

Development of mathematical models supporting sustainable agriculture in Europe

Introduction

European agriculture is facing the challenge to satisfy food and feed requirements while looking at sustainable solutions for managing the impacts caused by native pests and invasive alien species. Qualitative and quantitative losses attributable to pests and invasive alien species might be limited or prevented throughout the development and use of decision support tools based on Physiologically-Based Demographic models (PBDMs). These models are able to evaluate the spatio-temporal phenology and dynamics of pest populations and can be used to support quantitative Pest Risk Assessment (Gilioli et al., 2013; Sperandio et al., 2018) and Integrated Pest Management (Gilioli et al., 2016).

Research goal: Develop modelling tools supporting sustainable pest management in agriculture.
PBDMs will be applied to facilitate knowledge-based decision-making for...

Quantitative Pest Risk Assessment

PBDMs are indicated to support the quantitative assessment of risks linked to the entry, establishment, spread and impacts of invasive alien species (Fig. 1).

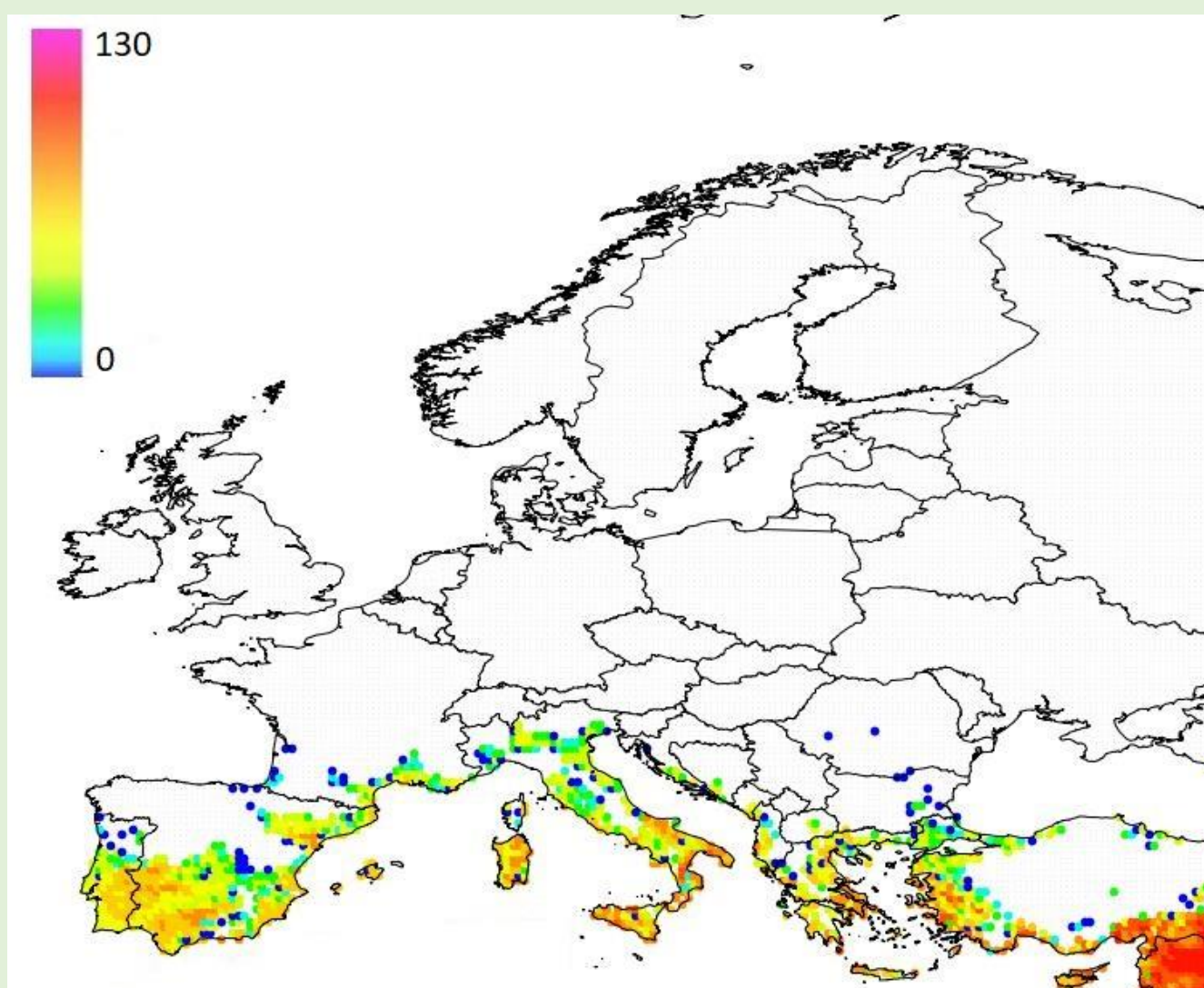


Figure 1. Predicted current distribution and abundance of the Mediterranean fruit fly (*Ceratitis capitata*) in Europe

This type of models could be useful for comparing future climate change scenarios, supporting the design of ad-hoc pest management strategies (Fig. 2).

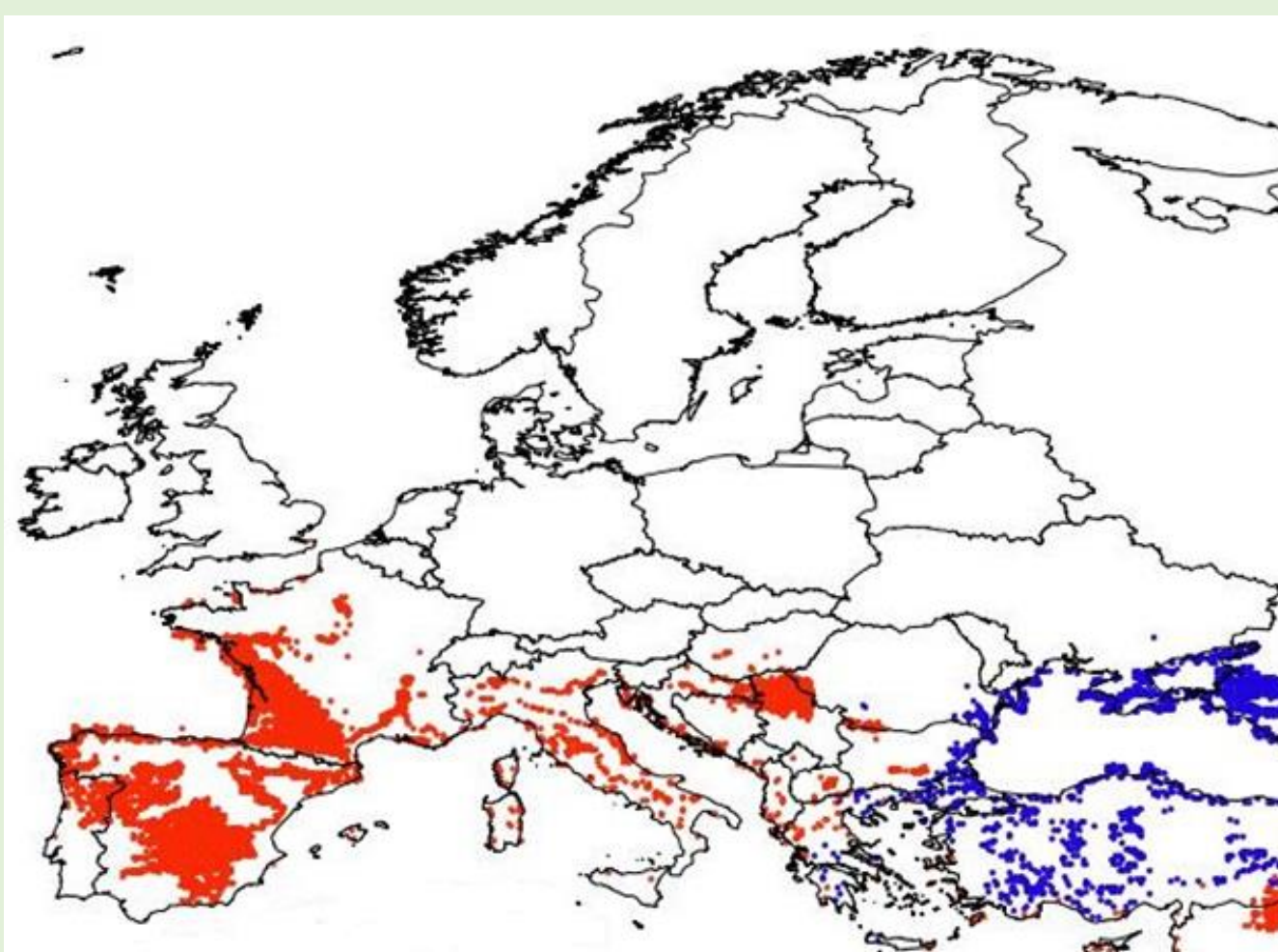


Figure 2. Projected (year 2050) positive (red dots) and negative (blue dots) differences in the presence of *C. capitata* by comparing two climate change scenarios.

Integrated Pest Management

Phenological models might be applied to predict the emergence of pests' developmental stages (Fig. 3) facilitating timing for sampling and pest control operations.

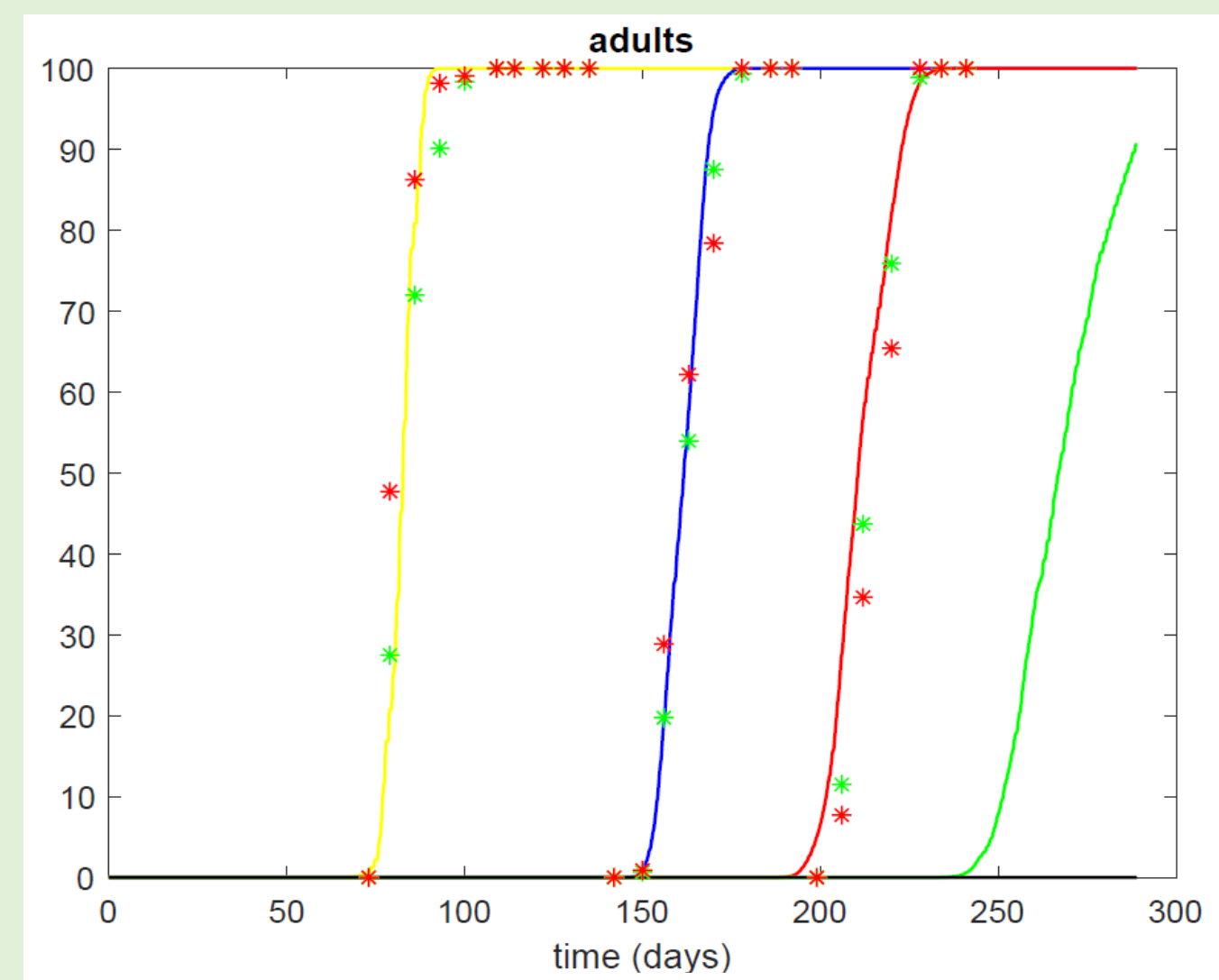


Figure 3. Simulated emergence of *Argyrotaenia pulchellana* adult stage (asterisks: monitoring data)

PBDMs can be used to run projections of pest's population dynamics, facilitating field-based decisions applied to Integrated Pest Management (Fig. 4).

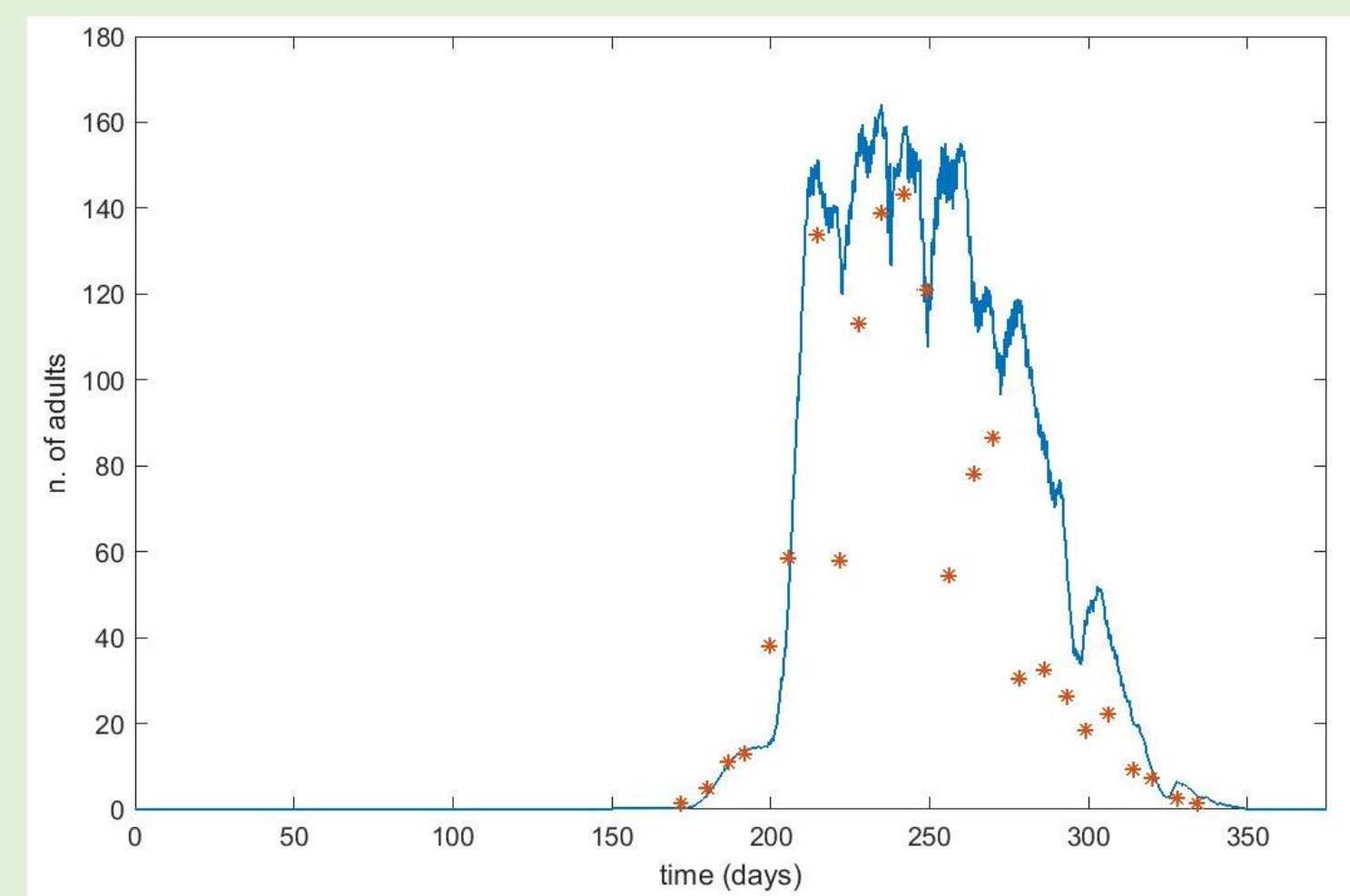


Figure 4. Simulated population dynamics of *C. capitata* adult individuals and comparison with monitoring data (red asterisks).

Take-home message

PBDMs are suitable tools for supporting the development and implementation of sustainable strategies for the management of native pests and invasive alien species relevant for the agricultural sector. In particular, PBDMs:

- mechanistically represent the processes underlying pests' demography and phenology;
- can be applied at different spatial and temporal scales;
- allow the exploration of complex scenarios, guiding the development and implementation of knowledge-based pest management strategies.

References

- Gilioli et al., 2013. *Pest management science*, 70(10), 1611-1623
Gilioli et al., 2016. *Ecological modelling*, 320, 348-357
Sperandio et al., 2018 (oral talk). *Book of abstracts - European PhD Network "Insect Science" - IX Annual Meeting*

Acknowledgments

This research was supported by "Fondazione Cariplo" and "Regione Lombardia", Grant Emblematichi Maggiori 2015-1080.