## Applications and Limitations of Common Larvicides for Mosquito Control

Adult mosquitoes can fly. Even the weak flyer *Aedes albopictus* has an average flight range of 100 metres. As thousands of mosquito larvae may exist in a single water body, routine mosquito control is typically targeted on the immature stages. While it must be emphasised that the removal of stagnant water and water-containing receptacles had always been the primary means for urban mosquito control, larvicidal treatment is one important supplementary measure since not all actual or potential breeding places could be eliminated.

Although the use of common larvicides for mosquito control is widely accepted locally and in other countries, there are occasions where the use of a given larvicide would not be appropriate. A short overview on the applications and limitations of common larvicides available in Hong Kong is compiled below, for use in conjunction with other reference materials for selecting a suitable larvicide.

### Applications and Limitations of Common Larvicides

**Temephos** is an organophosphate insecticide that is very effective against mosquito larvae. The sand granule formulation commonly used in Hong Kong is very convenient for application, and the sustained release characteristic also allows prolonged efficacy even when applied on surface channels with occasional water flow or temporary rain pools. However, as other common insecticides, it is moderately or highly toxic to susceptible aquatic organisms especially invertebrates. It is incompatible with alkali, and literature data revealed that it is not effective against mosquito pupae.

***Bacillus thuringiensis israelensis*** (*B.t.i.*) is a microbial insecticide. It produces protein toxins which are highly toxic to mosquitoes and blackfly larvae after ingestion but harmless to other aquatic animals, and therefore it can be used even in ecologically sensitive areas. It is often manufactured in corn cob granule or suspension formulations for easy application. *B.t.i.* is most effective for the early larval stage which is actively feeding, but is not effective from the late larval stage onwards as feeding has slowed down or stopped. Re-treatment at regular intervals is also needed as the existing formulations cannot persist in the environment.

**Larvicidal oils** are refined petroleum products, which sometimes fall into a discrete category aside from other larvicides. An oil film formed with a small amount of larvicidal oil spreading over the entire surface of a water body will cause suffocation of all mosquito larvae and pupae within. They are convenient and very effective for

suitable water bodies with limited surface areas such as sand traps or roadside gully pits. As the mode of action relies on the physical property, resistance problem does not exist. However, larvicidal oils would not be effective when the oil film could not cover the water surface completely, thus they are particularly unsuitable for surface channels with water flow. Likewise, inspection and reapplication would be required after heavy rain. Presence of floating refuse or vegetation protruding from the water surface could disrupt the oil film thereby compromising the efficacy, and must be cleared properly prior to applying the larvicidal oil. Lastly, larvicidal oil can harm aquatic organisms such as fish and plants.

**Insect growth regulators** (IGRs) are substances that adversely affect insect growth , but have little or no toxicity to other animals. Nevertheless, if used inappropriately, non-target insects and crustaceans might be severely affected. Besides, as the mortality from IGR could be delayed to the pupal stage, the viability of mosquito larvae and some pupae could not indicate whether an adequate amount of the IGR had been applied. This may create the false perception that the IGR is not effective, and may trigger over-application. Monitoring would also be difficult, as a loss of efficacy (from dilution, decomposition etc.) may only be detected ultimately upon the presence of emerged adults.

***Bacillus sphaericus*** (*B.s.*) as a larvicide is similar to *B.t.i.*, and is even more effective against *Culex* spp. mosquitoes in water with high organic content. Unfortunately it is not very effective against aedine mosquitoes, thereby limiting its range of applications.

**Monomolecular films** (MMFs) are substances that spread extremely thinly over the water surface for mosquito control. They are very effective against mosquito pupae, and are more environmental friendly than larvicidal oil. However, literature data suggested that the efficacy against larvae is suboptimal. Being chemicals floating on the surface (similar to larvicidal oil) which fail to kill all larvae (similar to IGR), MMFs bear the disadvantages associated with both properties. Consequently, larvae that survive an MMF application may successfully pupate and emerge as adults once the surface film is disrupted by adverse weather conditions or other causes.

**Points to Note for Applying Larvicides**

The following must be noted for applying larvicides:

1. Larvicides including larvicidal oil can be applied to stagnant water directly with dosage according to the label instructions.

2. Higher than required concentration of larvicide or excessive amount of larvicidal oil would not give better result on killing the mosquito larvae.
3. As pesticides, the larvicides used must have been registered with the Agriculture, Fisheries and Conservation Department.
4. Depending on the product, larvicide may be applied weekly into the stagnant water until the water has been removed.
5. Larvicidal oil needs not be applied into the stagnant water again if the oil is still present in the water.
6. Pesticide applicator should put on protective gears including face mask and rubber gloves during pesticide application as required by the label instructions.

C. K. YUEN, Pest Control Officer

# The science of insect repellents and the correct ways in using insect repellent sprays

There are many mosquito repellent products available in the market to protect people from mosquitoes. Knowing more about the relevant behavior of mosquitoes and the mosquito repellents will help us use the products correctly and effectively.

## How do mosquitoes detect our locations?

Mosquitoes detect the locations of hosts through olfactory, thermal and visual cues. Olfactory cues are the important long-range cues used by the mosquitoes during the host-seeking process. Carbon dioxide and sweat emanate from human are perceived by mosquitoes. It is believed that mosquitoes can smell a person up to 36 meters. Host's body heat and movement of hosts are the thermal and visual cues mosquitoes rely on at shorter distance.

## What are mosquito repellents and how repellents work?

Mosquito repellents are substances that disrupt the host-seeking behavior of mosquitoes. Some scientists suggest the repellents affect the function of olfactory system, so the mosquitoes cannot locate the hosts. On the other hand, some experiments suggested that mosquitoes simply avoid certain repellents because they dislike the smell of repellents. At this moment, the exact mechanisms of mosquito repellents remain unknown.

Repellents can be classified into two types, spatial repellents and contact repellents. Spatial repellents are used to protect a volume of space by releasing vapors that drive mosquito away. Some pyrethroids, e.g. allethrin, pyrethrin and metofluthrin are reported having spatial effects. Apart from having the knockdown and killing effect, some mosquito coils also repel mosquitoes because the products contain those pyrethroids. Contact repellents are substances that reduce the landing chance of mosquitoes on treated skin surfaces. This type of repellents must be applied to skin in order to carry out the repelling effect.

## What should be aware of when using mosquito repellents?

Mosquito repellents must be applied as directed on the product label. For contact repellents, users should avoid overapplication and use just enough repellents to cover exposed skin and clothing. Some products, like DEET, have little spatial repelling activity thus must be applied to all exposed (except irritated or wounded) skin in order to maximize the effect. To avoid applying large amount of repellents on the body, users should wear long-sleeved clothing to reduce the amount of skin surface that needs to be treated with DEET.

Before applying the repellents, users should also be aware of the duration of protection the products offer. Some repellents, especially those with a highly volatile active ingredient, are only effective for a short period. According to a World Health Organization publication, for example, citronella oil works for only 20–30 minutes, while DEET works for 4–6 hours. In addition, even using the same active ingredient, the exact duration of effect among different brands of products may vary. Users should read the label concerning the duration of protection and reapply the mosquito repellents when carrying out long hours of outdoor activities. In addition, sweating will remove the mosquito repellents from our skin. Therefore, users must reapply the products more frequently if they sweat extensively.

In short, different mosquito repellents have different directions to use. The product labels will guide you to using these products safely and effectively. Before applying a mosquito repellent, please read the label and make sure you know how to apply the product correctly and be aware of the duration of protection it offers.

References

1. Achee NL, et al. 2012. Spatial repellents: from discovery and development to evidence-based validation. Malaria Journal 11:164. doi:10.1186/1475-2875-11-164.
2. Breugel F, et al. 2015. Mosquitoes Use Vision to Associate Odor Plumes with Thermal Targets. Current Biology. doi:10.1016/j.cub.2015.06.046
3. Gillies MT and Wilkes TJ. 1972. The range of attraction of animal baits and carbon dioxide for mosquitoes. Studies in a freshwater area of West Africa. Bulletin of entomological research. 59(3): 441-456. doi: 10.1017/S0007485300047295
4. World Health Organization. 2011. Comprehensive Guidelines for Prevention and Controlof Dengue and Dengue Haemorrhagic Fever. WorldHealthOrganization, Regional Office for South-East Asia.

(http://apps.searo.who.int/pds_docs/B4751.pdf)

W. H. YAP, Pest Control Officer