Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect Pest Control Newsletter

https://www.iaea.org/topics/food-and-agriculture
http://www.fao.org/agriculture/fao-iaea-nuclear-techniques/en/

ISSN 1011-274X

No. 103, July 2024

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To Our Readers

Four databases maintained by the IPC subprogramme: the Tephritid Workers Database (TWD), the World-Wide Directory of SIT Facilities (DIR-SIT), the International Database on Insect Disinfestation and Sterilization (IDIDAS), and the International Database on Commodity Tolerance (IDCT). The FAO/IAEA databases provide access to scientific and technical information related to the integration of nuclear and pest management techniques in the control of insect pests (Source:IAEA, 2024).

The Insect Pest Control (IPC) Subprogramme of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture plays a key role in the dissemination of nuclear and related technology information by providing Member States with factual, comprehensive and current information about strategies, techniques, products and processes in the topics of Area-wide Integrated Pest Management (AW-IPM) and the Sterile Insect Technique (SIT). The four databases maintained by IPC: the Tephritid Workers Database (TWD), the World-Wide Directory of SIT Facilities (DIR-SIT), the International Database on Insect Disinfestation and Sterilization (IDIDAS), and the International Database on Commodity Tolerance (IDCT), contribute to this goal by providing, to the general public as well as to the scientific community, access to scientific and technical information related to the integration of nuclear and pest management techniques in the control of insect pests of agriculture, livestock and human health importance.

Detailed information of each database is provided in pages 26 to 28 of this newsletter. I would like to stress the importance of keeping these databases up-to date with new information collected daily.

We would like to congratulate the three regional fruit fly groups: Tephritid Workers of Europe, Africa and the Middle East (TEAM), Tephritid Workers of Asia, Australia and Oceania (TAAO) and Tephritid Workers of the Western Hemisphere (TWWH), for organizing their meetings during the first semester of 2024 (for more details please see pages 30 to 32). The meetings provide regular updates on the progresses of the thepritid fruit fly work, from research to field application, on the respective geographic regions.

Insect Pest Control Laboratory (IPCL) is reporting extensive work performed and progress made in Research and Development (R&D). We would like to highlight the identification of a temperature sensitive gene in *Aedes aegypti* that will be assessed as a selectable marker for the construction of a new genetic sexing strain for SIT applications (please refer to pages 19 to 24 for details). Additionally, three of the PhD students that conducted their work on tsetse presented their final defence of the PhD dissertations at the Technical University of Vienna (pages 32 to 33).

The Lee County Mosquito Control District (LCMCD) also initiated a new pilot project involving the sterile insect technique (SIT), which is now being used to suppress populations of disease vector mosquitoes in Fort Myers, Florida. This new pilot is built on previous experience and has already been tested out on Captiva Island in Florida, around 30 miles away, during a successful pilot project between 2020 and 2022. Male mosquitoes were mass-reared and sterilized before being released to mate with wild females. At the peak of the releases, approximately 400 000 sterile males were released per week in Captiva Island. The releases led to a significant reduction of the population in the first year, 2020, and complete suppression in 2021 and 2022.

Regarding IPC personnel matters, I am pleased to announce that Ms Teresa Vera was appointed as a Research Entomologist at the IPCL to conduct research on plan pests, mainly on fruit flies, which is in line with her extensive experience on research conducted in Argentina and internationally on the fruit fly behaviour. She has been a collaborator of the IPC subprogramme for a long period as chief scientific investigator of research contracts, but also on expert missions to support IAEA Technical Cooperation projects. I give a warm welcome to our new colleague.

Also, Chantel de Beer, previously working at IPCL as Livestock Entomologist, was reassigned to the Human Disease Vectors group at IPCL as a Medical Entomologist. In her new duties, she will be able to bring all the previous experience with R&D on tsetse and other animal disease vectors to the work on mosquito vectors of human diseases. I would like to express my gratitude for her previous work conducted on tsetse and to wish her success in her new position.

I would also like to welcome the new IPCL Head, Mr Polychronis (Chronis) Rempoulakis. He has extensive experience in fruit flies and biosecurity in different invasive insects in Australia, where he held a managerial position. Chronis has provided support to the IPC subprogramme for about 20 years, as a consultant, a scientific investigator of research agreements and as an expert to TC projects. I wish him all the best for his position as Head of the IPCL.

Rui Cardoso Pereira
Head, Insect Pest Control Section

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Forthcoming Events (2024–2025)

I. Research Coordination Meetings (RCMs) of FAO/IAEA Coordinated Research Projects (CRPs)

Third RCM on Improving Rearing, Handling, and Field Components for Fruit Fly SIT Application. 11–15 November 2024, Pretoria, South Africa.

Fourth RCM on Generic Approach for the Development of Genetic Sexing Strains for SIT Applications. 9–13 December 2024, Vienna, Austria.

Second RCM on Reproductive Biology of Male *Aedes* Mosquitoes for SIT Applications. 7–11 April 2025, Vienna, Austria.

Fourth RCM on Mosquito Irradiation, Sterilization and Quality Control. 5–9 May 2025, Athens, Greece.

First RCM on Field Application of MAT and SIT. 7–11 July 2025, Vienna, Austria.

First RCM on Tsetse Population Genetics. 20–24 October 2025, Vienna, Austria.

Third RCM on Improving the Mass-rearing of Lepidoptera Pests for SIT Programmes. 4Q 2025, Stellenbosch, South Africa.

Second RCM on Improvement of *Drosophila suzukii* Mass-Rearing and Released Methods for SIT Programmes. 3–7 November 2025, Mendoza, Argentina.

II. Consultants and Expert Meetings

Consultancy Meeting on Tsetse Population Genetics. 11–15 November 2024, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Fruit Fly Surveillance and Identification (under Regional TC Project RAS5097). 29 July–2 August 2024, Kuala Lumpur, Malaysia.

FAO/IAEA Regional Training Course on Mastering Colonization and Characterization of *Aedes* Mosquitoes Strain as an Initial Step towards Sterile Insect Technique (under Regional TC project RLA5092). 2–6 September 2024. Buenos Aires, Argentina.

FAO/IAEA Regional Training Course on GIS and Database on Fruit Fly Management (under Regional TC Project RAS5097). 7–10 October 2024, Hanoi, Vietnam.

FAO/IAEA Regional Meeting on the Establishment and Implementation of a New World Screwworm Eradication Programme (under Regional TC Project RLA5088). 14–18 October 2024, Montevideo, Uruguay.

FAO/IAEA Regional Training Course on Identification and Dissection Techniques to support SIT programmes for Controlling Tsetse Fly (under Regional TC Project RAF5087). 25–29 November 2024, South Africa.

Past Events (2024)

I. Research Coordination Meetings (RCMs) of FAO/IAEA Coordinated Research Projects (CRPs)

Fourth RCM on Improvement of Colony Management in Insect Mass-rearing for SIT Applications. 4–8 March 2024, Agrinio, Greece.

Fourth RCM on Assessment of Simultaneous Application of SIT and MAT to Enhance *Bactrocera* Fruit Fly Management. 22–25 April 2024 (virtual).

Second RCM on Improve the Mass-rearing of Lepidoptera Pests for SIT Programmes. 10–14 June 2024, Vienna, Austria.

First RCM on Improvement of *Drosophila suzukii* Mass-Rearing and Released Methods for SIT Programmes. 8–12 July 2024, Vienna, Austria.

II. Consultants and Expert Meetings

Consultancy Meeting on Thematic Plan for Fruit Flies Sterile Insect Technique. 24–28 June 2024, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Midterm Coordination Meeting on Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (under Regional TC Project RAF5087). 5–7 February 2024, Vienna, Austria.

FAO/IAEA Workshop on Dosimetry and Irradiation Procedures Applied in SIT Programmes for Control Tsetse Fly (under Regional TC Project RAF5087). 18–22 March 2024, Vienna, Austria.

FAO/IAEA Coordination Meeting on Validating the Sterile Insect Technique for the Control of the South American Fruit Fly (under Regional TC Project RLA5087). 8–12 April 2024, Lima, Peru.

Fifth TEAM (Tephritid Workers of Europe, Africa and the Middle East) Meeting. 15–18 April 2024, Belle Mare, Mauritius.

Eighteen Session of the Commission on Phytosanitary Measures (CPM-18), International Plant Protection Convention, FAO. 15–19 April 2024, Rome Italy.

Second TAAO (Tephritid Workers of Asia, Australia and Oceania) Meeting. 6–10 May 2024, Beijing, China.

FAO/IAEA Regional Training Course on Genetic Population Studies to Support Tsetse Field Projects (under Regional TC Project RAF5087). 6–17 May 2024, Cameroon.

FAO/IAEA National Coordination Meeting on Strengthening and Harmonizing Surveillance and Suppression of Fruit Flies in Regional Asia and the Pacific (Under Regional TC project RAS5097). 11–13 May 2024, Beijing. China.

FAO/IAEA National Training Course on Fruit Fly Surveillance Systems (under national TC Project JAM5015). 28–31 May 2024, Kingston, Jamaica.

11th TWWH (Tephritids Workers of Western Hemisphere) Meeting. 3–7 June 2024, Montego Bay, Jamaica.

FAO/IAEA Regional Workshop on Designing *Aedes* Population Suppression Trials for Sterile Insect Technique Validation (under Regional TC project RLA5092). 24–28 June 2024, Montevideo, Uruguay.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention FAO. 24–28 June 2024, Tucuman, Argentina.

Technical Cooperation Projects

The Insect Pest Control Subprogramme currently has technical responsibilities for the following technical cooperation projects that are managed by the IAEA. They can be classified under four major topics, namely:

- Biocontrol using radiation
- Human disease vectors
- Livestock pests
- Plant pests

Country	Project Number	Ongoing National Projects	Technical Officer
Bangladesh	BGD5035	Validating the Sterile Insect Technique as a Key Component of an Area-Wide Integrated Pest Management Programme Against *Aedes aegypti* in Dhaka	Maylen Gómez
Bolivia	BOL5023	Fruit Fly Control in Bolivia Using Integrated Pest Management Including the Sterile Insect Technique	Walther Enkerlin
Brazil	BRA5062	Application of the Sterile Insect Technique for the Control of *Aedes aegypti*	Rui Cardoso Pereira
Burkina Faso	BKF5023	Implementing the Sterile Insect Technique to Reduce Wild Populations of *Aedes aegypti* and Tsetse	Adly Abdalla Maylen Gómez
Cameroon	CMR5026	Supporting the National Fruit Fly Management Programme	Daguang Lu
Cambodia	KAM5011	Establishing SIT-based Area-wide Integrated Management of *Bactrocera zonata* and *Bactrocera dorsalis*	Daguang Lu
Chad	CHD5011	Implementing the Sterile Insect Technique to Control *Glossina fuscipes fuscipes* — Phase II	Adly Abdalla Chantel de Beer
Chile	CHI5051	Implementing Pilot Level of Sterile Insect Technique for Control of *Lobesia botrana* in Urban Areas	Walther Enkerlin
China	CPR5027	Demonstrating Feasibility of the Sterile Insect Technique in the Control of the Codling Moth, *Cydia pomonella*	Walther Enkerlin
China	CPR5028	Demonstrating the Feasibility of Applying Area-Wide Integrated Management Strategies Based on the Sterile Insect Technique in the Green Control of *Spodoptera litura*	Rui Cardoso Pereira
Cyprus	CYP5021	Preventing the Spread of the *Aedes albopictus* and *Aedes aegypti* Mosquitoes	Maylen Gómez
Dominican Republic	DOM0006	Building and Strengthening the National Capacities and Providing General Support in Nuclear Science and Technology	Walther Enkerlin
Ecuador	ECU5035	Assessing the Feasibility of the Sterile Insect Technique to Control the Invasive Vector Mosquito *Aedes aegypti* and the Mediterranean Fruit Fly at a Pilot Level	Maylen Gómez Walther Enkerlin
Ethiopia	ETH5024	Enhancing Livestock and Crop Production through Control of Tsetse and Trypanosomiasis to Contribute to Food Security	Chantel de Beer

El Salvador	ELS5015	Integrated Management of Fruit Flies using the Sterile Insect Technique to Establish Areas of Low Prevalence of Fruit Flies	Walther Enkerlin
Fiji	FIJ5007	Implementing Pesticide Free Suppression and Management of Fruit Flies for Sustainable Fruit Production — Phase II	Daguang Lu
Grenada	GRN0001	Building National Capacity through the Applications of Nuclear Technology	Rui Cardoso Pereira
Israel	ISR5022	Establishing the Sterile Insect Technique Methodology for the Management of the False Codling Moth, *Thaumatotibia leucotreta*, and Enhancing Integrated Pest Management Against the Peach Fruit Fly, *Bactrocera zonata*	Walther Enkerlin
Jamaica	JAM5015	Strengthening National Capacities for the Introduction of the Sterile Insect Technique for Pest Control, Mutation Breeding of Crops and Post-Harvest Treatment of Agricultural Produce Using a Self-Contained Gamma Irradiation Facility	Maylen Gomez
Kingdom of Eswatini	SWA5004	Utilizing the Sterile Insect Technique Integrated with Other Suppression Methods for the Management of the False Codling Moth	Daguang Lu
Mauritius	MAR5028	Enhancing National Capabilities on the Suppression of *Aedes albopictus* in an Urban Locality Using the Sterile Insect Technique as Part of an Integrated Vector Management Strategy	Maylen Gómez
Mexico	MEX5032	Scaling Up the Sterile Insect Technique to Control Dengue Vectors	Kostas Bourtzis
Morocco	MOR5040	Improving the Productivity of Livestock and Crops	Walther Enkerlin
Myanmar	MYA5029	Improving Fruit Yield and Quality by Using Sterile Insect Techniques as Part of Area-Wide Integrated Pest Management of Fruit Flies in the Mandalay Region	Daguang Lu
Oman	OMA5009	Establishing SIT-based Area-wide Integrated Management of *Bactrocera zonata* and *Bactrocera dorsalis*	Daguang Lu
Palau	PLW5003	Facilitating Sustainability and Ensuring Continuity of Area-wide Pest Management — Phase III	Daguang Lu
Panama	PAN5031	Validating the Sterile Insect Technique for the Control of the Mediterranean Fruit Fly, *Ceratitis capitata*	Walther Enkerlin
Portugal	POR5006	Integrating the Sterile Insect Technique in the Control of the Invasive Vector Mosquito *Aedes albopictus*	Maylen Gómez
Philippines	PHI5037	Assessing the Feasibility of the Sterile Insect Technique to Suppress the *Aedes aegypti* Population	Maylen Gomez
Senegal	SEN5044	Developing National Capacity for Implementing the Sterile Insect Technique against Tsetse Flies in the Sine-Saloum for 2024–2027	Chantel de Beer
Serbia	SRB5006	Strengthening National Capacity to Integrate the Sterile Insect Technique in the Control of *Aedes* Invasive Mosquitoes by Establishing a Mass Rearing Facility	Maylen Gomez

Seychelles	SEY5012	Establishing Area-wide Integrated Pest Management by Using the Sterile Insect Technique in Combination with Other Control Methods on the Suppression of the Melon Fly	Rui Cardoso Pereira
South Africa	SAF5019	Testing the Sterile Insect Technique Intervention as a Vector Control Tool against the Primary Malaria Vector, *Anopheles arabiensis*	HananoYamada
South Africa	SAF5020	Radiation Biology and Population Genetics of *Glossina brevipalpis* in Preparation of a Sterile Insect Technique (SIT) in Affected Communal Areas of North-eastern KwaZulu-Natal Province, South Africa	Adly Abdalla
Sri Lanka	SRL5054	Using Field Application of the Sterile Insect Technique in a Pre-Operational Trial for the Control of Dengue and Evaluating the Feasibility of the Application of the Sterile Insect Technique for the Control of Melon Fruit Flies	Kostas Bourtzis
Sudan	SUD5042	Implementing the Sterile Insect Technique for Integrated Control of *Anopheles arabiensis* — Phase III	Adly Abdalla
Turkey	TUR5026	Conducting a Pilot Program on Integrated Management of *Aedes aegypti* Including Sterile Insect Technique	Maylen Gómez
Turkey	TUR5027	Implementation of SIT for Suppression and Eradication of Medfly in Turkey	Daguang Lu
United Republic of Tanzania	URT5034	Implementing Pre-Operational Activities for the Elimination of *Glossina swynnertoni* through Area-wide Integrated Pest Management with a Sterile Insect Technique Component	Chantel de Beer
United Republic of Tanzania	URT5035	Implementing the Sterile Insect Technique as Part of Area-wide Integrated Pest Management for Controlling Invasive Fruit Fly Populations	Daguang Lu
		Ongoing Regional Projects	
Regional Africa	RAF5087	Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (AFRA)	Maylen Gómez
Regional Africa	RAF5092	Enhancing Agricultural Productivity for Improved Food Security in Africa	Daguang Lu Rui Cardoso Pereira
Regional Asia & the Pacific	RAS5090	Advancing and Expanding Area-wide Integrated Management of Invasive Pests, Using Innovative Methodologies Including Atomic Energy Tools	Walther Enkerlin
Regional Asia & the Pacific	RAS5095	Enhancing the Capacity and the Utilization of the Sterile Insect Technique for *Aedes* Mosquito Control	Rui Cardoso Pereira
Regional Asia & the Pacific	RAS5097	Strengthening and Harmonizing Surveillance and Suppression of Fruit Flies	Daguang Lu Rui Cardoso Pereira
Regional Europe	RER5026	Enhancing the Capacity to Integrate Sterile Insect Technique in the Effective Management of Invasive *Aedes* Mosquitoes	Wadaka Mamai Rui Cardoso Pereira

Regional Latin America	RLA5082	Strengthening Food Security through Efficient Pest Management Schemes Implementing the Sterile Insect Technique as a Control Method	Walther Enkerlin
Regional Latin America	RLA5084	Developing Human Resources and Building Capacity of Member States in the Application of Nuclear Technology to Agriculture	Walther Enkerlin Rui Cardoso Pereira
Regional Latin America	RLA5087	Validating the Sterile Insect Technique for the Control of the South American Fruit Fly (ARCAL)	Walther Enkerlin
Regional Latin America	RLA5088	Advancing Surveillance and Progressive Control of the New World Screwworm Using the Sterile Insect Technique	Walther Enkerlin
Regional Latin America	RLA5092	Enhancing Regional Capacity for the Adoption of the Sterile Insect Technique as a Component of Mosquito Control Programmes (ARCAL CLXXXVII)	Maylen Gomez
Regional Latin America	RLA7027	Applying Nuclear Technology in Agriculture, Water Resource Management and the Environment in Caribbean Member States (CARICOM)	Walther Enkerlin
		Interregional Project	
Interregional	INT5159	Atoms4Climate Adaptation and Mitigation: Non-Power Technologies for the Terrestrial Landscape	Rui Cardoso Pereira

Highlights of Technical Cooperation Projects

Strengthening and Harmonizing Surveillance and Suppression of Fruit Flies (RAS5097)

FAO/IAEA Consultancy Meeting on the Thematic Plan for Fruit Fly Management Using the Sterile Insect Technique

The Thematic Plan for Fruit Fly Control Using the Sterile Insect Technique was established in 1999. This plan aids in identifying the end users of the sterile insect technique (SIT) for tephritid fruit fly management and formulating an IAEA strategic vision to enhance the technology among the Member States (MSs). It is achieved through the internal research, external collaborative research via IAEA Coordinated Research Projects (CRPs), and technology transfer through the Technical Cooperation Programme, all of which yield tangible socio-economic benefits for the end users.

Given the 25 years that have passed since the first Thematic Plan was established, and the recent advancements in SIT application on tephritid fruit flies, along with changing global conditions, there is a need to update the Plan. To this end, a consultancy meeting was organized in Vienna at the IAEA headquarters from 24 to 28 June 2024. This meeting was a collaborative effort between the IAEA TC Department and the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, with the aim of developing and updating the Thematic Plan for fruit fly SIT.

Participants of the Consultancy Meeting on the Thematic Plan for Fruit Fly Management Using the Sterile Insect Technique, during the visit to the Insect Pest Control Laboratory (Seibersdorf, Austria).

Seven international experts and five project counterparts from MSs including Australia, Belgium, China, Guatemala, Indonesia, Malaysia, Mauritius, Mexico, Spain, Thailand, the United States of America, and Viet Nam, along with colleagues from the Insect Pest Control (IPC) Section of the Joint FAO/IAEA Centre, attended the meeting. On the first day of the meeting, participants shared the status of fruit fly management in their respective countries and regions and offered suggestions on the role of the IAEA in facilitating fruit fly SIT development and its application. To gain a deeper understanding of the research and development activities carried out at the Insect Pest Control Laboratory (IPCL), participants visited the laboratory on the second day. This was followed by a brainstorming session to further discuss the insights gathered.

The last three days were dedicated to the review of the old and the development of the new Thematic Plan, which was. entitled the "Thematic Plan for Fruit Fly Management Using the Sterile Insect Technique". It analyses current achievements and states the needs and challenges that fruit fly SIT programmes are facing. In addition, the Plan presents general and specific recommendations directed towards the IAEA and the Joint FAO/IAEA Centre, with a focus on several key areas including research and development, technology transfer, capacity development, normative activities, and delivery of services to MSs.

Second Coordination Meeting, 11–13 May 2024, Beijing, China

The meeting was hosted by China Agricultural University and attended by 16 project counterparts from 14 participating Member States (MSs) including Bangladesh, Cambodia, China, Fiji, Indonesia, Lao P.D.R., Malaysia, Myanmar, Nepal, Oman, Papua New Guinea, Sri Lanka, Thailand, and Viet Nam. The meeting reviewed the progress made on fruit fly management activities, discussed, and agreed on the approach and concrete strategy for the timely implementation of the project activities to meet the project outcome.

All MSs identified the major fruit fly pests of economic importance and hosts, and also presented the dacine fruit fly species recorded in their countries. However, most of the MSs do not have current or updated fruit fly infestation rates determined for hosts while some have only rough estimates. The surveillance and detection systems need to be strengthened as some of the MSs have surveillance only for a selected area (local fruit production or village ecosystem) for a certain duration of time or do not have a surveillance system established at all. Most fruit fly control methods in all MSs involve various techniques, including integrated pest management (IPM), bait application technique (BAT), male annihilation technique (MAT), sanitation, fruit bagging and insecticide spray, biopesticides and biological control but not all have them implemented in an area-wide approach.

The general support received from RAS5097 includes human resource development through the regional training courses, sponsored participation at regional/international fruit fly symposia, procurement on materials (lures and protein baits) and equipment (stereomicroscope with camera attachment). Some MSs also received specific support according to the country needs such as expert mission and

fellowship. All MSs expressed strong need for the IAEA's support through the RAS5097, which include materials, knowledge transfer, capacity building and technical support. The MSs also emphasized the strong demand of the training on fruit fly taxonomic identification, molecular technique for species identification, GIS and data management. The challenges faced by the MSs are similar, i.e. lack of funding (materials for field activities, i.e. lures, baits and traps), human resource availability and development and equipment (gamma irradiator, stereomicroscope).

Participants at the Strengthening and Harmonizing Surveillance and Suppression of Fruit Flies (RAS5097) Second Coordination Meeting. 11–13 May 2024, Beijing, China.

Due to the different progress and achievements made by the participating MSs, all expressed strong interest to continue the project and having plans to fill in the gaps on baseline data, establishment of national surveillance network, and training of human resource in the skill required in the implementation of AW-IPM with an SIT component. The meeting participants agreed to apply for a new TC project to continue and expand the current activities.

Validating the Sterile Insect Technique for the Control of the South American Fruit Fly (RLA5087)

Second Regional Project Coordination Meeting, 7–12 April 2024

The meeting was held in Lima, Peru, from 7–12 April 2024 and was attended by participants of the National Plant Protection Organisations (NPPOs) from Argentina, Brazil, Ecuador, Paraguay, Peru, Uruguay, and Venezuela.

During the meeting the progress made in project implementation during the years 2022 and 2023 was presented and reviewed. Moreover, the activities for 2024 and 2025 contained in the workplan were discussed and agreed with the project counterparts. Expert missions, training courses, corresponding venues for the training events and procurement needs were also agreed.

Participants to the TC project Validating the sterile insect technique for the control of the South American fruit fly (RLA5087) Second Regional Coordination Meeting (Lima, Peru).

One major activity was the presentation and discussion of a Master Plan (MP) and a Regional Strategic Plan (RSP) to transfer the technology for control of the South American fruit fly *Anastrepha fraterculus* using an area-wide integrated pest management (AW-IPM) scheme including the sterile insect technique (SIT). A fundamental aspect in the use of SIT against this pest, is the development of a genetic sexing strain (GSS) to provide technical and economic feasibility. Substantial progress in the development of the strain has been achieved by Argentina, Brazil and Peru in close collaboration with the Joint FAO/IAEA Insect Pest Control Laboratory located in Seibersdorf, Austria. Also, an important progress has been made in its artificial rearing as well as in the radiation biology. It is foreseen that the SIT package will be validated in the field at pilot scale in early 2025.

The MP and its RSP will be presented at decision making levels including the South American Regional Plant Protection Organisation (COSAVE) and the Regional Plant Protection Organisation of the Andean Countries (CAN). The aim is to seek support for the creation of a Regional Commission for the Control of the South American Fruit Fly using an SIT integrated AW-IPM approach.

A technical visit to the Servicio Nacional de Sanidad Agraria del Perú (SENASA) Sterile Fly Production Centre located at la Molina was conducted. The Centre is currently producing sterile Mediterranean fruit fly for sterile releases in areas under eradication in southern Peru. It also keeps a bisexual colony of *A. fraterculus* and a GSS strain under development.

Strengthening the Use of the Sterile Insect Technique (MOR5038)

The Mediterranean Fruit Fly Mass Rearing Facility in Agadir is ready for Sterile Insect Technique Implementation

The Mediterranean fruit fly mass rearing facility in Agadir, Morocco was reviewed by an IAEA expert in April 2024, and it was confirmed that it is ready to start operations. The facility is fully equipped with the functional equipment donated by Madeira Mediterranean fruit fly Programme, Portugal, and the equipment donated by the IAEA through national technical cooperation projects. The Agadir facility has enough space and equipment to operate at its maximum capacity and produce 130 million sterile pupae per week.

A major equipment that was procured by the IAEA and Morocco using a cost sharing scheme, is the irradiator. The mechanical part and Cobalt-60 housing parts of the irradiator arrived in Morocco and are stored at the facility's premises. It is expected that the cobalt-60 sources will arrive in the coming weeks. Therefore, the irradiator will be in operation in June/July 2024 after proper mapping and calibration of the source.

Agadir facility review team. (From left to right: Yassine Aoutil (MAROC CITRUS), Yahya Machal (MAROC CITRUS), Amine Laghlid (MAROC CITRUS), Carlos Caceres (IAEA expert), Zhor Dahbi (Regional Directorate ONSSA), Hassan Zouhry (MAROC CITRUS), Jamaâ Zim (MAROC CITRUS)).

The Mediterranean fruit fly genetic sexing strain Vienna-8 has been transferred from the Joint FAO/IAEA Insect Pest Control Laboratory in Seibersdorf, Austria to the facility in Agadir. It is intended that the facility starts producing 10 million male-only sterile pupae per week. With this, the importation of sterile flies from Valencia can be stopped. This production level is important since it will enable the facility staff to evaluate all systems and equipment and begin the local production. The total budget required to produce 10 million male-only sterile pupae per week (40 million per month) is equivalent to approximately 822 US dollars per million pupae. A new calculation will be necessary to estimate the cost of production at full capacity. The expectation is that the cost per million will be less than 300 US dollars per million since the fixed cost will not have strong variation.

Some relevant recommendations provided by the expert include: 1) before the facility becomes operational, a general maintenance on the heating and cooling units as well as other facility systems and equipment should be scheduled to ensure their proper functioning and reliability, 2) establish and implement the filter colony to maintain a local stock of pure strains, 3) the use of hydrolysed yeast to feed the adults is mandatory, 4) use sawdust to facilitate larval pupation, 5) pupae production should be scaled up in phases according to the affordability of the budget, and 6) continue providing support to the facility through staff training and expert mission once it becomes operational.

Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (RAF5087)

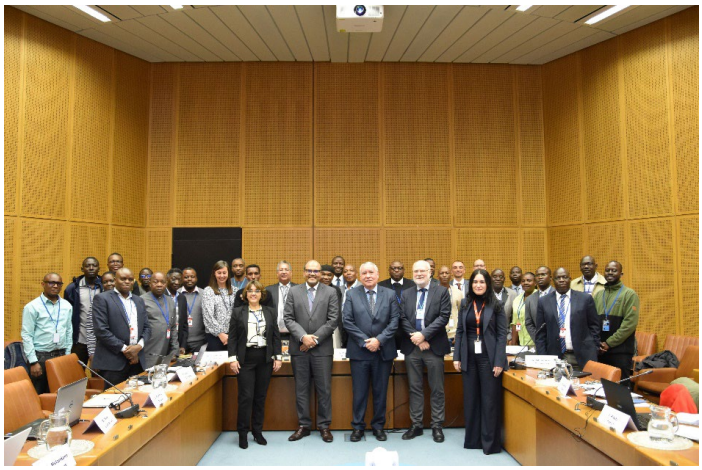
Mid-Term Coordination Meeting. 5–7 February 2024

The meeting was held at the IAEA headquarters in Vienna, Austria and attended by the project counterparts from 15 Member States (MSs) of the African region including Cameroon, Chad, Democratic Republic of Congo, Ethiopia, the Gambia, Kenya, Mali, Mozambique, Nigeria, Senegal, South Africa, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. In addition, experts from the Programme Against African Trypanosomosis (PAAT) of the Food and Agriculture Organization of the United Nations (FAO) and the African Union-Interafrican Bureau for Animal Resources (AU-IBAR) also participated.

The meeting objective was to review the project progress achieved in capacity building in 2022–2023 and to discuss the challenges faced at the regional level for adopting the sterile insect technique (SIT) technology targeting tsetse fly species. Additionally, the activities implemented by FAO-PAAT and AU-IBAR in support for African Trypanosomiasis and tsetse fly control were highlighted. The counterparts and the IAEA technical team reviewed and updated the work plan for 2024–2025 based on the region's priorities.

Senegal, the most advanced country on the application of tsetse SIT, shared valuable lessons learned and technological challenges encountered during the implementation of its successful eradication campaign as well as the positive benefits of removing tsetse flies from the highly productive agricultural region of Niayes using an AW-IPM approach with an SIT component. A highlight of the meeting was a

joint request to the IAEA from the MSs to organise a meeting with regional decision-makers supported by the project to raise awareness and secure political and financial commitment for the effective implementation of field campaigns towards the creation of sustainable tsetse and trypanosomosis free areas in sub-Sahara Africa.



Participants of the Mid-term Coordination Meeting on Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (Vienna, Austria).

The meeting provided a valuable platform for sharing knowledge, discussing technological challenges, and promoting collaborative efforts among the participating MSs in their fight against tsetse flies to reduce the Animal trypanosomosis burden in Africa.

Assessing the Feasibility of the Sterile Insect Technique (SIT) to Suppress the *Aedes aegypti* Population (PHI5037)

The Philippines initiated a new national Technical Cooperation project in 2024 (PHI5037) which aims to evaluate SIT at a pilot level to support its application as a tool in the Integrated Vector Management strategy to control mosquitoes at national level. *Aedes aegypti* is considered the primary vector of dengue arbovirus in the Philippines based on historical data and where the number of disease cases, mainly dengue, has been increasing during the past years. This two-year project started in January 2024 and has the Philippine Nuclear Research Institute (PNRI) as its counterpart.

With the support of IAEA regional TC project RAS5095 (Enhancing the Capacity and the Utilization of the Sterile Insect Technique for *Aedes* Mosquito Control), the Philippines has built essential capacities for testing SIT, and has benefitted from the capacity development and the baseline data collection under this and previous regional projects. Two areas have already been selected in Navotas city for conducting an SIT suppression trial against *Ae. aegypti.* They are around 62 ha in the pilot area and about 30 ha in the non-intervention area. Since August 2023, a surveillance network with ovitraps has been established in both areas, collecting the egg production levels weekly, as an expression of the mosquito adult population dynamics. This supports the characterization of the spatial extension and distribution of mosquito wild population in the selected areas. In addition, a small mosquito production facility was built at PNRI, which has also been equipped with essential equipment and consumables to support mosquito mass-rearing activities. The current maximum production capacity is estimated at 0.5 million sterile males per week. Besides, a local strain of *Ae. aegypti* has already been colonized and maintained under laboratory conditions. The strain's key rearing and behavioral parameters have been studied, since they are essential for the upscaling of the production. The Department of Science and Technology will support the irradiation activity. The local team has already developed a protocol for pupae sterilization under local conditions using the Ob-servo Sanguis -04 Gamma irradiator (IZOTOP, Budapest, Hungary), with an activity 6.28kCi; DUR: 1.1 at load configuration. Dose-response experiments are underway to determine the minimal sterilization dose required for male mosquitoes. Moreover, the local team is planning to evaluate and switch to adult sterilization because of the complexity of pupae sterilization.

Technical team and local authorities signed a MOU for surveillance and releases activities in the project's areas.

The mosquito production will be gradually scaled up, aiming to perform the Mark-Release-Recapture (MRR) studies in 2024 in both seasons, which are fundamental to estimating the size of the wild population in the pilot site as well as to determining the dispersal capacity and survival of sterile males in open field conditions. The information which will be collected from these studies will support the development of the release strategy. The team has also developed a strong collaboration with the local health and political authorities, which is essential for project implementation.

Strengthening National Capacities for the Introduction of the Sterile Insect Technique for Pest Control, Mutation Breeding of Crops and Post-Harvest Treatment of Agricultural Produce Using a Self-Contained Gamma Irradiation Facility (JAM5015)

Jamaica is willing to enhance its integrated vector management strategy (IVM) by incorporating the sterile insect technique (SIT) as a sustainable tool to suppress the mosquito, *Aedes aegypti*, vector of chikungunya, dengue and Zika viruses at the country level. For this aim, the Ministry of Health & Wellness has initiated efforts to build essential capacities for testing the SIT package. The National Vector Control Programme is coordinating the SIT activities. Two study sites have been selected in Kingston City for the SIT field trial. Both sites are entirely isolated, and two *Aedes* species are present, *Ae. aegypti* and *Ae. albopictus*. A monitoring network composed of ovitraps was established and field data has been collected weekly since 2021. Despite the presence of both *Aedes* species in the areas, the available field baseline information indicates a high prevalence of *Ae. aegypti*, which is the consequence of the host breeding site availability since it is a common practice to use water storage in these areas.

Facility for mosquito mass-rearing activities, Ministry of Health & Wellness (Kingston City, Jamaica).

To support mosquito-rearing activities, a local mass-rearing facility was built with the support of the local Health Ministry of Health & Wellness, with a production capacity of about 1.5 million sterile males/week. A local strain also colonized, well characterized, and reared routinely since 2018. The local team produces around 700 000 male pupae/week and 2.4 million eggs/week. Irradiation activities will be supported by the International Centre for Environmental and Nuclear Sciences (ICEN) which has a multidisciplinary laboratory with the necessary expertise.

National Workshop on Surveillance and Sterile Insect Technique (SIT). 29–31 May 2024, Kingston, Jamaica

Twenty professionals from the Plant Quarantine Produce Inspection (PQPI, the Jamaica National Plant Protection Organisation), Ministry of Agriculture, Fisheries and Mining, attended the workshop.

Workshop participants from the Jamaica Ministry of Agriculture Plant Quarantine Produce Inspection (PQPI).

The topics of the workshop covered the basic principles of the sterile insect technique (SIT) and its practical applications, including examples of operational programmes in the world, surveillance including trapping and fruit sampling, geographic positioning systems (GPS) and geographic information systems (GIS). During the last day of the workshop, a practical drill on the deployment of delimiting survey in case of a quarantine fruit fly incursion was implemented in the field at the Hope Gardens in Kingston. Traps were georeferenced in the field using GPS and the geographical coordinates of the traps were transferred to an online application for construction of a map showing the position of each trap and the layout of the delimiting trapping.

The PQPI benefited from this important training which is part of the capacity building to strengthen in Jamaica surveillance systems for early detection and emergency response to invasive fruit fly quarantine species. The risk of introduction of these fruit fly species is increasing by the day worldwide including in the Caribbean.

Enhancing Regional Capacity for the Adoption of the Sterile Insect Technique as a Component of Mosquito Control Programmes (RLA5092)

FAO/IAEA Regional Workshop on Designing *Aedes* Population Suppression Trials for Sterile Insect Technique Validation. 24–28 June 2024, Montevideo, Uruguay

The workshop was organized under the framework of Regional Cooperation Agreement for the Promotion of

Nuclear Science and Technology in Latin America and the Caribbean (ARCAL), and in corporation with the Ministry of Health of Uruguay and the Uruguayan University of the Republic and attended by 20 participants from 8 Member States (MSs) of Latin America and the Caribbean region (Argentina, Brazil, Cuba, Ecuador, Jamaica, Mexico, Peru, and Uruguay), in addition to two experts from the University of Florida (USA) and TRAGSA (Spain). The event was also attended by representatives of the Pan-American Health Organization (PAHO).

Participants of the FAO/IAEA Regional Workshop on Designing Aedes Population Suppression Trials for Sterile Insect Technique Validation (Montevideo, Uruguay).

The training focused on the eight most advanced countries of the region on the SIT application, and particularly on how to design small field pilot projects to evaluate the technology's efficacy in controlling *Aedes aegypti*. For the first time, PAHO participated in such a regional initiative, providing a unique opportunity for the participating MSs to discuss and share their challenges in implementing Aedes control activities. The progress achieved by each MS was reviewed during the workshop and it demonstrated their commitment in implementing the technology. More specifically, Argentina and Ecuador are initiating field releases of sterile males at the end of 2024, aiming at the suppression of the target population. Jamaica, Mexico, and Uruguay will conduct irradiation studies on male *Ae. aegypti adults* using gamma and X ray, respectively, as a key step before initiating the suppression phase. Peru is working on obtaining all regulatory authorizations for releasing sterile males in the field. Brazil and Cuba had already assessed the technology in the field and are planning to move ahead to apply SIT as a control component of their *Ae. aegypti* management strategy. As a main output of this workshop, each participating MS generated a dynamic activity chronogram to ensure the successful implementation of the upcoming suppression trials based on countries' priorities for the next two years.

FAO/IAEA Interregional Workshop on Dosimetry and Irradiation Procedures to Support Field Projects using the Sterile Insect Technique for Vector Control. (under RAF5087 & RAS5082)

As high demands of the Member States (MSs), the workshop was held at the Insect Pest Control Laboratory (IPCL) from 18–22 March 2024, under the framework of IAEA regional TC projects RAF5087 and RAS5082.

The workshop was focused on technical and practical aspects of dosimetry, irradiation and handling procedures used in SIT field projects for controlling *Aedes* mosquitoes and tsetse flies. In addition, the differences between X- and Gamma irradiators, and relevant factors affecting the dose-response in both insect species were also covered and discussed during the course. The training also provided a "basic irradiation package" to each participating MS to strengthen and harmonise procedures and standards in SIT projects. By providing hands-on sessions, participants became familiar with Gamma irradiators (Foss Model 812, Nordion Gammacell 220) and X-ray irradiators (Best Theratronics Raycell MK2, Precision Xrad 320 and Rad Source RS2400) for SIT application.

The practical sessions also provided the participants with essential information about using and calibrating the Gafchromic Dosimetry System for measuring absorbed doses, reading the exposed film and analysing the result. Providing technical guidance, practical sessions, and promoting open discussions, the training was a valuable platform for sharing knowledge and addressing challenges on such relevant SIT components for future implementation of new field projects against mosquitoes and tsetse flies.

Participants of the FAO/IAEA Interregional Workshop on Dosimetry and Irradiation Procedures to Support Field Projects using the Sterile Insect Technique for Vector Control.18–22 March 2024, Seibersdorf, Austria.

Coordinated Research Projects (CRPs)

Project Number	Ongoing CRPs	Project Officer
D4.20.17	Improvement of Colony Management in Insect Mass-rearing for SIT Applications (2018–2023)	Adly Abd Alla
D4.10.27	Assessment of Simultaneous Application of SIT and MAT to Enhance *Bactrocera* Fruit Fly Management (2019–2024)	Rui Cardoso Pereira
D4.40.03	Generic Approach for the Development of Genetic Sexing Strains for SIT Applications (2019–2024)	Kostas Bourtzis
D4.40.04	Mosquito Radiation, Sterilization and Quality Control (2020–2025)	Hanano Yamada
D4.10.29	Improving Rearing, Handling, and Field Components for Fruit Fly SIT Application (2021–2026)	Walther Enkerlin
D4.10.28	Improve the Mass-Rearing of Lepidoptera Pests for SIT Programmes (2022–2027)	Daguang Lu
D4.40.05	Reproductive Biology of Male Aedes Mosquitoes for SIT Applications (2023–2028)	Maylen Gomez
D4.10.30	Improvement of *Drosophila suzukii* Mass-Rearing and Released Methods for SIT Programmes (2024–2029)	Teresa Vera

Fourth RCM on Improvement of Colony Management in Insect Mass-rearing for SIT Applications, 4–8 March 2023, Agrinio, Greece

The Research Coordination Meeting (RCM) was held in Imperial Agrinio hotel, Agrinio, Greece with seventeen participants and seven observers from fourteen Member States (MSs) including Argentina, Brazil, Burkina Faso, Cameroon, Canada, Greece, Germany, Guatemala, Italy, Mexico, Netherlands, Spain, United Republic of Tanzania and United States of America attending it in person. The meeting was hybrid to enable two participants from Kenya and Israel and fifteen observers to attend virtually. The first two days of the meeting were devoted to presentations from the agreement and contract holders. During the remainder of the meeting, participants worked on preparing the RCM report and the final evaluation of the CRP. The special issue of the CRP was discussed, and it was agreed to submit manuscripts to the 'Insect Science' journal. The list of manuscripts was also revised.

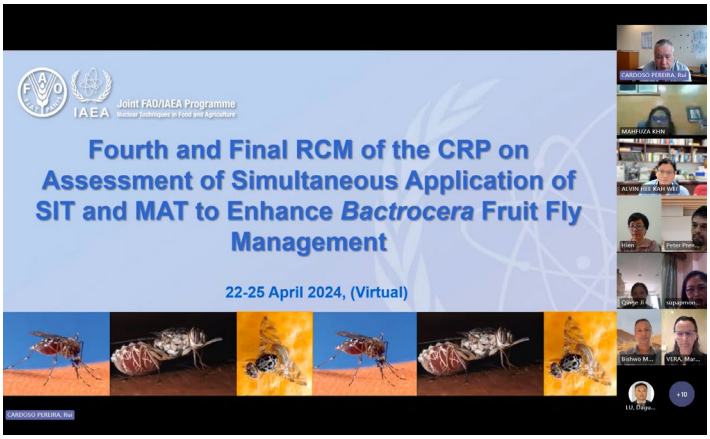
During this CRP, many milestone achievements were made with the aim of developing best practices for insect colony management to produce high-quality sterile males cost-effectively for SIT applications against major insect pests and disease vectors. This was achieved through a multidisciplinary approach involving entomologists, geneticists, ecologists, microbiologists, pathologists, virologists, and mass-rearing experts.

Participants of the fourth RCM on "Improvement of Colony Management in Insect Mass-rearing for SIT Applications" (Agrinio, Greece).

The achievements include the discovery and development of detection tools for several viruses infecting tsetse and fruit flies, the development of bi-environmental rearing cages for fruit flies and analysing the impact of *Spiroplasma* infection in tsetse flies. Additionally, the complete genome sequence of several tsetse species as well as bacterial symbionts and viruses of tsetse and fruit flies were obtained. Furthermore, different tools were developed and used to investigate the population genetics with microsatellites and RAPD methods to analyze the population genetics of insect populations in field conditions and to assess the impact of the domestication process on the insect genetic structure under mass-rearing conditions.

Fourth RCM on Assessment of Simultaneous Application of SIT and MAT to Enhance *Bactrocera* Fruit Fly Management. 22–25 April 2024 (virtual)

The meeting was held virtually with participants from Australia, Bangladesh, Brazil, China, Czech Republic, France, India, Israel, Kenya, Malaysia Mauritius, New Zealand, Pakistan, South Africa, Thailand and the United States of America. Each contract/agreement holder of this coordinated research project (CRP) reviewed and discussed the research progress and future plan.



Virtual RCM on Assessment of Simultaneous Application of SIT and MAT to Enhance Bactrocera Fruit Fly Management.

All participants agreed that the CRP has made significant progress in studying the impact of exposing major *Bactrocera* and *Zeugodacus* pest species to semiochemicals on earlier sexual maturation and improved male sexual performance, as well as reduced response of exposed sterile males to male annihilation technique (MAT) traps. The exposure of some dacine species to semiochemicals leads to earlier sexual maturation and significant improvement of male sexual performance. In addition, there is a 70% or greater reduction in trapping of males of some species that have been exposed to a semiochemical before release. The field cage evaluation of key parameters was also assessed, such as wild fly sex ratio, degree of lure response of sterile flies, sterile wild over-flooding ratio and bisexual release to determine their influence on the effectiveness of simultaneous MAT and sterile insect technique (SIT).

However, the Covid-19 pandemic posed difficulties and delayed the progress. The meeting participants recommended that a follow-up CRP should be proposed to enhance and expand the research achievement obtained during the past five years. Attempts need to be made 1) to increase the percentage of non-responding males while also maintaining the benefits of pre-release treatment, and the best means to achieve this, 2) to identify and develop promising female attractants for dacine fruit flies that can be used to suppress wild populations using an attract-and-kill approach, and 3) to evaluate key parameters in large field cages and in the field of simultaneous SIT, with either MAT or female suppression, within a pilot setting that includes compatible management practices.

Second RCM on Improve the Mass–rearing of Lepidoptera Pests for SIT Programmes. 10–14 June 2024, Vienna, Austria

The second research coordination meeting (RCM) was attended by 17 contract and agreement holders and 3 observers from 13 Member States: Argentina, Australia, Canada, Chile, China, Iran, Malaysia, Mauritius, Pakistan, South Africa, Syrian Arab Republic, United States of America and Viet Nam. The objective of this RCM was to review the research progress achieved so far and discuss the future plan of the individual research of the participants.

Participants to the RCM on Improve the Mass–rearing of Lepidoptera Pests for SIT Programmes (Vienna, Austria).

During the first two days of the meeting, all participants presented their research achievements relevant to this CRP, as well as their research plans for the next 18 months. At the following three days, general discussions were held to review the thematic areas, the Logical Framework (LFM) of the CRP and the RCM report with detailed R&D plans which shall be conducted during the next 18 months of the CRP.

The overall objective of this CRP is to expand and improve the sterile insect technique (SIT) for use against lepidopteran pests of crops, to improve food security and enhance human health and well-being with three specific research

objectives: 1) Establishing basic rearing technologies for Lepidoptera of economic concern; 2) Scaling and adapting basic rearing technologies to mass-rearing systems for the application of the SIT against lepidopteran pests, and 3) Optimizing existing mass-rearing systems for sterile Lepidoptera to increase efficacy and reduce the cost of area-wide SIT programmes. The overall achievements under each specific objectives are: 1) The semi-artificial/artificial diets of candidate species for SIT applications were explored to establish and maintain the laboratory colony with suitable rearing conditions. The diet contaminants were reduced by using appropriate antimicrobials; 2) Significant progress has been made in scaling up mass-rearing systems for various species such as *Lobesia botrana*, *Spodoptera litura, Eldana sacharina*, *Amyelois transitella*, and *Helicoverpa armigera.* Improvements in egg collection systems, insect marking, handling protocols, sex separation, have been also made, and 3) Optimization of the mass-rearing process for *L. botrana*, *Cydia pomonella*, *A. transitella*, *Thaumatotibia leucotreta* has progressed with advances in diets, automation, and mass-rearing systems.

First RCM on Improvement of *Drosophila suzukii* Mass-Rearing and Releasing Methods for SIT Programme. 8–12 July 2023, Vienna, Austria

The Spotted Wing Drosophila (SWD), *Drosophila suzukii*, is a pest species originated from Asia that expanded its area of distribution to important fruit production regions in Europe, Americas, and some African countries in this century. This major pest infests soft-skinned and higher sugar level fruits including cherries, raspberries, strawberries, blueberries, and blackberries, and, in some weather conditions, grapes. Growers use intensive chemical insecticides and laborious cultural methods to limit infestation of *D. suzukii* and losses in production. Limited options of insecticides, occurrence of resistance development and presence of many alternative hosts make its control more challenging. In this context, SIT is a promising alternative solution which has been proved to reduce crop damage in the field. As a follow up of a recently finished CRP (CRP D43003: Integration of the SIT with Biocontrol for Greenhouse Insect Pest Management), this new CRP is specifically devoted to *D. suzukii*. The overall objective is to advance the development and implementation of SIT and its integration with biocontrol agents in greenhouses and the open field. Activities will focus on the fine-tuning of rearing, quality control, and irradiation protocols for SIT application, the development of male-only genetic sexing strains, field releasing methods, and long-distance shipments of sterile insects. The overall expected outcome would be that the SIT and compatible control methods are being implemented and used by member states as appropriate, to reduce crop losses and pesticide residues in food.

Participants to the RCM on Improvement of Drosophila suzukii *Mass-Rearing and Releasing Methods for SIT Programme (Vienna, Austria).*

The RCM was attended by 25 participants from 14 countries including Argentina, Austria, Canada, Chile, China, France, Germany, Greece, Italy, Mexico, Morocco, Romania, United Kingdom, and United States of America. During the first two days of the meeting, the CRP agreement and contract holders presented their current research relevant to the CRP, and the research plans for the first year of the CRP. During the last three days of the meeting, general discussions were held to define and review the thematic areas of the CRP, the general and specific R&D objectives to be addressed during the entire five years of the CRP, and the CRP Logical Framework, in order to agree on minimum outputs to be achieved at the end of the CRP. Furthermore, participants were divided into two working groups to develop more detailed R&D plans to be conducted during the first 18 months of the CRP. Participants also conducted a mind mapping exercise to identify activities to be held under harmonized protocols and concerns to be considered for successful SIT implementation such as stakeholders' involvement and community awareness.

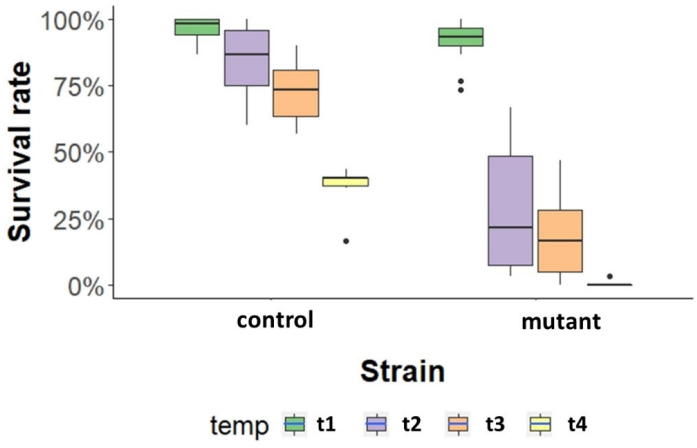
Developments at the Insect Pest Control Laboratory (IPCL)

Genetics and Molecular Biology

Identification of a Temperature Sensitive Gene in *Aedes aegypti*

The recent discovery of the *white pupae (wp)* and *temperature-sensitive lethal (tsl)* genes in *Ceratitis capitata* highlights the effectiveness of a generic approach in aiding the development of sexing systems for disease vectors. The identification of tsl traits in *Aedes aegypti* mosquitoes is a key focus of IPCL's efforts to create an efficient genetic sexing strain (GSS) for this species. To achieve this objective, we characterized potential *tsl* candidate genes using CRISPR/Cas9 gene editing techniques.

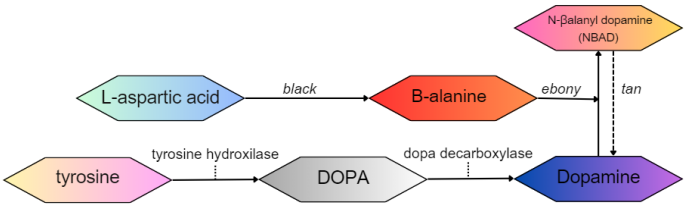
A wide range of genes known to confer a tsl phenotype in other insect species were evaluated and prioritized. Their evaluation was based on their mutant phenotypes in other species and their chromosomal location in *Ae. Aegypti.* The genes were ranked and the ones with the highest potential were targeted using CRISPR/Cas9 mutagenesis. One of these mutated genes showed promising results when exposed at higher temperatures, when compared to a wild-type strain. The survival rate of the mutant strain is significantly decreased as temperatures elevate. On the other hand, the control wild type strain shows resistance, despite the small, expected cost due to the high temperature. The line is currently evaluated for its fitness and in case the mutation does not confer any significant costs related to fecundity, fertility, and flight ability, it will be used for the construction of a novel GSS in *Ae. aegypti.* Such a selectable marker would streamline sterile insect technique (SIT) operations and reduce costs and labour for mass rearing facilities and large-scale programs.



Boxplot of the survival rates (%) between a control wild type and a mutant strain.

Genes Involved in Melanization as Candidate GSS Markers in Fruit Flies and Mosquitoes

The colour and pattern of insect bodies undergo significant changes throughout their development as they adjust to their environment. A considerable portion of this diversity can be credited to genes responsible for melanin synthesis and they can serve as candidates for the development of novel genetic sexing strains in fruit flies and mosquitoes. The mechanism that controls body pigmentation in insects involves a complex network of genes, including *yellow*, *black*, *ebony*, and *tan*.



Melanin pathway in insects. Modified from Liu, J., Lemonds, T. R., Marden, J. H., & Popadić, A. (2016). A pathway analysis of melanin patterning in a hemimetabolous insect. Genetics, 203(1), 403-413.

IPCL is continuously dedicating resources to isolate and characterize morphological markers specific to fruit flies and mosquitoes. These markers, including the genes involved in the melanization pathway, could serve a dual purpose: they could either directly integrate into a genetic sexing strategy or complement mutations like the *temperature-sensitive lethal* (*tsl*) ones. Even with a *tsl* mutation in hand, a closely linked morphological marker remains highly beneficial. It not only ensures the preservation of a *tsl*-based genetic sexing strain (GSS) but also facilitates rapid screening of the final product before male-only releases, as in the case of the VIENNA GSS strains used for the Mediterranean fruit fly.

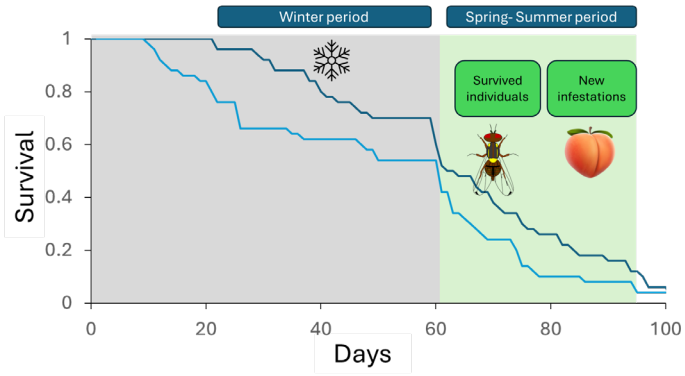
One of the genes involved in the pathway responsible for body coloration was targeted in *Anastrepha* species and *Ae. aegypti*. In the case of *Anastrepha* species a series of embryo injections led to the desired phenotype at the pupal stage through CRISPR/Cas9 knock-out mutagenesis. Quality control tests are currently being conducted to assess the viability of the strains carrying these mutations with the aim of developing new GSS with improved quality. In *Ae. aegypti* the same gene was also knocked out through CRISPR/Cas9 mutagenesis. The mutant line was constructed by participants of the IAEA coordinated research project (CRP) D44003 'Generic approach for the development of genetic sexing strains for SIT applications' and it was sent to IPCL for further assessment. The mutation was evident at the L3 and L4 larval stage, but also at the pupal stage. The mutant line was evaluated with the standard quality control protocols to determine whether it was

conferring a fitness cost to the strain. The mutant strain shows significant decrease in fecundity and sex ratio. Despite the fact that the selectable marker is visible at the larval stages, and it could be favourable for the development of a new GSS, the poor fitness of the mutant line ranks it out of the pool of candidates. The efforts to identify suitable selectable markers for *Ae. aegypti* are continuous and aim for a marker that will satisfy the requirements of an efficient GSS.

Plant Pests

Assessing fruit flies' overwintering capacity and cold tolerance in different European areas

The establishment of tropical or subtropical insect species, particularly fruit flies (Diptera: Tephritidae), in temperate regions worldwide is intricately regulated by climatic conditions and landscape. Climatic factors such as temperature typically delineate the northernmost boundaries of fruit flies' distribution and establishment. Establishment, in this context, refers to the capacity of the pest to complete at least one generation under the challenging temperate conditions prevalent in these regions and pose a threat for the upcoming year's crop production.



Survival curves of fruit flies during the winter period.

The cold winter of European temperate areas surpassing the critical thermal limits of these pests which determine their survival in a given area. However, recent investigations have shed new light on the adaptive capacity of fruit flies in such challenging conditions. Studies have documented their ability to overwinter in different life stages within temperate areas and last decades research has explored their capacity to expand critical thermal limits, potentially influenced by prior exposure to such challenging conditions.

Of particular concern are *Bactrocera* species, some of which are characterized as great invaders. Species such as *Bactrocera dorsalis* and *Bactrocera zonata* are multivoltine, highly polyphagous and exhibit high adaptive and plastic responses in challenging environmental conditions. Especially, *B. dorsalis* have been detected several times during the last five years in Italy, signaling the warning of potential new invasions and establishment. To assess the possibility of establishment of these species in new areas, it is essential to investigate their overwintering capacity.

Overwintering larvae inside the infested fruit.

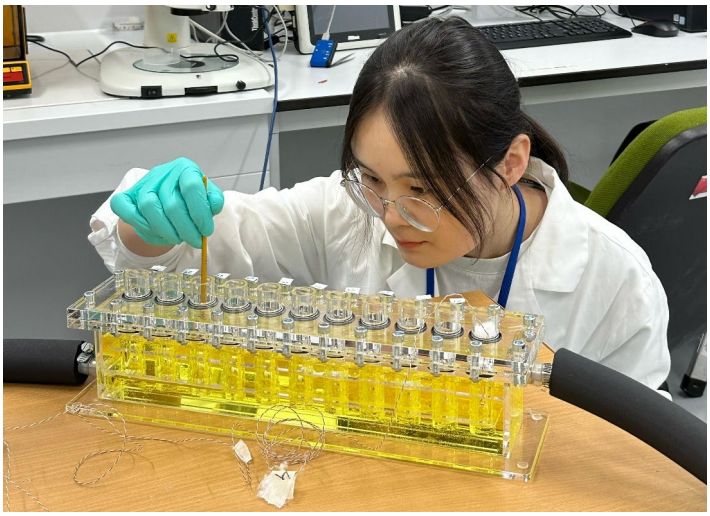
The present study is part of the EU-funded 'REACT' project titled: 'Rapid elimination of invasive insect agricultural pest outbreaks by tackling them with Sterile Insect Technique programs' and takes place in the facilities of IPCL. By analyzing climatic data spanning the last decades, the aim is to delineate the alterations in winter climatic profiles across various regions and the effect of winter temperatures on fruit flies' survival, cold tolerance, and life history traits. Recent investigations have underscored that, owing to milder winter temperatures, several species exhibit enhanced performance during the season, thereby altering both phenology and population dynamics, although further investigation on the effect of the winter cold temperatures on the fruit flies' performance is needed. In addition, the project focuses on the effect of freezing periods during the winter in population growth and pest occurrence.

Flies in chill comma during the winter period (freezing event).

In conclusion, the study underscores how the characterized high adaptive and plastic responses of fruit flies determine their capacity to survive the cold winters in temperate areas. By providing better understanding of invasion in such regions of the EU, we pave the way for adapting novel pest management methods based on pests overwintering biology.

FAO/IAEA/USDA phytosanitary treatment projects

We continue to assess potential factors that might affect phytosanitary irradiation efficacy for *Drosophila suzukii*. Given that *D. suzukii* late pupa has been described as the most radiotolerant stage associated with fresh fruit, the tolerance of newly emerged adult flies to phytosanitary irradiation was evaluated, simulating potential cases of emergence before the treatment. Preliminary results indicate that newly emerged females treated with the phytosanitary irradiation dose of 80 Gy can lay eggs, but they do not hatch, resulting in no F1 generation.



Liqiong Zhang (Ph.D. student) measuring the thermal limits of Anastrepha ludens.

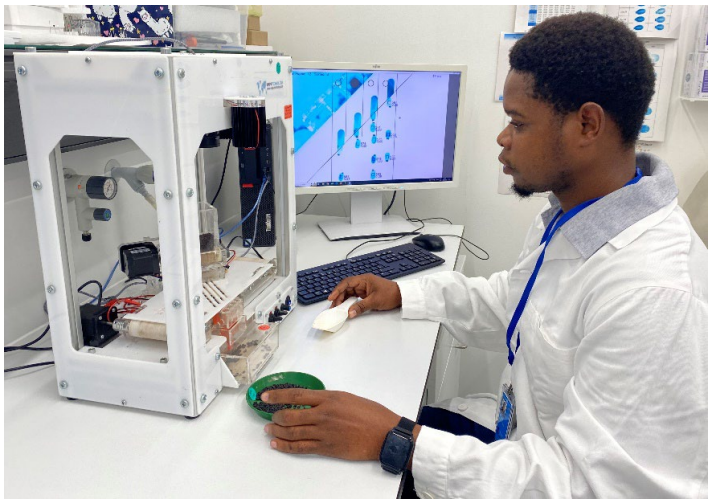
We are also assessing the thermal limits of acclimated and non-acclimated *Anastrepha ludens* adults from Belize, Guatemala, and Mexico. This collaborative effort has yielded promising results, which will be summarized in a manuscript for publication. Furthermore, new studies are underway to evaluate the effect of radiation treatment and genetic background on the thermal tolerance of *A. ludens*.

Livestock Pests

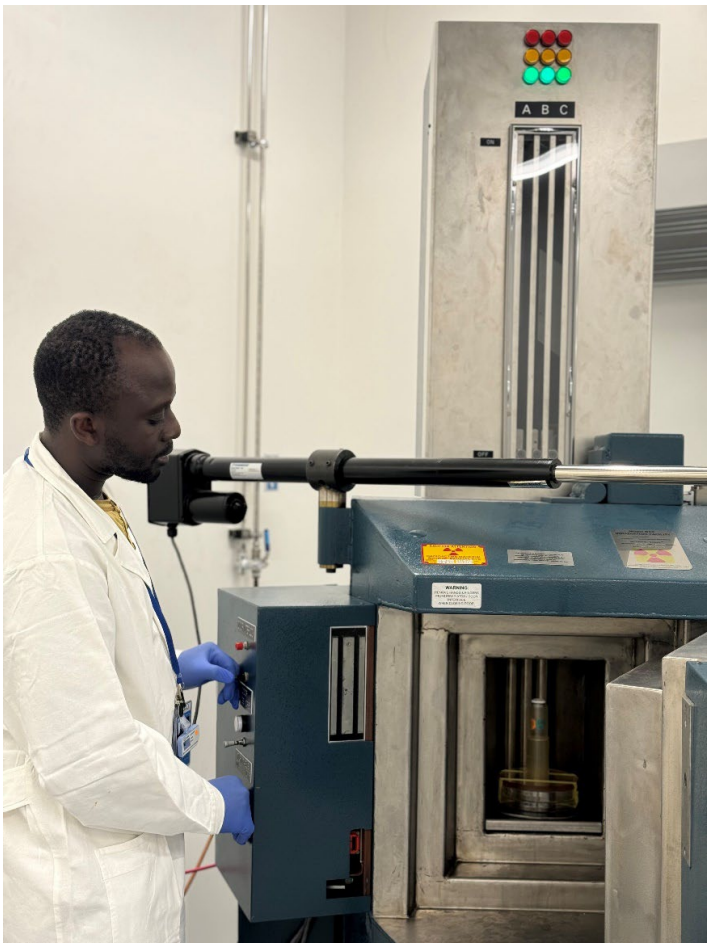
Radiation dose fractionation to enhance the quality of sterile male *Glossina palpalis gambiensis*

The production of large quantities of highly competitive sterile males to be released in the field is one of the most critical factors for implementing the sterile insect technique (SIT) for the management of tsetse. Although, several factors may influence the biological quality of sterile males, optimization of the irradiation protocols to limit unwanted somatic cell damage is important as this could improve male performance. In the context of refining gamma radiation protocols. We are conducting a study to evaluate the impact of dose fractionation on the quality of sterile tsetse males, with relation to sterility, longevity, and flight quality.

Male flies, after sorting with the Near Infrared Pupae Sex Sorter (NIRPSS), were irradiated as pupae between days 23 and 27 post-larviposition, receiving a 110 Gy dose administered either as a single dose or fractionated doses of 10 + 100 Gy, 50 + 60 Gy separated by 1-, 2-, and 3-day intervals, or 55 + 55 Gy separated by 4-, 8-, and 24-hour intervals. The findings revealed that all treatments resulted in over 90% sterility in females mated with irradiated males compared to untreated males and it was clear that irradiating *G. p. gambiensis* pupae using any of the dose fractionation combinations resulted in a decrease of induced sterility with increasing age. Furthermore, no significant differences were observed in emergence rate or flight propensity between fractionated and single radiation doses, nor among the different types of fractionations. Nonetheless, tsetse that were exposed as pupae on day 0 with a dose of 50Gy and then one day later with a dose of 60Gy, exhibited slightly higher induced sterility, flight propensity, and male survival under a feeding regime.



Mr Athumani Mkinga sorting Glossina palpalis gambiensis *pupae with the Near Infrared Pupae Sex Sorter before exposure to radiation.*



Mr Bénéwendé Aristide Kabore setting up the model 812 irradiator to expose the pupae.

It is clear that the value of hormesis induced in fractionally sterilized males is influenced by the pupal developmental stage and that the biological benefits are relatively modest when compared to the associated additional handling time. The immediate implementation of using a fractionated dose is not recommended however further considerations and optimizations are suggested. Alternative dose fractionation schemes could be investigated in the future to determine if there are more efficient ways to achieve better results while reducing workload.

Enhancing sterile *Glossina palpalis gambiensis* male survival through radiation in a nitrogen-enriched environment

It is well known that ionizing radiation creates free radicals, and this is enhanced in the presence of oxygen and that exposing insects to radiation in a low oxygen environment may reduce the somatic damage in the insects that is caused by these free radicals. The current radiation protocol for tsetse pupae only allows for radiation exposure in air. Therefore, this study aimed to explore the potential protective effect of nitrogen treatment against radiation to enhance the quality of sterile tsetse males for SIT implementation.

Mr Bénéwendé Aristide Kabore flushing the Glossina palpalis gambiensis *male pupa inside a Locknlock Twists container with nitrogen.*

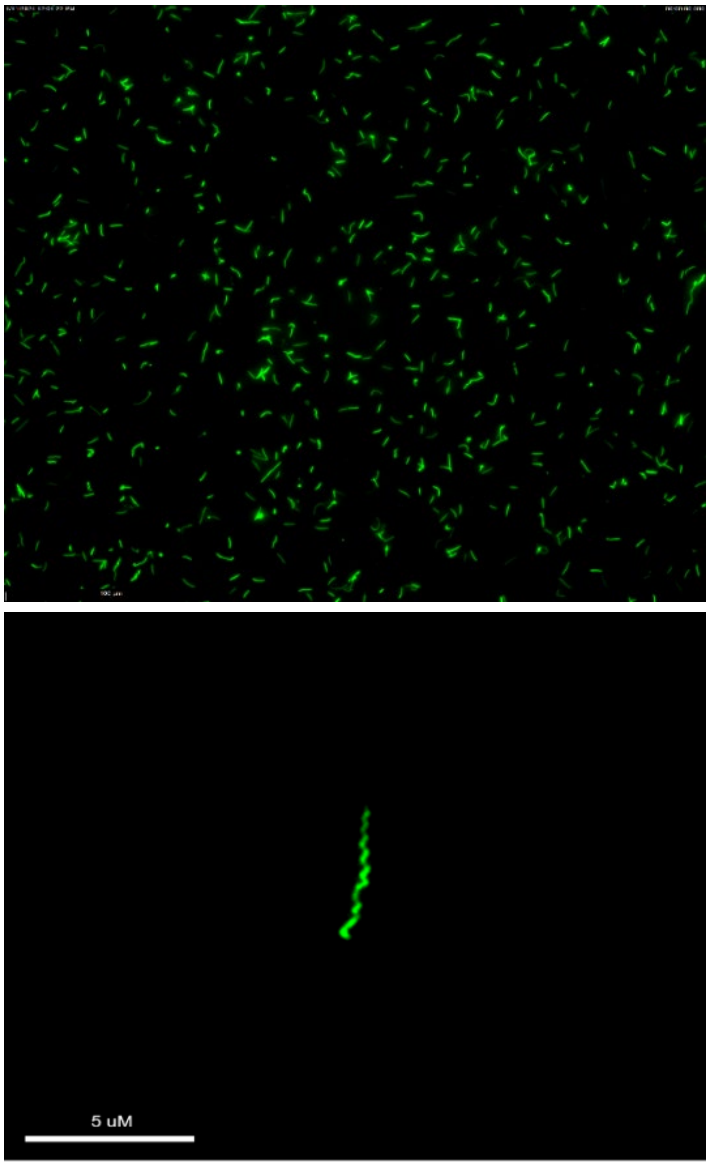
Glossina palpalis gambiensis male pupae aged 24-25 days were subjected to nitrogen inside a Locknlock Twists container for one hour before radiation. The pupae were then exposed to Gamma (Foss Model 812) and X-rays (Rad Source 2400) with varying doses of 110, 120, 130, 140, and 150 Gy. The pupae were removed from the nitrogen environment just after radiation treatment. The results indicate that atmospheric conditions did not significantly affect adult emergence rates. Moreover, male survival time under radiation treatment notably increased in a nitrogen atmosphere, suggesting radioprotective effects similar to those observed in other insect species. Nitrogen also required higher radiation doses, 115 Gy for X-rays and 135 Gy for gamma-rays to induce sterility in females compared to doses in air, 90 Gy for X-rays and 110 Gy for gamma-rays, indicating its potential as a radioprotective agent.

These results not only affirm the protective effects of radiation in a nitrogen environment on *G. p. gambiensis* pupae but also demonstrate the effectiveness of X-rays and gamma rays in achieving an acceptable level of sterility. The next step in this study is to assess the mating performance of males that were exposed to radiation in a nitrogen environment, and this is currently ongoing.

In vitro cultivation of the tsetse fly *Glossina fuscipes fuscipes* endosymbiont *Spiroplasma* and genome sequencing

Tsetse flies harbor diverse endosymbiotic bacteria such as *Wigglesworthia, Sodalis, Wolbachia* and *Spiroplasma* which have some serious impacts on tsetse mass-rearing. *Spiroplasma* is a bacterial symbiont of *Glossina fuscipes fuscipes (Gff)* and *Glossina tachnoides* (palpalis group) and has not been found so far in any other tsetse species. *Spiroplasma*, a helical, wall-less bacterium found in *Gff*, has recently attracted interest due to its negative impact on host reproductive homeostasis and potential modulation of vector competence through the inhibition of *Trypanosoma* in laboratory flies. To further analyze the interaction between

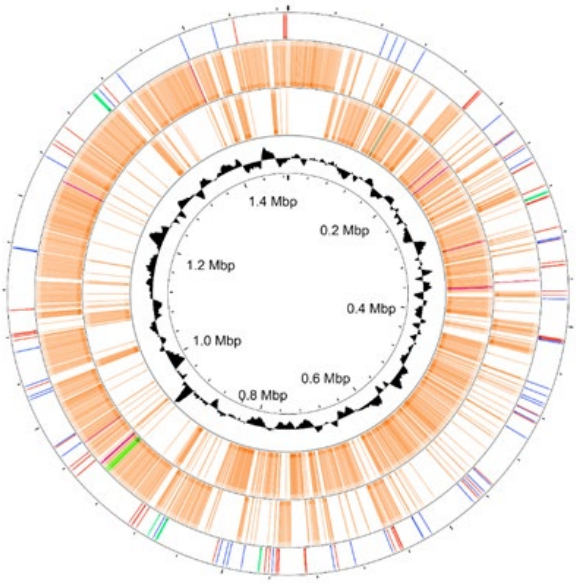
Spiroplasma and its host, attempts to establish an *in vitro* culture from *Spiroplasma* isolated from *Gff* adults were conducted. The results indicated that using a modified Barbour- Stoenner-Kelly H (BSK-H) medium, we obtained for the first time a stable culture of *Spirolplasma* isolated from *Gff* adults. Microscopic observation of cultured *Spiroplasma* after several passages proved that the maintained bacteria are helical- Spiro-shape bacteria.



Top: High density in vitro culture of Spiroplasma initiated from Gff hemolymph, passage 9. Bottom: Close-up of Spiroplasma morphology. Bacteria were stained with Syto9 live stain and imaged on a Leica fluorescent microscope.

Quantitative PCR detection proved that the bacteria density increased with the increase in incubation time. To further prove that the cultured bacteria are *Spiroplasma* and that they are related to those found in tsetse adults, the whole genome of the *Spiroplasma in vitro* culture was sequenced using nanopore sequence technology and compared with the whole genome sequence of *Spiroplasma* found in tsetse adults recently obtained by Serap Akosy's laboratory at Yale University, USA.

The genome sequence assembly revealed a complete circular genome of 1.48 million nucleotides and associated circular plasmids, encoding a total of 1857 genes. The homology between the genome sequence obtained from the cultured *Spiroplasma* and *Spiroplasma* from Gff adults was very similar providing evidence that the cultured bacteria are Gff- *Spiroplasma.* Several genes have been identified that may play an important role in the infection and colonization of the fly host and will be further investigated through functional studies. These findings may enhance the understanding of the symbiotic relationship between the tsetse fly *Gff* and *Spiroplasma* and potentially offer new insights into the mechanisms affecting vector competence. This work was performed by Mr Fabian Gstöttenmayer, a PhD student from Austria.

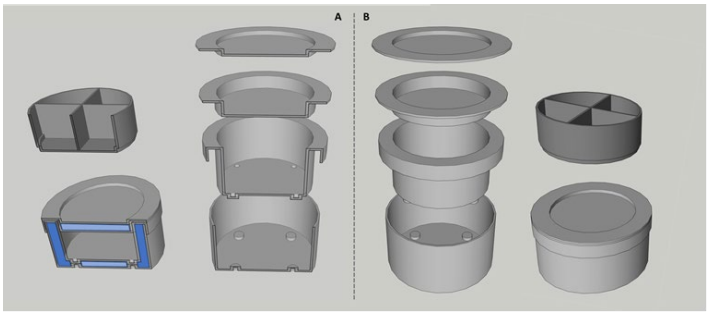


Circular genome of cultured Spiroplasma *(1.48 Mb) from* Glossina f. fuscipes*. From the innermost ring:1: GC content; 2,3: Annotated genes in forward and reverse direction (-,+); 4: Annotated mobile genetic elements.*

Human Disease Vectors

Irradiation canister

A 3D-printed phase change material based coolable canister was recently developed at IPCL which can compact, immobilize, and hold around 100 000 adult mosquitoes during radio sterilization procedures. Although this irradiation canister has shown excellent performance in maintaining and improving the quality of treated adults, an improvement in its thermal insulation could optimise the cooling period to avoid the exposure to variable or extreme temperatures. Moreover, the possibility of adjusting the cooling structures in the canister according to the radiation beam geometry would decrease the attenuation effects, maintaining the dose rate of the available irradiator. A new configuration of a thermoformed coolable canister with improved thermal insulation and adjustable positioning of the cooling structures has been therefore conceived and it is under production. This new model has a reduced compaction height and can accommodate cooling structures both vertically and horizontally depending on the orientation of the radiation source.



Cross-section view (A) and overall assembled technical drawing (B) of a new phase change material (PCM) based coolable plastic canister with improved thermal insulation and adjustable positioning of the PCM cooling packs. The canister has a removable compartment divided into 4 sections. The assembly of the four plastic pieces of the canister allows the creation of vertical (dark blue) and horizontal (clear blue) slots for the cooling PCM packs that can be used depending on the orientation of the radiation source.

Mass rearing cage for *Anopheles*

A new *Anopheles* mass rearing cage model has been produced to obtain a smaller and lighter plastic tool capable to maintain the same production capacity of the larger stainless-steel version A novel plastic thermoformed basal support has been designed and installed in an available standard *Aedes* plastic cage. The basal support is V shaped and may be partially filled with water to create an oviposition site. A perforated pipe placed all around the bottom introduces water into the cage to rinse the eggs through an outlet frontal valve. Mass rearing trials will be realised to obtain an effective insemination rate and eggs productivity in comparison with available data collected on larger available mass rearing cages.

A new Anopheles *mass rearing cage model.*

Density and presence of females has little effect on the sensitivity of longevity tests for sterile male QC in *Aedes aegypti*

Longevity tests can be performed to assess the quality of males, when comparing various treatments to non-treated control groups. However, there is no defined standardized protocol to perform longevity tests for example, for sterile male mosquitoes. Different test designs were compared to see whether other stress factors such as high cage densities, or the presence of females (continuous mating) would affect male longevity in such a way that the effects of the actual factor to be tested (in this case, high irradiation doses) would be clouded. It was found in *Aedes aegypti*, that the presence of females and high cage densities did reduce longevity overall, but proportionally equally in both treatment and control groups. Most importantly, the effects of high dose irradiation were significantly visible even when cage densities were high, and females were present. This shows that longevity test design in this case is not as crucial as initially anticipated. It is important though, to follow the mortalities throughout the life of the cage, as effects are often only visible in the latter half of the males' lives. It is recommended to keep longevity test protocols consistent to be able to compare results throughout time.

Reports

Sterile Insect Technique Used to Suppress Mosquito Disease Vectors in Florida

Sterile mosquitoes are being used to suppress mosquitoes that have become resistant to insecticide in Fort Myers, Florida in the United States of America. The pilot project is being carried out with the support of experts from the IAEA and the Food and Agriculture Organization of the United Nations (FAO) and aims to suppress populations of a disease-vector species of mosquito called *Aedes aegypti* which is prevalent in Florida.

Sterile Aedes aegypti *males inside a bucket ready for release on Captiva Island in Lee County, Florida. (Photo: LCMCD, USA).*

Aedes aegypti mosquito populations are particularly difficult to manage using traditional control techniques as they are diurnal mosquitoes that use cryptic breeding habitats, which makes their larvae difficult to find and remove. In addition, these mosquitoes are becoming increasingly resistant to insecticides. The Lee County Mosquito Control District (LCMCD), located in southwest Florida, USA, has been working to mitigate the public health threat posed by these mosquitoes since its inception in 1958. Increasing urbanization combined with increasing resistance to insecticides has led to a nearly ubiquitous spread of *Ae. aegypti* throughout the county and created a need for the LCMD to identify alternative ways to combat this challenging species.

A new pilot project involving the Sterile Insect Technique (SIT) is now being used to suppress populations of disease vector mosquitoes in Fort Myers, Florida. The SIT is an environmentally friendly pest control method which involves sterilizing male insects using radiation, before releasing them to mate with wild females, resulting in fewer or no offspring. The SIT pilot project is benefiting from extrabudgetary funding contributions from the IAEA's Peaceful Uses Initiative (PUI).

Rui Cardoso Pereira, Head of the Insect Pest Control at the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, says "the extrabudgetary PUI funds contributed by the USA have been instrumental for R&D based improvement of the SIT package for *Aedes* mosquitoes and its further transfer to pilot projects in our Member States." *Ae. aegypti* mosquitoes can spread diseases such as chikungunya, dengue, yellow fever and Zika, making them a significant threat to public health and therefore contributes to the attainment of Sustainable Development Goal 3, good health.

Releases of sterile mosquitoes being conducted at the Captiva Island. (Photo: LCMCD).

The SIT pilot project, which was initiated in the coastal city of Fort Myers, has already been tested out on Captiva Island in Florida, around 30 miles away, during a successful pilot project between 2020 and 2022. Male mosquitoes were mass-reared and sterilized before being released to mate with wild females. At the peak of releases, approximately 400 000 sterile males were released per week in Captiva Island. The releases led to a significant reduction of the population in the first year, 2020, and complete suppression in 2021 and 2022. Scientists were able to compare ecological indexes between Sanibel Island (the control area) and Captiva Island, where the sterile mosquitoes were released. Rachel Morreale, Manager of the Applied Science and Technologies Department at LCMCD, stated "it was remarkable to see the impacts that our sterile male releases had on the population of *Ae. aegypti* on Captiva."

Hurricane Ian devastated both Captiva and Sanibel islands completely in September 2022, making it impossible to access by car, and putting an end to the pilot project.

The damage caused was so significant that LCMCD determined that the best course of action would be to move the release programme to a new area on the mainland. Using lessons learned from the pilot project on Captiva Island, LCMCD collected baseline data to better inform their releases of sterile male *Ae. aegypti* in Fort Myers, which was initiated in February 2024. While the move to this new area was sooner than initially planned, the pilot project on Captiva Island allowed LCMCD to validate SIT as a component of an integrated mosquito management operation for the County. Using the knowledge gained from mass-rearing, releases, and fieldwork, LCMCD is hopeful to have similar successful outcomes in Fort Myers and provide relief and protection to local residents.

According to David Hoel, Executive Director of LCMCD, "the unique attributes of this programme and technical expertise provided to us by the IAEA is enabling LCMCD to gain a foothold in suppression of this mosquito which is difficult at best to control by conventional mosquito control techniques and shows great promise for future prevention of mosquito-borne disease threat in Lee County, Florida."

Source: IAEA Weekly News. By Emma Midgley, IAEA Office of Public Information and Communication, 7 June 2024. *https://www.iaea.org/newscenter/news/sterile-insect-technique-used-to-supress-mosquito-disease-vectors-in-florida*.

Insect Pest Control Databases: What's New?

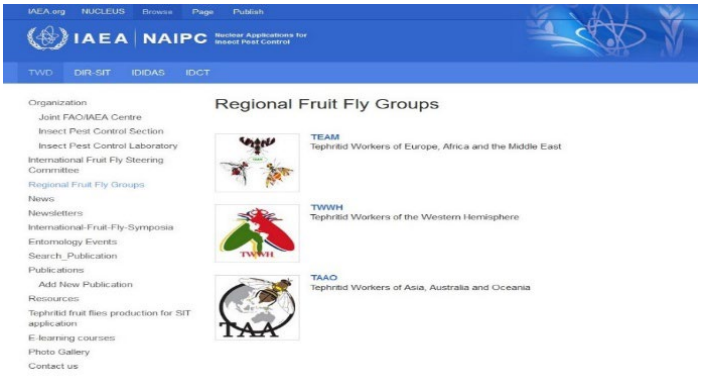
The Insect Pest Control Subprogramme (IPCS) of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture plays a key role in the dissemination of nuclear and related technology information by providing Member States (MSs) with factual, comprehensive and current information about strategies, techniques, products and processes in the topics of area-wide integrated pest management (AW-IPM) and the sterile insect technique (SIT). The four databases maintained by IPC: The Tephritid Workers Database (TWD), The World-Wide Directory of SIT Facilities (DIR-SIT), The International Database on Insect Disinfestation and Sterilization (IDIDAS), and The International Database on Commodity Tolerance (IDCT) contribute to this goal by providing, to the general public as well as to the scientific community, access to scientific and technical information related to the integration of nuclear and pest management techniques in the control of insect pests of agriculture, livestock and human health importance.

The Tephritid Workers Database (TWD)

Countries	Members	Countries	Members
Australia	166	Italy	27
USA	143	Guatemala	23
Mexico	131	Israel	23
Thailand	106	Morocco	23
Brazil	70	Panama	23
Spain	70	Indonesia	18
Argentina	56	Austria	16
China	50	Egypt	14
India	49	Pakistan	14
South Africa	49	Sudan	14
Greece	37	Japan	13
France	27	Turkey	13

The Tephritid Workers Database (TWD). In total, there are 1548 members in TWD from 120 countries (TWD, 2024).

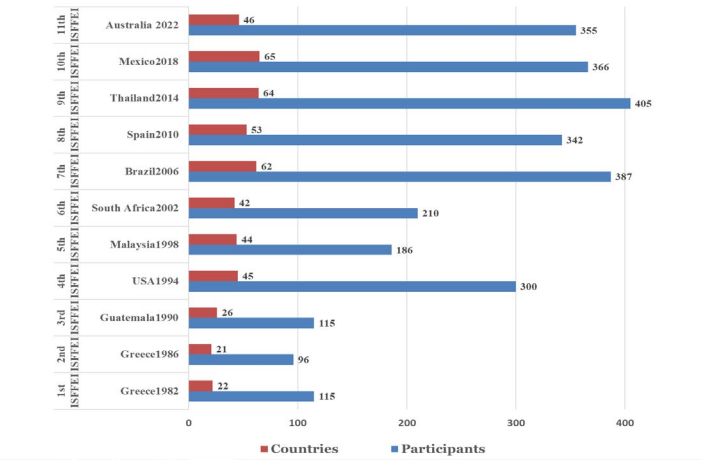
With 1548 members from 120 countries, TWD is the largest network of the tephritid fruit fly workers worldwide. TWD is hosting three regional groups: Tephritid Workers of Europe, Africa and the Middle East (TEAM), Tephritid Workers of the Western Hemisphere (TWWH); Tephritid Workers of Asia, Australia and Oceania (TAAO). Members get the latest news pertaining to the tephritid fruit flies either posted online or sent directly to their email inboxes if they had subscribed. Links to newsletters published by the regional groups and by IPC are made available as a grey source with rare information not published elsewhere. For example, a biannually newsletter, Fruit Fly News (FFN), highlights special issues relevant to tephritids in addition to members' professional stories and contributions.



Tephritid Workers Database (TWD) hosts three regional groups: Tephritid Workers of Europe, Africa and the Middle East (TEAM); Tephritid Workers of the Western Hemisphere (TWWH); Tephritid Workers of Asia, Australia and Oceania (TAAO).

The International Fruit Fly Steering Committee (IFFSC)

The community of tephritid fruit fly workers around the world has an International Fruit Fly Steering Committee (IFFSC) and all you want to know about this body is also posted in TWD. The IFFSC body includes 19 members having several years of work on fruit flies and representing 16 countries from all around the world.



International Symposium on Fruit Flies of Economic Importance (ISFFEI). Attendance trends from 1982 to 2022.

The IFFSC members are responsible for the scientific programme of the International Symposium on Fruit Flies of Economic Importance (ISFFEI), which takes place every four years to discuss the advances made on R&D and field application on fruit flies. The IFFSC meeting is also the

opportunity to identify and recruit new potential board members, nominate a new chair, assess the expression of interest from country delegates, and decide about the venue of the next ISFFEI based on the regional rotation (Africa, Americas, Asia, Australia, Europe) and the host country formal proposal.

The IFFSC had its beginnings in 1982 under the name of the Global Working Group on Fruit Flies of Economic Importance, which organized the first ISFFEI in Athens, 16–19 November 1982 and hosted 115 participants from 22 countries and three international organizations. Since then, the IFFSC has organized 11 symposia (Fig above). The next ISFFEI will be held in Agadir (Morocco) in 2026.

The International Database on Commodity Tolerance (IDCT)

The goal of IDCT is to aid stakeholders in MSs to identify the doses of radiation that are tolerated by different commodities including fresh fruits, vegetables and cut flowers. Currently, data of 384 commodity cultivars are compiled in IDCT. These commodities are from 44 families, and 59 genera. By far, the top seven most phytosanitary irradiated commodities include Rosaceae with the highest number of cultivars (121), followed by Rutaceae (54), Anacardiaceae (28), Vitaceae (24), Ericaceae (20), Sapindaceae (17) and Solanaceae (14). For each commodity, the database provides the corresponding literature from which the data were retrieved. Presently, there are 326 references on phytosanitary irradiation.

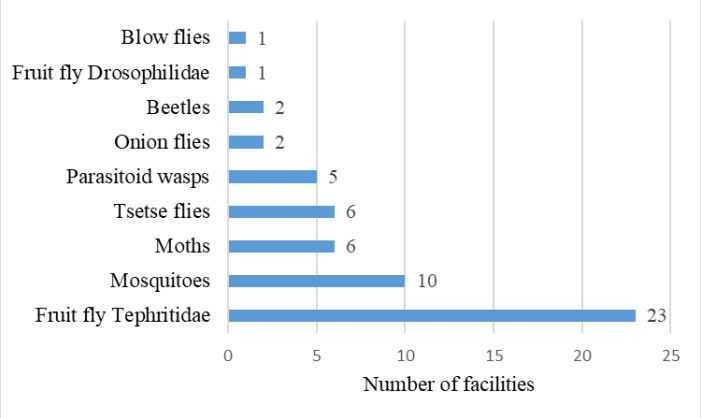
Commodities	Cultivars	Commodities	Cultivars	Commodities	Cultivars
Rosaceae	121	Actinidiaceae	4	Passifloraceae	2
Rutaceae	54	Arecaceae	4	Apiaceae	1
Anacardiaceae	28	Cactaceae	4	Araceae	1
Vitaceae	24	Dioscoreaceae	4	Betulaceae	1
Ericaceae	20	Lauraceae	4	Caryophyllaceae	1
Sapindaceae	17	Annonaceae	3	Chenopodiaceae	1
Solanaceae	14	Brassicaceae	3	Clusiaceae	1
Musaceae	8	Convolvulaceae	3	Gentianaceae	1
Myrtaceae	8	Moraceae	3	Iridaceae	1
Caricaceae	7	Agaricaceae	2	Lythraceae	1
Cucurbitaceae	7	Asteraceae	2	Malvaceae	1
Bromeliaceae	6	Ebenaceae	2	Oleaceae	1
Amaryllidaceae	5	Fagaceae	2	Pluteaceae	1
Liliaceae	5	Juglandaceae	2	Poaceae	1
		Oxalidaceae	2	Rhamnaceae	1

IDCT commodity families and their cultivars listed in decreasing order. There are 44 families and 384 cultivars (IDCT, 2024).

The World-Wide Directory of SIT Facilities (DIR-SIT)

The purpose of DIR-SIT is to play the role of a hub collecting information on sites mass-producing sterile insects and to facilitate the exchange of information among stakeholders and users of the SIT. In total, there are 40 sites mass-producing sterile insects in 29 countries. Some countries have more than one facility and produce more than one species. For example: USA has eight (8) facilities and Mexico has five (5).

Among the nine groups of insects (Tephritid fruit flies, mosquitoes, moths, tsetse flies, parasitoid wasps, onion flies, beetles, drosophila flies, and blow flies) produced for SIT applications, (Tephritid fruit flies lead in terms of the number of the production sites (23 facilities), the production volume (> three billion/week) and the number of species (10) and strains (>27), followed by mosquitoes *Ae. albopictus* and *Ae. aegypti* (10 facilities), moths (six facilities), and tsetse flies (six facilities). However, right now, only operational facilities with a significant level of mass production are posted online on DIR-SIT web site. Other facilities around the world would be added when their production reaches a significant level.



Number of mass-production facilities per group of insects for SIT applications (DIR-SIT, 2024).

For each production facility, DIR-SIT provides information on the country focal points, species, strains, production capacity, current production, and the irradiation treatment parameters, including the models and type of irradiation. The data can be filtered by country, species, irradiator type etc, and through multi-selection of these criteria. Furthermore, DIR-SIT includes other resources related to the mass-production of sterile insects.

The International Database on Insect Disinfestation and Sterilization (IDIDAS)

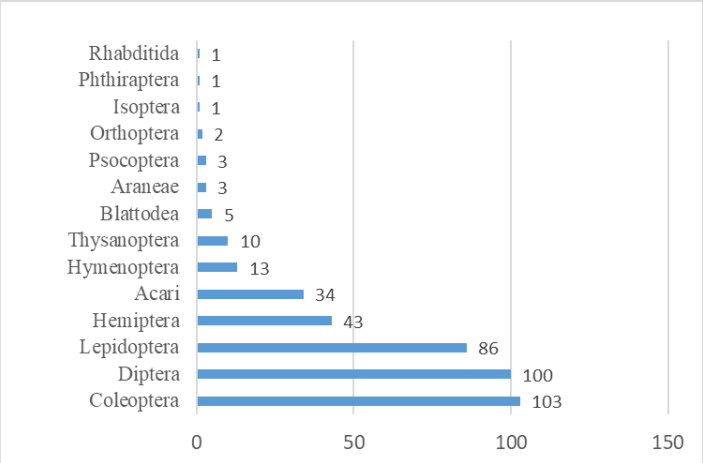
The IDIDAS provides information on the doses of radiation applied for these purposes to mites and insect pests of crops and veterinary and human importance.

In total, there are 405 species, for 252 genera, 98 families, 15 orders belonging to three classes (Insecta, Arachnida and Chromadorea) recorded in IDIDAS. The database is composed of four parts: the species taxa, the phytosanitary irradiation dose, the sterilization dose for the sterile insect technique purpose or other physiological studies, and the related list of references. Actually, there are 6077 references in IDIDAS.

Moreover, the targeted irradiated species stage could be the eggs, larvae, nymphs, pupae and adults.

Hence, users may explore the link between the tolerated doses by commodities (IDCT) and the disinfestation or sterilization doses of pest species (IDIDAS).

The IPCS databases will be continuously updated and used as a major hub for people to access information and general knowledge about SIT and your contributions and suggestions are highly appreciated.



The total species number of Insects, arachnids and nematodes, which have been subject to the irradiation treatment for sterilization and disinfestation (IDIDAS, 2024).

Mediterranean Fruit Fly Incursion to the Dominican Republic

An adult of the invasive Mediterranean fruit fly was detected in Punta Cana Dominican Republic in December 2023. After confirmation of the fly find, a Ministerial Declaration was published, and a Contingency Plan was immediately enforced.

To evaluate the implementation of the Contingency Plan and provide technical recommendations, the FAO subregional office for Mesoamerica in Panama and FAO Representation office in the Dominican Republic, setup a Technical Advisory Panel (TAP) which consists of a technical officer from the Joint FAO/IAEA Centre, and specialists from Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA) and FAO. The TAP conducted a technical mission to the Dominican Republic from 20 to 23 February 2024.

After a meeting with the Minister of Agriculture, the FAO Representative, and officials from the USA Embassy, TAP members visited the detection site in Punta Cana as well as a storage facility at the international airport in Punta Cana where imported agricultural commodities are held for quarantine inspection.

The field work and data analysis showed that it had been an early pest detection. Fortunately, by the time of the adult fly detection, the pest incursion had not spread beyond the core area of the initial detection. The rapid response to the pest incursion included the delimitation of the incursion using specific traps and fruit sampling. The delimited area consists of some 49 km^2 from which around 35 km^2 or 3,500 hectares is effective area where plant host material is present. Control actions including the weekly releases of sterile flies are being conducted over the area where hosts are present.

Evaluation of the Contingency Plan by a Technical Advisory Panel.

As a result of the effective application of the Contingency Plan, the Mediterranean fruit fly incursion is under control with no additional fly finds since the last week of January 2024. A minimum of 26 weeks (six months) of ongoing sterile releases (of about 3 million per week, but subject to adjustment) will be conducted to assure pest eradication. If no additional fly is detected, eradication of the pest incursion can be declared by October 2024.

Eighteenth Session of the Commission on Phytosanitary Measures

The Eighteenth Session of the Commission on Phytosanitary Measures (CPM-18) adopted four International Standards for Phytosanitary Measures (ISPMs) to strengthen collaboration for global plant health and advance compliance with phytosanitary standards. CPM-18, which was held from 15–19 April 2024 in Rome, Italy, brought together over 400 delegates from contracting parties of the International Plant Protection Convention (IPPC), to discuss the status of plant health worldwide and strategies to promote prevention and management of plant pests.

CPM-18 adopted 2022 amendments to ISPM 5 (*Glossary of phytosanitary terms*); Annex 1 (*Criteria for evaluation of available information for determining host status of fruit to fruit flies*) to ISPM 37 (*Determination of host status of fruit to fruit flies ((Tephritidae)*); revision of ISPM 4 (*Requirements for the establishment of pest free areas*) and Phytosanitary Treatment (PT) 46 (*Cold treatment for Thaumatotibia leucotreta* or False codling moth on *Citrus sinensis*), as Annex to ISPM 28 (*Phytosanitary treatments for regulated pests*).

Annex 1 to ISPM 37 outlines the criteria for evaluating available information to determine the host status of fruit to

fruit flies (Tephritidae), promoting consistency in the interpretation of the terms used in such information, to avoid trade disruption. It also explains the application of the host status of fruit to fruit flies when conducting pest risk analysis (PRA) for a fruit commodity.

Adopted in 1995, ISPM 4 outlines the requirements for establishment and maintenance of pest-free areas (PFAs), which can be used as a pest risk management option to protect plant resources in a given area, for agricultural, forestry or ecological conservation purposes. This helps to facilitate safe trade and increase market-access opportunities for exporting countries. Revision of ISPM 4 provides more consistent guidance to NPPOs on the initiation, establishment and maintenance of PFAs, considering new information and other ISPMs. The standard provides a framework in which NPPOs can set up a programme to ensure maintenance of PFAs, based on a regulatory framework to control the movement of regulated articles. This framework also supports surveillance, data collection, and outbreak detection and management.

Phytosanitary Treatment (PT) 46 focuses on cold treatment of fruit of *Citrus sinensis*, the sweet orange, to result in mortality of eggs and larvae of the *Thaumatotibia leucotreta* or false codling moth. False codling moth is a highly polyphagous pest whose larvae are usually intercepted on sweet oranges trees and among 50 other plant species. Oranges are an important economic crop, with global production of over 75 million tonnes, representing 46 percent of citrus fruit production.

The adopted revised standards resulted from a series of fruitful transparent meetings and inclusive consultations among phytosanitary experts from all over the world, coordinated by the Standards Committee (SC), a CPM subsidiary body. The development and adoption of standards, recommendations, diagnostic protocols, and phytosanitary treatments is the core function for which the IPPC was formed, and the CPM convened. The World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) recognizes ISPMs, which are developed under the auspices of the IPPC, as the only international standards for plant health.

Adoption of harmonized phytosanitary standards ensures that all countries follow the same benchmarks and use common information to trade plant products safely and protect the environment.

Source: https://www.ippc.int/en/news/cpm-18-update-revisions-to-phytosanitary-standards-and-recommendation-adopted/.

Technical Panel on Phytosanitary Treatments Meeting, International Plant Protection Convention. 22–26 June 2024, Tucumán, Argentina

The International Plant Protection Convention (IPPC) Technical Panel on Phytosanitary Treatments (TPPT) met in Tucumán, Argentina, to review, discuss, and draft phytosanitary treatments to be potentially adopted as annexes to the International Standard for Phytosanitary Measures (ISPM 28). A total of 13 phytosanitary treatment submissions by national plant protection organizations (NPPOs) were discussed during the meeting. An irradiation treatment for the light brown apple moth, *Epiphyas postvittana*, was recommended to the IPPC Standards Committee (SC) for approval for consultation. The TPPT also noted that supporting data generated from the FAO/IAEA Coordinated Research Project on Novel Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade may be used to support the generic irradiation treatment submissions currently under the evaluation by the TPPT.

Participants of the International Plant Protection Convention (IPPC) Technical Panel on Phytosanitary Treatments (TPPT) meeting (Tucumán, Argentina).

The criteria for evaluation of potential International Standards for Phytosanitary Measures No. 15 (ISPM 15) treatments were discussed, and a focal group formed to draft them further. Efficacy calculation methods from the IPPC Procedure Manual were revised and endorsed by the TPPT, and relevant changes were recommended to SC. The TPPT also agreed to recommend changes to the Phytosanitary Measures Research Group (PMRG) on the Guidelines for the Development of Cold Disinfestation Treatments for Fruit Flies, which will be applied after text modifications in the IPPC Procedure Manual are finalised. The TPPT also noted updates on liaison activities with the Ozone Secretariat, PMRG, and the International Forestry Quarantine Research Group (IFQRG). The TPPT work Plan for 2024–2025 was also reviewed, and TPPT members volunteered to actively seek out potential phytosanitary treatments to be submitted

through a regional or national plant protection organization as topics for SC approval.

5th TEAM Meeting. 15–18 April 2024, Mauritius

The 5th TEAM (Tephritid Workers of Europe, Africa and the Middle East) meeting took place in Belle Mare, Republic of Mauritius. The meeting was organized by the Ministry of Agro-Industry and Food Security of Mauritius. The local organizing committee was led by Dr Preeaduth Sookar and Ms Nausheen Patel of the Entomology Division of the Ministry, and was assisted by the TEAM Steering Committee, chaired by Dr Aruna Manrakhan (Citrus Research International, South Africa). The overarching theme of this meeting was "Food Security – Securing our fruit for healthy consumption".

This meeting was the first occasion for fruit fly researchers, students and policy makers at the region of Europe, Africa and the Middle East to meet up physically since 2016, as the previous TEAM meeting (4th TEAM meeting, 2020, La Grande Motte, France) had to be held virtually because of COVID19 related travel and social contact restrictions. The 5th TEAM meeting was attended by 126 participants in person, while another 28 participants attended virtually. Representatives of 34 countries participated in the event.

Participants of the 5th TEAM (Tephritid Workers of Europe, Africa and the Middle East) meeting, (Belle Mare, Mauritius).

The programme of the meeting consisted of three days of oral and poster presentations and discussions, grouped in ten sessions and covering all major disciplines related to current fruit fly research. Speakers could present in person or virtually. In total 50 oral presentations were given, and an additional 54 posters were shown. Three plenary speakers opened the daily programs with in-depth presentations on conservation of the island biodiversity within the context of invasive species (Florens Vincent, Mauritius), ecological and genomic investigations on the expansion of *Bactrocera dorsalis* in the Indian Ocean islands (Helene Delatte, La Réunion), and genetic breakthroughs to the advancement of sterile insect technique (SIT) (Marc Schetelig, Germany). During the third day a separate discussion was also organized on area wide integrated pest management (AW-IPM). On the fourth day, a visit to the SIT facilities of the Ministry of Agro-Industry and Food Security at Reduit was organized, followed by excursions to different parts of the island. In all, the meeting was perceived as being very successful by all members who attended, and the local organizers were congratulated with their accomplishment.

The 5th TEAM book of abstracts, together with a link to all the posters presented as well as a photo gallery of images taken during the meeting, are available on a dedicated website (https://team2024.govmu.org/team2024/). This website will remain active for a full year after the meeting and can be consulted by anyone interested. The proceedings of the 5th TEAM meeting will be published in a special issue of the Journal of Applied Entomology. The special issue will be an open call for papers presented at the 5th TEAM meeting.

2nd Symposium of the Tephritid Workers of Asia, Australia and Oceania (TAAO). 6–10 May 2024, Beijing, China

The TAAO was established as an independent professional and scientific organization with the purpose of bringing together Tephritid workers from Asia, Australia, and Oceania in managing pest fruit flies. The first symposium of TAAO was successfully held in 2016 in Putrajaya, Malaysia and agreed in the symposium that it should be held quadrennially to update the latest development on fruit fly management in the region.

Participants of the 2nd Symposium of the Tephritid Workers of Asia, Australia and Oceania meeting, (Beijing,China).

However, with the Covid pandemic raging on in 2020, the symposium could not be held as scheduled. A hybrid symposium was also not viable. After 8 years, 2024 marks the resumption of the symposium that was successfully organised by the China Agricultural University (CAU) and TAAO, with Entomological Society of Beijing as co-organisers. The organizing committee led by Prof Zhihong Li (CAU) worked very hard to promote the symposium that saw a turnout of 109 participants coming from 17 countries. The theme of the symposium was "Management of Tephritid Fruit Flies in Current Globalization Era". Three eminent female keynote speakers along with three other eminent male keynote speakers were invited. A total of 8 sessions relevant to present scenarios were organized that included survey and monitoring, risk assessment, management and communication, species complex and species diagnosis,

population tracing and invasive pathway, phytosanitary treatment and eradication, area-wide management and SIT; and global change and invasion mechanism. Each session had oral and poster presentations respectively.

A total of 6 plenary lectures, 55 oral presentations and 24 posters were presented. Students were also judged for their oral and poster presentations. A photo competition saw a contribution of 32 photographs judged. During the symposium, participants were also able to join in two workshops i.e., molecular identification of tephritids, and quantitative risk assessment. They were also treated to a visit to CAU and the National Zoological Museum of China.

At the TAAO general Steering Committee (SC) meeting, the venue for the 3rd TAAO Symposium to be held in May 2028, was awarded to Hanoi, Viet Nam, with Dr Thinh Hien as the host. The new Chair of the TAAO SC was also announced as Prof Zhihong Li (CAU). This marks her as the 3rd TAAO SC Chair after Alvin KW Hee (Malaysia), and Mark Schutze (Australia). Finally at the closing ceremony, winners for the best student oral presenters, poster presenters, and the photography competition were announced and honoured. The theme song for TAAO was also sung for the first time!

11th Meeting of the Tephritids Workers of Western Hemisphere (TWWH). 3–7 June 2024, Montego Bay, Jamaica

The meeting was successfully co-organized by the Ministry of Agriculture, Fisheries and Mining, Jamaica and the Tephritids Workers of Western Hemisphere (TWWH). It is the first time that the TWWH meeting took place in the Caribbean. Countries in the region suffer from the presence of fruit fly pests that limit fruit and vegetable production and trade. Given the transboundary nature of fruit fly pests and the increasing risks of introduction of non-native invasive species, strengthening integration and active participation of the Caribbean Community countries in the fruit fly working group of the Western Hemisphere is important.

Participants of the 11th Meeting of the Tephritids Workers of Western Hemisphere (TWWH) (Montego Bay, Jamaica).

The Minister of Agriculture, Fisheries and Mining, Mr Floyd Green welcomed the participants in the opening ceremony and emphasised the importance of the meeting for his Ministry.

Award presented to Mr Pablo Liedo Fernandez.

One hundred twenty participants representing 36 countries in the Western Hemisphere attended the meeting. Virtual participation was also possible. A total of 61 oral presentations were given, 23 posters were presented, and 26 students participated in a session specially devoted to presenting their work. Scientists and fruit fly workers presented and discussed current research and development and technological innovations; programme managers presented the status of current programmes and the major limitations affecting operations. Companies, that sponsored the meeting, presented their products and services including trapping materials, sterile fly release equipment (including drones) and laboratory equipment.

A panel of 9 experts and 3 moderators discussed various topics including the impact of climate change on the biology and ecology of fruit fly pests and how this affects the phytosanitary tools and control strategies used for an effective control. The participation and role of the beneficiaries in particular farmers and exporters in action programmes was also discussed as well as the impact of novel technologies on the effectiveness of operational programmes.

During the last day of the meeting, a technical tour was organized to the International Centre for Environmental and Nuclear Sciences (ICENS) where a nuclear reactor is held for research on nuclear applications, to the *Aedes aegypti* mosquito rearing facility at the Ministry of Health and to a citrus farm which process fruits and produces juice for internal and external markets.

At the closure, a recognition award was presented by the Steering Committee of the 11th TWWH to Mr Pablo Liedo Fernandez for his leadership and outstanding contributions

to the TWWH for 32 years, since the first meeting held in San Jose Costa Rica in 1992. In addition, the Steering Committee gave a sign of gratitude to Mr Damian Rowe, the Acting Chief Plant Quarantine Produce Inspector of Jamaica as representative of all the local organizers.

Mr Bénéwendé Aristide Kabore Obtains His PhD from Technical University Vienna (TU Wien)

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

DISSERTATION

Advancing the Sterile Insect Technique for tsetse (Diptera: Glossinidae): Exploring alternative radiation sources and protocols

ausgeführt zum Zwecke der Erlangung des akademischen Grades eines Doktors der Naturwissenschaften unter der Leitung von

Univ. Prof. Dr. Robert. L. Mach

E166

Institut für Verfahrenstechnik, Umwelttechnik und technische Biowissenschaften

eingereicht an der Technischen Universität Wien

Fakultät für Technische Chemie

von

Dr. rer. nat. Bénéwendé Aristide KABORE

Matrikelnummer 12213114

Josef-Baumann-Gasse 8a/214, 1220 Wien

Wien, 2024

Gamma rays have been traditionally used in the sterile insect technique (SIT) for male tsetse sterilization. However, the use of gamma sources is facing a growing restriction with regards to purchasing, shipment and transportation of isotope for reloading these irradiators. Alternative radiation sources are needed for the ongoing and future SIT programmes and X-rays have shown promise as an alternative radiation source that could circumvent the aforementioned constraints. Mr Bénéwendé Aristide Kabore, from Burkina Faso, in his PhD thesis entitled Advancing the Sterile Insect Technique for tsetse (Diptera: Glossinidae): Exploring alternative radiation sources and protocols (https://doi.org/10.34726/hss.2024.107302), explored the advances of alternative ionizing radiation sources and protocols for the advancement of the sterile insect technique for tsetse. The suitability of available X-ray sources as well as the refinement of the existing radiation protocols were assessed. Irradiation protocols under cold and low oxygen environment or fractionating radiation doses were also evaluated. Key parameters, such as induced sterility, the flies flight propensity, their survival, and mating competitiveness, were measured too.

Bénéwendé Aristide Kabore's results indicated that the Blood irradiator Raycell Mk2, the Rad Source 2400 and the X-Rad 320 are suitable to be used to induce sterility levels up to 95-99% in *Glossina palpalis gambiensis* males irradiated as pupae. To induce 95% of sterility, X-rays irradiators require less radiation dose compared to gamma-rays. In addition, there was no significant difference in the flight quality parameters and the mating competitiveness of flies irradiated with X-rays as compared to those irradiated with gamma-rays. Assessing the impact of the dose fractionation using gamma-rays, there was no significant effect on induced sterility and only small improvements with respect to flight propensity and survival were observed.

The nitrogen treatment exhibited a radioprotective effect, necessitating increasing radiation doses to achieve 95% sterility in male *G. p. gambiensis* and significant increase in male survival was observed. In the context of irradiation temperature, the results indicate that a reduction in temperature during radiation did not have a radioprotective effect for adults and had only a slight effect in pupae exposure. Whether the flies were irradiated under chilled or non-chilled conditions, those irradiated as adults survived longer than those irradiated as pupae revealing the importance of the choice of the life stage to be sterilized.

The findings of Bénéwendé Aristide Kabore's research significantly contributed on the importance of implementing dose-response assessments for both new and ongoing programs, emphasizing the necessity of employing a reliable dosimetry system. In conclusion, recommendations and perspectives are offered, addressing the selection of irradiation sources and irradiation protocols that are available.

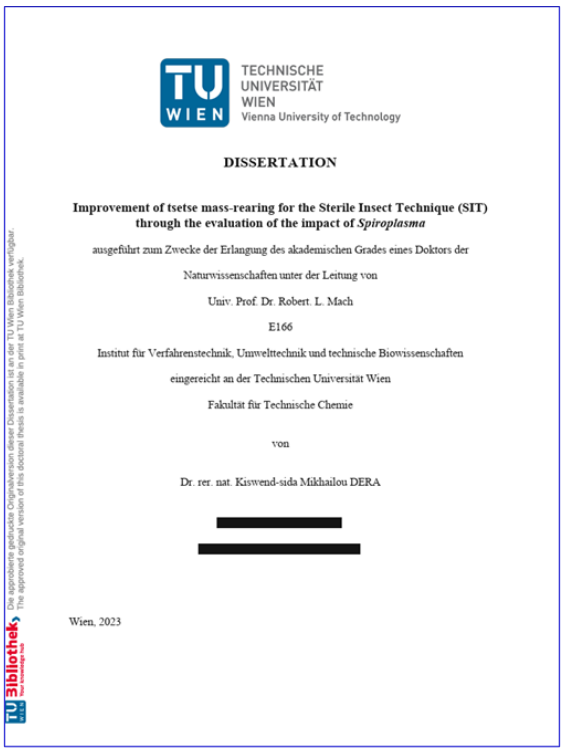
Mr Kiswend-sida Mikhailou Dera Obtains his PhD from Technical University of Vienna (TU WIEN)

Mr Kiswend-sida Mikhailou Dera from Burkina Faso successfully defended his PhD thesis at the Technical University of Vienna (TU WIEN) in mid-January 2024. His PhD research was conducted at the Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria.

Mr Dera's thesis entitled 'Improvement of Tsetse Mass-rearing for the Sterile Insect Technique (SIT) through the Evaluation of the Impact of *Spiroplasma*' https://doi.org/10.34726/hss.2024.107304 aimed to evaluate how the management of the symbionts of tsetse flies can be used to improve its mass-rearing for the SIT application. Indeed, the eradication of tsetse flies through the application of the SIT in an Area-Wild Integrate Pest Management (AW-IPM) requires a production of sterile males in mass-rearing facilities. Tsetse flies harbor natural endosymbionts that are crucial for their biology including *Spiroplasma* and *Sodalis*.

Mr Dera presented in his thesis four studies, one focused on the prevalence of *Sodalis* infection in wild tsetse population, and three focused on *Spiroplasma* infection in tsetse species and its impact on the tsetse fly's performance. In the first

study, he showed the ambiguity in the relation between *Sodalis* and *Trypanosoma.*



TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

DISSERTATION

Improvement of tsetse mass-rearing for the Sterile Insect Technique (SIT) through the evaluation of the impact of *Spiroplasma*

ausgeführt zum Zwecke der Erlangung des akademischen Grades eines Doktors der Naturwissenschaften unter der Leitung von

Univ. Prof. Dr. Robert. L. Mach

E166

Institut für Verfahrenstechnik, Umwelttechnik und technische Biowissenschaften

eingereicht an der Technischen Universität Wien

Fakultät für Technische Chemie

von

Dr. rer. nat. Kiswend-sida Mikhailou DERA

[redacted]

Wien, 2023

In the second study, Mr Dera reported the prevalence of *Spiroplasma* infection in wild tsetse populations and analyzed the interactions between *Spiroplasma* infection and trypanosome infection in *Glossina tachinoides*. This study demonstrated that the endosymbiont *Spiroplasma* can be useful to enhance refractoriness to the trypanosome infection and therefore improve the SIT.

In the third and fourth study, he analyzed the impact of *Spiroplasma* infection on tsetse fly's performance and demonstrated that *Spiroplasma* infection resulted in significant reduction in females' productivity, sperm mobility and reduced the male survival and mating competitiveness in field cages.

Mr Mouhamadou Moustapha Dieng Obtains his PhD from Technical University of Vienna (TU WIEN)

Mr Mouhamadou Moustapha Dieng from Senegal successfully defended his PhD thesis at the Technical University of Vienna (TU WIEN) in mid-January, 2024. His PhD research was conducted at the Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria.

The thesis entitled 'Interaction between tsetse symbiont, pathogens on trypanosome infection in wild tsetse populations' https://doi.org/10.34726/hss.2024.75781 is to evaluate the interactions between tsetse symbionts, pathogens on trypanosome infections in wild tsetse populations. This research aims to enhance our understanding of the dynamics of trypanosome infections associated with tsetse fly bacterial symbionts and pathogens, to optimize effective and safety use of sterile insect technique (SIT) on the eradication of tsetse flies. The microbial fauna of tsetse flies, include symbiotic bacteria like *Wigglesworthia*, *Sodalis*, *Wolbachia*, and *Spiroplasma*. Mr Mouhamadou Moustapha Dieng presented three studies in his thesis which aimed to explore the interaction between tsetse flies and its symbionts and pathogens. The first study showed the interactions between the salivary gland hypertrophy virus (SGHV), a pathogenic, double stranded DNA virus for some tsetse species, and tsetse symbionts in wild tsetse populations. The results of this study showed a negative correlation between *Wolbachia* infection and SGHV infection in some tsetse species, mainly *Glossina m. morsitans* and *G. austeni* which may indicate a possible protective role of *Wolbachia* against GpSGHV.

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

DISSERTATION

Interaction between tsetse symbiont, pathogens on trypanosome infection in wild tsetse populations

ausgeführt zum Zwecke der Erlangung des akademischen Grades einer Doktorin der Naturwissenschaften unter der Leitung von

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Wien, 2023

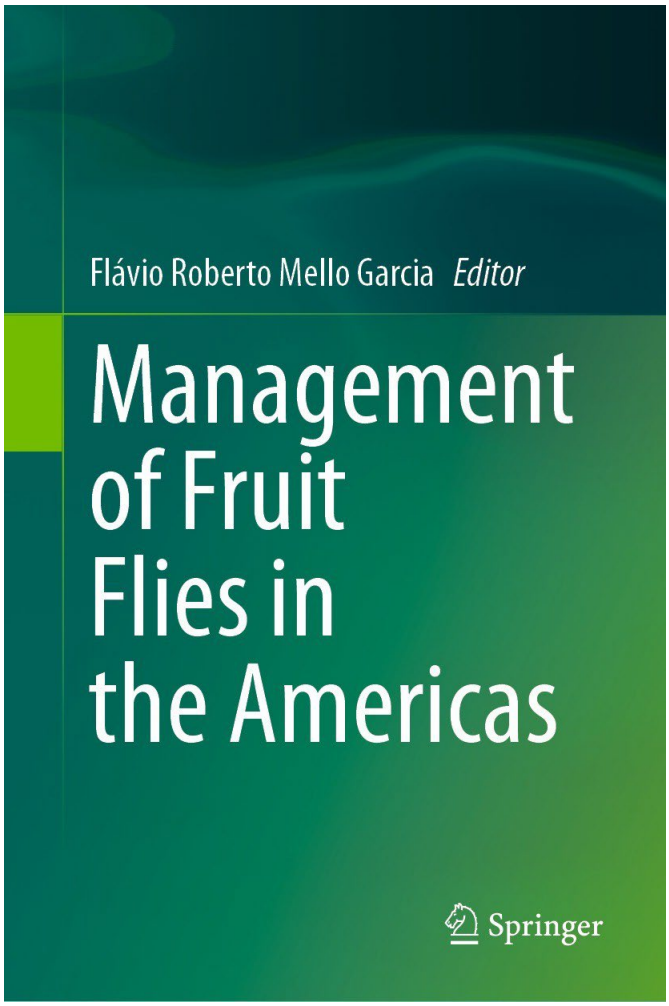
The second study showed the prevalence of *Sodalis* infection in wild tsetse populations and its interaction with trypanosome and other tsetse symbionts. The results clearly show that the prevalence of *Sodalis* and its interaction with other micro-organism circulating in the host are very complex and require further studies, however it reported significant positive correlations occur between *Sodalis* and *Trypanosoma* spp.

In the third study, the prevalence of *Spiroplasma* infection in wild tsetse species and its interaction with trypanosome infection was reported. The results indicated that *Spiroplasma* infection was limited to *Glossina fucipes fucipes* and *Glossina tachinoides* species and found that *Spiroplasma* potentially enhance tsetse refractoriness to trypanosome infections making this symbiont a good candidate for paratransgenesis.

Announcements

Management of Fruit Flies in the Americas

This book was published by Springer Cham. It comprises issues at the cutting edge of fruit fly management in the Americas, covering topics that are focal points of current activity and likely long-term importance to the progress of the field. The book is an invaluable source of ideas and inspiration for entomologists at all levels from graduate students to more-established researchers and professionals. Fruit flies (Diptera, Tephritidae) are the most important pests of fruit production worldwide. The purpose of this book is to integrate the experiences of leading scientists in the management of fruit flies in the Americas. In this work, species of fruit flies of economic importance are considered in the genera *Anastrepha*, *Rhagoletis*, *Bactrocera,* and *Ceratitis*. This book addresses fruit flies monitoring, biological control, chemical control, cultural control, sterile insect technique (SIT), Integrated Pest Management (IPM), and other control methods. The book provides invaluable resource material to scientists, professionals and students and it is available at https://doi.org/10.1007/978-3-031-48608-1.



Other News

Oriental Fruit Fly Quarantine Lifted in Santa Clara County, California

The California Department of Food and Agriculture (CDFA), with the U.S. Department of Agriculture (USDA) and Santa Clara Agricultural Commissioner, ended the Oriental fruit fly (OFF) quarantine in Santa Clara County following the eradication of the invasive pest.

The quarantine was put in place nearly nine months ago in parts of Sunnyvale, Santa Clara, Cupertino, San Jose, Milpitas, Mountain View, Saratoga, Campbell and Los Altos. During the quarantine, host crops, including citrus and other fruits, nuts, vegetables and berries were not allowed to be moved and commercial crops were required to meet stringent treatment or processing standards.

According to a CDFA press release: "Thanks to the responsiveness and cooperation of Santa Clara's residents, and our partners at the Santa Clara County Division of Agriculture and the United States Department of Agriculture, we were able to quickly and safely eradicate this infestation of the Oriental fruit fly," said Victoria Hornbaker, Director of CDFA's Plant Health and Pest Prevention Services Division. "As with so many invasive species, when we can detect infestations early and respond promptly, we stand the best chance of protecting our backyard fruits and vegetables and ultimately safeguarding California's agricultural heritage."

Although the Santa Clara County quarantine is over, the CDFA is still urging residents and industry members across California to remain vigilant for signs of invasive pests to help prevent any future introductions of invasive species. There are currently six other active fruit fly quarantines in California.

Source: Western Growers Association. By Michelle Rivera, 28 May 2024. https://www.wga.com/news/oriental-fruit-fly-quarantine-lifted-in-santa-clara-county/.

USDA Protects Hundreds of Crops from Invasive Fruit Flies with Five- Year Strategy

The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) has released "Fruit Fly Exclusion and Detection Program Fiscal Years 2024-2028 Strategy." APHIS worked with members of the National Plant Board to develop a unified roadmap for USDA and its partners to protect American agriculture from the threat of invasive fruit flies and measure our progress along the way.

The five-year strategy prioritizes strengthening the following goals for fruit flies of regulatory significance:

- Domestic surveillance to support early detection.
- Management and emergency response to ensure timely mitigation.
- Targeted and effective sterile insect technique for preventive release and eradication programs (assuring rearing facilities are maintained for efficiency and safety).
- International and import efforts to mitigate against the introduction and spread of invasive fruit flies in the United States.

To address the unprecedented outbreaks of exotic fruit flies, Agriculture Secretary Tom Vilsack recently released $103.5 million from the Commodity Credit Corporation to fund APHIS' supplementary emergency response activities. These funds allow APHIS to reach beyond what the agency's appropriated funding would be able to accomplish over the next few years.

Currently, there are exotic fruit fly quarantines in eight counties in California and five counties in New York. The California Department of Food and Agriculture and APHIS have established parallel quarantines and are working with the State's agricultural commissioners to eradicate and prevent the statewide spread of the Queensland fruit fly, Tau fruit fly, Mediterranean fruit fly, and Oriental fruit fly in California.

Invasive fruit flies feed on over 400 crops, including citrus and other fruits, nuts, vegetables, and berries. Fruit flies can damage fruits and vegetables when they lay their eggs under the skin of the produce. There, developing larvae make the fruits and vegetables unfit for human consumption. Infested produce may not look damaged from the outside but may take on a brown, mottled appearance as the larvae feed from the inside. Resources to combat invasive fruit fly threats are limited, so developing an efficient strategy to manage or eradicate invasive fruit flies is critical.

To reduce the spread, APHIS and affected states will work together to reduce, and to the extent possible, prevent human-assisted movement. Together, we will also promote public reporting to encourage early detection, and we will leverage the latest research and management tools available. The 5-Year Strategy drives Federal and State responders to explore new population suppression technologies, such as male annihilation technique, mass trapping, and the development of new and/or improved sterile fruit fly strains. Integrating these new technologies into the inter- agency response to invasive fruit flies will help improve the program's efficiency.

The new strategy also builds the capacity to combat invasive fruit flies in areas at high risk of introduction and will leverage the public's assistance to prevent further spread of these damaging agricultural pests.

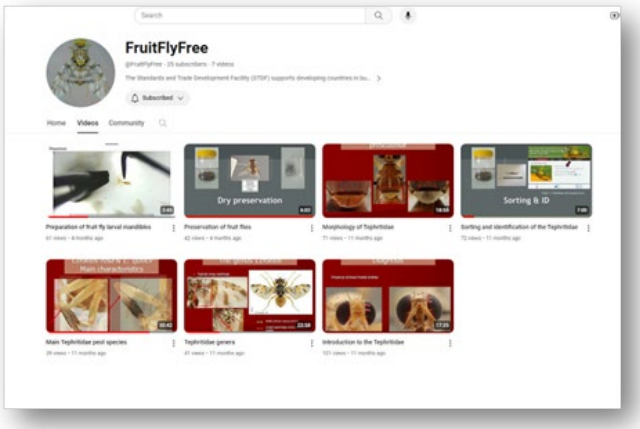
Federal and State partners will also unite their research resources and share knowledge about fruit flies to limit their movement and distribution. While leveraging best practices in the field, State and Federal partners will prioritize more research on climate and host-plant suitability, as well as other effective management tools.

Source: USDA-APHIS news. 17 April 2024. https://www.aphis.usda.gov/news/agency-announcements/usda-protects-hundreds-crops-invasive-fruit-flies-five-year-strategy.

Fruit Fly Free YouTube Channel

The Standards and Trade Development Facility (STDF) supports developing countries in building capacity to implement international sanitary and phytosanitary (SPS) standards, guidelines and recommendations. Project F3 Fruit Fly Free is funded by STDF and a collaboration between various research institutions and government departments. The Agricultural Research Council (ARC) (South Africa) is the implementing organization. Other partners in the project include the Departments of Agriculture, Land Reform and Rural Development (South Africa) and its Mozambican counterpart, Citrus Research International (South Africa), Stellenbosch University (South Africa), Eduardo Mondlane University (Mozambique) and the Royal Museum for Central Africa (Belgium).

The colleagues of Stellenbosch University (South Africa) and the Royal Museum for Central Africa (Belgium) developed a number of webinars covering the following topics: (1) Morphology of the Tephritidae; (2) Sorting and identification of Tephritidae; (3) Preservation of fruit flies (Tephritidae); (4) Main Tephritidae pest species; (5) Tephritidae genera; (6) Preparation of fruit fly larval mandibles; and (7) Introduction to the Tephritidae. All these webinars can be accessed at the YouTube Channel: https://www.youtube.com/@FruitFlyFree.



This channel aims specifically at providing supporting information for development, implementation and recognition of Pest Free Areas (PFA) and Areas of Low Pest Prevalence (ALPP) for regulated fruit fly pests of commercial fruit commodities in southern Africa, following the directives of the relevant International Standards for Phytosanitary Measures (ISPMs), as approved by the International Plant Protection Convention (IPPC). The webinars that posted in this YouTube Channel aims provide basic information on the identification and handling of fruit flies or accurate record-keeping, and more.

Source: https://www.youtube.com/@FruitFlyFree.

Queensland Fruit-fly don't Bother Me: South Australia Releases 1 Billion Sterile Fruit Flies

South Australia has now dispersed one billion sterile Queensland fruit flies into its Riverland fruit-growing region in response to an outbreak of the destructive citrus pest.

Bactrocera tryoni is commonly referred to as Queensland fruit fly or 'Q-fly' and is found across Australia's northern tropics and east coast. It is less commonly found in South Australia and Western Australia, though outbreaks have been known to occur.

South Australia has strict biosecurity laws and polices the importation of certain fresh food products from outside its borders. The state's citrus-growing Riverland region bordering the Murray River is experiencing 47 Q-fly outbreaks.

A Queensland fruit fly. Credit: Chloe Johnson / PIRSA.

To combat this, the state's 8-year-old Sterile Insect Technique facility based in Port Augusta has now neutered and released 1 billion male fruit flies into the region. This process will continue until mid-February 2024 with around 40 million sterile files being reared each week.

A case of X-ray sterilization

As with other efforts to eradicate pest species, the premise of insect sterilisation is to introduce numerous individuals of a target species that can't produce viable offspring.

The aim is for sterile males to outnumber their wild counterparts. By mating with wild females, the populations of Q-fly, which have short lifespans of under 2 months, should rapidly decrease.

The sterilization process is one of the final steps used by agricultural authorities when rearing its candidate males, whereby eggs collected in a secure facility are left to hatch into larvae (or maggots) on special tray towers, where they will feed for about a week.

They are then harvested and bagged with vermiculite to provide a medium where the maggots harden their skin and transition into their pupal form.

In these dark-coloured, hardened stages, the pupae are separated from the vermiculite medium and exposed to X-rays to sterilize them before being shipped out to hatch and distributed in the environment.

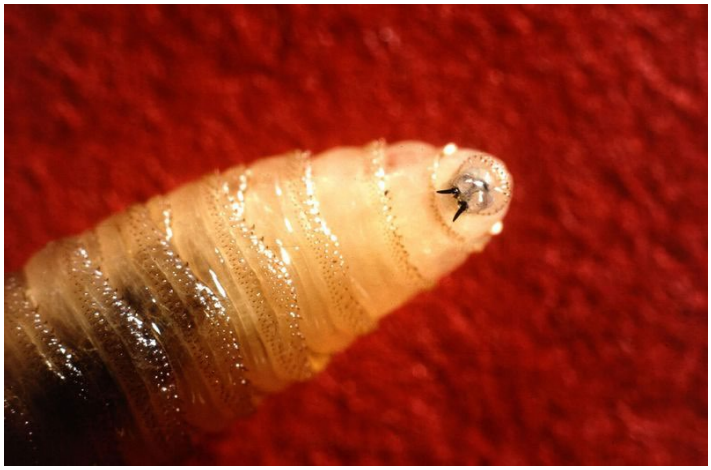
South Australia's Department of Primary Industries and Regions (PIRSA) is responsible for the state's sterile fly program and anticipates continuing the release of these specimens until mid-February. PIRSA estimates the outbreak will end on 20 March 2024.

Source: cosmosmagazine.com. By Matthew Ward Agius, 5 January 2024. https://cosmosmagazine.com/earth/agriculture/q-fly-dont-bother-me-sa-releases-1-billion-sterile-fruit-flies/.

Burrowing, Flesh-Eating Fly Larvae Outbreak Sparks National Emergency in Costa Rica

Nearly seven months after declaring a re-emergence of the New World screwworm fly in Costa Rica, a state of emergency was declared in the country on 7 February 2024 as the flesh-eating insect population continues to rise.

New World screwworm (NWS) flies (*Cochliomyia hominivorax*), which are a species of blowfly (family Calliphoridae), are native to much of North and South America and have been popping up and wreaking havoc across the continents for centuries. Having been known to decimate livestock populations, as well as infecting domestic pets and even humans, the fly lays its eggs inside the open wounds of any mammal (and sometimes bird) species. Once hatched, the larvae burrow deep inside the living tissue, causing painful infections, tissue loss, and even death.



Despite best efforts to keep the population under control in Costa Rica, the numbers reportedly continued to rise. As of March this year, the first case of human infection was reported by the Ministry of Health and National Animal Health Service (SENASA), marking the country's inaugural case of human infestation.

However, due to a decades-long eradication campaign by using sterile insect technique (SIT)by the US Department of Agriculture (USDA) which saw the first successful eradication of NWS in North America in the 1960s, it is hoped that through combined government efforts they can once again "prevent, control, and eradicate" Costa Rica's NWS population.

Source: IFLScience.com. By Charlie Haigh, 8 April 2024. https://www.iflscience.com/burrowing-flesh-eating-fly-larvae-outbreak-sparks-national-emergency-in-costa-rica-73724.

Scientists in Argentina use Nuclear Energy to Reduce Disease-carrying Mosquitoes

Scientists in Argentina are using a new technique to reduce the number of dengue, Zika, and chikungunya infections in the population and save lives. - Copyright AP Photo.

Scientists in Argentina are using a new technique to reduce the number of dengue, Zika, and chikungunya infections in the population and save lives. They breed and sterilize *Aedes aegypti* mosquitoes, a vector for these diseases, with gamma irradiation before releasing them back into the wild to mate. When the mosquitoes are bred in the laboratory, scientists separate the males and females based on size. The males are then irradiated at the Ezeiza Atomic Centre.

"This irradiation makes them sterile, but they are given a specific dose so that they do not lose competitiveness. Then the mosquitoes are released in the area. They remain competitive mosquitoes that will mate with females, and the result of this mating will not produce offspring. In this way, the population in that area decreases," said Mariana Malter Terrada, from Argentina's National Atomic Energy Commission.

The team behind the *Aedes* control project says the sterile insect technique (SIT) is like birth control for insects.

"These sterile males compete with wild males to mate with wild females, and the result of this mating is unviable. In this way, with each release, the population in the targeted area decreases," said Malter Terrada.

Argentina has especially been hit by mosquito-borne diseases with 68 deaths and over 130,000 confirmed cases in 2023, according to the country's Ministry of Health.

The SIT - first introduced by American entomologist Edward F. Knipling in the 1950s, has been used to contain, prevent, and even locally eradicate populations of pest insects and disease vectors. It doesn't require the traditional spraying of pesticides, which eliminates human or animal exposure to toxins that can lead to other health issues. According to experts, it acts specifically on the vector and does not detrimentally affect the wider ecosystem.

The *Aedes aegypti* mosquito project began amid the Zika outbreak in 2016. "This raised all alarms due to the importance of this disease, as it was observed that pregnant women contracting this disease could have babies with malformations," said Malter. "This, coupled with the spread of *Aedes* and its relevance as a vector of various diseases such as the Zika and chikungunya viruses, not only in Argentina but worldwide".

As the reproduction of infected mosquitoes rises with soaring temperatures and humidity, scientists are now stepping up their sterilization efforts.

Source: euronews.com. By Roselyne Min with AP, 3 January 2024. https://www.euronews.com/health/2024/01/03/scientists-in-argentina-use-nuclear-energy-to-reduce-disease-carrying-mosquitoes.

Relevant Published Articles

How Plastic Are Upper Thermal Limits? A Comparative Study in Tsetse (Family: Glossinidae) and Wider Diptera

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Abstract

Critical thermal maximum (CTmax) describes the upper thermal tolerance of an animal where biological functions start to fail. A period of acclimation can enhance CTmax through plasticity, potentially buffering animals from extreme temperatures caused by climate change. Basal and acclimated CTmax vary within and between species and may be explained by traits related to thermal physiology, such as body size and sex. Differences in CTmax have not been established among species of tsetse fly (*Glossina* spp.), vectors of animal and human African trypanosomiasis. Here, we investigated basal CTmax and its plasticity for five tsetse species following adult acclimation at constant 25 or 30 ◦C for five days. We then set our findings in context using a meta-analysis on 33 species of Diptera. We find that, of the five tsetse species considered, only *Glossina palpalis gambiensis* and *Glossina brevipalpis* exhibited plasticity of CTmax, with an increase of 0.12 °C and 0.10 °C per 1 °C acclimation respectively. Within some species, higher basal CTmax values were associated with larger body size and being female, while variation in plasticity (i.e., response to the acclimation temperature) could not be explained by sex or size. Our broader meta-analysis across Diptera revealed overall CTmax plasticity of 0.06 °C per 1 °C acclimation, versus a similar 0.05°C mean increase in tsetse. In contrast, there was greater CTmax plasticity in males compared to females in Diptera. Our study highlights that CTmax and its plasticity varies even among closely related species. Broader patterns across groups are not always reflected at a finer resolution; we thus emphasise the need for detailed experimental studies across a wide range of insect species to capture their capacity to cope with rapidly warming temperatures.

Keywords: Heat tolerance Acclimation Critical thermal maximum Body size Temperature stress.

The full paper was published in: Journal of Thermal Biology, https://doi.org/10.1016/j.jtherbio.2023.103745.

A Fast and Reliable Larval Sampling Method for Improving the Monitoring of Fruit Flies in Soft and Stone Fruits

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Abstract

The spotted-wing drosophila, *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), threatens both the soft-skinned and stone fruit industry in Asia, Europe, and America. Integrated pest management requires monitoring for infestation rates in real time. Although baited traps for adult *D. suzukii* are widely used for field monitoring, trap captures are weakly correlated to larval infestation rates. Thus, monitoring for larvae instead of adult flies represents the most reliable monitoring technique. Current methods for larval monitoring (e.g., sugar or salt floatation) are time-consuming and labor-intensive. In this study, we develop a new "sleeve method" for detecting larvae in strawberries through the inspection of individual fruits crushed within transparent plastic sleeves. Samples can be optionally frozen until further processing. Based on count data from non-expert observers, the estimation of larval infestation with the sleeve method is fast, precise, and highly repeatable within and among observers. Mean processing time is half the time compared to previous methods (33–80s per sample depending on infestation levels). As the accuracy of the sleeve method decreases with infestation levels, we suggest ways to improve its accuracy by incubating fruits for 48 h and calibrating data using fruits with a known number of larvae. The method could also be used in other fruits, as it is easier to use, faster, and requires less equipment than previous monitoring methods. Finally, the method represents a promising tool for growers or researchers to effectively monitor and manage *D. suzukii* and other insect pests of soft and stone fruits.

Key words: spotted-wing drosophila, larval infestation, transparent plastic sleeve, integrated pest management, SWD.

The full paper was published in: Journal of Economic Entomology, https://doi.org/10.1093/jee/toae001.

Effect of X-ray Irradiation on the Biological Parameters of *Xestia c-nigrum*

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Abstract

The sterile insect technique (SIT) is widely used to control Lepidopteran pests by inducing inherited sterility. The noctuid moth *Xestia c-nigrum* is a polyphagous pest whose subterranean larvae severely injure cereals and some vegetables. The goals of this study were to assess the impact of X-ray irradiation on the development and survival of X. c-nigrum and use the data to select suitable sterilizing doses for potential future use in pest management. Batches of male pupae were exposed to 0 (control), 10, 30, 50, 100, 200, 300, or 400 Gy of X-rays, approximately 24 h before adult emergence. Exposure of late-stage pupae to 10–200 Gy of radiation had no significant effect on adult emergence, but all doses (10–400 Gy) reduced adult longevity, the number of spermatophores in mated females, and the number of eggs laid per female in the irradiated parental generation compared with the controls. Exposure to 10 and 30 Gy had no significant effects in the F_1 generation on 1) the rate of egg hatch, 2) the duration of larval or pupal development, or 3) adult longevity. However, exposure to 50 Gy reduced the rate of egg hatch in the F_1 generation, and when male pupae were exposed to 100 Gy only 1% of the F_1 eggs hatched. Also at 100 Gy, the developmental durations of larvae and pupae were significantly prolonged, and longevity of adult moths was reduced. There were no significant differences between the control group and any treatments in 1) the sex ratio of the F_1 adults, 2) the duration of F_1 pre-oviposition or oviposition periods, or 3) the number of eggs laid per F_1 female. Our findings indicate that a dose of 100 Gy can effectively slow pest development and reduce larval survival in the F_1 generation. In addition, F_1 adults from lines treated with 100 Gy were able to mate and lay eggs, but all F_2 eggs failed to hatch. Our results suggest that use of X-ray irradiation has potential to control this polyphagous pest at the regional level.

Keywords: *Xestia c-nigrum*, sterile insect technique, x-ray irradiation, inherited infertility, longevity, survival

The full paper was published in: Frontiers in Physiology, Invertebrate Physiology, https://doi.org/10.3389/fphys.2024.1362991.

Chemical Ecology and Management of Dengue Vectors

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Abstract

Dengue, caused by the dengue virus, is the most widespread arboviral infectious disease of public health significance globally. This review explores the communicative function of olfactory cues that mediate host-seeking, egg-laying, plant-feeding, and mating behaviors in Aedes aegypti and *Aedes albopictus*, two mosquito vectors that drive dengue virus transmission. *Aedes aegypti* has adapted to live in close association with humans, preferentially feeding on them and laying eggs in human-fabricated water containers and natural habitats. In contrast, *Ae. albopictus* is considered opportunistic in its feeding habits and tends to inhabit more vegetative areas. Additionally, the ability of both mosquito species to locate suitable host plants for sugars and find mates for reproduction contributes to their survival. Advances in chemical ecology, functional genomics, and behavioral analyses have improved our understanding of the underlying neural mechanisms and reveal novel and specific olfactory semiochemicals that these species use to locate and discriminate among resources in their environment. Physiological status; learning; and host- and habitat-associated factors, including microbial infection and abundance, shape olfactory responses of these vectors. Some of these semiochemicals can be integrated into the toolbox for dengue surveillance and control.

Keywords: semiochemicals, behavior, dengue, arbovirus surveillance, arbovirus control, *Aedes aegypti*, *Aedes albopictus*

The full paper was published in: Annual Review of Entomology, https://doi.org/10.1146/annurev-ento-020123-015755.

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Impressum

Insect Pest Control Newsletter No. 103

The Insect Pest Control Newsletter is prepared twice per year by the Insect Pest Control Section, Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratories, Seibersdorf

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, July 2024

24-03289