather series match the observations for these cultivars in Córdoba. The advance in flowering date is also cultivar-dependent, being Arbequina the most and Moraiolo the less reactive to temperature: a 2 ºC warming – a common prediction for most Mediterranean olive growing area in the 2070 – 2100 period – would generate a timing advance of 24, 19 and 13 days in the flowering dates of the cv. Arbequina, Hojiblanca and Moraiolo, respectively.

Conclusions

The simulation exercise presented suggests that flowering occurrence and date may be heavily affected for some cultivar under global warming conditions. The suitability of the phenological matching of olive cultivars to future climate scenarios must be analyzed by means of models, which continuous improvement is essential.

Acknowledgements

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References

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