

Fruit Flyer



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Fruit Flies In-silico
Prevention & Management

FF-IPM

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This is the fifth Newsletter Publication of the EU-funded research project FF-IPM, with the aim to protect fruit production and trade from threats posed by fruit flies.

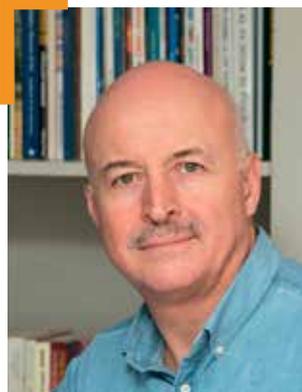
The newsletter is published quarterly, highlighting the actions, news, progress related to the issue at hand.

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Dr. Nikos T. Papadopoulos, PhD

Professor of Applied Entomology
 Director of Entomology + Agricultural Zoology Laboratory
 University of Thessaly
 FF-IPM Project Manager

Relaxation of COVID-19 restrictions regarding in person participation in scientific activities allowed FF-IPM partners to present some of the generated outputs in major meetings regarding pest management and fruit production. Hence, scientists from our consortium had the opportunity to interact and share novel results and ideas generated during the course of the project with peers and stakeholders. First of all, the FF-IPM partners presented two posters and three oral presentations in the meeting of the International Organization of Biological Control (IOBC) on the biological control of citrus pests and diseases that took place in Nafplion, Greece in early April. Our partner from Cervantes Ltd, Darren Kriticos, delivered a keynote presentation regarding the impact of climate change on the distribution and population dynamics of major agricultural and horticultural pests, with emphasis on fruit flies and the results generated by the FF-IPM project. FF-IPM partners organized and participated in an important round table discussion regarding the threats of invasive pests on citrus production in the Mediterranean countries and the ways to mitigate them. Secondly, the FF-IPM project participated in the 10th International Peach Symposium that was organized by the International Society of Horticultural Science (ISHS) in Naoussa, Greece, at the end of May – beginning

*The third season of the
 FF-IPM project is in full
 force and several challenging
 and important field pilot
 tests are in progress*

of June. A whole session on integrated pest management was presented in the symposium, supported by FF-IPM partners from the Royal Museum of Central Africa, the Benaki Phytopathological Institute, the InSilico IPM and the University of Molise, including a keynote presentation (UTH). Other important dissemination activities of the FF-IPM project of the last few months include participation in the 19th Panhellenic Entomological Conference with three presentations (BPI, UTH), a keynote presentation in the Hortgro Technical Symposium 2022 that was held in South Africa, and a presentation of the main concept and outputs of the FF-IPM project to the regional meeting of CEFTA Decision on Facilitating Trade for Fruit and Vegetables in Western Balkans. In addition, two webinars were presented by Marc De

Meyer (RMCA) and David Nestel (ARO) on “Fruit fly detection and interception” and “Smart trapping and deployment strategies”, respectively.

Continuing the series of interviews by prominent stakeholders and scientists, Ana Larcher and Uli Schiefer host an interesting discussion with Polychronis Rempoulakis (New South Wales Department of Primary Industries) in the current issue. Polychronis laid out the role of NSW DPI in the Australian Biosecurity and the active involvement of Australian stakeholders on research and actions regarding invasive pests that pose a major threat to horticulture. The funding system for Agricultural Research in Australia is robust and multidimensional and can serve as a paradigm for other countries.

Our colleagues Josep Jaques, Joaquin Cruz-Miralles and Michella Gruzzo from University Jaume I, summarize interesting studies regarding the role of ground predators on fruit fly biological control and highlight the contribution of FF-IPM on developing novel ground cover management approaches to facilitate the action of ground dwelling predators against the Mediterranean fruit fly.

The third season of the FF-IPM project is in full force and several challenging and important field pilot tests are in progress. Our main concepts and ideas and the already developed tools and approaches are currently tested in collaboration with stakeholders in several countries. We are looking forward to presenting additional new findings to you!



Enjoy reading
the 5th issue
of the FF-IPM
Newsletter!

The 13th Citrus Meeting of the International Organization for Biological and Integrated Control of Noxious Animals and Plants

WEST PALEARCTIC REGIONAL SECTION (IOBC-WPRS) MEETING

The 13th IOBC-WPRC Meeting of the Citrus Working Group on “Integrated Control in Citrus Fruit Crops” was successfully held on April 4-6, 2022, in Nafplion, Greece. The event was organized by the Hellenic Agricultural Organisation - Demeter (HAO-DEMETER), the University of Thessaly (UTH), the Benaki Phytopathological Institute (BPI), the Institute of Agrifood Research and Technology, the Directorate of Rural Development and Veterinary of Argolida, and the Agricultural Union of Argolida. The FF-IPM Project Manager, Prof. Nikos T. Papadopoulos served as a member of the Scientific and the Organizing committee of the meeting.



The meeting successfully covered major issues regarding both the improvement of the already existing Integrated Pest Management (IPM) programs and the development of new such strategies in the Mediterranean countries. The participants had the opportunity to discuss critical research findings regarding citrus pests, pathogens and weeds, and exchange knowledge and ideas about new management strategies in citrus orchards for both emerging and already known and established pests and diseases that pose imminent threats to citrus industry.

The program of the meeting included presentations and talks by keynote speakers and prominent scientists in plant pathology, insect biological control, and climatic population modelling. The meeting included presentations organized in five different sessions: (a) Biological

Control, (b) Integrated Pest Management, (c) Challenges in Pest and Disease Management, (d) Biology of Citrus Pests, and (e) Pest Ecology and Physiology. An additional session of a Round Table discussion, organized in the framework of the FF-IPM Project, with the title: "Invasive pests threaten the citrus production in the Mediterranean countries", was also included in the program of the meeting, followed by a Poster Discussion session.

Eight members of the FF-IPM project presented their most recent research output: **Darren Kriticos** was invited as a keynote speaker of the meeting. **Vasilis Rodovitis, Apostolos Kapranas, Eirini Anastasaki, Panagiotis Mylonas** orally presented their research, whereas **Eleftheria-Maria Bali** and **Mario Bjelis** presented posters of their work.

Group photo of the 13th IOBC-WPRC Meeting of the Citrus Working Group on "Integrated Control in Citrus Fruit Crops"



Darren Kriticos – Keynote speaker at the IOBC Meeting

Darren Kriticos, the WP5 Lead of the FF-IPM Project, was a keynote invited speaker of the meeting. His talk focused on climate change and its impact on the distribution and population dynamics of agricultural and horticultural pests. This impact leads to pests that can spread into higher altitudes and northern regions, which will pose a major challenge on the currently used pest management strategies.

Dr. Kriticos highlighted the fact that future climate simulations are based on highly uncertain inputs of Greenhouse Gas Emissions, which will consequently lead to uncertainties in the prediction of the appropriate future pest management strategies, if traditional heuristic models are to be used. The renowned scientist suggested a pro-active multi-faceted strategy for dealing with climate change impacts of pests. This strategy would



Darren Kriticos

include (a) the identification of analogue climates in the present that would simulate the future climate in an area of interest, and (b) the assessment of the adaptations that might be required in the current pest management strategies based on these analogue climates. Finally, the researcher highlighted the importance of close collaboration among scientists to facilitate the development of such strategies by collecting, analyzing, and sharing all critical information through platforms like the IOBC meetings.



Presentations at the IOBC Meeting

Vasilis Rodovitis (University of Thessaly, UTH) presented their research entitled “Spatio-temporal population trend of the Mediterranean fruit fly in mixed fruit orchards in Central Greece”. The researcher pointed out the strong effect of altitude, type of host plant and type of trapping system on monitoring medfly population dynamics and phenology, and their subsequent effect on the design and implementation of the appropriate population management strategy.

One such strategy is the use of entomopathogenic nematodes that was discussed by Apostolos Kapranas (Benaki Phytopathological Institute, BPI) who investigated their utilization as a tool for medfly population suppression using different species and doses of nematodes under semi-field conditions and discussed their results in a presentation with the title “Entomopathogenic nematodes for control of Mediterranean fly *Ceratitis capitata*: prospects and limitations”. Eirini Anastasaki (BPI) presented their study with the title “Characterization of the volatile infestation-fingerprint of oranges by *Ceratitis capitata*, *Bactrocera zonata* and *B. dorsalis* and conversion into a detection tool (e-Nose)”. The study demonstrated the development of a useful and innovative tool (e-Nose) that can be used for the detection of fruit fly infestation avoiding destructive sampling and based on the specific profile of volatile organic compounds (VOCs) emitted by infested fruits.

Panagiotis Milonas (BPI) presented their work with the title “Population dynamics of medfly on citrus orchards in Korinthos region, Greece”. In this study, different trapping systems were used for medfly population monitoring during two consecutive years. Medfly captures differed depending on both the trapping system used and the climatic conditions of each year.

Darren Kriticos

suggested a pro-active

multi-faceted strategy

for dealing with climate

change impacts of pests



Vasilis G. Rodovitis



Apostolos Kapranas



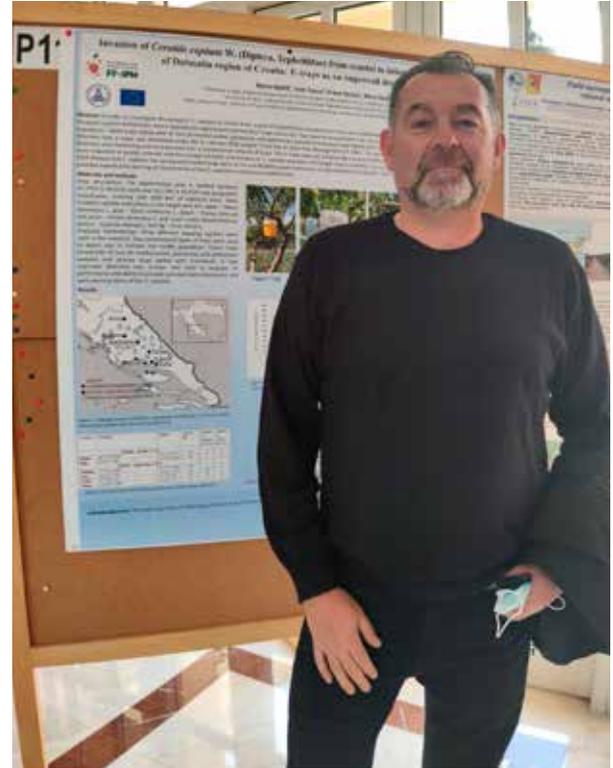
Eirini Anastasaki

Posters at the IOBC meeting

Eleftheria-Maria Bali presented their research in a poster with the title “Effect of thermal acclimation and prevailing conditions on the response of adult Mediterranean fruit flies to traps”. The study demonstrated that prevailing climatic conditions during the trapping period significantly affected adult captures, whereas adult acclimation affected adult trapping only during spring.

Mario Bjelis (University of Split) presented their poster with the title “Invasion of *Ceratitis capitata* W. (Diptera, Tephritidae) from coastal to inland areas of Dalmatia region of Croatia: E-traps as an improved detection tool”. The researcher detected the invasion of the medfly in new inland areas of Croatia utilizing the innovative electronic detection tool (E-trap) that was developed in the framework of the FF-IPM Project, in combination with a network of conventional traps.

Mario Bjelis



Poster section of the 13th IOBC Citrus Meeting



FF-IPM Round table in IOBC meeting

A whole session of the IOBC meeting was dedicated to a Round Table Discussion that was sponsored by the FF-IPM Project. The FF-IPM Project Manager, Prof. Nikos Papadopoulos served as the moderator of the Round Table along with Dr. Antonia Soto (Universitat Politècnica de València, Spain). The theme of the discussion was “Invasive pests threaten the citrus production in the Mediterranean countries”. The round table panel that consisted of research experts (Panagiotis Milonas, Benaki Phytopathological Institute, Athens, Greece; David Horta Lopes, Universidade dos Açores, Portugal; Darren Kriticos, Cervantes LTD, Australia) and representatives of local governmental agencies (Christos Arabatzis, Ministry of Agricultural Development and Food, Athens, Greece), discussed important thematic areas regarding (a) the development and implementation of policies for the response to biological invasions, (b) climate change and bioclimatic modeling, and (c) prevention of biological invasions in the citrus producing areas of the West Palearctic region.

The discussions steered by N. Papadopoulos and A. Soto reached the following recommendations regarding the prevention response to invasive pests:

- Development of eradication plans for risk areas and ready-to-implement plans for high priority pests
- Establishment of preemptive biological control when this is feasible
- Harmonization of the biological control practices among the different EU countries
- Establishment of an information sharing system regarding biological questions within the Citrus research community
- Performance of simulation eradication exercises in target areas
- Reconsideration of setting eradication as the first option of response against invasion incidences and exploration of options such as containment as additional tools
- Investment on the development of smart detection systems that can provide reliable and timely information
- Performance of elaborated pest risk analysis for target invasive organisms



FF-IPM Round Table discussions
in the IOBC Meeting

All relevant information regarding the 13th IOBC Citrus Meeting will be made available through the [IOBC meeting website](#) and the [FF-IPM Project website](#).

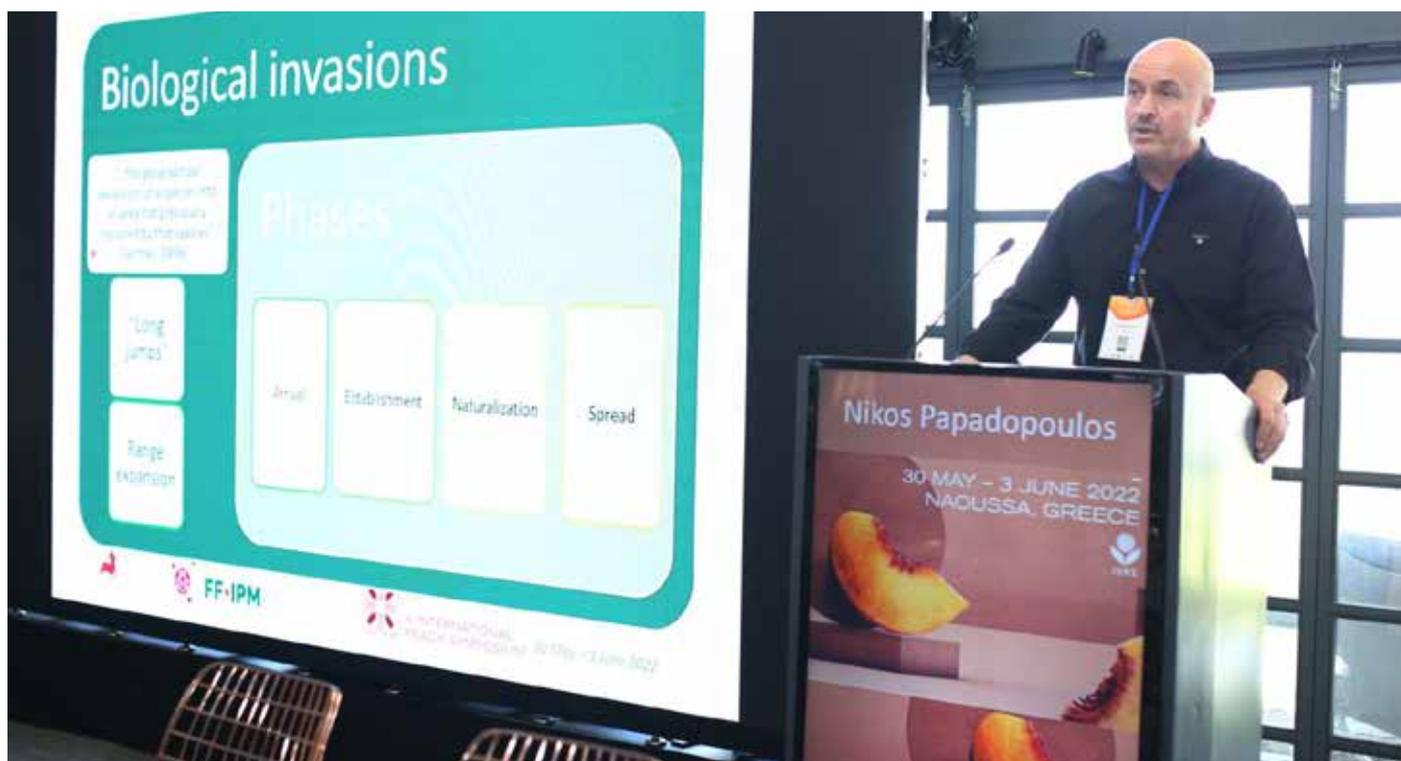




FF-IPM Project participation in the 10th International Peach Symposium

The 10th International Peach Symposium was successfully held on 30 May – 3 June 2022 in Naoussa, Greece. The Symposium was held under the auspices of the International Society of Horticultural Science (ISHS). The program of the Symposium included plenary lectures, oral presentations, poster presentations, stakeholder talks and one round table that provided the opportunity for researchers, professionals, and students with an interest in peach, to present their work, exchange knowledge and discuss new ideas from both basic and applied research perspectives.





Prof. Nikos Papadopoulos

A whole session of the Symposium was dedicated to Integrated Pest Management. The moderators of this session were Slawomir Lux, WP6 Lead of the FF-IPM Project, and Eirini Anastasaki (Benaki Phytopathological Institute, BPI).

The session started with an interesting and enlightening lecture by Prof. Nikos Papadopoulos who was invited as a keynote speaker of the Symposium. The presentation was entitled "Challenges and opportunities in management of emerging and alien invasive pests in peaches". Prof. Papadopoulos described the risk of the infestation of peach crops by the Mediterranean fruit fly and the peach fruit fly, due to increased global fruit trading, intensified human mobility, and climate change that allow the arrival and spread of emerging and alien invasive species into novel areas. Prof. Papadopoulos concluded his lecture with a comprehensive overview of the new strategic approach for biological invasion management, proposed by the

FF-IPM Project, that utilizes innovative tools for early electronic detection and identification of intercepted and trapped flies, and algorithmic prediction of the distribution and population dynamics of invasive pests based on climate change predictions.

The session continued with a presentation by Dr. Massimiliano Virgilio (Royal Museum for Central Africa, RMCA) with the title: "A multi-access identification key to fruit flies (Diptera, Tephritidae) of economic importance in Europe". The researcher presented an interactive identification key for fruit flies (Diptera, Tephritidae) of economic importance in Europe that was recently developed within the framework of the FF-IPM Project. This free available key includes multiple features linked to detailed illustrations and high-resolution pictures as well as hyperlinks with relevant information on the pest geographic distribution and host plant preferences that facilitate its use even by non-specialists.



Dr. Apostolos Kapranas (Benaki Phytopathological Institute, BPI) was the next FF-IPM researcher that presented his work on “Biological control of Mediterranean fly *Ceratitis capitata* with entomopathogenic nematodes: from laboratory assays to field application”. Dr. Kapranas described the use of entomopathogenic nematodes (EPN) for controlling Medfly, particularly for off-season or early-season control. The researcher presented their findings on the percentage of suppression of emerging medflies after the application of EPN under different temperatures and doses and suggested an application scheme where a single, relatively low dose of EPN in autumn, (off season) or spring (early season), targeting overwintering medfly larvae can substantially reduce the medfly emergence later in the growing season.

Dr. Slawomir A. Lux (inSilico-IPM), the WP6 Lead of the FF-IPM Project, continued the series of FF-IPM presentations with his work: “Implications of farm structure and crop management on fruit infestation and medfly IPM”. The researcher described an innovative in-silico approach that

Dr. Kapranas presented their findings on the percentage of suppression of emerging medflies after the application of EPN under different temperatures and doses

allows stochastic simulation of medfly behaviour with the PESTonFARM model. The model assesses the combined effects of farm structure, fruit phenology and fruit size management on the development, dispersal, and fruit infestation of the medfly, and provides useful information for the improvement of IPM applications against medfly.

The session continued with a presentation by Dr. Marco Colacci (University of Molise, Italy) with the title: “The status of medfly and IPM practices based on case studies in Italy”. Dr. Colacci explored: a) host

fruit phenology, b) medfly overwintering resources and their capacity, c) annual patterns of medfly immature stages and adults, and d) the socio-economic background information of two different areas in Italy. Based on all the previous explorations, they managed to a) define the spatio-temporal dynamic of medfly in each farm and the key host species for overwintering, b) evaluate the pest status for various fruit species and cultivars, c) establish the range of pesticides and other means used for medfly control, and d) calculate the costs related to the implemented IPM practices, i.e., trap monitoring, mass trapping, insecticide spray application, sanitation.

The last presentation of the session was presented by Eirini Anastasaki (BPI) with the title "Chemical characterization of the volatile infestation-fingerprint of peaches by *Ceratitis capitata*, *Bactrocera zonata* and *B. dorsalis* and conversion into a detection tool (e-Nose)".

Eleni Verykouki (UTH) presented her work entitled "Occurrence and phenology of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae) in the peach producing area of Central Macedonia, Greece" at the poster section of the Symposium. In the framework of the FF-IPM Project the researcher studied the occurrence, spatial dispersion, and seasonal phenology of the Mediterranean fruit fly in Central Macedonia, Greece, an area where medfly occurrence was considered sporadic and non-threatening. The data of the coordinates of trap location, host, date, and sex were coded and then introduced into a structured database. The analysis of the data showed that low populations of medfly are wide dispersed in central Macedonia and pose a substantial risk for the commercial fruit commodities in the areas that needs to be considered for future control measures to reduce the impact of medfly dispersion of fruit production and trading.

Important distinction for Vasilis Rodovitis at the ISHS Young Mind Awards Competition

A special mention goes to the young FF-IPM researcher Vasilis Rodovitis that participated in the ISHS Young Mind Awards Competition organized by the Symposium with a presentation entitled "Population dynamics of Mediterranean fruit fly in mixed fruit orchards in Central Greece" and took the very well deserved third place in a competition among remarkable young scientists. In the framework of the FF-IPM Project, the researcher studied: a) the phenology and seasonal biology of adult medflies in a coastal area of Greece, using different types of traps in different mixed fruit orchards for two consecutive years, and b) the infestation status and rates of fruit samples collected from the same orchards, and presented a number of findings that are expected to set the stage for developing spatial adjusted, farm tailored decision-making models towards achieving sound Integrated Pest Management (IPM) to address medfly in mixed fruit orchards.



Interview by
Ana Larcher Carvalho and Ulli Schiefer

Dr. Polychronis Rempoulakis



National Action plans for fruit flies in Australia

Could you start by telling us about yourself and your work?

I grew up in Crete, Greece in a family of farmers cultivating olives, and from young age I got involved in pest control activities to reduce the damage from olive fruit fly (*Bactrocera oleae*) to our family and village olive oil production. During my university years as Biologist, I got interested in the development of alternative control methodologies for fruit fly control and

continued with Postgraduate studies researching on the same topic (MSc working with Mediterranean fruit fly (*Ceratitidis capitata*), and PhD on the mating behaviour of olive fruit fly.

My involvement with research on those insects later developed into an interesting and rewarding international career that blessed me with many experiences and good friends all over the world. For more than a decade I travelled and worked in

several countries and projects either as a researcher, consultant or participating in United Nations expert missions. During those years I developed a working relationship with International Atomic Energy Agency, since the broad topic of my research was on the development, refinement and implementation of the Sterile Insect Technique, an environmentally friendly control method, particularly suitable for application against fruit fly insect pests.

In 2015 my family and I arrived in Australia, to participate in a large SIT program, and I established my research team in

one of the prominent universities here working with a group of PhD students and technical officers on various aspects of the method. In 2018 I assumed the responsibilities of Leader Entomologist for the Branch of Biosecurity and Food Safety of NSW DPI, the governmental research organisation of the state of New South Wales.

Since then, in this capacity I assist and supervise a diverse team of entomologists that work on a very broad spectrum of research activities, and also conducting my own research on fruit flies, to a lesser extent than before of course.

PART 1. INSECT PEST CONTROL IN AUSTRALIA

You are the Leading Entomologist for the Branch of Biosecurity and Food Safety of New South Wales. Could you tell us a bit about the institutional set up for pest control in Australia and the work of the Biosecurity and Food Safety branch? Maybe you could clarify the concept of biosecurity and what it means in terms of shared responsibilities for stakeholders?

Biosecurity is indeed a shared responsibility (incidentally this is the motto of our Branch!), meaning that all shareholders, government, research providers, industry and the general public have an important role to play in protecting our natural environment, precious resources and production capabilities. Our role in NSW DPI is vital in ensuring that the State has the ability to prevent entry and respond rapidly in novel incursions of pests, pathogens and diseases that might arrive from other areas within Australia or from abroad.

For this reason, we develop and maintain a strong component of diagnostic capacity, emergency response capacity

and planning, and also a strong policy framework. In the unfortunate event that a pest or pathogen succeeds to become established here, we continue our support to the industry with expert advice, extension activities, and most importantly with quality research outcomes for pest control (development of novel control methods, insecticide resistance management, molecular diagnostics, integrated pest management and many more).

Our organisation NSW DPI is more than 120 years old, and proud on standing in the global top 1% in terms of scientific output in Agricultural Sciences. We have a strong capacity in research with more than 600 scientists in 23 research stations in NSW. To succeed in this mission, we are not alone, but we closely collaborate with other states, universities, funding agencies, and other research providers in consortia involving complex projects, joint appointments and co-investment to research for the benefit of our primary industries that have a significant socio-economical value in society, for the

domestic and export value of quality agricultural and livestock products but also for the employment and wellbeing of our regional and rural communities.

How are the links between research and action established in Australia and namely how are the scientific results produced by research transformed into action to improve pest control?

Australia has a robust system of funding for the agricultural research through the Research and Development

corporations (RDC's): currently there are 15 of them, covering the vast majority of commodities nationwide. Those non for profit organisations, supported by the Federal Government, are responsible for commissioning large research projects with an applied orientation that answers the needs of the primary industries. That ensures that the research that we conduct has the ability to be easily implemented and addresses the needs of the industry (producers), providing solutions in pre and post-harvest pest reduction, improved market access plans, etc.



Stable isotope studies on fruit flies of Economic importance (Photo credits, Aaron Darc)

Major threats we will face in the future: Increased mobility of insect pests due to commercial activities, an expansion and shift of range of pests due to climate change and a reduction to conventional control methods

What are the key pests of concern in Australia and what are the main strategies to deal with them?

Every sector of primary production (i.e. commodity) is suffering from a variety of pests and diseases, it will take a long list to enumerate all here, but I can note that for fruits and vegetables fruit flies are among the most destructive insect pests. Also, for leafy vegetables recent introduction of leaf miners are of great concern, and also moths (e.g. Fall armyworm and other Lepidoptera) create great damage. A combination of chemical control, with approved and strictly controlled insecticides, biological control agents, mass trapping and more complex control methods (including SIT), are among the weapons in our arsenal for dealing with those pests.

In terms of research, you work extensively on novel methods of control for pest control. Could you identify some of the ones you consider most relevant?

We work extensively on fruit fly behavioural ecology, spatial ecology, nutrition and chemical ecology.

Those areas can find applications in the optimisation of the Sterile Insect Technique, novel trapping methods, lure and kill methods, spacing and positioning of trapping systems for detection and surveillance and more. In our work we also focus on post-harvest disinfestation methods with fumigants, altered atmospheres and combination treatments, and also phytosanitary irradiation, where Australia is at the forefront with cutting edge commercial irradiation facilities. Finally, we work on Integrated Crop Management methods and systems approaches for improved market access. Another important component of our work is in the biosecurity preparedness, where we develop science-based scenarios for timely and effective response to future threats, such as the Oriental fruit fly (*Bactrocera dorsalis*).

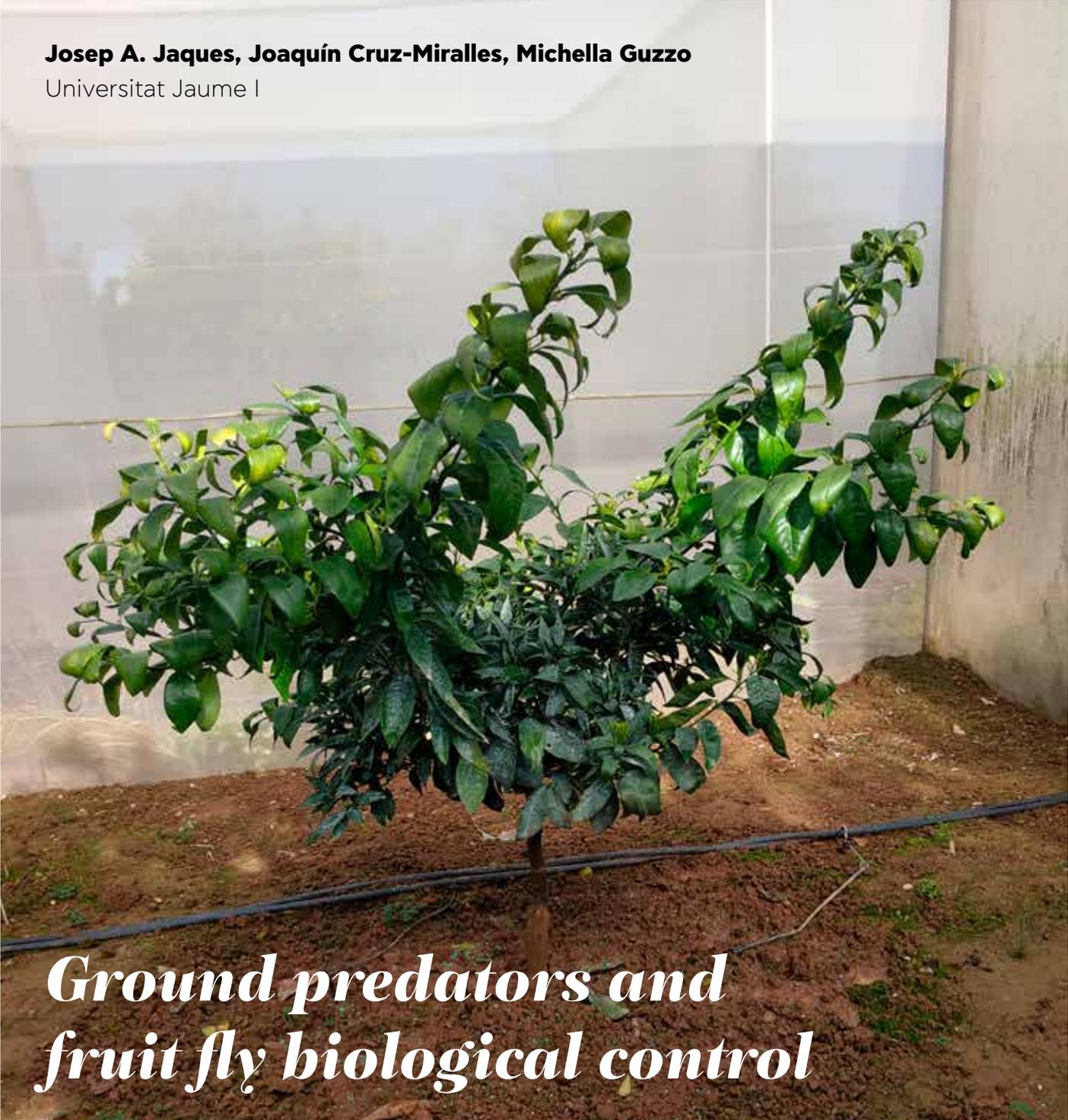
In relation to insect pests in the world, what so you consider to be the key areas of concern for the future?

To my view, the major threats we will face in the future are: Increased mobility of insect pests due to commercial activities, an expansion and shift of range of pests due to climate change (currently we work a lot on modelling this, considering several global warming scenarios), and a reduction to conventional control methods, mainly due to phasing out of harmful chemical insecticides and the developed resistance.

The second part of our interview with Dr. Rempoulakis will be published in the next issue. **Stay tuned!**

Josep A. Jaques, Joaquín Cruz-Miralles, Michella Guzzo

Universitat Jaume I



Ground predators and fruit fly biological control

Fruit flies (Diptera: Tephritidae) have three developmental stages that can be found in the soil. These are late third instar larvae (the “popping larvae”), pupae, and teneral adults, which remain on the ground until they can fly. As a consequence, these stages are susceptible to predation by generalist ground-dwelling predators. Ants (Hymenoptera: Formicoidea), spiders (Araneae), and staphylinid and carabid beetles (Coleoptera) have been reported as the most common predators of fruit flies in the soil (Urbaneja et al., 2006, El Keroumi et al., 2010, Monzó et al., 2011, Benhadi-Marín et al., 2019).

Ants are widely distributed worldwide and are predominant in many terrestrial ecosystems. Their impact on sympatric species is relevant. They are often the major cause of mortality and subsequently population reduction of other arthropods, including fruit flies (Pemberton and Willard, 1918; Hodgson et al., 1998; Aluja et al., 2005). In some cases, though, ants can play a double role. In addition to their huge potential as invertebrate biological control agents, they may protect honeydew-producing homopterans, which are often pests. Although this sugary food source can also help sustain other relevant parasitoids in the system (Queiroz and Oliveira, 2001), overall, ants may be considered as a problem in some agroecosystems. In a survey of ground predators, conducted in a citrus orchard in Spain, ants were reported as the most abundant group of ground-dwelling species (Urbaneja et al., 2006). In this study, the highest disappearance rate of sentinel pupae of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), pupae coincided with highest activity-density of ants.

Spiders constitute another important group of generalist ground-dwelling predators. In a Spanish citrus orchard, over 50 different species of spiders were found. The most abundant species was *Pardosa cribata* Simon (Araneae: Lycosidae) (Monzó et al., 2007), which under laboratory conditions could effectively predate on third instar larvae and young adults of *C. capitata* (Monzó et al., 2009). In a field assay, *P. cribata*, effectively preyed upon emerging adults (Monzó et al., 2010). In Portugal, three species belonging to three different guilds, namely the active ground hunter *Haplodrassus rufipes* (Lucas) (Araneae: Gnaphosidae), the orb-weaver queueing predator (*Araniella cucurbitina* (Clerk) (Araneae: Araneidae), and the ambusher sit-and-wait predator *Synema globosum*

Ants, spiders, and staphylinid and carabid beetles have been reported as the most common predators of fruit flies in the soil

(F.) (Araneae: Thomisidae), were studied (Benhadi-Marín et al., 2019). All three species showed a prey preference for flies compared with large (crickets) and medium (moths) sized prey (Benhadi-Marín et al., 2019). In Israel, the reported most common species of spider and dominant predator is *Chiracanthium mildei* L. Koch (Araneae: Clubionidae). This is a nocturnal generalist predator guided by olfactory cues to recognize the prey, which has been found in male medfly traps (Kaspi, 2000).

Carabid and staphylinid beetles are also considered an important group of generalist ground-dwelling predators. In Spanish citrus orchards, the carabid *Pseudophonus rufipes* De Geer (Coleoptera: Carabidae) was reported as the most abundant carabid on the ground surface (Tortosa et al., 2005). Monzó et al. (2007) reported a high predation rate of this species on *C. capitata* in the laboratory, with a preference for the pupal stage. The efficacy of this predator on fruit flies in the field resulted lower than in the laboratory. This was attributed to the presence of alternative prey (Monzó et al., 2011). Contrary to spiders, which preferred emerging adults, *P. rufipes* showed a preference for less mobile developmental stages of *C. capitata* (Monzó et al., 2011).



Results have shown that both the seeded cover and the straw of mulch can effectively increase the abundance of ants, spiders and beetles, but also that of earwigs

Within the FF-IPM Project, the effect of three ground cover management methods, namely, bare soil, a seeded ground cover of the grass *Festuca arundinacea*, and a mulch of straw have been studied as a means of manipulating ground-dwelling predators and, as a consequence, the impact of predation on *C. capitata* adult emergence. Results have shown that both the seeded cover and the straw of mulch can effectively increase the abundance of ants, spiders and beetles, but also that of earwigs, another important group of ground-dwelling predators revealed in this study. These enhanced populations resulted in reduced emergence of sentinel *C. capitata* along the year. Therefore, ground cover manipulation should be considered as an effective more sustainable tool to control *C. capitata*.

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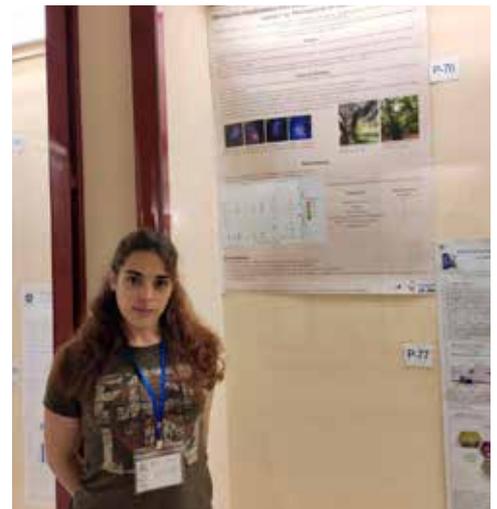
FF-IPM Project participation in the 19th Panhellenic Entomological Conference

Members of the FF-IPM Project presented their most recent work at the 19th Panhellenic Entomological Conference that was held on May 23-27, in Agrinio, Greece. The project participated in the conference with the following presentations and posters:

- **Georgia D. Papadogiorgou – presentation:** “Effect of host fruit and temperature on the demographic characteristics of different Mediterranean fruit fly populations.”
- **Aikaterini Psoma – presentation:** “Characterization of the volatile infestation-fingerprint of fruits infested by *Ceratitis capitata*, *Bactrocera zonata*, and *Bactrocera dorsalis*, and conversion into a detection tool (e-Nose).”
- **Eleftheria-Maria Bali – poster:** “Factors affecting trapping of adults of the Mediterranean fly *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae).”



Georgia D. Papadogiorgou



Eleftheria-Maria Bali

Participation in Hortgro Technical Symposium 2022

On the 6 - 10 June, 2022, Prof. Nikos Papadopoulos presented an invited talk entitled “Managing new and emerging pests in a changing world: the fruit fly paradigm in Europe” in the Hortgro Technical Symposium 2022.



Invited presentation to CEFTA

Prof. Nikos Papadopoulos was invited to present the FF-IPM Project to CEFTA (Central European Free Trade Agreement) in Session 5 of their regional meeting on June 1, 2022.

The participants of the meeting were CEFTA Phytosanitary and Food Safety agencies.

Webinars



A series of webinars supported and organized by the FF-IPM Consortium has been launched on April 2022. These webinars are related to the FF-IPM project, its scope, deliverables, and scientific suggestions towards an in-silico supported Integrated Pest Management approach for the detection and prevention against new and emerging fruit flies.

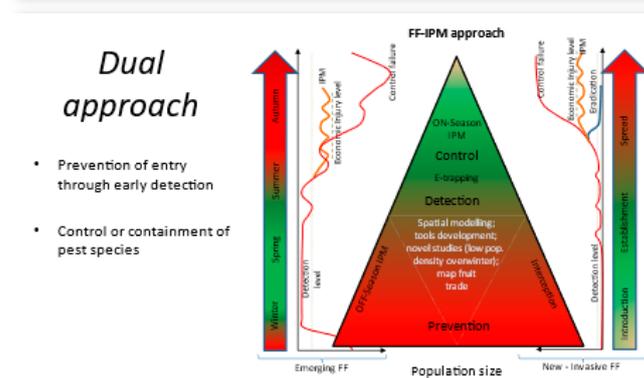
WEBINAR 1

Fruit Fly detection and interception, the FF-IPM project response

On the 28th of April 2022, the FF-IPM Project organized the first webinar of the series entitled "Fruit Fly detection and interception, the FF-IPM project response". The webinar was moderated by Prof. Nikos Papadopoulos, the FF-IPM Project Manager, and presented by Dr. Marc De Meyer, the WP3 Lead and Technical Manager of the FF-IPM Project. Dr. De Meyer is the Head of the invertebrates unit, acting head of the department of African Biology, and member of the directive and scientific committees at the Royal Museum for Central Africa (RMCA, Tervuren, Belgium). His expertise lies in taxonomy, systematics, and phylogeny of Diptera with an emphasis on specific African groups that include the tephritid fruit flies.

Dr. De Meyer presented a detailed introduction on the new and emerging risks to the European Union (EU) plant health posed by fruit flies. The presenter described the socioeconomic impact of the spread of fruit flies such as *Ceratitis capitata*, *Bactrocera dorsalis* and *Bactrocera zonata* on EU and global fruit production and trade and the gaps on the current EU strategies on the surveillance of invasive fruit flies. The researcher also presented the suggestion of the FF-IPM Project on a holistic dual approach consisted of both the prevention of fruit fly entry through early detection and the control or containment of pest species. The

presentation of the proposed strategy was supported by several tools recently developed in the frame of the FF-IPM Project and based on innovative systems for electronic detection (e.g. e-nose, e-trap), morphological and molecular identification of intercepted and trapped flies (e.g. Key fruit flies of importance to EU), and algorithmic predictions for distribution and population dynamics of agricultural and horticultural pests based on climate change.



WEBINAR 2

Smart-trapping & deployment strategy for surveillance of invasive fruit flies

The second webinar of the series of webinars organized by the FF-IPM Project was held on the 30th of June with the title “Smart-trapping & deployment strategy for surveillance of invasive fruit flies”.

The webinar was moderated by the FF-IPM Project Manager, Prof. Nikos Papadopoulos and presented by Dr. David Nestel, senior researcher at the Department of Entomology of the Agricultural Research Organization (ARO, Israel), partner of the FF-IPM Project, and expert scientist on fruit flies and pest management.

Dr. Nestel’s research focuses, among other topics, on the spatio-temporal dynamics of tephritid fruit flies and its application on pest control strategies, with an emphasis on the exploration of spatio-temporal patterns of the Medfly, the Ethiopian fruit fly, and the olive fruit fly. The researcher has been involved in the development of electronic

monitoring traps and IPM algorithms for various insects.

Dr. Nestel presented a comprehensive and detailed overview on the current knowledge on smart-trapping, and invasive fruit fly surveillance and interception. The researcher, also, talked about the strategy proposed by the FF-IPM Project for the optimization of the surveillance of invasive fruit flies, and the results generated during the first 2 years of the project. The proposed strategy includes the development of a novel smart-trap specifically tailored for invasive *Bactrocera* and *Ceratitis* species, the deployment options, and the use of decision-making algorithms for surveillance of invasive fruit flies. The application of this strategy is expected to significantly reduce the cost and increase the effectiveness of surveillance, monitoring and decision-making on fruit fly population control.

WEBINAR 02 | 30.6.2022 Smart-trapping & deployment strategy for surveillance of invasive fruit flies



Dr. David Nestel
Institute of Plant Protection Dept. of Entomology Volcani-CR ARO

Optical Sensor:
Light-interrupted by
trespassing flies

Fig. 16 - The proposed electronic counting trap for the oriental fruit fly (medfly) in the field.

Fig. 17 - Deployment test of the developed remote monitoring system for the oriental fruit fly: (A) present of the trap conducted at the farm field on the NTU range.

A GSM-based remote wireless automatic monitoring system for field infestations: A case study for ecological monitoring of the oriental fruit fly, *Bactrocera dorsalis* (Hendall)



FF-IPM Fruit Flies In-silico
Prevention & Management

Upcoming Webinars

The series of FF-IPM webinars will be continued with the three following webinars:

- **WEBINAR 3**
“Exploiting functional biodiversity to manage the populations of fruit flies”
by Dr. Darren Kriticos.
- **WEBINAR 4**
“Effect of ground management on survival of *Ceratitis capitata*”
by Prof. Josep A. Jaques.
- **WEBINAR 5**
“Interception of fruit fly infested fruits in cargo shipment” by Dr. Panos Mylonas.

STAY TUNED

→ visit the [webinars page](#) for updates

Partner replacement update

The Australian Government Agency, Commonwealth Scientific and Industrial Research Organisation (CSIRO) that was initially a partner of the FF-IPM Project was replaced with CERVANTES.

Link: <https://cervantesagritech.com/>



Links with other projects

FF-IPM partners came in contact and created a reciprocal link with H2020 projects SmartProtect and NOVATERRA and discussed knowledge sharing actions.



Article publication on the National Rural Network

An article was published on the National Rural Network that described the aims and outputs of the FF-IPM Project.

Link to the article: <https://ead.gr/research-project-ff-ipm/>



Fruit Flies In-silico
Prevention & Management
FF-IPM

 Horizon 2020
European Union Funding
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