Degree-day-based model to predict egg hatching of *Philaenus spumarius*, vector of *Xylella fastidiosa*

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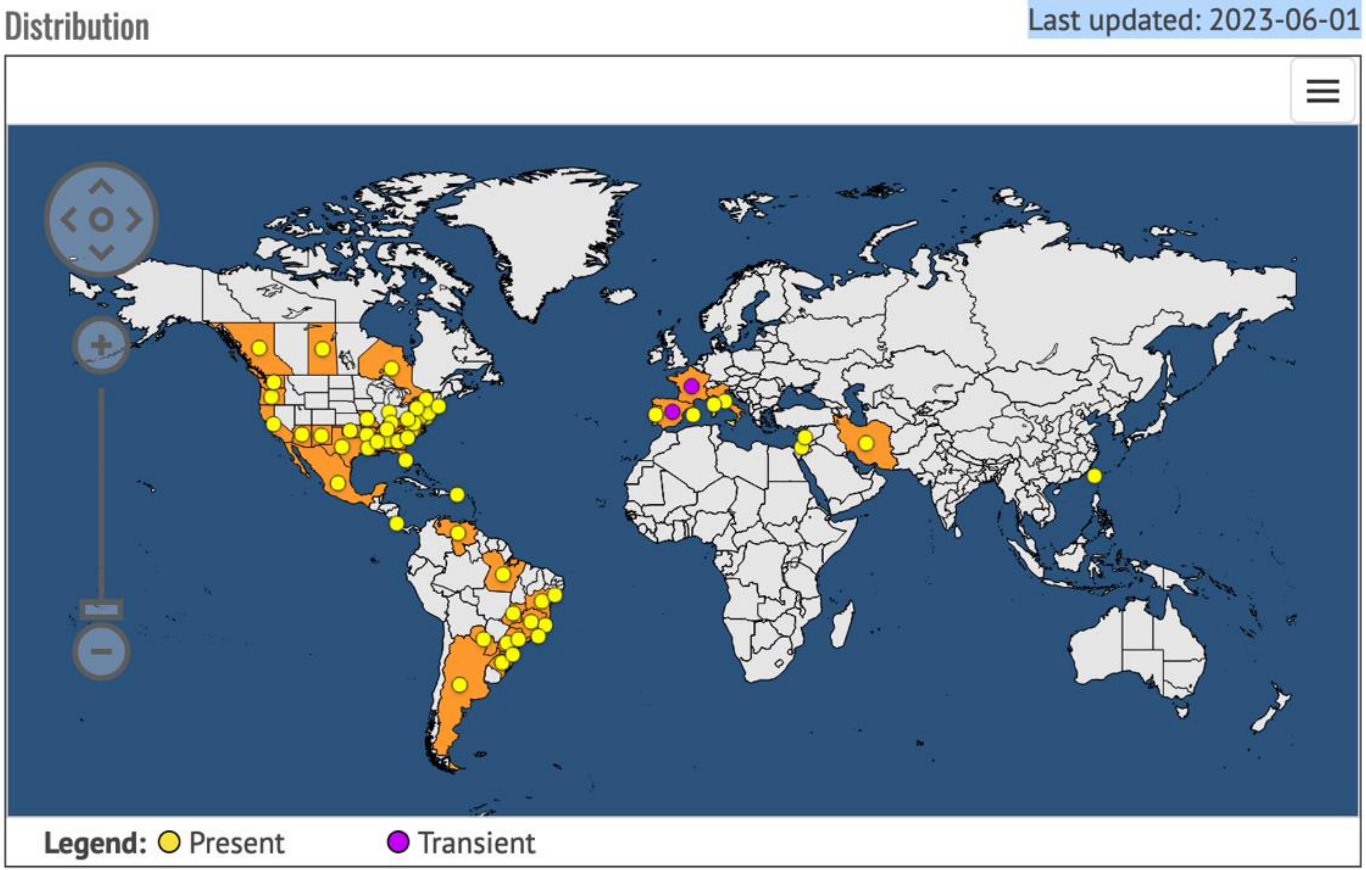
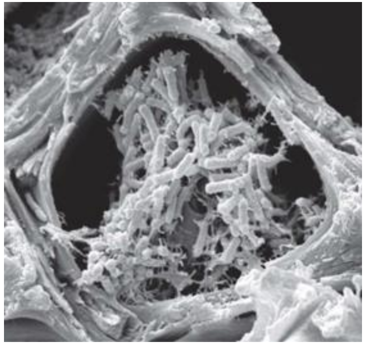
4th European Conference on *Xylella fastidiosa*. Lyon, France. August 20, 2023

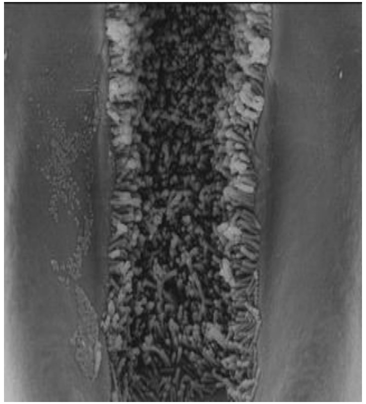
INTRODUCTION

- *Xylella fastidiosa* causes severe disease epidemics in main crops such as Olive, Grapevine, Almonds, Citrus that are of high economic importance in the Mediterranean.
- Its present distribution in the Mediterranean includes, Italy, France, Spain, Portugal, Israel and Lebanon.
- In Spain has caused severe epidemics in Mallorca and Alicante

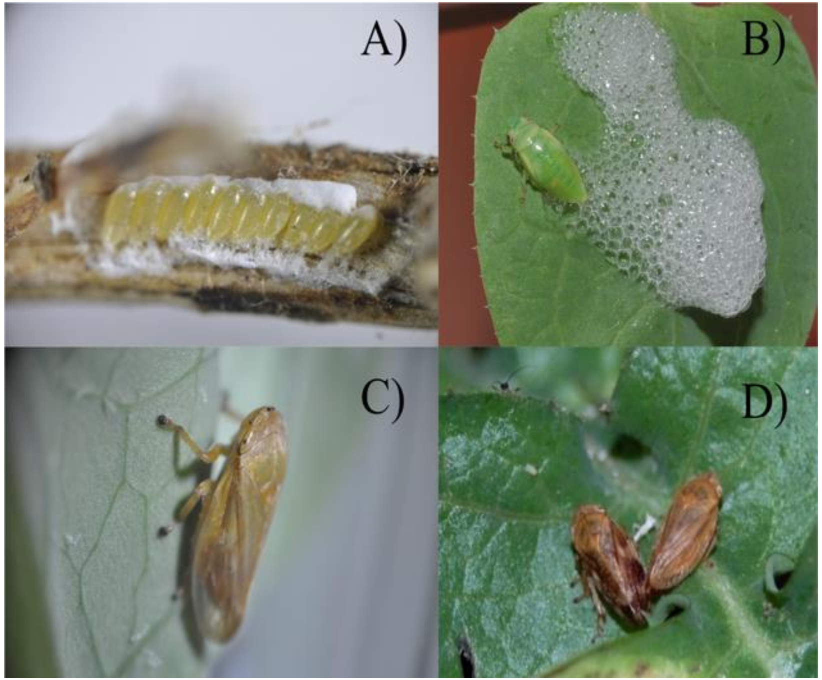


INTRODUCTION





Philaenus spumarius
(Hemiptera: Aphrophoridae)



In Europe, *P. spumarius* is the main vector, although other species can also transmit

INTRODUCTION

BIOLOGICAL CYCLE OF PHILAENUS SPUMARIUS

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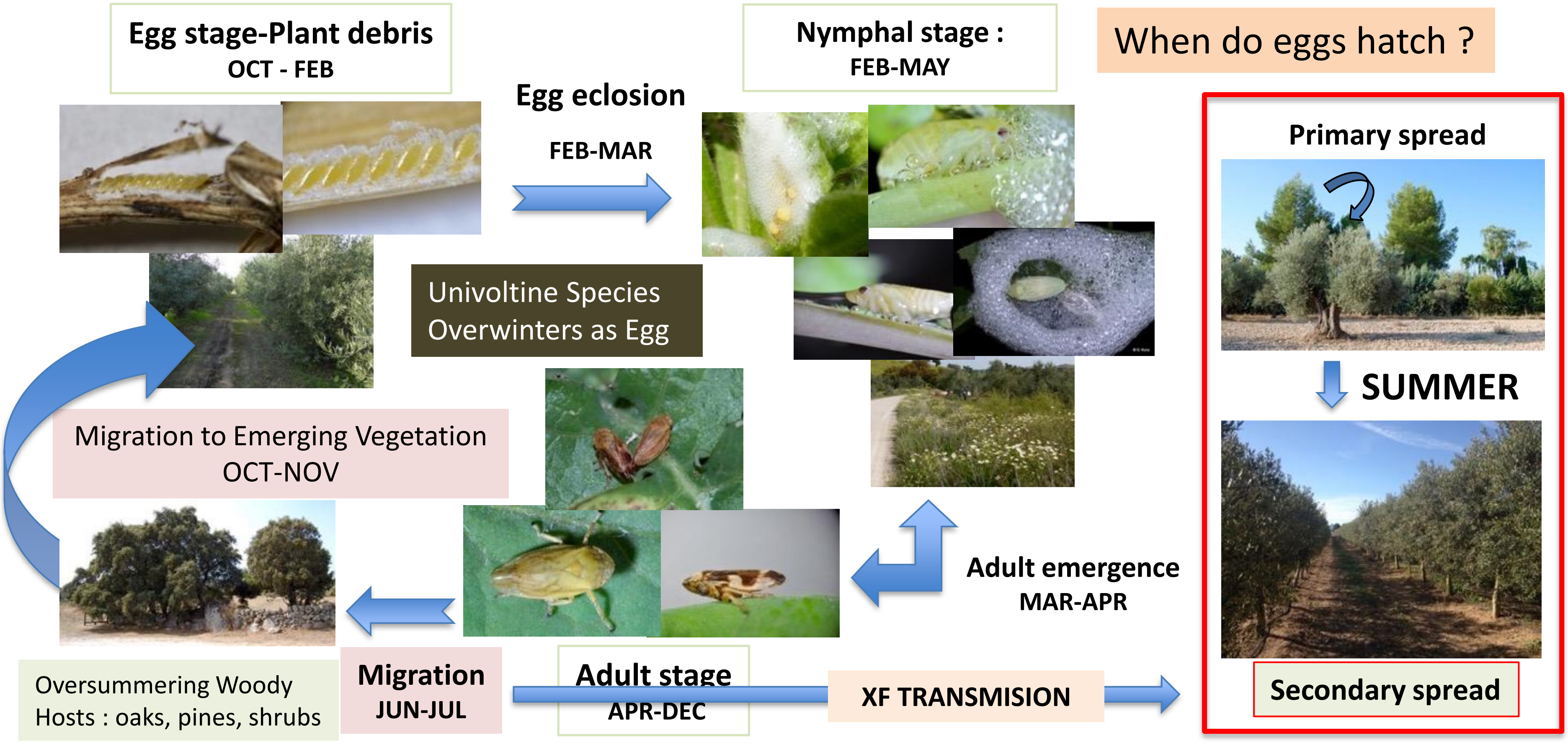


INTRODUCTION

Degree day-based model (GDD)

GDD accumulation

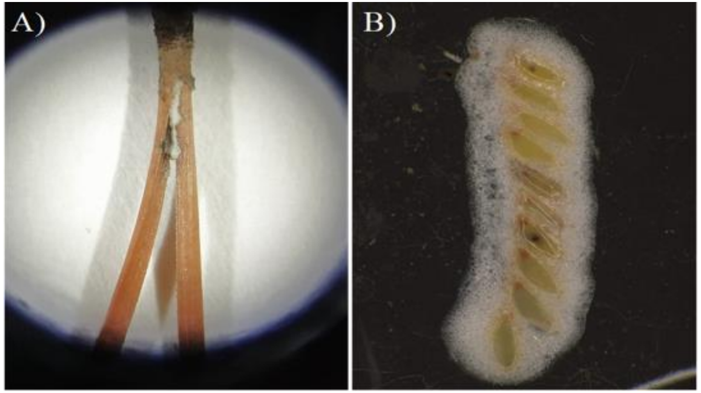
GDD heat accumulation units –hour by hour- above and below given temperature thresholds ($T_{max-}T_{min}$) **Developmental thresholds**

- **Objective:** To develop a GDD model to predict egg hatching of *Philaenus spumarius*
- Field observations and systematic samplings in different regions of Spain

- **Final Goal**: Build a decision support tool to predict the best timing for *Philaenus spumarius* management

MATERIAL AND METHODS

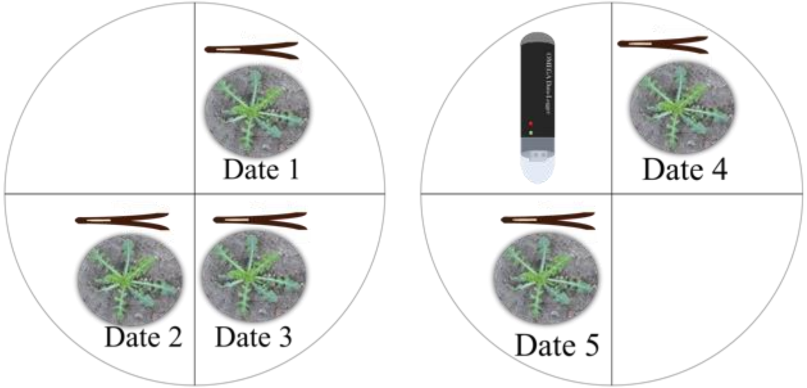
Egg masses: October-November 2020



Monitoring of egg hatching, T, & HR (in the field inside cages)

Alcalá de Henares (588 m)
Pedrezuela (880 m)
Mataelpino (1.086 m)
Bustarviejo (1.222 m)

Oviposition dates
08-10-2020
14-10-2020
22-10-2020
29-10-2020
04-11-2020



Egg masses were transferred to Sonchus plants before hatching

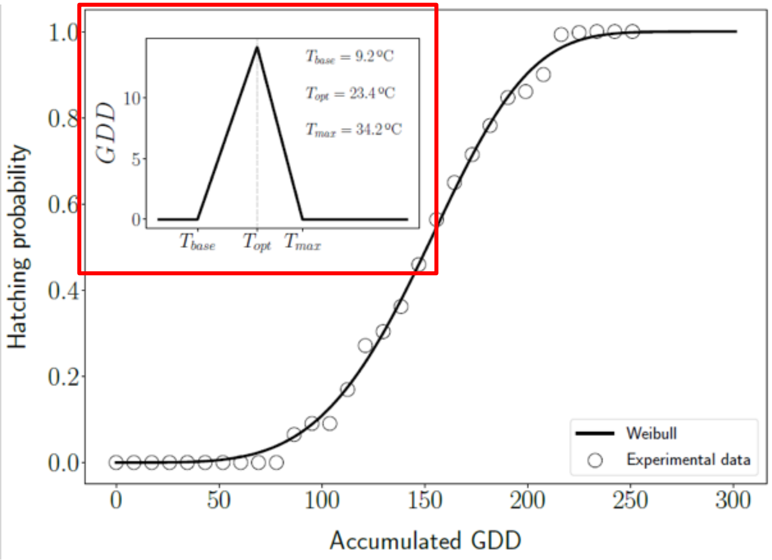
MATERIAL AND METHODS

4. Model construction

Calculating GDD as a function of temperature

t_0 diapause ending and t_f egg hatching

Diapause ending? November, December, or January were tested- 1st December best fit



5. Model Calibration

GDD accumulation depends on T

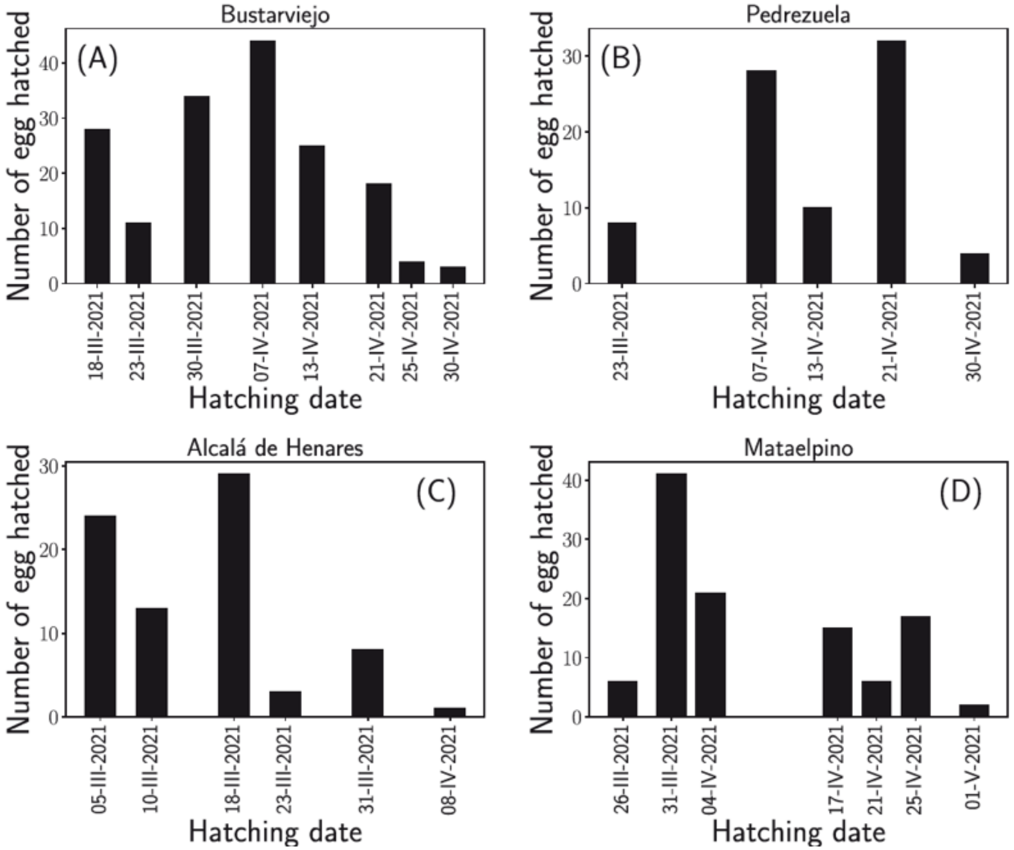
Calculate different temperature profiles: T_{base} T_{opt} T_{max} which best fit experimental data (error <1%)

6. Model validation Field observations from systematic field surveys from 2016-2021 (Murcia, La Rioja, Sevilla)

7. Model was used to calculate the precise timing for controlling *P. spumarius* nymphs most efficiently.

https://github.com/agimenezromero/PSEggHatching

RESULTS



- 435 nymphs hatched in the 4 surveyed regions

Hatching occurred between early March and early May

RESULTS

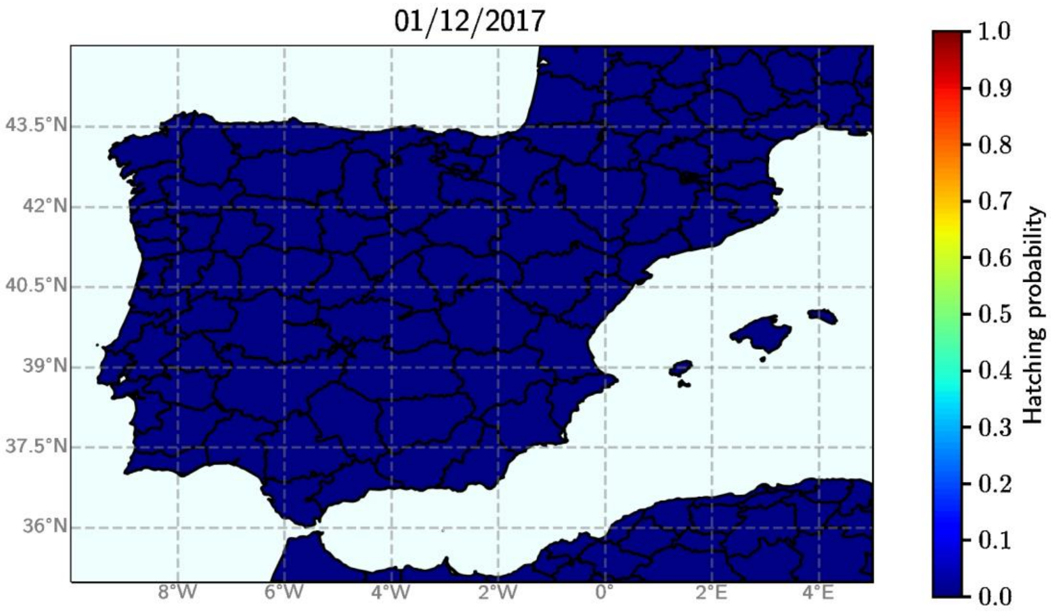
Model validation and model predictions

ERA5-Land

Model predictions applied to the Iberian Peninsula over time compared with field observations

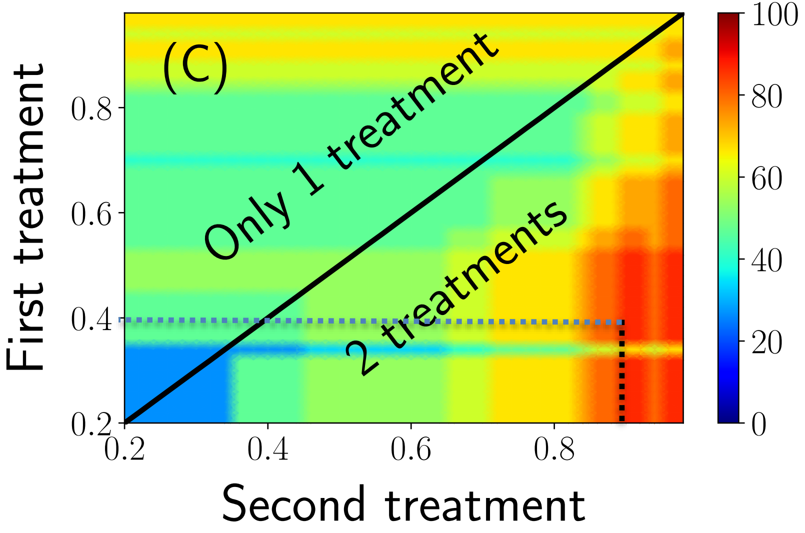
White dots represents field observations (2018)

Diapause ending : December 1st



RESULTS

Decision-support tool to determine the best timing for controlling *P. spumarius* nymphs



Number of control treatments?

High variability in the hatching dates (2.5 months)

Nymphal development 5-6 weeks

→ Two different action dates

When should we apply treatments?

When most eggs have hatched but before nymphs reach the adult stage → maximum (%) of targeted nymphs

↓

North (latitud> 40º) 1st: 40% 2nd: 90%

South (latitud< 40º) 1st: 30% 2nd: 90%

DS tool: https://pseggs.ifisc.uib-csic.es/

Take home messages

Temperature is a critical factor that impacts egg hatching of *P. spumarius*

It is essential to understand the diapause of *P. spumarius* to improve nymphal control

Considering the diapause ending on December 1st model predictions are consistent with field observations of egg hatching in Spain

Applying control measures on two different dates allows to target the highest number of nymphs

Our DSS can predict the best timing for application of control actions to manage *P. spumarius* based on the GDD accumulation on a given field site (meteorological station) in Spain.

Lago, C., Giménez-Romero, À., Morente, M., Matías, M. A., Moreno, A., & Fereres, A. (2023). Degree-day-based model to predict egg hatching of Philaenus spumarius (Hemiptera: Aphrophoridae), the main vector of Xylella fastidiosa in Europe. *Environmental Entomology*, *52*(3), 350-359.

ACKNOWLEDGEMENTS

Alex Gimenez-Romero

Manuel Matias

MINISTERIO DE CIENCIA E INNOVACIÓN

Grants: MCIN Plan Nacional I+D+I AGL2017-89604-R & PRE2018-083307 ; SuMaEco: RTI2018-095441-B-C22; Unidad de Excelencia María de Maeztu MDM-2017-0711