

# Insecticide Mode of Action Classification:

A key to effective insecticide resistance management



Insecticide Resistance Action Committee

## Introduction

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. A selection of MoA groups is shown below.



#### IRAC website: www.irac-online.org

## Effective IRM strategies: Alternations or sequences of MoA

All effective insecticide (and acaricide) resistance management (IRM) strategies seek to minimise the selection for resistance from any one type of insecticide or acaricide. In practice, alternations, sequences or rotations of compounds from different MoA groups provide sustainable and effective IRM. This ensures that selection from compounds in the same MoA group is minimised. 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(s) of concern. Local expert advice should always be followed with regard to spray windows and timings. Several sprays of a compound 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, and where this is known to occur, the above advice must be modified accordingly.

## Moulting & Metamorphosis

Group 18 Ecdysone agonist / disruptor Diacylhydrazines (e.g. Tebufenozide) Group 7 Juvenile hormone mimics JH analogues, Fenoxycarb, Pyriproxyfen, etc

## Midgut

### Group 11 Microbial disruptors of insect midgut membranes

Toxins produced by the bacterium Bacillus thuringiensis (Bt): Bt sprays and Cry proteins expressed in transgenic Bt crop varieties (specific cross-resistance subgroups)



## Nervous System

Groups 1A & B Acetylcholinesterase (AChE) inhibitors Carbamates and Organophosphates Group 2 GABA-gated chloride channel antagonists Cyclodienes OCs and Phenylpyrazoles (Fiproles) Group 3 Sodium channel modulators DDT, pyrethroids, pyrethrins Group 4A Acetylcholine receptor (nAChR) agonists Neonicotinoids Group 5 nAChR agonists (Allosteric) [not group 4A] Spinosyns Group 6 Chloride channel activators Avermectins, Milbemycins Group 22 Voltage dependent sodium channel blocker Indoxacarb

## Non-specific MoA

Group 9 Compounds of nonspecific mode of action (selective feeding blockers) Pymetrozine, Flonicamid, etc.



## **Cuticle Synthesis**

Groups 15 and 16 Inhibitors of chitin biosynthesis Benzoylureas (Lepidoptera and others), Buprofezin (Homoptera)

## Metabolic Processes

Many groups acting on a wide range of metabolic processes including: *Group 12 Inhibitors of oxidative phosphorylation, disruptors of ATP* Diafenthiuron & Organotin miticides *Group 12 Uncouplers of oxidative phosphorylation via disruption of H proton gradient* - Chlorfenapyr



#### **Non-specific MoA** Group 10 Compounds of non-specific mode of action (mite growth inhibitors) Clofentezine, Hexythiazox, Etoxazole

### Metabolic processes

Group 20 Mitochondrial complex III electron transport inhibitors Acequinocyl, Fluacrypyrim, etc Group 21 Mitochondrial complex I electron transport inhibitors Rotenone, METI acaricides Group 23 Inhibitors of lipid synthesis Tetronic acid derivatives