LIFE: International Journal of Health and Life-Sciences
ISSN 2454-5872

Lekha Karthikeyan, 2016

Volume 2 Issue 1, pp. 16-23

Year of Publication: 2016

DOI- http://dx.doi.org/10.20319/lijhls.2016.21.1623

This paper can be cited as: Karthikeyan, L. (2016). Sterile Insect Technique to Combat Dengue. LIFE: International Journal of Health and Life-Sciences, 2(1), 16-23.

STERILE INSECT TECHNIQUE TO COMBAT DENGUE

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Abstract

Global warming and globalization indicate the next biggest challenge is zoonotic diseases. Dengue is one of the fastest growing tropical pandemic in the world. There are no approved vaccines for the dengue virus. Prevention thus depends on control of and protection from the bites of the mosquito that transmits it, the dengue mosquito, and Aedes aegypti. Existing methods of controlling the dengue mosquito, which include spraying or fogging using chemical pesticides, have failed to stop the spread of the disease. This is partly because the mosquitoes have developed resistance and also because the Aedes aegypti mosquito lives in and around human habitation. In countries where the human-vector interaction cannot be reduced in a short period of time, Sterile Insect Technique maybe the best and most environment friendly way to prevent the spread of this fast growing pandemic.

Keywords

Dengue, Sterile Insect Technique, Zoonotic Diseases

1. Overview on Dengue

The Aedes aegypti mosquito spreads dengue fever, which at conservative estimate infects 50 million people a year. WHO has categorized it under Neglected Tropical Diseases. Dengue flourishes in urban poor areas, suburbs and the countryside but also affects more affluent neighborhoods in tropical and subtropical countries.

2. How Sterile Insect Technique (SIT) Works for Dengue

For decades Sterile Insect Technique (SIT) has been used in agriculture to eradicate disease-causing insects. The aim is implement the use of this technique in combating Dengue. The Sterile Insect Technique Control Program is the system through which genetically modified mosquitoes are released and monitored in a dengue-hit area over a predetermined and sustained period of time. By applying the SIT Control Program to an area, the mosquito population in that area can be dramatically reduced or eliminated. This approach is targeted at a single species, unlike conventional insecticides or pesticides, which kill insects indiscriminately. This means that, as well as being more effective; it is much better for the environment than conventional tools.

2.1 Epidemiology

Figure 1: *Dengue Countries or Areas at Risk 2009**

In Fig.1 it is seen that most of the countries in tropic and subtropics regions are affected. Due to the speed of its spread, its increasingly serious complications and the overwhelming burden of illness and death it causes, many consider dengue as the world's most important insect-transmitted viral disease.

2.2 Current Control Methods

Vector control has long been seen as the only available tool against some major vector-borne diseases, for example, dengue. It is increasingly seen as a major tool for malaria control. Currently, mosquito populations are controlled by chemical pesticides, which harm many other

insects in addition to mosquitoes and have not stopped the spread of the disease. Methods of vector control include the elimination or management of larval habitats, larviciding with insecticides, the use of biological agents and the application of pesticides.

2.3 Sterile Insect Method

The Sterile Insect Technique (SIT) involves mass rearing of a pest species, which are then usually sterilized by irradiation. SIT is currently used to control insect pests that damage crops.

The irradiated males once released seek out females in the wild.

- When a wild female mates with a sterilized male no viable offspring will be produced, ultimately suppressing the population.
- For maximum effectiveness, the sterile males released must outnumber the fertile, native male mosquitoes by a considerable margin. In order to reduce populations when conditions are highly favorable for fly reproduction, the ratio of released sterile males to native males should be at least 2 to 1 (Knipling, 1955) and may, in certain circumstances, have to be as high 15 to 1.

It therefore follows that SIT is most cost-effective when the target population is low. On the other hand, insecticide applications cost the same, regardless of the insect population density and are, therefore, most cost-effective when the target population density is high. This suggests that the phased and complementary use of both "conventional" methods and SIT would result in maximum efficiency throughout the phase of intervention (Figure 2).

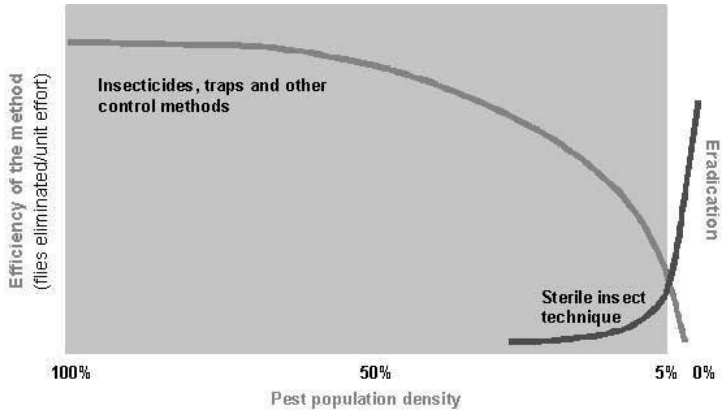

Figure 2: *Optimizing the Efficiency of an Insect Pest Intervention Campaign by using Conventional Control and SIT in an Integrated, Phased Approach*

3. Pros of using SIT

• Removal or suppression of an invasive exotic species might be considered somewhat desirable. In general, though many species (birds, fish, arthropods, scavengers, and microbes) will feed on live or dead mosquitoes (adult or immature stages) if they find them, there seem to be rather few species that depend on mosquitoes. Even then, the species-specific nature of SIT means that only a single species would be removed or suppressed; this approach is perhaps as precisely targeted and environmentally benign as any vector control method can be. Further, should unacceptable consequences be observed, SIT suppression is reversible before global eradication of the target species.

• SIT programmed are far less intrusive than other control methods. In particular, SIT does not require access to households. This is in contrast to conventional control methods for aegypti mosquitoes, which require households to be fogged in order to get to adult mosquitoes

4. Cons of using SIT

- Although SIT has proven to be a very effective technique to control some insect pests, it does have limitations. One major problem is that irradiating insects can damage their health. If the released males are less healthy than the wild males, they won't compete well for females, and so aren't very effective at reducing the population.
- As with insecticide treatment, repeated treatment is sometimes required to suppress the population before the use of sterile insects. Application to large areas should be long lasting, otherwise migration of wild insects from outside the control area could repopulate.
- The major drawback to this technique is that the cost of producing such a large number of sterile insects is often prohibitive in poorer countries

5. Previous Successful Trials

- Screwworm fly (Cochliomyia hominivorax) eradicated from the United States,

Mexico and Libya

  - Cost of SIT program for over 40 years: 1 billion USD
  - Benefit in 1 year alone: 1 billion USD.

- Mexican fruit fly (Anastrophe ludens, Loew) eradicated from most of northern mexico.
- Tsetse Fly eradicated from Zanzibar.

A four-year campaign on the island of Zanzibar has achieved a historic breakthrough in the battle against the tsetse fly - an insect pest that causes hundreds of millions of dollars of damage every year and has forced farmers and herds to abandon wide areas of land across Africa. Using the Sterile Insect technique (SIT) the campaign succeeded in completely eradicating the island of the flies that carry the parasitic cattle disease trypanosomiasis.

- Medfly (Catties capitata, Weidman) eradicated from northern part of Chile and southern part of Peru
- Melon fly (Bactrocera cucurbit, Coquilles) eradicated from Okinawa, Japan.

5.1 Latest Trial in Guangzhou, China 2015

Guangzhou, the provincial capital, reported more than 35,000 cases of dengue last year, accounting for more than 80% of all reported cases in the province.

The laboratory was opened on July 17 and can produce 10 million male mosquitoes every week that are infected with Walachia, bacteria that exists widely in many insects, including mosquitoes. Research shows that eggs produced by mosquitoes that mated with Walachia-infected male counterparts are infertile. This will cause a decrease in the number of mosquitoes living in the wild after a certain period.

6. Conclusion

- SIT strategy is a sophisticated new technology that can eliminate local populations of vector mosquitoes much more efficiently than insecticides and without side effects or pollution. In doing so, it uses male mosquitoes that do not take blood meals and do not transmit the dengue virus.
- It is the most sustainable and environmentally friendly technology ever created for insect control, superior to classical biological control, which can threaten indigenous species.
- Biotechnological approaches based on genetically modified organisms (transgenic organisms) are still under development. However, since no legal framework exists to authorize the release of such organisms in the nature, sterilization by irradiation remains the most used technique.
- SIT programs will benefit tremendously if genetic methods can be developed that enable only male insects to be reared.

- When implemented on an area-wide basis and with economies of scale in the mass rearing process, the use of SIT for suppression is cost competitive with conventional control, in addition to its environmental benefits.

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