Estimation of Chilling and Heat Requirement of Chemlali Olive Cultivar and Its use to Predict Flowering Date

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Study Context

The Mediterranean Region is the main area in the word devoted to the olive tree crop (*Olea europaea* L.) where it is one of the most important agriculture activities. In Tunisia, olive orchards are a key component of agricultural systems with more than 1.6 Mha producing 843 500 T of olive. *Olea europaea* L. "Chemlali" is the most cultivated cultivar. It occupies nearly 85% of the surface reserved to oil production and contributes to a total of 80% of the national oil production. Vegetative development, production and fruit quality traits of this cultivar were well described but information concerning the tree phenology, chilling and heat requirements of flowering are generally poor.

Knowledge and forecasting of the flowering behaviour provides useful data for both forecasting olive fruit yields and useful information to manage and prevent allergic symptoms.

Study Purpose

The aim of this work was to predict flowering dates of Chemlali cultivar linked with original data sample of meteorological variables and phenological dates. Such knowledge would provide a better understanding of tree development and improve the description of plant phenology in relation to climatic variability. In this study, climatic parameters, introduced into models with different methods including chilling and heat requirements were used as the predictive parameters to obtain the best-forecast model.

In particular, three aims were considered: (i) to construct a numerical model able to identify chilling and heat accumulations and base temperature which were used as the predictive parameters in a phenological model, (ii) to validate and use this model in the case of Chemlali olive cultivar and (iii) to test the hypothesis that flowering dates was affected by winter conditions just after bud burst.

Materials and Methods

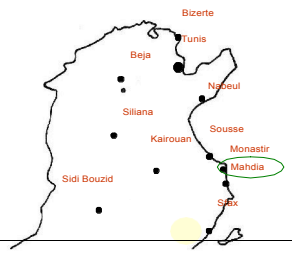
Experimental Data

(1) Phenological Dates.

- Flowering dates observed during eight years at Monastir, a traditional Chemlali olive-growing region in the Center of Tunisia

(2) Climatic Data.

- Daily minimum and maximum temperatures for the entire period measured at the same location



Theoretical Approach

As for many other studies, the constructed phenological model assumes that there are two processes in the flower formation chain: a process leading to dormancy release which is dependent on chilling accumulation; and a forcing phase that depends upon the accumulation of thermal time above the base temperature. In this modeling approach, daily maximum and minimum temperatures are input to the model.

(1) Hourly Course of Air Temperature

The hourly course of air temperature is described by a truncated sine wave in daylight and an exponential decrease in temperature at night (Parton and Logan, 1981).

(2) Chilling accumulations

Chilling accumulations were estimated in chilling unit (CU) following the sine function proposed by Linvill (1990). As proposed by Richardson et al. (1974), the start day of chilling accumulation was considered to be the day after the last negative CU accumulation of every season.

(3) Heat accumulations

When the required chilling (CR in CU) was accumulated, the forcing phase starts. To assess heat requirement for the flowering stage (HR in GDH), the asymmetric sine function proposed by Anderson and al. (1986) was chosen using the three cardinal temperatures: a base temperature (Tb in ◦C) which is a model parameter, an optimum temperature of 25°C, and a critical temperature of 35°C.

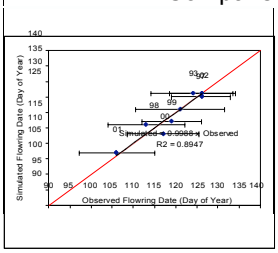
Results and Discussion

Identified parameters

Parameter	Symbol	Value	Unit
Chilling Requirement	CR	225	CU
Heat Requirement	HR	8344	GDH
Base Temperature	Tb	11.0	°C

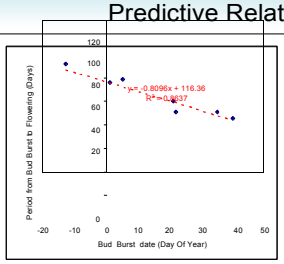
- The value of chilling requirement identified for Chemlali cultivar (CR = 225 CU) is in good agreement with the literature on chilling where values between 150 CU and 700 CU were reported for other olive cultivars.
- Apparently the value of heat requirement identified for Chemlali cultivar (HR = 8344 GDH) is lower than that reported for other olive cultivars where values between 400 GDD and 550 GDD were founded.
- The value of T_b is 11.0 °C. T_b values determined by others are between 9.1 and 13.0°C.

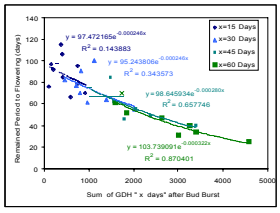
Comparison Observed/Simulated Flowering Date



- The plot of predicted on observed days of full flowering shows that the model had a good performance.
- The Mean Error (ME) was 0.13. The Mean Absolute Error (MAE) was 1,65. The Root Mean Square Error (RMSE) of the estimates of the DOY of flowering was 2.09.

Predictive Relations of Flowering Date





- An important correlation was found between the date of bud burst (date of rest completion = date of satisfaction of chilling requirement) and the number of day to flowering.
- The relation observed between the sum of GDH sixty days after the bud burst and the date of flowering harvest confirmed the importance of temperature during the early time of flower bud growth

Conclusion

- In this study a numerical model able to identify chilling and heat accumulations and base temperature which were used as the predictive parameters in a phenological model has been developed.
- Based on original data sample of meteorological variables and flowering date, the characteristic chilling and heat requirements and base temperature of Chemlali cultivar.
- Relations between both bud burst date and cumulated GDHs 60 days after season start date and remaining time to flowering were highlighted.