

A holistic approach to address invasive fruit flies (Diptera: Tephritidae) in Europe: the FF-IPM project

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Background: Fruit fly invasions threaten the fresh fruit production and trade worldwide. This threat is enormous in Europe with several, mainly tropical, species intercepted in ports of entry and, currently, detected in “friendly” for their establishment areas. In addition, the Mediterranean fruit fly, *Ceratitis capitata*, in response to climate change, is progressively dispersing to more northern latitudes. The EU funded project FF-IPM “In-silico boosted, pest prevention and off-season focused IPM against new and emerging fruit flies” targets two invasive (i.e. *Bactrocera dorsalis*, *B. zonata*) and one emerging (*C. capitata*) pests addressing all steps of invasion.

Methods: Extensive laboratory and field cage experiments using wild populations, release recaptures studies in open field conditions, review of the existing literature, and pilot testing in several countries have been conducted. Several functions to automatically collect meteorological data have been developed to feed population modelling approaches. From the study design to implementation and pilot testing the active involvement of stakeholders have been assured. Twenty one partners of the FF-IPM project have been involved in experimental and other activities throughout 10 European and four non-European countries.

Results: Novel data, including thermal biology, dispersion capacity, establishment dynamics and genetic affinity of wild populations, of the above species s have been generated. Advanced climatic modeling using the CLIMEX and DYMEX platforms have been generated. Advanced interception and detection tools have been developed, like an e-nose system to intercept fruit fly infested fruit, molecular and morphological identification tools, e- traps to detect and algorithms to automatically recognize and count captured adults. A range of Integrated Pest Management (IPM) tools have been developed, improved, and tested for Off-Season management, including mass trapping devices, entomopathogenic nematodes and fungi, methodology for increasing the abundance and activity of ground predators. Innovative approaches to assess the risk of fruit fly establishment have been developed and new strategies to increase detection efficacy are tested in pilot sites in four countries. Off an On-Season IPM approaches based on the PestOnFarm platform to address *C. capitata* in areas considered marginal for its establishment have been developed and are tested in six pilot sites in three countries.

Conclusion: The FF-IPM project has generated important results, tools and methods to address invasive fruit flies in Europe at all steps of the invasion process. The problem of fruit fly invasion is multidimensional, complex and requires involvement of all stakeholders as well as coordination and support by national, European and regional organizations. We discuss the weaknesses of the European system to deal with ongoing invasion events and the opportunities to establish a more efficient preparedness strategy against invasions in fruit producing systems.

Keywords: Biological invasions, Oriental fruit fly, Peach fruit fly, thermal physiology, trapping, interception, detection