Larviciding and Insecticide Resistance Management

Insecticide Resistance Action Committee

www.irac-online.org

Objectives

Introduction and background

Mosquitoes are vectors of many human diseases, including malaria. The emergence of species resistant to insecticides widely used in vector control has the potential to severely impact on the control of these disease vectors. The lack of available suitable alternative insecticides for vector control is becoming a serious issue. It is therefore vital that effective insecticide resistance management (IRM) strategies are implemented to ensure that the efficacy of existing compounds can be maintained for as long as possible. There are several larvicides which have totally different modes of action (MoA) to the available adulticides and therefore offer the opportunity to control resistant mosquitoes where the major classes of adulticide insecticides are resisted.

Note: For details on larvicides and resistance see IRAC Poster: Theory and Practice of Mosquito Larviciding. The MoA Classification is available from the IRAC website www.irac-online.org. It is recommended that only WHOPES approved larvicides are used to ensure quality.

Effective IRM strategies, sequences or alterations of MoA

All effective insecticide resistance management (IRM) strategies seek to minimise the selection of resistance to any one class of insecticide. It is recommended that rotations of compounds from different MoA groups can provide sustainable and effective IRM for mosquitoes. This ensures that selection by compounds in the same MoA group is minimised, and resistance less likely to evolve. The practice of using an insecticide until resistance occurs becomes a limiting factor in public health and is rapidly eroding the number of suitable insecticides for vector control. The limitations of current public health interventions such as IRS and LLINs mean that successive generations of the mosquito are exposed to compounds from the same MoA group. This also applies to larviciding where repeated use of the same larvicide may lead to resistance. This makes IRM in public health more challenging than in agriculture.

Resistance Monitoring

The susceptibility status of the target mosquito population should be monitored during the planning phase of a larviciding intervention to guide choice of insecticide. Resistance monitoring can be carried out using bioassays (WHO[1, 2] and/or CDC[3] standard test kits and procedures) and also using biochemical/molecular methods. This testing should ideally be conducted annually to monitor any changes in susceptibility that may occur and thus allow timely use of alternative products or vector control methods. Note that it is contra-indicated to use products with the same class of insecticide for adulticiding as larviciding e.g. use of an organophosphate as an IRS and temephos as a larvicide.

Resistance test methods can be found from the websites:

1. www.who.int/whopes/resistance/en/
2. http://whqlibdoc.who.int/hq/2005 /WHO_CDS_WHOPES_GCDPP_2005.13.pdf
3. www.cdc.gov/ncidod/wbt/resistance/assay/bottle/index.htm

Note: It may be valuable to use larval resistance test methods as well as adult methods as resistance levels can vary between the two life stages.

Chemical Larvicides – Nerve & Muscle Targets

Most current insecticides act on nerve and muscle targets. And as such are generally fast acting.

Group 1 Acetylcholinesterase (AChE) inhibitors

Inhibit AChE, causing hyperexcitation. AChE is the enzyme that terminates the action of the excitatory neurotransmitter acetylcholine at nerve synapses.

1B Organophosphates (e.g. Temephos, pirimiphos-methyl)

Group 5 Nicotinic acetylcholine receptor (nAChR) allosteric modulators

Allosterically activate nAChRs, causing hyperexcitation of the nervous system. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.

5 Spinosyns (e.g. spinosad)

Further information:

IRAC publication: Prevention and management of insecticide resistance in vectors of public health importance www.irac-online.org

WHO (2006): Pesticidesand their application WHO/CDC/NTD/WHOPES/GCDPP 6th edition, 114pp. www.who.int/whopes/en/

Juvenile Hormones, Chitin Synthesis Inhibitors

Insect development is controlled by the balance of two principal hormones: juvenile hormone and ecdysone. Insect growth regulators act by mimicking one of these hormones or directly affecting cuticle formation/deposition or lipid biosynthesis. Insecticides that act on individual targets In this system are generally slow to moderately slow acting.

Group 7 Juvenile hormone mimics

Applied in the pre-metamorphic instar, these compounds disrupt and prevent metamorphosis

7A Juvenile hormone mimics (e.g.Methoprene, Hydroprene)

7C Pyriproxyfen

Group 15 Inhibitors of chitin biosynthesis Type 0

Incompletely defined MoA leading to inhibition of chitin biosynthesis

15 Benzoylureas (e.g. Diflubenzuron, Novaluron)

Biolarvicides - Midgut

Derived from bacteria, these toxins need to be ingested and disrupt the insect midgut membranes.

Group11 Microbial disruptors of insect midgut membranes

Bacillus thuringiensis var.israeliensis and *Bacillus sphaericus*

Note: Only use products whose manufacturer`s conduct on-going quality control.

Note: When treating any water which may be used for drinking purposes the larvicide used must have WHO/JMPR potable water clearance (see below).

WHOPES Approved Mosquito Larvicides

Larvicides WHOPES recommended

MoA	Class	Insecticide or Product
1B	Organophosphate	Temephos*, Chlorpyrifos, Pirimiphos-methyl, Fenthion
5	Spinosyns	Spinosad *
7A	Juvenile Hormone Mimics	Hydroprene, Methoprene*
7C	Pyriproxyfen	Pyriproxyfen*
15	Benzoylureas	Diflibenzuron,*Novaluron*
11	Bacterial Larvicides	*Bt var. israeliensis*,* *Bacillus sphaericus**

* Larvicides with WHO/JMPR potable water clearance, check Guidelines for Drinking Water Quality Fourth Edition, 2011 – WHO…. for approved dose rates.

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CropLife