IRAC - Insecticide Mode of Action Classification

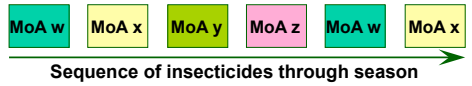
Insecticide Resistance Action Committee **www.irac-online.org**

Introduction

Insecticide Resistance Action Committee [IRAC] promotes the use of a Mode of Action (MoA) classification of insecticides as the basis for effective and sustainable insecticide resistance management (IRM). Insecticides are allocated to specific groups based on their target site. Reviewed and re-issued periodically, the IRAC MoA classification list provides farmers, growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of insecticides or acaricides in IRM programs. Effective IRM of this type preserves the utility and diversity of available insecticides and acaricides. Sample MoA groups are shown below.

Effective IRM strategies: Sequences or alternations of MoA

All effective insecticide resistance management (IRM) strategies seek to minimise the selection of resistance to any one type of insecticide. In practice, alternations, sequences or rotations of compounds from different MoA groups provide sustainable and effective IRM for pest Lepidoptera. This ensures that selection from compounds in the same MoA group is minimised, and resistance is less likely to evolve.



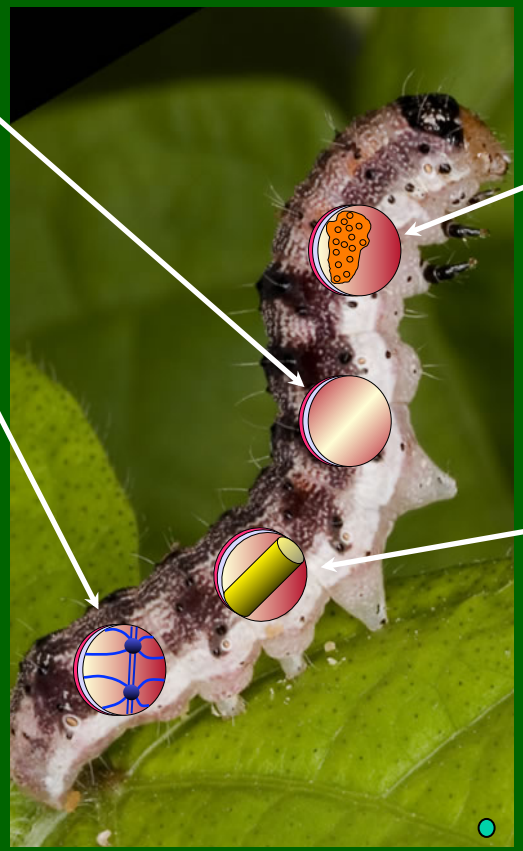
Applications are often arranged into MoA spray windows or blocks that are defined by the stage of crop development and the biology of the pest species of concern. Local expert advice should always be followed with regard to spray windows and timings. Several sprays may be possible within each spray window but it is generally essential to ensure that successive generations of the pest are not treated with compounds from the same MoA group. Metabolic resistance mechanisms may give cross-resistance between MoA groups, and where this is known to occur, the above advice must be modified accordingly. IRAC also provides general recommendations for resistance management tactics regarding specific MoA groups, e.g. neonicotinoids (Group 4A).

Growth & Development targets

Group 7 Juvenile hormone mimics
7A Juvenile hormone analogues (e.g. **Methoprene**)
7B **Fenoxycarb,** ***7C*** **Pyriproxyfen**)
Group 10 Mite growth inhibitors,
10A **Clofentezine, Hexythiazox,** ***10B*** **Etoxazole**
Group 15 Inhibitors of Chitin biosynthesis, Type 0
Benzoylureas (e.g. **Flufenoxuron, Novaluron**)\
Group 16 Inhibitors of chitin biosynthesis, type 1 **Buprofezin**
Group 17 Moulting disruptor, Dipteran **Cyromazine**
Group 18 Ecdysone agonists / moulting disruptors
18 Diacylhydrazines (e.g. **Methoxyfenozide, Tebufenozide**)

Nerve & Muscle Targets

Group 1 Acetylcholinesterase (AChE) inhibitors
1A Carbamates (e.g. **Thiodicarb**),
1B Organophosphates (e.g. **Chlorpyrifos**)
Group 2 GABA-gated chloride channel antagonists
2A Cyclodiene Organochlorines (e.g. **Endosulfan**),
2B Phenylpyrazoles (e.g. **Fipronil**)
Group 3 Sodium channel modulators
3A Pyrethrins, Pyrethroids (e.g. **Cypermethrin, λ-Cyhalothrin**)
Group 4 Acetylcholine receptor (nAChR) agonists
4A Neonicotinoids e.g. **Imidacloprid, Thiamethoxam**)
4C **Sulfoxaflor**
Group 5 Nicotinic acetylcholine receptor channel agonists (Allosteric)
Spinosyns (e.g. **Spinosad**, **Spinetoram**)
Group 6 Chloride channel activators Avermectins (e.g. **Abamectin**, **Emamectin benzoate, Lepimectin**)
Group 9 Compounds of non-specific mode of action (selective feeding blockers)
9B **Pymetrozine,** ***9C*** **Flonicamid**
Group 14 Nicotinic acetylcholine receptor channel blockers Nereistoxin analogs ***(***e.g. ***Cartap hydrochloride)***
Group 19 Octopamine receptor agonists **Amitraz**
Group 22 Voltage dependent sodium channel blockers
22A **Indoxacarb**, ***22B*** **Metaflumizone**
Group 28 Ryanodine receptor modulators
Diamides (e.g. **Flubendiamide, Chlorantraniliprole, Cyantraniliprole**)



Respiration targets

Group 12Inhibitors of mitochondrial ATP synthesis
12A **Difenthiuron,** ***12B*** Organotin miticides **(e.g. Cyhexatin), 12C Propargite, 12D Tetraifon**
Group 13 Uncouplers of oxidative phosphorylation via disruption of H proton gradient **Chlorfenapyr**
Group 20 Mitochondrial complex III electron transport inhibitors
20A **Hydramethylnon,** ***20B*** **Acequinocyl,**
20C **Fluacrypyrim**
Group 21 Mitochondrial complex I electron transport inhibitors
21A **METI acaricides (eg. Pyridaben, Tebufenpyrad)**
Group 23 Inhibitors of acetyl CoA carboxylase
Tetronic & Tetramic acid derivatives (e.g. Spirodiclofen)
Group 25 Mitochondrial complex II electron transport inhibitors **Cyenopyrafen, Cyflumetofen**

Midgut Targets

Group 11 Microbial disruptors of insect midgut membranes
11A Bacillus thuringiensis
11B Bacillus sphaericus

Unknown

UN Compounds of unknown or uncertain mode of action (**e.g. Azadiractin, Bifenazate, Pyridalyl , Pyrifluquinazon*****) ,**

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For further information visit the IRAC website: **www.irac-online.org**
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