Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect Pest Control Newsletter

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To Our Readers

Production and exports of Pitahaya (dragon fruit) in Ecuador from Pest Free Production Sites (PFPS). The PFPS is a pest risk mitigation scheme described in the International Standard of Phytosanitary Measures (ISPM) No. 10 'Requirements for the establishment of pest free places of production and pest free production sites'. Member States of FAO and IAEA are increasingly using this scheme to open international markets that discriminate against fruit fly pests (Source: AGROCALIDAD).

The Pest Free Production Sites (PFPSs) is a pest risk mitigation scheme adopted by the Commission on Phytosanitary Measures and is increasingly being used to facilitate trade. Ecuador is among one of the countries that have benefited from this scheme and increased the number of PFPSs from 303 in 2018 to 1094 in Sept 2023. With this scheme Ecuador has been exporting non-traditional fruits including pitahaya (dragon fruit), tree tomato and golden berries (Uchuva) to the USA and more recently to China and Peru. Bilateral workplans have been subscribed between Ecuadorian Agency for Regulation and Control of Plant and Animal Health (AGROCALIDAD) and recognized as such by the National Plant Protection Organizations (NPPO) of these importer countries. The work plans contain the specific phytosanitary measures that need to be applied by the producers and exporters to be eligible for participation in the export programme. Among the measures being used is the area-wide application of the sterile insect technique (SIT). Sterile flies are imported weekly from the mass-rearing and sterilization facility of the Moscamed Programme located in El Pino, Guatemala, and released over 855 hectares of commercial fruit crops and surrounding areas. The PFPS is achieved when at least one year of surveillance demonstrates the absence of fruit flies of quarantine importance specifically the Mediterranean fruit fly and the South American fruit fly. The detection of a single fruit fly per hectare in one week will trigger the enforcement of a contingency plan. The sites where the detection occurs are excluded from the export programme until the fruit fly free status is regained in the production site.

The possibility for fruit exports using this pest risk mitigation scheme, has been an incentive to the fruit industry that has expanded the production of these non-traditional crops. In the case of pitahaya, the production area has increased to over 1 700 hectares with over 34 000 tonnes of fruit being exported, valued at more than US$ 73 million in 2023 (until September 2023).

In line with the above, the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization of the United Nations (FAO) jointly launched 'Atoms4Food', a new flagship initiative to help boost food security and tackle growing hunger around the world. The Atoms4Food initiative will support countries to use innovative nuclear techniques in enhancing agricultural productivity, reducing food losses, ensuring food safety, improving nutrition, and adapting to the challenges of climate change.

The initiative builds on IAEA and FAO programmes to provide tailor made comprehensive support to countries and will be delivered through partnership and cooperation with multi-stakeholders, as appropriate. Specifically on contributions form Insect Pest Control to this flagship initiative, the changing climatic conditions, increased global trade and human migration enable invasive insect pests to expand into new regions across borders. The SIT offers a solid cost-effective solution to curb target invasive insect pest populations contributing to the reduction of insecticide applications and protection of the environment.

Additionally, we would like to highlight a valuable book which was recently published by FAO titled 'Case Studies of The Use of Agricultural Biotechnologies to Meet the Needs of Smallholders in Developing Countries'. The book presents a case study in Ecuador on the use of the SIT as part of an integrated pest management approach to control fruit fly pests. The book contains details on the use of agricultural biotechnologies and is available at: https://www.fao.org/3/cc8940en/cc8940en.pdf.

Also, the International Guideline on Phytosanitary Procedures for Area-Wide Management of Fruit Fly Pests, was recently prepared. This 224-page guideline describes in detail the most widely used classic and modern phytosanitary procedures for the management of fruit fly pests that infest fruits and vegetables and that are of quarantine and economic importance, specifically species of the genera *Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis* and *Zeugodacus*. For more details, please see page number 31 of this newsletter.

Furthermore, on references, I would like to raise your attention to two special issues recently published in the journal 'Insects' with scientific data produced in the framework of the Coordination Research Project (CRP) on 'Mosquito Handling, Transport, Release and Male Trapping Methods' (https://www.mdpi.com/journal/insects/special_issues/Mosquit_Handling_Transport_Release_and_Male_Trapping_Methods) and the CRP on 'Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes' (https://www.mdpi.com/journal/insects/special_issues/Improved_Field_Performance_Sterile_Male_Lepidoptera).

Finally, I would like to acknowledge three colleagues who left the Agency in July and August 2023, Mr Jeremy Bouyer, Mr Carlos Caceres and Mr Marc Vreysen. We would like to give our thank to Jeremy for his work and contribution to the Insect Pest Control (IPC) Subprogramme during the last six years and wish him all the best for the new chapter ahead, to Carlos for his valuable support and contribution to the IPC Subprogramme for 15 years, wishing him all the best for his deserved retirement, and at last to Marc for his long service to the Insect Pest Control Subprogramme, mainly on the 13 years as Insect Pest Control Laboratory (IPCL) Head (2009–2023) where he served with dedication and leadership specially during two challenging periods of the IPCL, the transition to the new Laboratory and the COVID pandemic. We wish him all the best for his deserved retirement.

Rui Cardoso Pereira
Head, Insect Pest Control Section

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Forthcoming 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, Agrinio, Greece.

Fourth RCM on Assessment of Simultaneous Application of SIT and MAT to Enhance *Bactrocera* Fruit Fly Management. 19–23 April 2024, Reduit, Mauritius.

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

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

Fourth RCM on Generic Approach for the Development of Genetic Sexing Strains for SIT Applications. 2–6 November 2024, Reduit, Mauritius.

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

II. Consultants and Expert Meetings

Consultancy Meeting on Tsetse Population Genetics. 10–14 June 2024, Vienna, Austria.

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.

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.

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 Interregional Training Course on The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests (under Interregional TC Project INT5159). 29 July–23 August 2024, Metapa de Dominguez, Chiapas, Mexico.

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). 7–11 October 2024, Hanoi, Viet Nam.

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, Pretoria, South Africa.

Past Events (2023)

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

Third RCM on Improvement of Colony Management in Insect Mass-rearing for SIT Applications. 27 February–3 March 2023 (virtual).

Third RCM on Generic Approach for the Development of Genetic Sexing Strains for SIT Applications. 24–28 April 2023 (virtual).

Second RCM on Improving Rearing, Handling, and Field Components for Fruit Fly SIT Application. 15–19 May 2023, Vienna, Austria.

First RCM on Mosquito Male Performance. 3–7 July 2023, Vienna, Austria.

Third RCM on Mosquito Irradiation, Sterilization and Quality Control. 6–10 November 2023 (virtual).

II. Consultants and Expert Meetings

Consultancy Meeting on Thematic Plan for Lepidoptera Sterile Insect Technique. 6–10 February 2023, Vienna, Austria.

Consultancy Meeting on *Drosophila suzukii*–New Other Species for SIT. 20–24 March 2023, Vienna, Austria.

Consultancy Meeting on Thematic Plan for Tsetse Area-wide Integrated Pest Management Programmes Involving the Sterile Insect Technique. 29 May–2 June 2023, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Workshop on Genetic Diversity Analysis and Colony Management. 23–25 February 2023, Patras, Greece.

FAO/IAEA Regional Group Scientific Visit on Area-Wide Eradication Programmes of the New World Screwworm (RLA5088). 3–7 March 2023, Pecora, Panama.

FAO/IAEA Regional Meeting on Genetics, Breeding Procedures and other Characteristics of the New Genetic Sexing Strain of *Anastrepha fraterculus* (Wiedmann) (RLA5087). 27–31 March 2023, Mendoza, Argentina.

Seventeen Session of the Commission on Phytosanitary Measures (CPM-17), International Plant Protection Convention, FAO. 27–31 March 2023, Rome, Italy.

FAO/IAEA Regional Training Course on Applying State of the Art Dosimetry and Quality Control Tests for South American Fruit Fly *Anastrepha fraterculus* Wied. (RLA5087). 8–12 May 2023, Seibersdorf, Austria.

FAO/IAEA and OIRSA Regional Workshop on Emergency Response to Outbreaks of the Invasive Bactrocera spp. Fruit Flies (RLA5082). 8–12 May 2023, San Salvador, El Salvador.

FAO/IAEA Regional Training Course on Genetic Population Studies to Support Tsetse Field Projects (RAF5087). 8–19 May 2023, Nairobi, Kenya.

FAO/IAEA Coordination Meeting on Enhancing Capacity for the Use of the Sterile Insect Technique as a Component of Mosquito Control Programs (RLA5083). 19–23 June 2023, Havana, Cuba.

5th WHO Meeting of Stakeholders on Elimination of Human African Trypanosomiasis (Gambiense and Rhodesiense). 7–9 June 2023, Geneva, Switzerland.

FAO/IAEA Regional Training Course on Collection of Entomological Baseline Data, and Data Management Tools to Support SIT Projects for Mosquito Control (RLA5083). 10–21 July 2023, Juazeiro, Bahia, Brazil.

FAO/IAEA Regional Workshop on Public Information and Outreach on New World Screwworm Surveillance, Prevention and Eradication Programmes (RLA5088). 24–28 July 2023, Vienna, Austria.

36th General Conference of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC). 18–22 September 2023, Mombasa, Kenya.

FAO/IAEA Regional Training Course on Socio-economic Assessment (RAF5087). 28 August–1 September 2023, Dakar, Senegal.

FAO/IAEA Interregional Training Course on Dosimetry and Irradiation Procedures to Support SIT Field Projects for Vector Control (RLA5083, RER5026). 9–13 October 2023, Vienna, Austria.

Horizon 2020 Project, Controlling and Progressively Minimizing the Burden of Animal Trypanosomosis (COMBAT) Second Annual Meeting. 10–12 October 2023, Rome, Italy.

FAO/IAEA Regional Training Course on Area-wide Fruit Fly Integrated Pest Management Including Sterile Insect Technique (SIT) and Male Annihilation Technology (MAT) (RAS5097). 6–10 November 2023, Bangkok, Thailand.

FAO/IAEA Final Project Review Meeting on Enhancing the Capacity to Integrate the Sterile Insect Technique in the Effective Management of Invasive *Aedes* Mosquitoes (RER5026). 4–6 December 2023, Vienna, Austria.

FAO/IAEA Regional Training Course on Mosquito Sterile Insect Technique (SIT) Package in a Large-Scale Mass Rearing Facility (RER5026). 11–13 December 2023, Singapore.

Technical Cooperation Projects

The Insect Pest Control Subprogramme currently has technical responsibilities for the following technical cooperation projects that are managed by the IAEA's Department of Technical Cooperation. 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 Techni7que 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	BRA5061	Using the Sterile Insect Technique to Apply a Local Strain in the Control of *Aedes aegypti* (Phase II)	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	KAM5006	Implementing Fruit Fly Surveillance and Control Using Area-wide Integrated Pest Management	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	CPR5026	Applying the Sterile Insect Technique as Part of an Area-wide Integrated Pest Management Approach to Control Two Fruit Flies	Daguang Lu
China	CPR5027	Demonstrating Feasibility of the Sterile Insect Technique in the Control of the Codling Moth, *Cydia pomonella*	Walther Enkerlin
Cuba	CUB5021	Demonstrating the Feasibility of the Sterile Insect Technique in the Control of Vectors and Pests	Rui Cardoso Pereira
Cyprus	CYP5020	Developing a National Rapid Response Strategy for the Prevention of the Establishment of the Asian Tiger Mosquito	Hanano Yamada
Dominican Republic	DOM0006	Building and Strengthening the National Capacities and Providing General Support in Nuclear Science and Technology	Walther Enkerlin
Ecuador	ECU5031	Enhancing the Application of the Sterile Insect Technique as Part of an Integrated Pest Management Approach to Maintain and Expand Fruit Fly Low Prevalence and Free Areas	Walther Enkerlin

Ecuador	ECU5032	Building Capacity for Mass Rearing, Sterilization and Pilot Release of *Aedes aegypti* and *Philornis downsi* Males	Maylen Gómez Walther Enkerlin
Ethiopia	ETH5023	Enhancing Livestock and Crop Production through Consolidated and Sustainable Control of Tsetse and Trypanosomosis 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	FIJ5003	Implementing Pesticide-Free Suppression and Management of Fruit Flies for Sustainable Fruit Production	Daguang Lu
Grenada	GRN0001	Building National Capacity through the Applications of Nuclear Technology	Rui Cardoso Pereira
Israel	ISR5021	Assisting in the Development of a Strategy to Counteract *Bactrocera zonata*	Walther Enkerlin
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	JAM5014	Establishing a Self-Contained Gamma Irradiation Facility for the Introduction of Sterile Insect Technique and Experimental Mutagenesis and Diagnostic Technologies	Rui Cardoso Pereira
Libya	LIB5014	Supporting Control of Fruit Flies by Establishing a Low Fruit Fly Prevalence Zone	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	MOR5038	Strengthening the Use of the Sterile Insect Technique	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
Palau	PLW5003	Facilitating Sustainability and Ensuring Continuity of Area-wide Pest Management — Phase III	Daguang Lu
Portugal	POR5006	Integrating the Sterile Insect Technique in the Control of the Invasive Vector Mosquito *Aedes albopictus*	Maylen Gómez
Senegal	SEN5040	Strengthening National Capacities to Create a Tsetse-Free Zone Using the Sterile Insect Technique	Chantel de Beer
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	SAF5015	Supporting the Control of Nagana in South Africa Using an Area-wide Integrated Pest Management Approach with a Sterile Insect Technique Component - Phase I	Adly Abdalla
South Africa	SAF5017	Assessing the Sterile Insect Technique for Malaria Mosquitoes — Phase III	Hanano Yamada
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	RAF5074	Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods	Daguang Lu
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 Asia & the Pacific	RAS5086	Assessing the Efficiency of the Sterile Insect Technique for the Control of the Cocoa Pod Borer	Daguang Lu
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	Maylen Gomez
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	RLA5083	Enhancing Capacity for the Use of the Sterile Insect Technique as a Component of Mosquito Control Programmes	Maylen Gómez

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
		New National Projects to Start in 2024	
Brazil	BRA5062	Application of the Sterile Insect Technique for the Control of *Aedes aegypti*	Rui Cardoso Pereira
Cambodia	KAM5011	Establishing SIT-based area-wide integrated management of *Bactrocera zonata* and *Bactrocera dorsalis*	Daguang Lu
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	Hanano Yamada
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
Fiji	FIJ5007	Implementing Pesticide Free Suppression and Management of Fruit Flies for Sustainable Fruit Production — Phase II	Daguang Lu
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
Morocco	MOR5040	Improving the Productivity of Livestock and Crops	Walther Enkerlin
Oman	OMA5009	Establishing SIT-based area-wide integrated management of *Bactrocera zonata* and *Bactrocera dorsalis*	Daguang Lu
Philippines	PHI5037	Assessing the Feasibility of the Sterile Insect Technique to Suppress the *Aedes aegypti* Population	Maylen Gomez
Panama	PAN5031	Validating the Sterile Insect Technique for the Control of the Mediterranean Fruit Fly, *Ceratitis capitata*	Walther Enkerlin

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
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
		New Regional Projects to Start in 2024	
Regional Africa	RAF5092	Enhancing Agricultural Productivity for Improved Food Security in Africa	Daguang Lu Rui Cardoso Pereira
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
		New Interregional Project to Start in 2024	
Interregional	INT5159	Atoms4Climate Adaptation and Mitigation: Non-Power Technologies for the Terrestrial Landscape	Rui Cardoso Pereira

Highlights of Technical Cooperation Projects

FAO/IAEA Interregional Training Course on Dosimetry and Irradiation Procedures to Support Field Projects using the Sterile Insect Technique for Vector Control; 9–13 October 2023, Seibersdorf, Austria

Through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, the training course has been conducted under the framework of IAEA regional and national TC projects. Thirteen scientists from 12 Member States including Albania, Argentina, Bangladesh, Brazil, Croatia, Cuba, Ecuador, Greece, Jamaica, Peru, Senegal and Serbia participated in the training course at the Insect Pest Control Laboratory (IPCL).

Participants of the FAO/IAEA Interregional Training Course on Dosimetry and Irradiation Procedures to Support Field Projects using the Sterile Insect Technique for Vector Control (Seibersdorf, Austria).

The training course aimed to teach participants about dosimetry, irradiation and handling procedures used in SIT projects targeting *Aedes* mosquito control. The course covered both theoretical and practical sessions including topics such as: (1) the differences between X-ray and Gamma irradiators; (2) basics of radiation biology and dosimetry; (3) dose distribution for sample canister; (4) irradiation of chilled mosquito adults, packing and transportation; (5) characteristics of Gafchromic film; and (6) factors affecting the dose-response in mosquitoes.

The training also provided a 'basic irradiation package' to each participating Member State to strengthen and harmonise procedures common in SIT pilot trials at the interregional level. The hands-on sessions were particularly important, allowing participants to become familiar with the use and calibration of the Gafchromic Dosimetry System for measuring absorbed dose, reading the film and analysing the results. Additionally, the practical sessions provided participants with essential information about Gamma irradiators (Foss Model 812, Nordion Gammacell 220) and X-ray irradiators (Best Theratronics Raycell MK2, Precision Xrad 320 and Radsource RS2400) for SIT application. As the sterilization process by ionizing radiation is the basis of the SIT technology, the training course was instrumental in developing knowledge, skills, and capabilities in these relevant subjects for future implementation of new SIT projects against *Aedes* mosquitoes.

Enhancing the Application of the Sterile Insect Technique as Part of an Integrated Pest Management Approach to Maintain and Expand Fruit Fly Low Prevalence and Free Areas (ECU5031)

Exports of non-traditional fruits applying pest free production sites (PFPS) as a phytosanitary measure in Ecuador

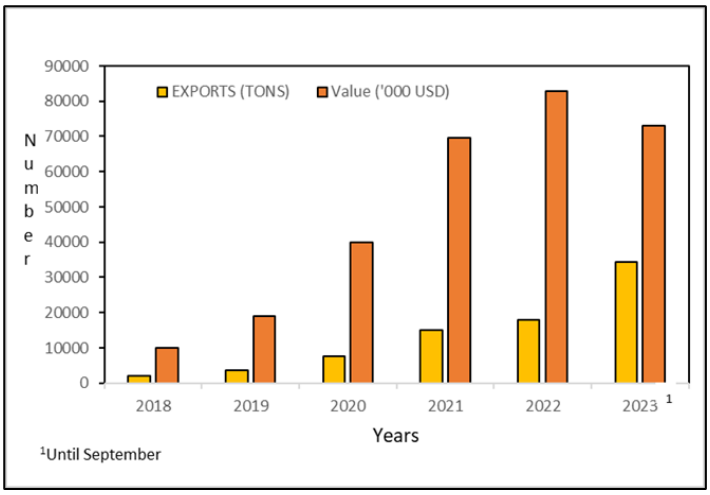
Since 2018, Ecuador has been exporting non-traditional fruits including pitahaya (dragon fruit), tree tomato and golden berries (Uchuva) to the USA and more recently to China and Peru. Exports have been possible by applying the fruit fly pest mitigation measures known as 'Pest Free Production Sites (PFPS)' which is described in the International Standard of Phytosanitary Measures (ISPM) No. 10 'Requirements for the establishment of pest free places of production and pest free production sites' and ISPM26 'Establishment of pest free areas for fruit flies (Tephritidae)'.

Today, 1094 PFPSs (from 303 in 2018) of these non-traditional fruits have been certified by the Ecuadorian Agency for Regulation and Control of Plant and Animal Health (Agrocalidad) and recognized as such by the National Plant Protection Organizations (NPPO) of these importer countries. Bilateral workplans have been subscribed between Agrocalidad and the NPPOs of the importer countries. The work plans contain the specific phytosanitary measures that need to be applied by the producers and exporters to be eligible for participation in the export programme. The PFPS is achieved when at least one year of surveillance demonstrates the absence of fruit flies of quarantine importance specifically the Mediterranean fruit fly (*Ceratitis capitata*) and the South American fruit fly (*Anastrepha fraterculus*). The detection of a single fruit fly per hectare in one week will trigger the enforcement of a contingency plan. The sites where the detection occurs are excluded from the export programme until the fruit fly free status is regained in the production site.

The phytosanitary scheme being used by farmers and exporters in Ecuador, was transferred to Ecuador with support from FAO and IAEA through the IAEA TC project EUC5031.

Pitahaya (dragon fruit) exports from Ecuador.

Phytosanitary measures that were transferred and are in use to establish and maintain the PFPSs include fruit fly surveillance and population suppression and eradication methods. Among the measures being used is the area-wide application of the sterile insect technique (SIT). Sterile flies are imported weekly from the mass-rearing and sterilization facility of the Moscamed Programme located in El Pino, Guatemala, and released over 855 hectares of commercial fruit crops and surrounding areas.



Pitahaya export volumes and values from Pest Free Production Sites (PFPS).

The possibility for fruit exports using this pest risk mitigation scheme, has been an incentive to the fruit industry that has expanded the production of these non-traditional crops. In the case of pitahaya, the production area has increased to over 1 700 hectares with over 34 000 tonnes of fruit being exported valued at more than US$ 73 million in 2023 (until September 2023).

The Mediterranean Fruit Fly Threatening Galapagos Islands Unique Biodiversity

The Mediterranean fruit fly, *Ceratitis capitata*, is widely known to be one of the most destructive pests affecting production and trade of fruits and vegetables worldwide, thus a major constraint to food security and safety. However, this invasive pest has rarely been regarded as a threat to biodiversity and ecosystems.

The invasive Mediterranean fruit fly was introduced to the Galapagos Islands in 2008 constituting a major threat to the subsistence production of fruits and vegetables consumed by around 33 000 inhabitants. Fruits such as citrus, coffee, guavas, loquat, Malay apple and mangos, which are hosts of this pest, constitute an important component of the human diet for the local population including farmers and fishermen. To face the fruit fly problem, fruit growers have to intensively use synthetic insecticides to protect their crops. The irrational application of insecticides seriously compromises human and environmental health and negatively affects beneficial ecosystem service providers such as natural enemies and pollinators. Moreover, given the polyphagous nature of this invasive pest and its rapid capacity to adapt and invade new ecosystems, it also represents a major threat to the islands' unique ecosystem and biodiversity.

Given this threat, and in response to a request from Ecuador's Ministry of Environment through the Galapagos Regulatory and Biosecurity Agency (ABG) to the FAO and IAEA, in 2022, an international expert was commissioned by the IAEA to conduct an initial environment impact assessment in the four Galapagos islands where the pest is currently present. At this point there is insufficient data to be able to quantify the potential environmental impact of this invasive species on Galapagos biodiversity. Nevertheless, considering the well documented biotic potential of Mediterranean fruit fly and the delicate ecological balance in the Galapagos, the risk of devastating negative impacts could be high including a decline on a number of species of flora such as the native Opuntia cactus, and the Galapagos tomato or tomatillo (*Lycopersicon cheesmanii*) and fauna such as land iguanas, Galapagos tortoises, and birds including the Galapagos finch birds, for which this native flora is part of their staple food. Opuntia plants have a very close association with several species of finch birds as well as tortoises providing an essential food source. Populations of these animals would be negatively affected in case there is a decline in the availability of Opuntia cactus fruits (prickly pears), because of Mediterranean fruit fly infestations. Prickly pear is known to be a host of Medfly in some regions including in the islands of Porto Santo and Madeira in the Portuguese Madeira archipelago and in some Mediterranean countries in northern Africa. Also, the Galapagos tomato is a native plant species present in most Galapagos Islands. The fruits are also an important food source for tortoises which in turn serve as a means of spread of the seeds that pass through their digestive systems and are deposited long distances from the source. If Mediterranean fruit fly was to infest this plant, fruits would fall to the ground prematurely and decompose, on one hand, reducing this source of food to the tortoises and affecting the dispersal mechanisms of the seeds.

It is important to take into consideration that the ecological balance in the Galápagos, which took millions of years, is extremely fragile due to the limited biodiversity in comparison with the ecosystems present in mainland. The introduction, establishment and spread of Mediterranean fruit fly would represent an additional source of pressure to the Galapagos ecosystems.

Galapagos tortoises feeding on Opuntia *cactus.*

Eradicating Mediterranean fruit fly from the four islands where it is currently present, would have a two-fold benefit: (1) eliminating the damage caused by Mediterranean fruit fly to the fruit produced locally; and (2) preventing its spread to the rest of the Galápagos islands and the detrimental effects to its unique biodiversity. For this to be possible a green and sustainable approach safer than the use of hazardous chemicals, would have to be used. Given the nature of the Galapagos islands, the only technology that could achieve Mediterranean fruit fly eradication in a sustainable manner is the sterile insect technique (SIT) using an area-wide approach. Unlike other biological control agents, sterile insects are species specific and are not self-replicating. These features make SIT the most environmentally friendly technique available for insect pest control. SIT has been used to suppress and eradicate several invasive species including an outbreak of Mediterranean fruit fly in the Dominican Republic in 2017 and an outbreak of the cactus moth *Cactoblastis cactorum* from Isla Mujeres and Isla Contoy off the coast of the Yucatan Peninsula in Mexico in 2009. Eradicating Mediterranean fruit fly from the Galapagos would add to the successful application of SIT to prevent or eradicate invasive pests. This would foster the transfer of this technology against other invasive pests that affect agriculture and the environment.

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

FAO/IAEA Regional Training Course on Area-wide Integrated Fruit Fly Management including Sterile Insect Technique (SIT) and Male Annihilation Technique (MAT) in Southeast Asia and Pacific Islands. 6–11 November 2023, Bangkok, Thailand

Fruit and vegetables are a vital part of cuisines and nutrition around the world. Consuming enough of fruit and vegetables has many benefits on children's growth and development, longer life, better mental health, healthy heart, lower cancer, obesity and diabetes risk, better gut health and improved immunity. The World Health Organization (WHO) currently recommends consuming at least 400 grams of fruit and vegetables each day–or five servings of 80 grams each. According to the FAO statistics, the world's main producing region of both fruit and vegetables, by a long way, is East Asia, followed by South Asia.

Participants to the regional training course on Area-wide Integrated Fruit Fly Management including Sterile Insect Technique (SIT) and Male Annihilation Technique (MAT) in Southeast Asia and Pacific Islands, during a field visit, observing the sterile pupae distributed (Thailand).

However, fruit flies (Diptera: Tephritidae) are among the most destructive and economically important pests attacking soft fruits and fleshy vegetables and threaten the fruit and vegetables production around the world. The *Bactrocera* species are particularly important in South Asia, Southeast Asia and the Pacific islands, and many of them are invasive and rank high on quarantine lists worldwide. Countries in the region are suffering major economic losses from infestations of tropical fruit flies, not only because of yield losses by direct damage to fruits and vegetables, but also because of the serious losses in trade value due to international quarantine trade restrictions.

The regional Technical Cooperation (TC) project RAS5097 on *Strengthening and Harmonizing Surveillance and Suppression of Fruit Flies* aims to enhance the regional

capacity on the detection, surveillance, monitoring, management and suppression of invasive and native fruit fly species through the integration of sterile insect technique (SIT) with other area wide integrated pest management (AW-IPM) approaches. As one of the core activities under this TC project, this training course was hosted by the Thailand Institute of Nuclear Technology (TINT) and attended by 23 participants from 11 Member States in the region of Southeast Asia and Pacific islands including Cambodia, China, Fiji, Indonesia, Malaysia, Myanmar, Nepal, Oman, Papua New Guinea, Thailand and Viet Nam.

During the week, two international experts from Australia and Mauritius and an FAO/IAEA staff, delivered comprehensive lectures that covered various aspects related to the fruit fly aera wide integrated management including SIT and male annihilation technique (MAT). A technical visit to the fruit fly mass-rearing facility at TINT and a fruit fly low pest prevalence area in Trok Nong (Chanthaburi province) maintained with SIT release was also organised to enable the participants to gain knowledge not only from theoretical lectures, but also from practical exercises and field operations. At the last day of the training course, a group discussion was also arranged so the participants can make a practical workplan focused on different AW-IPM approaches.

Advancing Surveillance and Progressive Control of the New World Screwworm Using the Sterile Insect Technique (RLA5088)

Regional Workshop on Public Information and Outreach on New World Screwworm Surveillance, Prevention and Eradication Programmes. 24–28 July 2023, Vienna, Austria

The workshop was attended by 16 Participants from 10 different countries including Bolivia, Brazil, Chile, Dominican Republic, Ecuador, Panama, Paraguay, Peru, Uruguay and Venezuela and supported by two experts in communication of information.

The objective of the workshop was to discuss and elaborate on communication strategy and information campaign for different target groups to support national New World Screwworm (NWS) surveillance, prevention, and eradication programmes in the Member States of South America where the pest is present.

The work done during the workshop included: (1) exchanged information on the current NWS situation and actions being implemented by the veterinary services in the countries including public information in support of NWS control; (2) drafted a communications strategy and planning, defined key messages, audiences and specific materials to be designed; (3) designed samples of brochures, posters, material for social networks, storyboards and different print and digital materials; and (4) presentation by country of proposed communication plans on their planning and the designed materials.

Participants to the Regional Workshop on Public Information and Outreach on New World Screwworm Surveillance, Prevention and Eradication Programmes (Vienna, Austria).

To team in the workshop Veterinarians with Communicators to build a joint strategy and plan for communications was an excellent exercise. Participants were able to identify means to support public awareness and call to action instruments. The participants exchanged resources and open ways for interaction and better use of the materials produced.

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

FAO/IAEA Regional Training Course on Socio-economic Assessment Studies to Support Tsetse Intervention Programmes. 28 August–1 September 2023, Dakar, Senegal

The training course was organised in cooperation with the Senegalese Institute for Agricultural Research (ISRA) and attended by 18 participants from 17 African Member States (MSs) including Angola, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Democratic Republic of Congo, Djibouti, Ethiopia, Ghana, Kenya, Mali, Nigeria, Senegal, South Africa, Uganda, United Republic of Tanzania, and Zambia. Three international experts from the United Kingdom, Uganda and Senegal were invited to provide the training lectures with the objectives: (1) to enhance and develop regional capabilities on the basic principle of socio-economic aspects; and (2) to train the participants on basic economic principles for estimating the burden of African Animal Trypanosomosis (AAT) to develop evidence-based planning to support field projects for tsetse management.

This training specially focused on requirements for collecting data to understand the impact of AAT in the field, thus focusing on economic in farm/herd level. Open discussion sessions and transparent information exchange

occurred throughout the week to address the main challenges and difficulties faced by the Member States to conduct economic studies as crucial information to persuade stakeholders and partners to mobilize resources to support tsetse control campaigns in the region.

Participants of the FAO/IAEA Regional Training Course on Socio-economic Assessment Studies to Support Tsetse Intervention Programmes (Dakar, Senegal).

At the end of the training, and with the expert and participants' collaboration, upcoming targets and priorities regarding socio-economics studies under the framework of the RAF5087 project were identified for the region. Countries also requested additional training on this subject, which will be instrumental in developing knowledge and necessary skills to conduct studies aiming at estimating the economic impact of AAT at the national level.

36th General Conference of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC). 18–22 September 2023, Mombasa, Kenya

The International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) is a statutory council of the African Union Commission. The council was established to promote international cooperation in the control of African trypanosomiasis through regular general scientific conferences on tsetse and trypanosomiasis research and control. To this end the 36th ISCTRC Conference was held in Mombasa, Kenya from the 18–22 September 2023. The theme of this ISCTRC was 'Sustainable tsetse and trypanosomiasis control for socio-economic development'.

The conference was divided into three main thematic areas: (1) Human African Trypanosomiasis (HAT); (2) African Animal Trypanosomosis; and (3) Glossina biology, control and eradication. There were 96 Oral, and 25 Poster presented. Under the Country Reports section, a total number of 14 countries highlighted their tsetse and trypanosomosis control activities during 2020–2023. There were also 18 international organisation reports including a report on the TC regional project RAF5087 that was given by Shaukat Abdulrazak, the director of Division for Africa, Department of Technical Cooperation, IAEA. An oral presentation entitled 'Automated tsetse pupae sex sorting by utilising near-infrared imaging' was presented from experiments conducted and scientific data collected at the Insect Pest Control laboratory (IPCL).

IAEA supported Participants of the 36th International Scientific Council for Trypanosomiasis Research and Control Conference (Mombasa, Kenya).

The TC Regional project RAF5087 also supported the attendance of 5 participants from, Congo, Burkina Faso, Mali, the Republic of Tanzania and Zimbabwe. Mr Learnmore Nyakupinda from Zimbabwe presented a poster intitled 'Enhancing and updating the national atlas of tsetse and trypanosomiasis in Zimbabwe' and it was awarded the 2nd place in the poster competition.

Enhancing Capacity for the Use of the Sterile Insect Technique as a Component of Mosquito Control Programmes (RLA5083)

FAO/IAEA Regional Training Course on Collection of Entomological Baseline Data, and Data Management Tools to Support SIT Projects for Mosquito Control. 10–21 July 2023, Juazeiro, Bahia, Brazil

The training was held at Moscamed Brazil with 19 participants from 17 Member States of the Latin America and Caribbean region, including Argentina, Antigua & Barbuda, Bahamas, Bolivia, Brazil, Chile, Cuba, Dominican Republic, Ecuador, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Saint Vincent & the Grenadines, and Uruguay. The training was focused on technical aspects of baseline data collection procedures, GIS tools, and data management as crucial components to plan and prepare a field intervention based on SIT to control *Aedes* mosquitoes. In addition, the 'Mosquito Data Management System' was transferred to all participating MSs aiming at strengthening and harmonising procedures, protocols, and mechanisms for

developing baseline data collection and management in sterile insect technique (SIT) pilot trials at the regional level.

Participants of the FAO/IAEA Regional Training Course on Collection of Entomological Baseline Data, and Data Management Tools to Support SIT Projects for Mosquito Control (Juazeiro, Bahia, Brazil).

Reviewing regional procedures on 'baseline data collection and data management' was an important evaluation exercise. By identifying critical components and challenges, the training facilitated constructive feedback and recommendations for improvement. The technical lectures covered various critical aspects, including site selection, trapping methods, data analysis, mosquito biology, and the significance of entomological indices in SIT implementation. The hands-on sessions, where participants engaged in practical fieldwork and laboratory sample analysis, provided invaluable experiential learning. Using a beta version of data banks further enhanced their understanding of data collection and management, leading to better visualisation and standardised practices.

Three international experts were invited for this training course. Their role in delivering technical lectures and hands-on sessions was crucial in equipping the participating Member States with essential skills and knowledge on such relevant subjects. At the end of the training, the upcoming targets and priorities for the region related to baseline data collection and data management procedures were also discussed and agreed upon with the participants. In conclusion, the training course contributed to building participating Member States' capacity to effectively implement baseline data collection procedures as a key component for implementing SIT pilot projects to control *Aedes* mosquitoes. Providing technical expertise, practical sessions, and fostering open discussions, the training was a valuable platform for sharing knowledge, addressing challenges, and promoting collaborative efforts to combat mosquito-borne diseases.

Final Coordination Meeting. 19–23 June 2023, Havana, Cuba

The RLA5083 is a regional TC project that aims to strengthen the capacity in the region of Latin America and Caribbean on the use of the sterile insect technique (SIT) to suppress *Aedes aegypti* mosquito populations. In this context, the project´s target is to provide technical support for the participating Member States (MSs) to develop and enhance their capacities in monitoring of mosquito population by the collection of field entomological baseline data, performing mass-rearing and quality control evaluation, irradiation, handling, transportation, and release methods of sterile male *Aedes* spp, as components of the SIT package to control *Ae. aegypti*, which is the primary vector of human diseases such as dengue, chikungunya and Zika in Latin America and the Caribbean region. The final coordination meeting of the project took place in Havana, Cuba, with 21 participants, including the project's counterparts from 15 MSs of the region as follows: Argentina, Bolivia, Brazil, Chile, Cuba, Dominican Republic, Ecuador, Guyana, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, and Uruguay.

Participants of the Final Coordination Meeting on Enhancing Capacity for the Use of the Sterile Insect Technique as a Component of Mosquito Control Programmes (Havana, Cuba).

The meeting was aimed at providing an update on the project status, highlighting the progress achieved between 2022–2023. The counterparts fulfilled the meeting's objectives by presenting the progress made and challenges they faced at national and regional levels for evaluating and validating the SIT package targeting *Aedes* species. In addition, the meeting featured in-depth technical discussions centred on the phase conditional approach which is an instrumental tool for the preparation and successful execution of SIT field trials. Advanced countries such as Brazil and Cuba shared valuable lessons learned and challenges encountered during the implementation phase of their pilot projects for the evaluation of the SIT technology for suppressing *Ae. aegypti* population in open field conditions. The collaborative effort served to enrich the knowledge-sharing process and foster a

supportive environment for all participating MSs. A highlight of the meeting was the unanimous request 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 evaluating the SIT package in the region.

In addition, the counterparts led by the project's technical officer and project designated team member reviewed and consolidated the design of the new regional project for TC cycle 2024–2025 which aims to continue building and enhancing capacities on this technological package at the regional level. This new regional project will be supported under the framework of the Regional Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) and will be the first TC project on such relevant thematic area supported by the ARCAL mechanism.

Enhancing the Capacity to Integrate the Sterile Insect Technique in the Effective Management of Invasive *Aedes* Mosquitos (RER5026)

Final Project Review Meeting. 4–6 December 2023, Vienna, Austria

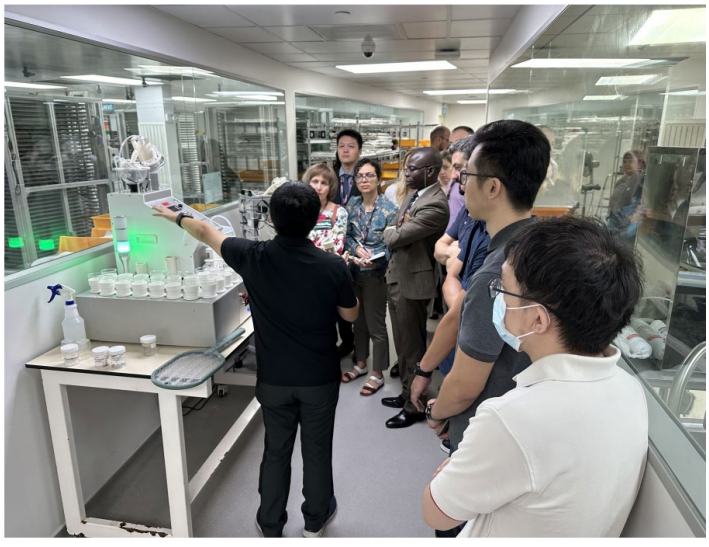
Thirteen counterparts from participating Members States (MSs) (Albania, Croatia, Cyprus, Greece, Portugal, North Macedonia, Serbia, Türkiye), along with four international experts from Italy, Switzerland, Spain, USA, and IAEA staff members participated in the meeting. The goal of the meeting was to evaluate the overall project implementation and achievements, discuss lessons learned and propose future directions for mosquito control activities integrating the sterile insect technique (SIT) with other suppression methods.

Participants to the final review meeting of the project on Enhancing the Capacity to Integrate the Sterile Insect Technique in the Effective Management of Invasive Aedes *Mosquitoes (Vienna, Austria).*

Throughout the project, various activities such as training courses, coordination meetings, fellowships, expert missions, scientific visits, and procurement of equipment. were implemented. These efforts resulted in significant advancements in the application of the SIT for mosquito control among the MSs in the region. These achievements included i) increased awareness among policy makers and other stakeholders, ii) enhanced capacity in mosquito mass-rearing, sterilization, release of sterile males and monitoring, iii) establishment of pilot mass-rearing facilities or importation of sterile males, and iv) development of methodologies and protocols tailored to the European context. The knowledge gained, protocols developed, and collaborative efforts made during this project will undoubtedly contribute to more effective and sustainable mosquito control strategies within the participating MSs. The success achieved through this project lays a solid foundation for continued progress in the field of mosquito control and public health. However, it is crucial to sustain these positive outcomes through ongoing networking efforts.

FAO/IAEA Regional Training Course on Mosquito Sterile Insect Technique (SIT) Package. 11–13 December 2023, Singapore

The training course was organized by the Joint FAO/IAEA Programme in cooperation with the Government of Singapore through the Environmental Health Institute, National Environment Agency. Nine counterparts and stakeholders/decision-makers from five participating Members States engaged in establishing mass-rearing facilities, mark-release-recapture and pilot suppression programmes against invasive *Aedes* mosquitoes (Albania, Croatia, Cyprus, Greece, Serbia) took part in the training course.



Participants visiting the mosquito mass rearing facility at the National Environment Agency (Singapore).

The training consisted of visiting facilities, learning advanced skills on specialized/automated equipment and engaging in discussions about the challenges on the overall mosquito SIT package, from mass-rearing to release and surveillance, including facility design and stakeholders and government engagement.

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)	Rui Cardoso Pereira

First RCM on Reproductive Biology of Male *Aedes* Mosquitoes for SIT Applications. 3–7 July 2023, Vienna, Austria

The use of the sterile insect technique (SIT) in Area-Wide Integrated Pest Management (AW-IPM) programmes is continuously rising due to increased requests from Member States. One of these requests aims to develop and refine the SIT package for mosquitoes as an innovative and sustainable approach to control mosquito populations and reduce the burden of mosquito-borne diseases on human health. The success of the SIT relies on the efficiency of released irradiated male mosquitoes to compete with wild males in mating with wild females to enable suppression of the target populations. However, several abiotic and biotic factors can affect the male sexual performance in the field which may compromise the effectiveness of the SIT. Therefore, it is crucial to understand various aspects of mosquito's reproductive biology under field conditions such as their precopulatory, copulatory and post copulatory behaviours. In this context, this new CRP aims to investigate the factors contributing to the mating success of sterile males in SIT programmes, particularly investigating the male mosquito reproductive biology.

Participants of the first RCM on Reproductive biology of male Aedes *mosquitoes for SIT applications (Vienna, Austria).*

The first RCM meeting was held in Vienna at the IAEA headquarters and attended by 19 scientists from 13 Member States including Albania, Argentina, Burkina Faso, China, Cuba, France, Greece, Indonesia, Italy, Jamaica, Mexico, United Kingdom, and USA. During the meeting, participants presented research relevant to the CRP and discussed their proposed research plans for the entire five years of the CRP.

The meeting also included general discussions on three thematic areas to improve the male sexual performance for SIT application against *Aedes* species. These included (1) precopulatory behaviour of *Aedes* mosquitoes; (2) copulation and insemination process in *Aedes* mosquitoes; and (3) patterns of female remating and factors that control it. The objectives of the CRP, the Logical Framework and the proposed outcomes were reviewed and discussed with the participants to agree on minimum outputs to be achieved at the end of the CRP. Furthermore, the Chief Scientific Investigators (CSI's) developed detailed individual technical programmes to be conducted during the first 18 months of the. The potential subjects for collaboration were also discussed during the meeting.

Third RCM on Mosquito Irradiation, Sterilization and Quality Control, 6–10 November 2023 (virtual)

The RCM was held virtually with 38 scientists from 18 CRP participating Member States including Bangladesh, Brazil, Burkina Faso, Canada, China, Ecuador, France, Greece, Indonesia, Italy, Mauritius, Mexico, Philippines, Senegal, South Africa, Spain, Thailand, and USA.

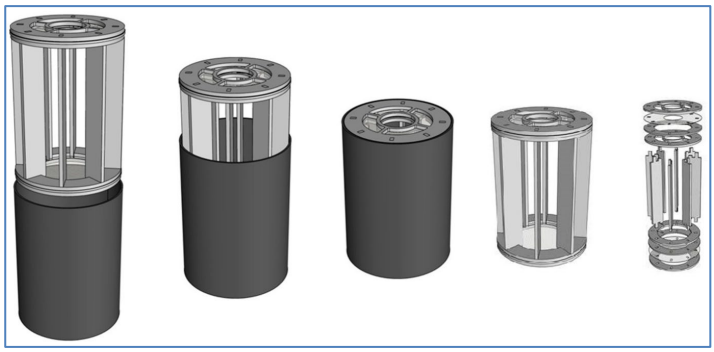
Irradiated sterile, and non-irradiated fertile male mosquitoes competing for virgin mature non-sterile females in semi-field cages to evaluate the mating competitiveness of sterile males following various treatments.

During the first three days of the meeting, the research contract and agreement holders presented their results achieved in the past 18 months, pertaining to the topic of mosquito irradiation and quality control and future planned activities for the next 18-month period. On the last two days of the meeting, general discussions were held: (a) to review the thematic areas of the CRP, the results and the future plans that were presented in the first three days, and (b) to discuss topics and high impact results, as well as research gaps that need to be addressed.

Main achievements in the past 18 months included: (1) irradiation of *Aedes* mosquitoes at egg stage resulting in 96% adult emergence from pupae, with >92% sterility in males; (2) sterilization of male mosquitoes using mid and high energy e-beam; and (3) the use of cold acclimation and cold-active miRNAs to improve *Ae. aegypti* sterile male performance in low temperatures.

Special Issue on Mosquito Handling, Transport, Release and Male Trapping Methods

The CRP 'Mosquito Handling, Transport, Release and Male Trapping Methods' was conducted from 2015 to 2020. The main objective was to provide the necessary technical advances in the handling, release, and subsequent monitoring of male mosquitoes to enable the cost-effective application of the SIT against mosquitoes to reduce the burden of mosquito-borne diseases in affected Member States.



All-in-One Mosquito Containers developed under the CRP on Mosquito Handling, Transport, Release and Male Trapping Methods.

The research carried out in the framework of this CRP generated key achievements including: (1) novel and efficient self-marking techniques were established to improve our understanding of male movement, competitiveness, survival, and potential interaction with closely related species post-release; (2) the novel large-scale marking of male mosquitoes via administration of Rhodamine B via sugar feeding was evaluated which brings the advantage of marking all of the tissues of the mosquitoes; (3) the impacts of temperature, time, and compaction, and the interactions between them, were explored to improve the handling, shipping, and transportation of chilled males. Suitable protocols for short- and long-distance shipments were developed for *Aedes aegypti*; (4) methods for ground and aerial releases (using drones) were developed and evaluated. Remotely piloted aircraft systems (RPASs) with embedded mosquito release devices have been developed and evaluated under laboratory and field conditions for *Ae. aegypti* in countries such as Mexico; (5) a novel all-in-one release container was developed to maximize release densities while maintaining male viability. It allows mosquitoes to be maintained in relatively undisturbed conditions from the pupal stage until release as adults, to eliminate the negative effects of post-emergence handling associated with the majority of large-scale release systems; and (6) the behavioral responses of male *Ae. albopictus* to different volatile compounds were studied to identify chemicals which may enhance male *Ae. albopictus* surveillance.

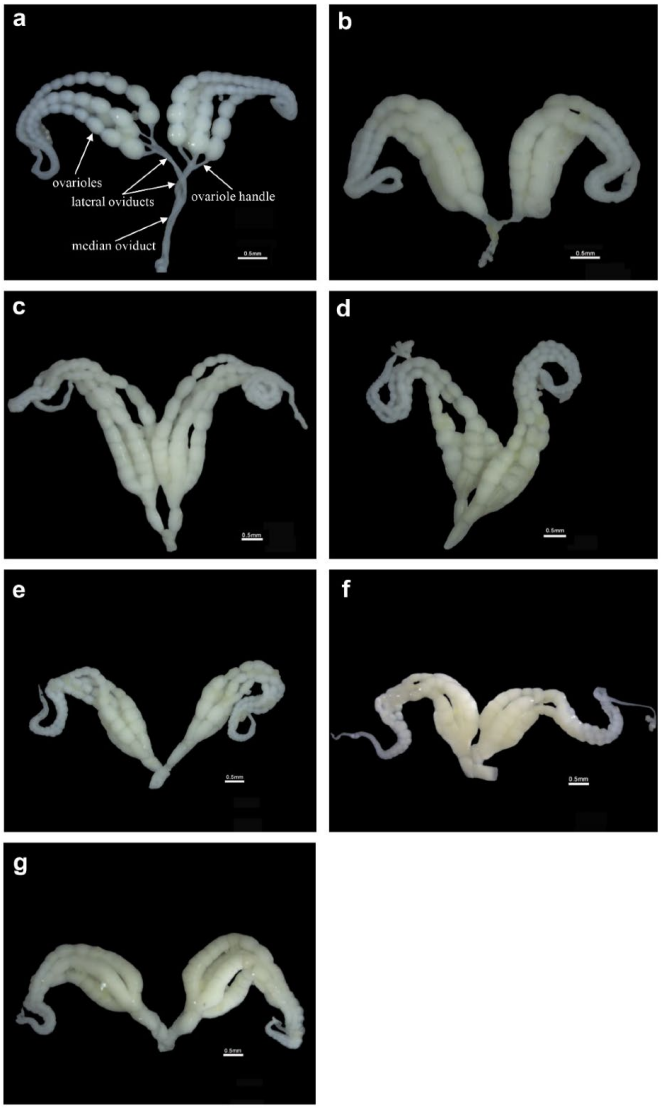
The current Special Issue (SI) has compiled ten papers reporting results in the areas outlined above. Alongside these results, the next step is to transfer these new tools and procedures to Member States to benefit mosquito SIT pilot trials worldwide.

The Special Issue is open access and can be downloaded at https://www.mdpi.com/journal/insects/special_issues/Mosquit_Handling_Transport_Release_and_Male_Trapping_Methods.

Special Issue on Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes

The CRP on 'Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes' was implemented from 2016 to 2021, and the following research tied to the field performance of the sterile insects was conducted: (1) improved rearing and maintenance of colonies based on selection for favourable behaviours; (2) better collection and irradiation methods to enhance results; (3) the application of two-sex or male-only release strategies; (4) improved handling, transport and release methods; (5) practical and effective methods for quality assessment; and (6) better deployment strategies to improve cost-effectiveness and outcomes.

The Special Issue aims to provide a summary of the research conducted during the period of CRP on the following topics: (1) determining the effect of different rearing parameters and behavioural traits that have an impact on the competitiveness of sterile moths, by the correlation of laboratory, semi-field, and open-field performance; (2) determining the impact of adult and pupal collection and irradiation methods on field competitiveness; (3) determining the effect of sterile females on population suppression; (4) determining best practice methods for handling, transporting and releasing sterile moths to maintain field competitiveness;(5) determining the relative effectiveness of different methods for quality assessment of sterile and wild moths; and (6) developing the best practice deployment of sterile insects in relation to hotspots, taking into account moth competitiveness and field performance.



Study on Flight Performance, Fecundity, and Ovary Development of Grapholita molesta *(Lepidoptera: Torticidae) at Different Ages.*

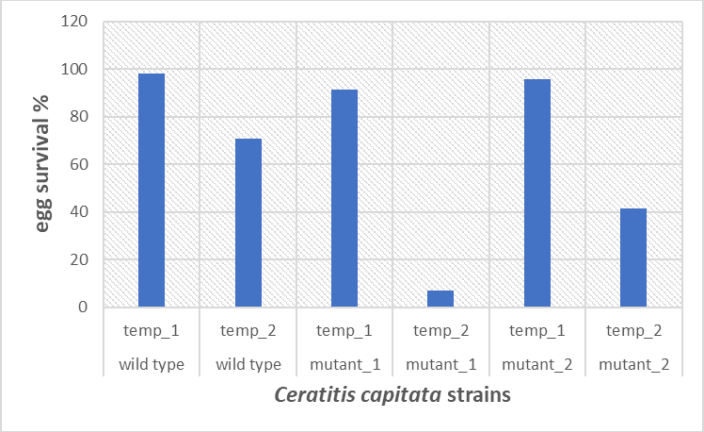
The Special Issue is open access and can be downloaded at https://www.mdpi.com/journal/insects/special_issues/Improved_Field_Performance_Sterile_Male_Lepidoptera.

Developments at the Insect Pest Control Laboratory (IPCL)

Genetics and Molecular Biology

Identification of *Temperature Sensitive Lethal* Genes in *Ceratitis capitata*

The success story of the *Ceratitis capitata* SIT programmes is attributed to a large extent to the VIENNA 8 Genetic Sexing Strain (GSS). The strain carries two selectable markers (*white pupae* (*wp*) and *temperature sensitive lethal* (*tsl*) genes) which allow the mass-rearing and release of only males. The development of the VIENNA 8 GSS was accomplished through classical genetic approaches and research efforts lasted more than 20 years. However, the requests for developing SIT against different insect pests have been intensified in recent years and the necessity to develop GSSs for these pests through a time-efficient approach has emerged.



Egg hatching rates of wild-type and CRISPR-mutant strains after exposure to an elevated temperature (temp_2).

The availability of genetic tools and the transformative power of genome editing can serve this purpose. The concept called "the generic approach" aims to develop generic strategies that will be applied for the construction of GSS for SIT applications. The generic approach has already been applied for the *white pupae* selectable marker and the gene as well as the causal mutation that results in the white pupae strains has been identified for three tephritid species, including *C. capitata*. The *tsl* trait, which is currently available only in *C. capitata*, has been one of the main targets of the generic approach since it could be a useful selectable marker for developing GSSs in different SIT target species. The IPCL has identified candidate genes with mutations that have been shown to induce *tsl* phenotypes. 'Chasing' of these genes was done by deploying a series of approaches that included (cyto)genetics, genomics, bioinformatics, and CRISPR/Cas9 gene editing. The mutant lines that were created exhibited lethality when exposed to elevated temperatures (see below figure). These candidate genes can be considered in the development of novel genetic sexing strains in insect plant pests, disease vectors and livestock pests.

Identification of *Temperature Sensitive Lethal* Genes in *Aedes aegypti*

The recent identification of the *wp* and *tsl* genes in *C. capitata* has made evident that the generic approach can be a reliable ally for the development of sexing systems in disease vectors. The identification of *tsl* traits in *Aedes aegypti* mosquitoes is part of the IPCL's efforts to develop an efficient GSS for this species. Towards this goal we have unfolded a combined strategy that includes screening for temperature resistant and temperature sensitive phenotypes and characterization of potential *tsl* candidate genes through CRISPR/Cas9 gene editing.

Several temperature-resistant and -sensitive strains coming from different genetic backgrounds were exposed in a diverse array of temperatures. Their response to the elevated temperatures allowed us to draw their thermal pattern and assess it genetically to conclude on the monogenic or polygenic nature of the *tsl* trait. CRISPR/Cas9 knockouts have led to the identification of *tsl*-like genes that are currently functionally characterized for their *tsl* phenotype. Both approaches aim to assist in the identification of a *tsl* marker that is expressed as early as possible in the developmental process. This marker will allow for the construction of an *Ae. aegypti* GSS strain that will benefit mass rearing facilities and large-scale operational programmes in terms of cost and labour.

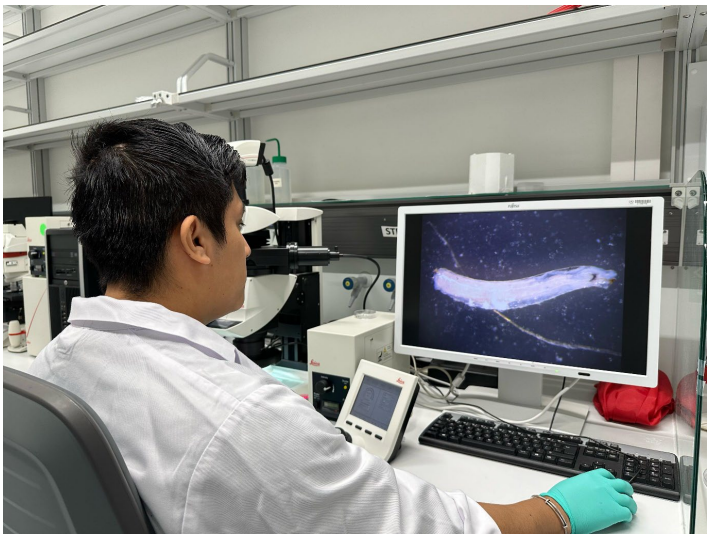
Plant Pests

FAO/IAEA/USDA Phytosanitary Treatment Projects

Ionizing radiation can be successfully used as a phytosanitary treatment to disinfest commercial fruit attacked by *Drosophila suzukii*. Yet, assessing potential factors that might affect phytosanitary irradiation efficacy is needed for *D. suzukii*. To fill in those gaps in knowledge, Ms. Inajara Viana, a Ph.D. student from the University of Natural Resources and Life Sciences, Vienna, Austria (BOKU), together with Ms. Lissette Grana Carrera, a master student from the University of Vienna, Austria, have been evaluating the extent to which irradiation under modified atmospheres combined with chilling and X-ray energy levels can affect phytosanitary irradiation efficacy against *D. suzukii*.

Prior studies have shown no radioprotective effects of low oxygen treatments during irradiation of *D. suzukii* pupae with maximum absorbed doses of 78 or 80 Gy. Still, the interaction between chilling, modified atmospheres, and radiation treatment has never been evaluated. Likewise, little is known about the effect of different energy level of X-rays on phytosanitary irradiation efficacy. Preliminary results from Ms. Viana's studies suggest that both irradiation of infested chilled fruit under low oxygen levels and X-ray energy levels do not reduce the effectiveness of phytosanitary irradiation doses against *D. suzukii.*

On other experiments evaluating the most tolerant stage of *Bactrocera dorsalis* populations from Mauritius to vapor heat treatment are nearly completed. All immature life stages of *B. dorsalis* in naturally infested mangoes could be identified, a critical step for the future comparison of heat tolerance between the most tolerant stages of wild-collected and laboratory-reared *B. dorsalis* trains or populations. This study will provide data to address a long-standing question in phytosanitation on the effect of domestication on the insect's response to post-harvest treatments.



Mr Jhonatan Sanchez (Insect Pest Control Laboratory technician) photographing a Bactrocera dorsalis *larva for further instar identification.*

Livestock Pests

Tracking of Tsetse with a Harmonic Radar System

One of the essential prerequisites for the successful implementation of the sterile insect technique (SIT) is that the factory-produced sterile male insects must be competitive with their wild counterparts. Gathering information on the behaviour of wild and sterile tsetse in the natural habitat and assessing whether there are similarities or discrepancies between the two groups is very important for action programmes. Mark-release-recapture studies have traditionally been used to study the ecology and biology of tsetse, however, the data that emanate from these studies are limited to population densities and spatial occupation of the habitat and do not provide information about the actual behaviour of the insects. There are however methodological constraints to identify and track individuals of most tsetse species within complex ecosystems and harmonic radars might be the tool to overcome this constraint.

Glossina brevipalpis *mating pair with a transponder attached to male's thorax.*

Scientist at the Department of Electronics and Telecommunications, Polytechnic University of Turin, Italy has developed an innovative harmonic radar system that covers a large field of view and can track insects in complex environments for up to 500m. They also developed lightweight transponders that can potentially be caried by *Glossina brevipalpis*.

Radar setup operated in the field test in Mozambique to detect tagged Glossina brevipalpis.

To test the feasibility to track individual tsetse with harmonic radar, tests were conducted at the IPCL to select an appropriate glue for the transponder attachment and to evaluate the flight propensity and mating performance of *G. brevipalpis* males with a lightweight transponder attached. Two commercially available glues were found to be suitable and *G. brevipalpis* could fly and even successfully mate with the attached transponder. Thereafter field evaluations were

conducted in collaboration with scientists from the Eduardo Mondlane University, Centro de Biotecnologia, Maputo, Mozambique. Wild and sterile *G. brevipalpis* were fitted with the transponder and released in the field to be tracked. Flight paths of both individual wild and sterile *G. brevipalpis* were mapped and flight paths of up to 185m for an uninterrupted flight could be followed. The ability to track sterile tsetse males can lead to the better understanding of aspects such as survival, dispersal, and mobility at the individual level.

Identification of Tsetse Species and Subspecies with High Resolution Melting Curve qPCR

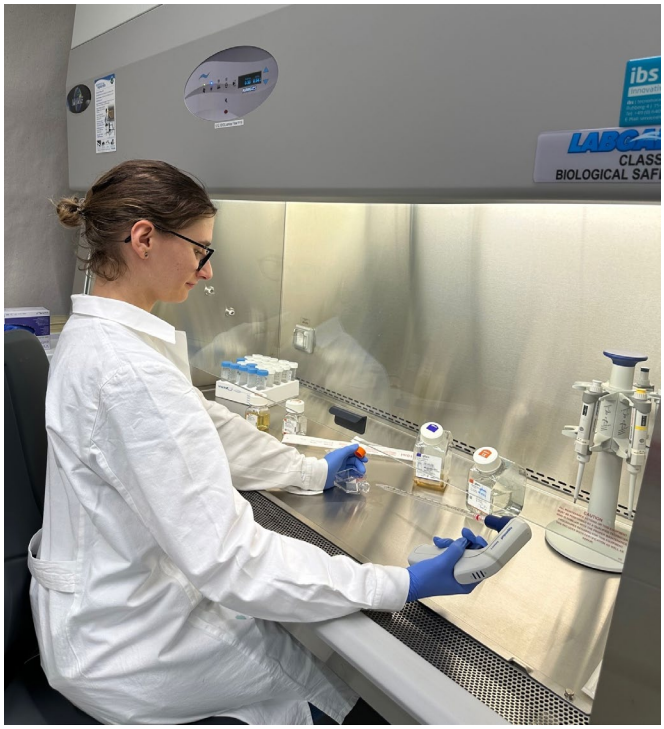
Identification of tsetse species and subspecies is crucial for the effective implementation of the sterile insect technique (SIT), and several methods have been developed for this purpose, following classical morphological taxonomic features and / or a combined molecular approach. The molecular approach is based on PCR and / or sequencing of mitochondrial, genomic, and *Wolbachia* markers. Recently, the complete mitochondrial (mtDNA) genomes of six tsetse species were obtained. Comparative sequence analysis of the variable region allowed the design of specific primers and the development of high-resolution melting analysis (HRM) test. In a recent field collection in Cameroon, tsetse flies were initially identified morphologically as *Glossina fuscipes fuscipes* (Gff) species.

Mr Dialinli Tankoano performing resolution melting analysis quantitative PCR analysis to identify tsetse species.

However, later collections from the same area were identified as *G. palpalis palpalis* (Gpp), raising doubts about the accurate identification of these flies. To address this issue, the HRM test was implemented using colonized tsetse flies Gpp from CIRAD, France, *G. palpalis gambiensis* (Gpg), and Gff from the IPCL colonies as references. The results indicate that out of the 40 collected flies from Mabkaou, Cameroon, only three flies showed HRM profile close to Gff, and two flies were close to Gpp. However, the remaining flies exhibited an intermediate profile between the Gff and Gpp profiles, making the accurate identification of these flies questionable. Further analyses are undertaken to clarify this issue. This work was conducted by Mr Dialinli Tankoano, a fellow from the Insectarium de Bobo Dioulasso (IBD) at Bobo-Dioulasso, Burkina Faso and in collaboration with Prof. Flobert Njokou, University of Yaounde, Cameroon.

Isolation of Tsetse *Iflavirus* and *Negevirus* using an Insect Cell Culture

Glossina morsitans morsitans Negevirus (GmmNegev) and *G. morsitans morsitans* Iflavirus (GmmIV) were recently found to infect tsetse flies. Both viruses are found mixed in the haemolymph of the tsetse species *G. morsitans morsitans* as well as other species from the morsitans group. Attempts to isolate and purify both viruses using sucrose gradient and ultracentrifugation did not work as both viruses have similar size and density coefficient. Insect cell cultures have been established for many species and are known to be permissive for certain virus infections.



Ms Hannah-Isadora Huditz maintaining cell lines in the IPCL cell culture facility.

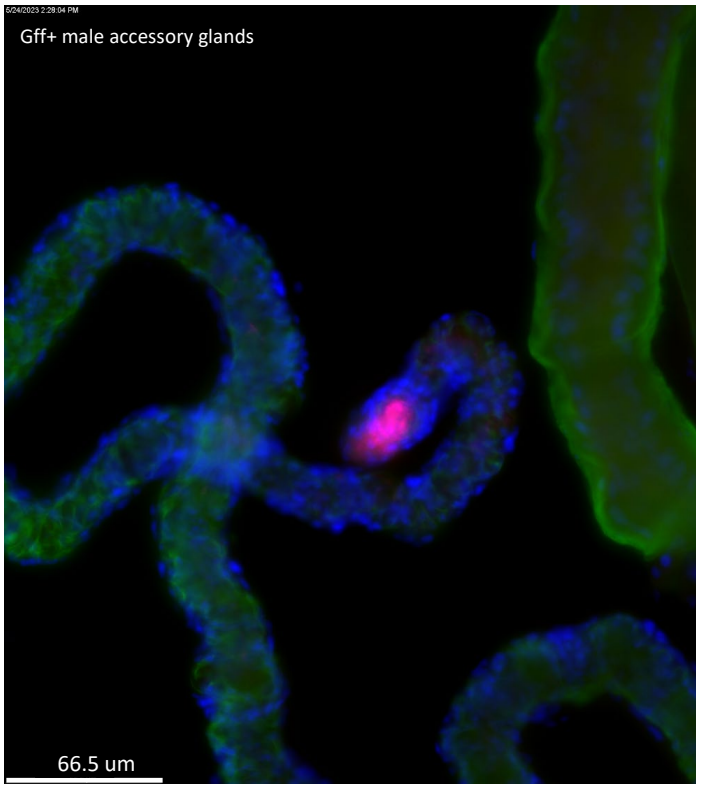
In this study, we investigated the permissiveness of SF9 cells derived from *Spodotera frugiperda* and C6/36 from *Aedes albopictus* mosquito for GmmNegeV and GmmIV infections. The preliminary results indicated that both cell lines were permissive for GmmIV but not for GmmNegeV. This finding might pave the way for the isolation and the purification of the GmmIV, opening the door to investigate the impact of this virus infection on tsetse fly performance indicators. This work was conducted by Ms Hannah-Isadora Huditz, a PhD student from Austria, in collaboration with Prof Monique van Oers, Wageningen University, The Netherlands and Prof. Ben Raymond, University of Exeter, United Kingdom.

Impact of *Spiroplasma* Infection on the Survival and Mating Competitiveness of *Glossina fuscipes fuscipes* Colony

Spiroplasma is a bacterial symbiont which has been so far detected only in two tsetse species, *Glossina fuscipes fuscipes (Gff)* and *G. tachnoides* (palpalis group). Two colonies of *G. fuscipes fuscipes* were established at IPCL to study the impact of *Spiroplasma* infection on the survival and male mating competitiveness of this species: one colony was infected with a high prevalence of *Spiroplasma* (~60%) (Gff Spi+) and the other with a low prevalence (~10%) (Gff Spi-). The survival of adult flies under starvation conditions as well as the male mating competitiveness in both colonies were investigated. Preliminary results showed that uninfected flies have a longer survival time compared to infected flies, with males outliving females in both colonies. Furthermore, we assessed the mating competitiveness of males from Spi- and Spi+ colonies in a semi-field cage. Males from both colonies competed with females from Spi- and Spi+ colonies in separate field cages. The results indicated that, regardless *Spiroplasma* infection status of the females, males from Spi- colony had a significantly higher relative mating index than males from Spi+ colony. This suggests that males from Spi- colony are more competitive than males from Spi+ colony. These findings suggest a negative effect of *Spiroplasma* on *G. fuscipes fuscipes*, which should be considered during the establishment and mass rearing of a Gff colony for SIT applications. This work was conducted by Mr. Mikhailou Dera, a PhD student from Burkina Faso.

Localization and Quantification of *Spiroplasma* in *Glossina fuscipes fuscipes* Tissues

To better understand the dynamics of *Spiroplasma* infection in *Glossina fuscipes fuscipes* (Gff) colonies and the interaction among *Spiroplasma*, the tsetse host and associated microbiota, it is essential to first identify its tissues tropism. To address this question, different tissues of *Spiroplasma*-infected and uninfected *G. fuscipes fuscipes* flies were dissected and quantitative PCR was performed to localize the bacterium and quantify its infection levels. Preliminary results indicate different infection patterns in females and males. In females, the salivary glands, gut and spermathecae have the highest density. The presence of *Spiroplasma* in the salivary glands suggests a co-localization with Trypanosomes which may explain their reduced prevalence in *Spiroplasma*-infected flies. However, the exact mode of interaction is currently unknown. In males, the highest density is found in the accessory glands and testes. Validation of these results and visualization using fluorescent in-situ hybridisation (FISH) is currently in progress. This work was conducted by Mr Fabian Gstöttenmayer, a PhD student from Austria.



Fluorescence in situ hybridization (FISH) of Glossina fuscipes fuscipes *salivary glands. Green: actin; Blue: 4',6-diamidino-2-phenylindole (DAPI) staining, Pink:* Spiroplasma.

Human Disease Vectors

Irradiation at Pupal *vs* Adult Stage in *Anopheles arabiensis*

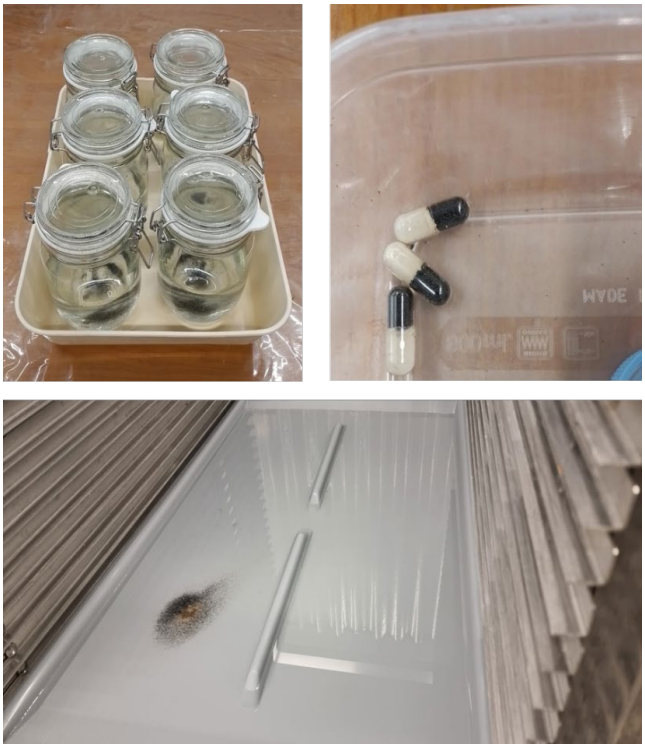
The irradiation of mosquitoes to render males sterile can be performed at pupal or adult stage. Both methods have advantages and disadvantages. However, which protocol results in better quality males? The quality of sterile male *Anopheles arabiensis* was assessed following irradiation at pupal *versus* adult stage, by performing longevity, flight ability and mating competitiveness tests. It was observed that the flight ability of the males was about the same (not significantly different) regardless of life stage at which they were irradiated, whereas it was clear that males irradiated as adults lived longer than those irradiated as pupae, especially over the first 14 days. Mating competitiveness was also significantly improved by irradiating at adult stage rather than at pupal stage. These observations support the recommendation to expose *An. arabiensis* males to irradiation at adult stage in sterile insect technique programmes against this important malaria vector.

Irradiation of *Aedes* Adult Mosquitoes with a Coolable 3D Printed Canister

Pupal irradiation conditions have proven difficult to standardise with unpredictable sterilizing effects, the manipulation of mosquitoes at adult stage appear the most effective procedure to achieve an effective and reliable

sterilization of large quantities of mosquitoes for SIT application. It is therefore imperative to design and validate dedicated tools to safely compact and immobilize the fragile mosquito adults at high densities during the sterilization process. A 3D-printed phase change material based coolable canister capable to hold about 100 000 adult mosquitos has been produced and tested to sustain the radio sterilization procedures for large-scale SIT operational programmes. The irradiation and compaction treatments performed over 30 minutes in this trial affected the survival and the flight ability of *Ae. albopictus* and *Ae. aegypti* adult males but the use of the proposed irradiation canister under cooling conditions significantly improved their final quality performance. The use of this cooled canister has been proven to be an essential tool during adult irradiation, especially when it is necessary to move the sample between different facilities or for irradiation with long exposure times.

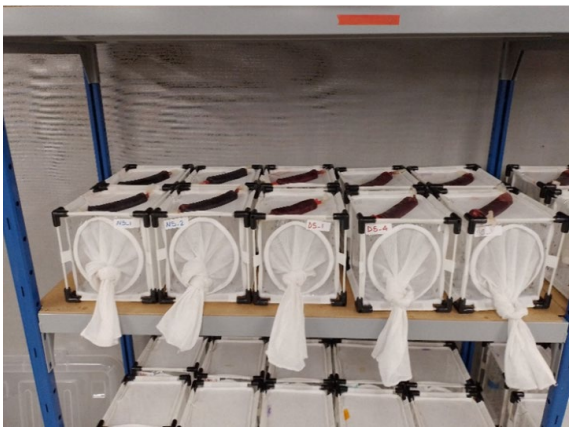
Hatching and Dispensing Larvae to Mass-Rearing Trays



Standard hatching methods (top left) and dissolvable capsules containing Aedes *eggs and diet powder (top right) to be introduced directly inside mass rearing trays (bottom).*

The available standard hatching procedures to obtain consistent and synchronous number of larvae per rearing tray require preparing and conditioning a pre-defined volume of eggs inside hatching jars. One single jar is prepared with 700 ml of boiled water and the addition of the correct amount of hatching solution. In the morning the young larvae hatched in each jar must be transferred manually to each rearing tray that has therefore to be filled in advance with a reduced quantity of water to account for this operation. In a large mass-rearing facility this procedure is clearly not sustainable considering that about 300-400 trays are required weekly to produce 1 million *Aedes* male pupae. Some automated mosquito larval hatchers and counters have been recently proposed but their counting rate varies from 5 to 10 minutes per tray and still requires manual procedures to transfer the larvae to each tray. The use of dissolvable capsules to aliquot and transfer eggs to the rearing trays has been proposed in the past but has never been fully investigated under *Aedes* mass-rearing conditions. Using dissolvable capsules, the *Aedes* eggs will be aliquoted, transferred and hatched directly inside each tray which will be filled at its final water capacity in one single procedure. The overall number of eggs needed will be weighted once and all the capsules needed for the entire production will be prepared in one single procedure using a commercially available manual capsule filling machine. Tests were performed to compare the larval survival and the pupation rate under mass rearing conditions using the standard procedures. The use of dissolvable capsules to load the rearing trays indicated similar parameters when *Ae. albopictus* and *Ae. aegypti* eggs' viability was higher than 70%. This method is anticipated to strongly facilitate the mass rearing procedures without the use of large numbers of costly and mechanised electronic procedures.

Blood Feeding Trials



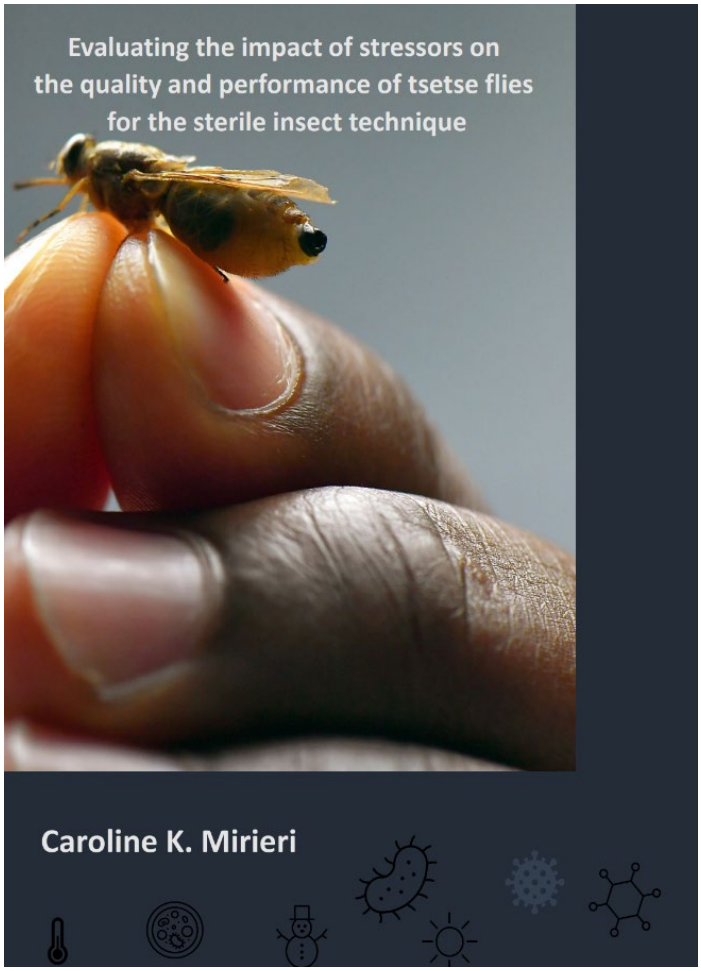
Different storage blood samples used during blood feeding trials on Aedes aegypti.

The use of frozen blood or artificial meals to sustain *Aedes* mass-rearing productions is also under investigation at IPCL. The continuous availability of blood of sufficient quality and quantity is a common constraint affecting all mosquito mass-production facilities. Different trials have been carried out on blood storage methods, additives, and temperature to sensibly increase the feeding rate, fecundity and fertility of *Aedes* mosquitoes using frozen blood. A high variability was observed within the data with the only clear indication on the beneficial effect of low storage temperature (- 80°C) on blood quality. However, different additives have been selected to test new possible phagostimulant products, and their economical and operational sustainability. Further feeding trials will be organised to investigate all these diets to achieve a final recommendation and possibly a consistent and safe method to sustain mosquito mass-production.

Reports

Ms Caroline Mirieri Obtains Her PhD from Wageningen University

Ms Caroline K. Mirieri from Kenya successfully defended her PhD thesis at Wageningen University, the Netherlands, in early September 2023. Her PhD research was completed under a sandwich programme, dedicating 80% of her time to research at the Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria and the remainder at the Laboratory of Virology at Wageningen University, Netherlands.



Her thesis, titled 'Evaluating the Impact of Stressors on the Quality and Performance of Tsetse Flies for the Sterile Insect Technique', focused on various stress factors potentially affecting the performance of tsetse sterile males. These factors encompassed irradiation under different conditions like hypoxia and normoxia, chilling, handling of sterile males, and the infection of RNA viruses. Notably, the volume and quality of her research were impressive, leading to the publication of her findings in two prestigious peer-reviewed journals.

Caroline's research significantly contributed to establishing a foundational platform for future endeavours. The data derived from her thesis not only advanced our comprehension of stress factors on tsetse sterile male performance but also provided crucial insights into the impact of irradiation treatment on RNA viruses infecting tsetse flies. In addition, her work explored the potential of using hypoxia conditions to mitigate the negative effects of irradiation treatment on sterile male performance, essential for the successful implementation of the sterile insect technique (SIT) programmes.

Mr Germano Sollazzo Obtains His PhD from Justus Liebig University Giessen, Germany


Institute of Insect Biotechnology

Department of Insect Biotechnology in Plant Protection

Justus-Liebig-University Gießen

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Characterization of genes used as selectable markers for the development of genetic sexing strains for SIT applications against tephritid pest species using CRISPR/Cas9

INAUGURAL DISSERTATION

zur Erlangung des Doktorgrades (Dr. rer. nat.)

im Fachbereich Agrarwissenschaften, Ökotrophologie und Umweltmanagement der Justus-Liebig-Universität Gießen

vorgelegt von

Germano Sollazzo

geboren in Vallo della Lucania (Italy)

Gießen, 2023

Genetic Sexing Strains (GSSs) are pivotal in the sterile insect technique (SIT), a highly effective strategy for insect pest control and population management, as elucidated by Germano Sollazzo in his PhD thesis which research was conducted at the Insect Pest Control Laboratory (IPCL) in Austria and the Justus Liebig University Giessen, Germany (https://jlupub.ub.uni-giessen.de//handle/jlupub/18797).

The SIT involves the release of sterile insects into designated areas to prevent, suppress, or eradicate pest populations. Crucially, in certain contexts, it is vital to release solely sterile males, as females can inflict damage through egg-

laying and/or biting. Achieving male-only releases is feasible through GSSs, which currently utilize two selectable markers for sex separation and female elimination at the embryonic stage: the as-yet unidentified *temperature-sensitive lethal* (*tsl*) gene and the recently discovered *white pupae* (*wp*) gene. These have been instrumental in the development of the most successful GSSs to date, namely the *Ceratitis capitata* VIENNA 7 and VIENNA 8.

In his thesis, Germano Sollazzo presents three studies aimed at pinpointing the location of the *tsl* gene in *C. capitata* and identifying the specific *tsl* genes and mutations responsible for the temperature-sensitive lethal phenotype.

The first study involved conducting temperature-sensitive lethal tests on twenty-seven *C. capitata* strains, encompassing wild-type, genetic sexing, and *tsl* mutants. This was to discern temperature sensitivity variations among different populations and select reference strains for subsequent research.

The second study adopted a multifaceted approach, integrating genomic, transcriptomic, bioinformatic, and cytogenetic data, to characterize and scrutinize the putative *tsl* genomic region in *C. capitata*. This led to the identification of several candidate genes within the *tsl* region potentially linked to the temperature-sensitive lethal phenotype. These insights are invaluable for further exploration into the genetic mechanisms underlying this phenotype.

In the third study, the *deep orange* (*Ccdor*) gene, identified as a potential *tsl* candidate, was targeted using CRISPR/Cas9 to ascertain its role in the temperature-sensitive lethal phenotype. Through CRISPR/Cas9-mediated Non-Homologous End Joining (NHEJ), the *Ccdor* gene was knocked out and a specific point mutation was introduced in the *tsl* mutant strain via CRISPR/Cas9-mediated Homology-Directed Repair (HDR). This led to the generation of multiple strains, causing a temperature-sensitive lethal phenotype at various developmental stages.

The outcomes of Germano Sollazzo's research mark significant progress in identifying potential markers for constructing new GSSs in tephritid species, offering promising avenues for enhancing SIT efficacy in pest management.

Announcements

Interregional Training Course on the Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests. 29 July to 23 August 2024, Tapachula, Chiapas, Mexico

Context: Food insecurity is inherently linked to pests and diseases. The losses caused by diseases and pests at both the pre- and post-harvest levels average at 30-40% of agricultural outputs. This is a very inefficient use of agricultural investments in land, seeds, water, fertilizer, animal feed, labour and other inputs available to feed the growing human population.

Current reliance on pesticides and drugs is not sustainable, impairing the natural balance and causing outbreaks of secondary pests, contaminating the environment and leaving residues on food commodities, and leading to the development of resistance to pesticides used.

In addition, as a result of increasing crop and animal movement and trade, as well as climate change, there is an unprecedented increase of invasive animal and plant pests with dire socio-economic consequences.

An area-wide integrated approach that targets the management of total populations of major pest insects, although management-intensive and logistically more complex, can contribute in most situations to a more effective and sustainable control.

Purpose of the Course: The purpose of this four-week interregional course is to provide a broad overview on the application of nuclear-related techniques, within the context of area-wide integrated insect pest management programmes, to managers of insect control programmes, animal health and plant protection officials and applied research entomologists.

The course will include radiation-induced sterility, the sterile insect technique (SIT), F1 sterility, other methods of insect control, integration of control methodologies for area-wide insect management, the biology, ecology and dynamics of pest insect populations subjected to control, economic analysis of area-wide programmes and reviews of successful and ongoing area-wide programmes with an SIT component.

The aim is to widen the knowledge and horizon of current and future decision makers to a broader list of major insect pest problems, including pests or vectors of diseases that are currently not yet established in the participants' countries.

Participants: The course is directed at top-level vector disease and pest control management personnel that are or will likely become high level decision makers and senior managers of pest control programmes or campaigns. A key aspect of this training is to develop good pest control managers in Member States with the broad background and skills required to conduct complex area-wide programmes. There is a need to transfer technology while also developing the required managers of projects to effectively integrate the SIT. Future decision makers need to be made aware of upcoming risks, develop a sense of preparedness, and be trained on preventive and management strategies against potential new major pests and disease vectors.

Application Procedure: Candidates wishing to apply for this event should follow the steps below:

1. Access the InTouch+ home page (https://intouchplus.iaea.org) using the candidate's existing Nucleus username and password. If the candidate is not a registered Nucleus user, she/he must create a Nucleus account (https://websso.iaea.org/IM/UserRegistrationPage.aspx) before proceeding with the event application process below.
2. On the InTouch + platform, the candidate must:
   a. Finalize or update her/his personal details, provide sufficient information to establish the required qualifications regarding education, language skills and work experience ('Profile' tab) and upload relevant supporting documents;
   b. Search for the relevant technical cooperation event under the 'My Eligible Events' tab, answer the mandatory questions and lastly submit the application to the required authority.

NOTE: Completed applications need to be approved by the relevant national authority, i.e. the National Liaison Office, and submitted to the IAEA through the established official channels by the provided designation deadline.

For additional support on how to apply for an event, please refer to the InTouch+ Help page. Any issues or queries related to InTouch+ can be addressed to InTouchPlus.Contact-Point@iaea.org.

Should online application submission not be possible, candidates may download the nomination form for the meeting from the https://www.iaea.org/services/technical-cooperation-programme/how-to-participate (**Deadline for nominations: 31 March 2024).**

Participants' Qualifications: The course is open to about 24 participants from IAEA and FAO Member States in all geographical regions. Preference will be given to qualified candidates from developing countries. Applicants must have at least a Bachelor of Science degree or equivalent in entomology or a related biological field. As the course will be conducted in **English**, participants must have an adequate working knowledge of that language.

Preference will be given to those in pest control policy-formulating positions or involved in preparing applied pest control programmes, or who have had at least several years of practical experience in applied research or teaching on pest control. The key criteria are the candidate's actual participation in operational area-wide pest control programmes and the potential when he/she has returned home to provide leadership in area-wide pest management and the use of the SIT in future programmes.

Important Dates on Regional Fruit Fly Group Meetings

	Deadlines		Date of Meeting
	Abstract Submission	Early Bird Registration	
TEAM*	15 January 2024	16 February 2024	15–18 April 2024
TAAO#	1 March 2024	1 March 2024	6–10 May 2024
TWWH†	23 February 2024	15 March 2024	3–7 June 2024

** 5th Meeting of the Tephritid workers of Europe, Africa and Middle East (TEAM) https://team2024.govmu.org/team2024/.*

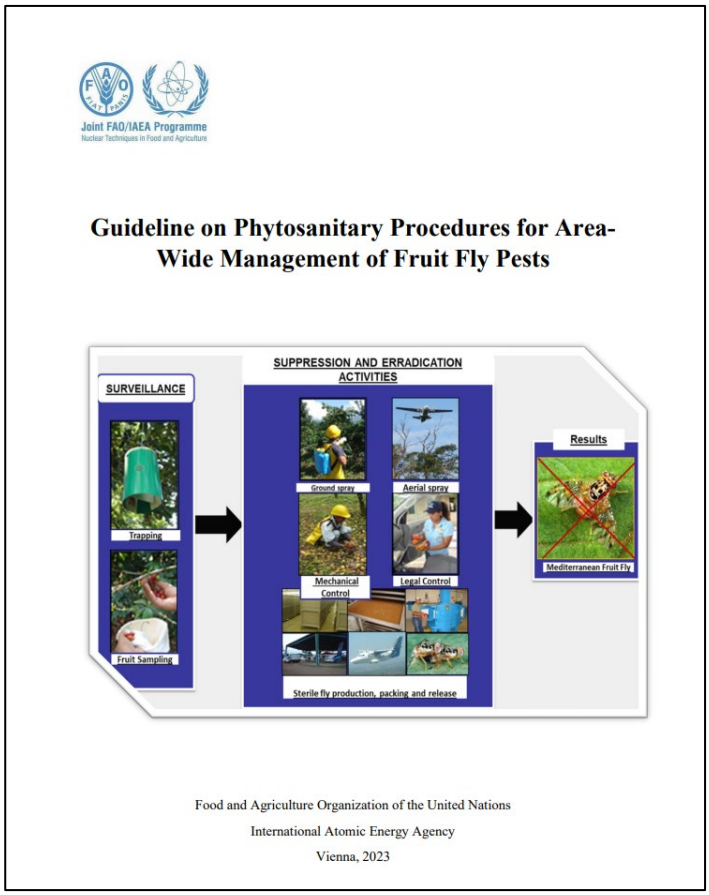
 # 2nd meeting of Tephritid Workers of Asia, Australia, and Oceania (TAAO) https://taao.scievent.com/.

† 11th meeting of the Tephritids Workers of Western Hemisphere (TWWH).

International Guideline on Phytosanitary Procedures for Area-Wide Management of Fruit Fly Pests

This guideline describes the most widely used classic and modern phytosanitary procedures for the management of fruit flies that infest fruits and vegetables and that are of quarantine and economic importance, specifically species of the genera *Anastrepha, Bactrocera, Ceratitis, Dacus, Rhagoletis* and *Zeugodacus*. Pest management can be aimed at the native species of fruit flies or to prevent the introduction, establishment and spread of those non-native species.

It is the first comprehensive guideline developed by FAO/IAEA for area-wide fruit fly pest management including area-wide suppression, containment, eradication, and exclusion strategies. It is a much-needed complement to the already published FAO/IAEA guidelines for fruit fly survey 'Trapping Guidelines for Area-wide Fruit Fly Programmes' and 'Fruit Sampling Guidelines for Area-Wide Fruit Fly Programmes'.



The guideline is available in PDF version and can be downloaded at IPC website: https://www.iaea.org/sites/default/files/guideline_on_phytosanitary_procedures.pdf.

In Memoriam

Guy Bush (1929–2023)

With great sadness we have to inform that Professor Guy Bush, a distinguished biologist and fellow of the Academy of Arts and Sciences passed away on 2 August 2023. Guy was a renowned, internationally recognized scientist and esteemed member of the academic community, and his contributions to the field of biological sciences in evolution and ecology will not be forgotten.

Guy graduated from Iowa State University with a Bachelor of Science in entomology, which was followed by a Master of Science from Virginia Polytechnic Institute and a PhD. in biology from Harvard. Guy also spent two years in Australia on a postdoctoral fellowship at the University of Melbourne.

In 1970, Guy was an Assistant Professor at the University of Texas at Austin. He had a young postdoc, Ronald Prokopy and they were carried out research in Door County, Wisconsin, on the behaviour of *Rhagoletis pomonella,* apple maggot fly, and how it uses host-plant cues to distinguish between alternative host species.

These findings resulted in an important paper - Modes of Animal Speciation-published in 1975 at Annual Review of Ecology and Systematics, that was a kick-off for many studies on sympatric speciation on genus *Rhagoletis* in North America.

Guy had in his lab at the University of Texas some fellows that had fruit flies as a major field or work like Gary Steck, Joao S. Morgante, Aldo Malavasi and Daniela P. Frias.

Although not working for so long on fruit flies after moving from the University of Texas to Michigan State University, his insights of speciation associated with genetics and behaviour were quite important to elucidate this process in temperate climate.

In 2001, Guy received the awards of Honorary Fellows, the highest honour bestowed by the Royal Entomological Society. He was also appointed as a Hannah Distinguished Professor of Evolutionary Biology Emeritus – Evolutionary and Population Biology and Ecology in Michigan State University.

Other News

Millions of Fruit Flies are Being Dropped on Los Angeles. Here's How They're Raised

The small, two-engine Beechcraft King Air is getting jostled by light winds over the Los Angeles basin. Having taken off from Los Alamitos Army Airfield Base, it's flying toward one of the 1 750 square miles across Southern California it regularly covers.

A photo of a Mediterranean fruit fly against maps of Southern California that line the walls of Mediterranean Fruit Fly Preventive Release Program offices (Medfly PRP) on the Los Alamitos Joint Forces Training Base in Los Alamitos (Brian Feinzimer/LAist).

The pilot is guiding the plane while hundreds of thousands of his passengers are crammed inside metal chambers right behind his seat. They're kept in comas by refrigeration, meant to keep them from hurting themselves while in the tight space.

The inside of a Mediterranean fruit fly PRP airplane that releases Mediterranean fruit flies over Southern California (Brian Feinzimer/LAist).

They'll wake up only after the pilot opens the trap door, and they start to warm as they fall through the sky, cascading over the city of Los Angeles some 2 000 feet below.

Every week, 3 to 9 million sterile male Mediterranean fruit flies are dropped over Los Angeles, Orange, Riverside and San Bernardino counties as part of the California Medfly Preventative Release Program (PRP)—a critical tool in stopping the spread of invasive fruit flies, which can threaten the state's agricultural industry.

Once they land on yards and in fruit trees, they're hardwired to seek out female flies to copulate with. The idea being that if the state drops enough sterile flies, they'll preoccupy fertile females that get brought in on produce and stop them from reproducing. The flies can lay their eggs beneath the skins of various crops like pomegranates and figs. When the larvae hatch, they eat the produce, drop to the ground and pupate in the soil, before turning into adult flies. Leaving behind damaged goods.

Just last month (October 2023), five invasive Mediterranean fruit flies were discovered in the Leimert Park area. Since then, the programme has increased its drops over the area to 6 million flies per week, and it will continue with the schedule until at least next June to make sure the problem is solved.

A fruit fly's trans-continental journey

While the programme's home is at the Los Alamitos Joint Forces Training base near Long Beach, a sterile fly's journey begins in either Hawaii or Guatemala. "We want to keep our breeding colonies offshore in an area where the fly is already established in the event any flies escape the facility, they don't start an infestation," said Ian Walters, director of the medfly preventative release programme at Los Alamitos.

A Mediterranean fruit fly at the Medfly PRP facility (Brian Feinzimer/LAist).

Adult female flies have their eggs collected from large mating cages, and placed on an edible bedding material, so the larvae have something to munch. Once they're ready to pupate, they'll pop themselves out of the trays and into water baths, where they're once again gathered. This time though, they are tossed into a giant mixer and covered in pink dye that'll help scientists identify them with a UV light if they're caught in traps throughout Los Angeles.

Along the way they are irradiated with Gamma rays to make sure that they're sterile, and then shipped via commercial

airlines to California, where about 225 million pupae arrive per week.

Turned on by ginger and dropped from an airplane

Once at Los Alamitos, they go into a hot and humid bungalow, where they become adult flies, munching on a mixture of seaweed extract, sugar, and water. Strangely enough, when you walk into check them out in their giant metal towers, the entire room smells like fresh baked gingerbread.

Mediterranean fruit fly incubation crates at the Medfly PRP facility (Brian Feinzimer/LAist).

"Ginger root oil has a natural organic compound in it, which increases the mating competitiveness of the sterile males. They also tested orange oil, which has that same compound. But we found that ginger root oil was the most effective," Walters said.

From there, they get put into refrigerated trucks and are chilled to 3 ℃ so that they fall into comas. They're then placed into special hoppers ready to be dropped from an airplane.

If they wake up when they're crammed into the tight space, they could injure themselves, so they sleep until they warm up as they fall through the sky. The length of an individual fly's life can vary, but typically lasts around 30 days.

How effective is the programme?

There doesn't seem to be much debate that the programme has helped mitigate the number of medfly outbreaks since it began. Please find a video explaining all the California Medfly PRP at:

(https://www.youtube.com/watch?v=a9qmPscGgr4&t=78s)
"They haven't had as many outbreaks as prior to that. So, in that sense it's effective in suppressing them," said James Carey, an entomologist at UC Davis, who's an expert in invasion biology.

However, there is disagreement about where the invasive flies the state keeps finding in traps are coming from. Carey argues that it's likely the medfly has made itself at home here, in part, because they keep showing up in the same relative areas.

But when I asked Jason Leather, the entomologist who oversees the fruit fly programme, how likely it is that they're established, he said, "I think it's actually zero." "Airline passengers are the biggest pathway for fruit flies into California," he added. "During the pandemic, air travel stopped, and our traps were really empty."

What is certain is that the programme will continue for the foreseeable future. And that threats from other exotic pests like the oriental fruit fly need to be dealt with.

Source: LAist.com. By Jacob Margolis, 27 November 2023. https://laist.com/news/climate-environment/millions-of-fruit-flies-are-being-dropped-on-la-heres-how-theyre-raised.

Diagnostic Protocol 32: Genus Ceratitis

The International Plant Protection Convention (IPPC) Standards Committee, on behalf of the Commission on Phytosanitary Measures (CPM), has adopted Diagnostic Protocol 32: Genus Ceratitis that would help protect important crops from the fruit fly genus Ceratitis.

Diagnostic protocols are a set of procedures and methods for detecting and identifying regulated plant pests and are crucial in appropriately applying phytosanitary measures to facilitate safe international trade.

The genus Ceratitis, which is part of the family Tephritidae, commonly referred to as fruit flies, includes species that damage crops used for commercial and subsistence agriculture.

Oranges showing damages caused by Ceratitis capitata (Source: FAO).

Once a female lays eggs into the fruit and the eggs hatch, the larvae feeds on the fruit and directly damages it. Indirect damage is caused by the increased susceptibility of the plant to opportunistic fruit pathogens resulting from injuries when the female lays eggs into the fruit as well as damages from larval feeding.

The *Ceratitis* species can feed on any fruit, but some are known to feed on a particular fruit or a lineage of plant species. However, the known relationship between many species of *Ceratitis* and their host plants is incomplete. In fact, some species may infest a wider range of hosts than currently reported.

Diagnostic protocol 32 includes six economically important *Ceratitis* species based on their distribution and status as

polyphagous pests or those feeding on multiple plant species.

The most destructive species in the genus is the Mediterranean fruit fly (*Ceratitis capitata*), native to sub-Saharan Africa but has successfully spread to other regions of Africa as well as in Hawaii, South America, Central America, Australia and countries in the Mediterranean region. Hundreds of plant species have been reported as hosts of the Mediterranean fruit fly.

Meanwhile, the mango fruit fly (*Ceratitis cosyra*) is a pest of many fruit hosts apart from mango, including soursop, loquat, peach and guava. It is found throughout much of sub-Saharan Africa and is reported to be a cryptic species complex.

The other four species included in the protocol are *Ceratitis fasciventris*, *Ceratitis anonae, Ceratitis rosa* and *Ceratitis quilicii*. They infest a wide range of commercially grown hosts. The distribution for each of these four species includes multiple countries across sub-Saharan Africa. Although each species has a different distribution range, these ranges can overlap.

The newly adopted diagnostic protocol contains detailed information and is available at the Adopted Standards (ISPMs) webpage: https://www.fao.org/3/cc8308en/cc8308en.pdf.

Source: IPPC News #25, 30 Nov 2023. https://www.ippc.int/en/news/two-new-diagnostic-protocols-adopted-to-prevent-harmful-pests-to-crops/.

The Western Cape Government Commits to Protecting Export Fruit Industry with R2m Investment

The Western Cape Department of Agriculture of South Africa has invested R2m (€100 000) in pioneering research to protect the export fruit industry from pests. The financial support was given to citrus growers in the Western Cape using the sterile insect technique (SIT) for false codling moth (FCM).

The SIT programme is delivered by X Sterile Insect Technique (X-SIT), forming part of the RBX Group, and is a subsidiary of the Citrus Growers' Association of Southern Africa (CGA).

The RBX Group develops, supplies and supports sustainable crop protection products that assist in keeping export crops free of pests so that they can meet international phytosanitary regulations and food safety requirements. X-SIT helps to retain international market access for a critical sector of the South African economy.

The Western Cape exports approximately 20 million 15kg cartons of citrus per season, generating a substantial amount of revenue and supporting approximately 30 000 jobs in the province. The citrus industry as a whole sustains the livelihoods of 140 000 South Africans.

Sustainable Integrated Pest Management

The SIT used by X-SIT is a sustainable and environmentally safe practice that does not make use of any pesticides. In combating FCM, the practice involves rearing large numbers of male and female moths, sterilising them by exposure to radiation and then releasing them into the orchards. When the sterile moths mate with wild moths, the eggs that are produced are not viable. This leads to a huge reduction in the FCM population over time.

The SIT treatment programme started in 2007 in Citrusdal, following research by the CGA's research subsidiary Citrus Research International, as well as the International Atomic Energy Agency and the United States Department of Agriculture. Hannes de Waal, Chairman of the CGA, welcomed the support from the provincial government for the programme. "We are truly grateful to the Western Cape Department of Agriculture. Projects such as this are important in keeping key markets like Europe and the USA open to producers. We are proud to contribute to communities through both job creation and environmental preservation."

Playing a critical role in the fruit and export basket

The Western Cape Minister of Agriculture, Dr Ivan Meyer, said: "The Western Cape Department of Agriculture's support gives access to citrus growers who find the SIT Programme unaffordable, supports compliance with export requirements and protects jobs within the citrus industry." Minister Meyer continued: "The citrus industry plays a critical role in the fruit and export basket of the Western Cape, and job creation and economic development in the province."

"The SIT is a proven intervention, as research has shown that it reduces fruit infestation and export rejections, and reduces the risk of fruit destined for export being rejected by the importing country," added the Minister.

The SIT programme supports 140 direct jobs and is not only used for citrus crops. Currently, it is used on 19 500 hectares of varied crops, including table grapes and stone fruit. The facility in Citrusdal has the potential to increase this to over 40 000 hectares.

De Waal is hopeful about the future. "SIT programmes around the world are rather expensive but serve as a critical base for a more sustainable Integrated Pest Management approach to key pest control. We hope support will continue and encourage other funders to realise the importance of the SIT in export crop protection."

Source: Bizcommunity.com- AGRICULTURE NEWS SOUTH AFRICA, 12 October 2023.
https://www.bizcommunity.com/Article/196/472/242735.html.

Biological Control of Spotted Wing Drosophila in Soft-fruit Outperforms Insecticides

UK trials of a biological, and chemical-free, technique for the control of spotted wing drosophila (SWD) in soft-fruit crops have shown how it can outperform insecticides when used in commercial conditions.

Developed by British start-up BigSis, the system, using the sterile insect technique (SIT), reduced numbers of the damaging adult female SWD by up to 88% compared to a conventional, sprayed control.

Funded by an international company that has been working with BigSis to validate the chemical-free solution for global use, the trials also achieved an 80% reduction in signs of SWD activity on the fruit and saw fruit waste during picking cut by more than half.

“Only two years ago, we completed a world-first field trial of an SWD control solution based on SIT,” says BigSis founder Glen Slade, “with results that showed up to 91% reduction of female SWD numbers in commercial strawberries.

“To achieve such good levels of control this year, again on a commercial farm, but this time compared to industry standard insecticide use is a vindication of SIT’s ability to provide growers with a non-chemical, non-GMO, non-toxic route to effective and affordable insect pest control.”

The UK trials focused on an 11-hectare field of Maravilha raspberries divided into three maturities, a common practice that allows continuous harvesting from early July to early September. In each maturity, BigSis SIT was compared to control plots that received a single spray of Tracer (spinosad). Insect traps recorded adult female numbers in each plot. The fruit waste during picking was monitored across all plots, and marketable fruit was inspected for signs of SWD activity.

First deployed more than 60 years ago, SIT, which uses sterile male insects to arrest the growth of an in-crop pest population, had been regarded as expensive to deploy commercially.

But BigSis has revitalized interest in the technique. Its approach, which combines artificial intelligence and robotics to raise, sort, and sterilize millions of male insects in an automated production facility, has effectively reinvented SIT and slashed its cost by up to 90%, making it affordable.

BigSis launched its season-long insect control as a service (ICaaS) in 2023, offering growers on-farm releases of its sterile male insects.

“We’re delighted with the results, as is the company that funded the trial,” enthuses Glen. “Our SIT is a zero-regulatory approach for many of the key markets in soft-fruit production, including England and four leading states in the USA.

“Effective control of SWD addresses a major global need in high-value crops while enabling farmers to meet the expectations of regulators and consumers by reducing the use of crop protection chemicals in food crops.”

Source: Hortidaily.com. 15 December 2023.
https://www.hortidaily.com/article/9586136/biological-control-of-spotted-wing-drosophila-in-soft-fruit-outperforms-insecticides/.

The Right Chemistry: How Screwworm flies were Made Infertile without Affecting Their Love Life

Bringing the screwworm fly to its knees took a critical observation about the female's sexual appetite, a laboratory full of rabbits and an X-ray machine.

It was the 1950s. In the southern USA, screwworms were literally screwing cattle and figuratively doing the same to ranchers who were annually losing the equivalent of $1.8 billion in today's dollars.

The somewhat comical-sounding name has nothing to do with the worm's mating habits. And the screwworm isn't even a worm. It is the larva of *Cochliomyia hominivorax*, commonly known as the "screwworm fly." The creature does look somewhat like a worm and the little spikes that cover its body give the appearance of the thread of a screw. It is these spikes that allow the "worm" to burrow into the flesh of animals as a screw might do. Then the screwworm starts chomping away, eating the animal alive. Ranchers were at their wits end. Fortunes were being lost in dead cattle. As if that weren't enough, "hominivorax" literally means in Latin "man-eater." Indeed, there have been cases, mercifully very few, in which wounds in humans became host to the screwworm and its voracious dining habits.

Scientists were finally able to find a way to proverbially bring the screwworm fly to its knees, but it took a critical observation about the female's sexual appetite, a laboratory full of rabbits, a Nobel laureate's concern about nuclear war, an X-ray machine and a letter from the Caribbean island of Curacao.

In the 1930s, entomologist Edward Knipling discovered that while male flies were promiscuous, females mated only once.

The life cycle of the screwworm fly is only about three weeks, but that is long enough to cause catastrophic damage. A female can lay up to 400 eggs in one shot, preferring an open wound where the eggs can hatch into larvae that, resembling a screw being driven into an object, immediately dive deeper into tissues. Such wounds may come from branding, dehorning, castrating or just being scratched by barbed wire. An animal can die from damage to critical organs or from secondary bacterial infections of open wounds. Once the larvae have gorged themselves, they drop to the ground, where they burrow into topsoil, pupate, and emerge as flies to start the dreadful cycle again.

In the 1930s, entomologists Edward Knipling and Raymond Bushland were struggling to find a solution to the screwworm fly problem at the U.S. Department of Agriculture's research station in Menard, Texas. Rabbits inflicted with lesions proved to be an ideal breeding ground and as the flies multiplied, Knipling made a crucial observation. I can't imagine how, but he noted that while male flies were promiscuous, females mated only once. An idea was quickly hatched.

If somehow male flies could be sterilized and released into the wild, females, unaware of the males' lack of potency, would be lured into mating but would produce no offspring. Even to colleagues, the "sterile insect technique (SIT)" idea seemed far-fetched. One amusingly commented that the duo could not possibly castrate enough of the male flies.

Realistically, Knipling and Bushland did not have any sort of insect vasectomy or surgical removal of the flies' gonads in mind. They were floating the idea of some sort of chemical agent that would sterilize males. There already was a model for such a possibility with diethylstilbestrol, a synthetic estrogen developed in the 1930s to prevent miscarriage that was also found to inhibit sperm production. However, none of the chemicals they tried was effective in sterilizing flies.

The researchers' frustration continued until 1950, when Knipling came across an article by Dr Hermann Muller, who had received the 1946 Nobel Prize in Medicine and Physiology for "the discovery that mutations can be induced by X-rays." The article had nothing to do with screwworms but warned about the dangers of radioactive fallout from nuclear testing, with Muller alluding to his observation that fruit flies exposed to X-rays become sterile. This prompted Knipling to contact Muller and solicit his thoughts about sterilizing the screwworm fly with X-rays. Muller's response that the idea was sound got the ball rolling.

By this time, much to the relief of rabbits, Knipling and Bushland had found that large numbers of screwworm flies could be raised on ground meat. Luckily, they also had a friend at a hospital with access to X-ray equipment. Off they went with a brood of flies to give the theory a shot.

The X-rays did indeed render the flies infertile and they did that without affecting their love life. But a laboratory experiment was one thing. Would releasing the flies into the wild have an effect? And where could this be tried? Once again, chance opened the door.

The Caribbean Island of Curacao was experiencing a screwworm fly infestation. Goat herds were being decimated. An official reached out to Knipling, who had already made a name for himself in the scientific literature

with his publications on diseases transmitted by biting insects. The entomologist jumped at the opportunity to carry out a real-world experiment. X-ray machines were not a practical way to sterilize large numbers of flies, but it turned out that radiation from Cobalt-60, a byproduct of nuclear reactors, fit the bill. In 1953, millions of sterile flies were dropped from the air over Curacao and the screwworm fly was eradicated. The success of that experiment led to a widespread programme of sterile fly release in the USA and by 1966 cattle were no longer tormented, ranchers relaxed and consumers enjoyed lower beef prices.

Sporadic infestations by screwworm flies migrating from South America have occurred since, but today a large facility in Panama continuously raises sterile flies ready to be released at the first sign of an infestation. Curiously, given that government-funded research resulted in the development of an effective method to control this devastating insect, the granting of government funds to "study the mating habits of the screwworm fly" is still sometimes brought up as an example of wasteful squandering of public money.

That's a nonsensical view. Without such funding, researchers would not have been able to successfully screw the screwworm fly.

Source: Regina Leader Post. By Joe Schwarcz, 9 June 2023. https://leaderpost.com/opinion/columnists/the-right-chemistry-how-screwflies-were-made-infertile-without-affecting-their-love-life.

Costa Rica Battles Cattle Screwworm Outbreak

Costa Rica is teaming up with Panama and the USA in an urgent battle to eliminate an outbreak of invasive cattle screwworms first detected last month near the Panama border. The National Animal Health Service (SENASA) of Costa Rica is collaborating closely with the Panama-USA Commission for the Eradication and Prevention of Cattle Screwworm (COPEG) to control this dangerous parasitic pest before it wreaks havoc on Costa Rica's livestock industry.

Seven screwworm cases have already been confirmed across the border region, affecting cattle, sheep, and a dog. To disrupt the fly's breeding cycle, planes have released over 10 million sterile male screwworm flies over outbreak zones on 31 July and 3 August 2023. The aerial release will continue for as long as needed to suppress the population.

"This sterile insect technique (SIT) has proven successful to eliminate screwworms in the past," said Dr Alejandra Umana, a SENASA veterinarian. "As sterile flies mate with wild females, they produce no offspring, causing the infestation to die out."

In tandem, SENASA has deployed traps to monitor the pest's distribution and ground teams are visiting farms and tracking cases to contain the outbreak. New animal control checkpoints in Sabanillas de Limoncito and on the road to Golfito aim to stop transportation of infested livestock.

"Producers must be vigilant and report any potential infestations immediately," urged Alexis Sandi, SENASA's Head of Epidemiology. "Early detection and treatment is critical."

All citizens can help by promptly notifying SENASA if they suspect screwworm cases. The agency is conducting heightened surveillance countrywide to find new cases quickly before extensive agricultural damage occurs.

Costa Rica Agriculture Minister Angel Gonzalez vowed to continue the fight for as long as required. "We will not rest until this severe threat to Costa Rica's livestock and wildlife is eliminated," he stated. "Controlling invasive pests demands collaboration across borders and between governments and citizens."

The joint Costa Rica-Panama-USA mission aims to safeguard the nation's biodiversity and economic interests. The SENASA urges full public cooperation and promises ongoing updates as progress unfolds.

Source: The Tico Times, By Ileana Fernandez, 5 August 2023. https://ticotimes.net/2023/08/05/costa-rica-battles-cattle-screwworm-outbreak.

'First of Its Kind' Fruit and Vegetable Treatment Facility to be Built in Adelaide, South Australia

The South Australian producers will no longer need to send their fruit and vegetables out of state for treatment following the construction of a new AUD$ 50 million post-harvest facility. Work will begin on the new inspection, quarantine and treatment facility in February 2024. It will be built on the site of the South Australian Produce Market in Adelaide's north.

An artist's impression of the new biosecurity treatment facility in South Australia. (Source: South Australia Produce Market).

Once completed, the new facility is expected to unlock an additional AUD$ 100 million in fresh produce exports over a five-year period and create up to 172 new jobs. It is also expected to reduce transport costs, increase shelf life of produce, improve profitability and, in turn, lower product wastage and reduce the cost of supermarket produce.

The AUD$ 50 million industry-led initiative is funded through AUD$ 9.8 million from the Federal Government, AUD$ 4.2 million from the SA Government and the remaining AUD$ 36 million from industry.

The South Australian Produce Market CEO Angelo Demasi thanked the state and federal governments for their investment in the facility he said would greatly benefit local producers and consumers and the state's economy. "South Australian Produce Market is excited to host this world leading precinct which will enable our industry to access state-of-the-art post-harvest treatment services, enabling us to deliver quality local produce even more efficiently and sustainably to our South Australian customers," he said. "This project also represents a significant step towards making our produce even more attractive to our existing global customers. "South Australia will soon become an attractive destination for global produce companies looking to establish a presence in the Asia-Pacific region, strengthening our industry's position in the global market. "South Australia Trade and Investment Minister Nick Champion agreed. "This facility, the first of its kind in the nation, will ensure South Australia's premium, clean, and green produce – the envy of the world – is protected," he said. "The importance of safeguarding our environment for agribusiness and exports cannot be understated and will only bolster our international reputation as we are able to get produce to market faster."

South Australia growers have previously faced challenges in selling to certain markets which have restrictions based on what pests and diseases are prevalent in the region where the fruit is grown.

For example, a current Queensland fruit fly outbreak in parts of the Riverland means produce cannot be sent to other parts of South Australia, Tasmania, or Western Australia where Queensland fruit fly does not have a presence, unless it is treated.

The new facility will use pressure cooling and treatment technology to ensure produce coming from fruit fly impacted areas are inspected, quarantined and treated, so it can be distributed safely. Federal Agriculture and Fishers Minister Murray Watt said federal government funds, supplied under the Building Resilience to Manage Fruit Fly package, were earmarked with this precise objective. "There is no one-size-fits-all approach to tackling fruit fly, so the funding will be aimed at several different methods of controlling this pest, including through post-harvest treatment," he said. "These projects will contribute to driving down fruit fly pest pressure, reducing fruit fly incursions into South Australia and building industry resilience to manage this pest.

"The package will give us a huge boost towards our goal of completely eradicating our current outbreaks and retaining South Australia's fruit fly free status, as well as reducing the impacts of fruit fly nationally."

Federal funding is also being provided to build and expand sterile insect technique facilities, update interstate trade protocols, roll out electronic plant health certification and put in additional roadblocks to protect the Riverland pest-free area.

Queensland fruit fly Primary Industries and Regional Development Minister Clare Scriven said the funding would protect the state's AUD$ 1.4 billion horticulture industry and ensure a stable supply chain. "Having this technology here also opens the door to other potential and exciting benefits to the state from sectors such as health and medical, space and defence," she explained.

Source: PS News.com, by Travis Radford, 24 October 2023. https://psnews.com.au/first-of-its-kind-fruit-and-vegetable-treatment-facility-to-be-built-in-adelaide/121327/.

Relevant Published Articles

How Rearing Systems for Various Species of Flies Benefit Humanity

Carlos Pascacio-Villafán[1], and Allen Carson Cohen[2],

[1] *Red de Manejo Biorracional de Plagas y Vectores, Clúster Científico y Tecnológico BioMimic®, Instituto de Ecología A.C., Xalapa 91073, Veracruz, Mexico*

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Abstract

Flies (Diptera) have played a prominent role in human history, and several fly species are reared at different scales and for different beneficial purposes worldwide. Here, we review the historical importance of fly rearing as a foundation for insect rearing science and technology and synthesize information on the uses and rearing diets of more than 50 fly species in the families Asilidae, Calliphoridae, Coelopidae, Drosophilidae, Ephydridae, Muscidae, Sarcophagidae, Stratiomyidae, Syrphidae, Tachinidae, Tephritidae, and Tipulidae. We report more than 10 uses and applications of reared flies to the well-being and progress of humanity. We focus on the fields of animal feed and human food products, pest control and pollination services, medical wound therapy treatments, criminal investigations, and on the development of several branches of biology using flies as model organisms. We highlight the relevance of laboratory-reared Drosophila melanogaster Meigen as a vehicle of great scientific discoveries that have shaped our understanding of many biological systems, including the genetic basis of heredity and of terrible diseases such as cancer. We point out key areas of fly-rearing research such as nutrition, physiology, anatomy/morphology, genetics, genetic pest management, cryopreservation, and ecology. We conclude that fly rearing is an activity with great benefits for human well-being and should be promoted for future advancement in diverse and innovative methods of improving existing and emerging problems to humanity.

Keywords: Diptera rearing; human wellbeing; animal feed; medical maggots; pollination services; forensic entomology

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Suppression Trial through an Integrated Vector Management of *Aedes albopictus* (Skuse) Based on the Sterile Insect Technique in a Non-Isolated Area in Spain

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Abstract

Abstract: In recent years, *Aedes albopictus* (Skuse, 1984) has expanded its distribution globally due to its high ecological plasticity. This expansion has increased the population's susceptibility to contracting diseases such as dengue, Zika, and chikungunya, among others, which are transmitted by this mosquito species. In the absence of effective control methods, the application of the sterile insect technique (SIT) is proposed as part of an integrated vector management (IVM) program. From 2007 to 2020, this strategy has been tested in a non-isolated mosquito population urban area of 45 ha, representative of the municipalities of the Valencian region (Spain). The population levels of adult females and eggs collected in the traps have been reduced by 70–80% compared to the control area, demonstrating its efficacy in reducing mosquito populations. This work analyzes the impact of the migration of the wild mosquito population from the peri-urban area to the urban core.

Keywords: SIT; vector control; mosquitoes; insect production; mass rearing; dengue; Europe

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