Insecticide Mode of Action Classification: Mosquito adulticides with WHO Prequalification

Insecticide Resistance Action Committee

www.irac-online.org

Introduction

Insecticides have been used since the 1940s to control the mosquito vectors of disease and have been a vital component in the fight against malaria and other vector borne disease. However, resistance to some insecticides has developed and is widespread in populations of the major mosquito vector species. As insecticide resistance continues to develop, there is a real danger that the efficacy of these valuable tools will be lost. An understanding of the insecticide modes of action groups is a fundamental step in developing Insecticide Resistance Management (IRM) programmes.

Further reading:

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

IRAC Mode of Action classification. See the classification scheme for comprehensive information.

Nb. Prequalification relates to products, not individual insecticides or insecticide mode of action groups. Refer to the WHO Prequalification website to identify prequalified Vector Control products
www.who.int/pq-vector-control/en/

Anopheles stephensi courtesy of Syngenta

MoA 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.

1A	Carbamates:	
	Bendiocarb	IRS
1B	Organophosphates:	
	Malathion	SS
	Pirimiphos-methyl	IRS

MoA group 3.

Sodium channel modulators: Keep sodium channels open, causing hyperexcitation and, in some cases, nerve block. Sodium channels are involved in the propagation of action potentials along nerve axons.

3A	Pyrethroids:	
	Alpha-cypermethrin	IRS, LLIN
	Bifenthrin	IRS
	Deltamethrin	IRS, LLIN
	d, d, trans-cyphenothrin	SS
	Etofenprox	IRS
	Lambda-cyhalothrin	IRS
	Permethrin	LLIN
	Prallethrin	SS
	S-bioallethrin	SS
	Transfluthrin	SS, SE

MoA group 4.

Nicotinic acetylcholine receptor (nAChR) competitive modulators: Bind to the acetylcholine site on nAChRs, causing a range of symptoms from hyper-excitation to lethargy and paralysis. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.

4A	Neonicotinoids:	
	Clothianidin	IRS[1]
	Imidacloprid	SS[2]
4D	Butenolides	
	Flupyradifurone	SS[3]

MoA group 7.

Juvenile hormone mimics: Pre-metamorphic instar - disrupt and prevent metamorphosis Adult - reduces fecundity and fertility.

7C	Pyriproxyfen	LLIN[4]

MoA group 13.

Uncouplers of oxidative phosphorylation via disruption of the proton gradient: Protonophores that short-circuit the mitochondrial proton gradient so that ATP cannot be synthesized.

13	Pyrroles:	
	Chlorfenapyr	LLIN[5]

MoA group 30.

GABA-gated chloride channel allosteric modulators: Allosterically inhibit the GABA-activated chloride channel, causing hyperexcitation and convulsions. GABA is the major inhibitory neurotransmitter in insects.

30	Meta-diamides:	
	Broflanilide	IRS, SS
	Isoxazolines:	
	Isocycloseram	IRS

Notes:

IRS, Indoor Residual Spraying
LLIN, Long Lasting Insecticide treated Net
SS, Space Spray
SE, Spatial Emanator

1. Prequalified alone and in combination with deltamethrin
2. Prequalified in combination with prallethrin
3. Prequalified in combination with transfluthrin
4. Prequalified in combination with alpha-cypermethrin
5. Prequalified in combination with alpha-cypermethrin, bifenthrin or deltamethrin

Prequalified status correct as of December 2025

Aedes aegypti courtesy of Syngenta

Insecticide Resistance Management

- Plan:

IRM should be considered an integral part of any vector control programme and included during the planning phase in the context of wider Integrated Vector Management activities

- Monitor:

The susceptibility status of the target mosquito populations should be monitored regularly to guide the design of the IRM programme, and choice of intervention

- Rotation:

Guided by susceptibility monitoring data, plan to rotate insecticides by MoA group, either temporally or spatially. In the absence of susceptibility data, the rotation of products between IRAC MoA groups will reduce selection pressure for resistance development

- Mixtures:

The use of mixtures of insecticides will have the greatest IRM benefit if the insecticides in the mixture are from different MoA groups, and the target mosquito population is susceptible to both

- Integrated Vector Control:

Include mosquito larvicides, or other interventions, with alternative MoA in the vector control programme where appropriate

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