The Zika Virus Mosquitoes

How can the sterile insect technique help?

Summary

The Americas, especially Latin America and the Caribbean, are facing a major health threat from *Aedes* mosquitoes that transmit diseases through their bite — resulting in the spread of Zika, chikungunya and dengue. Countries in Africa and Asia have also reported Zika cases.

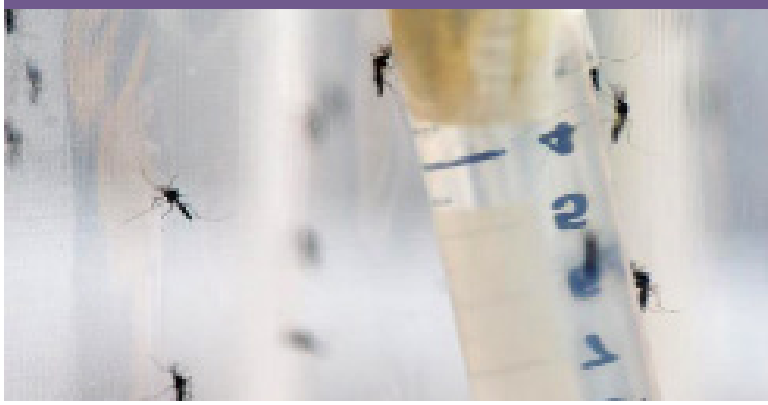
The IAEA has received urgent requests from affected Member States who wish to harness the sterile insect technique (SIT) for the control of the mosquito menace.

SIT is a type of biological pest control that uses radiation to sterilize male insects. This proven nuclear technique has been used to control major agricultural insect pests such as fruit flies, screwworm flies, moths and tsetse flies for decades. SIT has the potential to be effective against *Aedes* mosquitoes as well.

The sterile insect technique has been used effectively against many insect pests.

This environmentally friendly method is being adapted for the suppression of disease-transmitting mosquitoes.

Recent developments show promise of efficient mass-rearing and irradiation for the release of sterile male mosquitoes.



***Aedes* mosquitoes may transmit viruses that cause dengue, chikungunya and Zika. (Photo: D. Calma/IAEA)**

Introduction

The Zika virus is a member of the virus family Flaviviridae and the genus *Flavivirus*. Its name originates from the Zika forest of Uganda, where the virus was first isolated in 1947. Since the 1950s, the area of its occurrence was mainly within a narrow equatorial belt from Africa to Asia. But, from 2007 to 2016, the virus spread eastward, across the Pacific Ocean to the Americas, leading to the 2015–2016 Zika virus epidemic. In early 2016, the World Health Organization (WHO) declared Zika a public health emergency of international concern and, by August 2016, 70 countries had reported confirmed cases.

There is now scientific consensus that Zika virus infections during pregnancy can cause microcephaly in newborns, as well as other central nervous system malformations. The latest reports also suggest a link between the Zika infection and Guillain-Barré syndrome, an uncommon sickness of the nervous system.

Following the Zika outbreak in Brazil and in the broader Latin America and Caribbean region, countries from around the world have requested urgent IAEA assistance in developing and validating SIT to suppress populations of disease-carrying mosquitoes.

In response, the IAEA, in cooperation with the WHO and the Food and Agriculture Organization of the

Participants trained to detect the Zika virus at the IAEA Seibersdorf laboratories. (Photo: O.Yusuf/IAEA)

United Nations (FAO), has initiated a number of activities to provide assistance to affected countries in their efforts to suppress Zika-transmitting mosquitoes.

Under certain conditions, SIT can complement conventional, insecticide-based mosquito control methods, particularly as pest resistance to insecticides is increasing, and there are environmental concerns regarding insecticide use.

What exactly is the sterile insect technique?

SIT has been used for over 50 years to suppress or eradicate a number of major insect pests. It uses ionizing radiation to sterilize insects that have been mass-produced in special rearing facilities. The sterilized insects are then released over affected areas, where they mate with wild insects, producing no offspring. As a result, the number of insects gradually decreases, leading to a reduction in the spread of the insect-borne diseases and damage.

The IAEA, in partnership with the FAO, spearheads global research in the development and application of SIT. This scientific method to control mosquitoes is developed at the FAO/IAEA Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria. Today, the IPCL provides support to IAEA technical cooperation projects with an SIT component in over 70 countries.

In the case of mosquitoes, only male insects can be released. This is because it is the bite by female mosquitoes that transfers diseases, so mass releasing them would actually spread rather than control the spread of viruses. In order to be able to release only sterile male insects, it is necessary to separate males from females. In some insect pests, this process is already well established. In the case of mosquitoes, research is currently underway to create an efficient system to separate male from female mosquitoes before irradiation and subsequent release.

While further research and field trials to study the effectiveness of the technique in the species of mosquitoes that spread the Zika, chikungunya and dengue viruses are ongoing, the potential of introducing SIT as part of integrated mosquito control programmes is being considered by several countries.

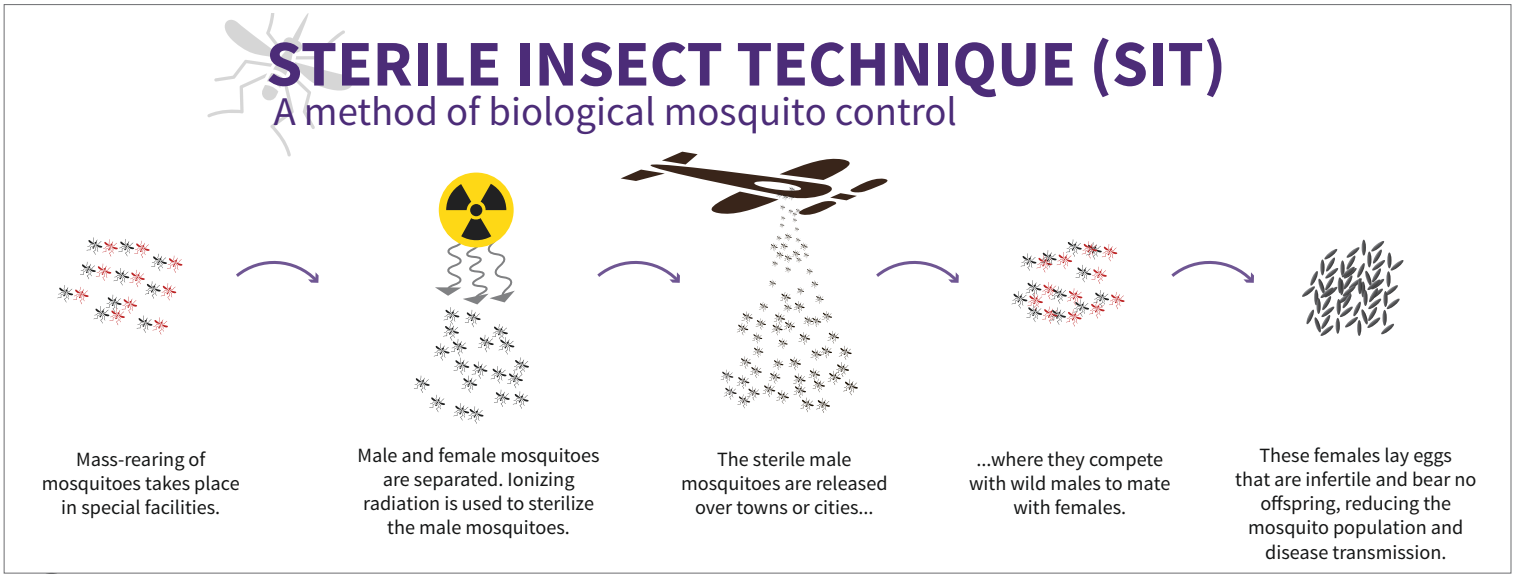
IAEA support to Member States

To fight disease-transmitting mosquitoes, the IAEA has undertaken the following actions to support affected countries:

In February 2016, a group of international experts from Brazil, China, Colombia, Guatemala, Mexico, Sweden, Thailand, Trinidad and Tobago and the USA reviewed all the available scientific data as well as newly developed technologies for the population control of *Aedes aegypti*. At this meeting hosted in Brazil, technical recommendations were issued that include the SIT being considered as a component of integrated vector management approaches.

In the same month, authorities and scientists from 16 Latin American and Caribbean countries participated in a regional meeting in Brazil to analyse the Zika outbreak in the region, provide expert technical advice on integrated vector management and identify potential pilot trials for implementation of SIT.

In March 2016, the IAEA launched a four-year regional project worth €2.3 million to help Latin America and the Caribbean countries apply SIT as part of integrated vector control measures. A strategy workshop for defining a pilot testing approach and roadmap was conducted in



August 2016 with experts from the IAEA, Brazil, Mexico and the USA.

The IAEA has facilitated and supported the transfer of a gamma cell irradiator to Brazil to help the country in its battle with the Zika virus. The equipment will allow Brazil to scale up the production of sterile male mosquitoes to be released in selected areas of the country most affected by the Zika virus outbreaks.

A Southeast Asia regional workshop on SIT-based approaches to control populations of mosquito disease vectors, with special reference to dengue, chikungunya and Zika vectors, took place from 5 to 9 September 2016 in Kuala Lumpur, Malaysia.

A new IAEA technical cooperation project to address the Zika virus was initiated in May 2016 in response to the declaration of a state of emergency in the Marshall Islands. In May 2016, in collaboration with the WHO, an expert mission was carried out to identify local mosquito species and their potential involvement in the ongoing Zika virus outbreak on Majuro, the most populated atoll in the country. In addition, scientists from the Marshall Islands were trained on SIT. In response to the health emergency declared by the Marshall Islands in December 2015, the IAEA approved a project entitled "Strengthening national capacities for the early and rapid detection of Zika virus infections in the Marshall Islands". Under this project, the IAEA provided reverse transcriptase–polymerase chain reaction (RT–PCR) equipment for detection of the Zika virus and organized two scientific visits in June to instruct about Zika virus detection and differential diagnosis. An expert mission in October trained staff from the Ministry of Health in the Marshall Islands on the use of the RT–PCR equipment.

The third research coordination meeting on exploring genetic, molecular, mechanical and behavioural methods of sex separation in mosquitoes was held in Tapachula, Mexico, from 10 to 14 October 2016.

A regional Latin America and Caribbean training course on mass-rearing and SIT-related activities for the control of *Aedes* mosquitoes, the major vectors of dengue, chikungunya and Zika, was held from 7 to 11 November 2016 in Juazeiro, Brazil.

Detecting Zika using nuclear-derived technology

The IAEA has hosted a couple of training courses at its Seibersdorf laboratories on the use of RT–PCR, a molecular diagnostic technique, which can identify the Zika virus within three hours and provides a quick turnaround and interpretation of results.

In a training course in April 2016, organized in coordination with the WHO and the Pan American Health Organization, professionals involved in relevant national laboratories were given hands-on training in this specialized nuclear-derived technology.

The IAEA has also provided real time RT–PCR equipment to ten countries in Central America and the Caribbean (Costa Rica, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua and Panama) and the Pacific (Marshall Islands). In addition, two regional projects were initiated to support Zika detection training.

In the absence of vaccines and efficient, safe and inexpensive drugs to treat people suffering from dengue, chikungunya and Zika, many Member States consider vector control as the most promising approach to managing the problem and the SIT is being developed and validated as part of their integrated national mosquito suppression programmes.

Planned IAEA activities for Member States include:

- The second research coordination meeting on mosquito handling, transport, release and male trapping methods, to be held from 24 to 28 April 2017 in Valencia, Spain.
- Technical support will be provided for the planning and conduct of a few SIT pilot projects in Brazil, Cuba and Mexico to suppress disease-transmitting mosquito populations in urban areas of Member States that have the appropriate technical capacity and the necessary baseline data.
- Funds provided by the USA to support the project on surge expansion of the SIT to control mosquito populations that transmit Zika virus will contribute to significantly expand research activities at the IPCL on the development and validation of an SIT package for disease-transmitting mosquitoes, with an emphasis on Zika. The funds, which total US $3.96 million, will support hiring additional specialized research staff, expanding laboratory space for mosquito rearing, and the purchase of urgently needed laboratory equipment.
- Japan, France and the USA have also contributed to TC projects to support Latin America and the Caribbean to fight Zika. Japan has provide €242 000, France €30 000, and the USA €1.3 million.
- The ongoing research and development activities on mosquitoes at the IPCL will continue to focus on the development of genetic sexing strains, optimization of the mass-rearing processes, development and validation of product quality control tests, handling and release of sterile insects, and optimization of traps for male mosquitoes.

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IAEA, Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Email: info@iaea.org • Telephone: +43 (1) 2600-0 • Facsimile +43 (1) 2600-7