

### Introduction

IRAC has developed a Mode of Action (MoA) classification for insecticides. It promotes the use of this as the basis for effective and sustainable insecticide resistance management (IRM). Thus, 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.

When resistance to an insecticide arises, not only does this resistance render the selecting compound ineffective but it also confers cross-resistance to other chemically related compounds. This is because compounds within a specific chemical group usually share a common MoA. It is common for resistance to develop that is based on a genetic modification of this target site. When this happens the interaction of the selecting compound with the target site is impaired and the compound loses its pesticidal efficacy. Because all compounds within the same chemical sub-group share a common MoA, there is a high risk that the resistance that has developed will automatically confer cross-resistance to all the compounds in the same sub-group.

By selecting sequences of insecticides from different MoA groups a sustainable IRM program can be developed. Effective IRM of this type can help to preserve the utility and diversity of insecticides for pest insect control. This poster details the mode of action of insecticides available for the control of whiteflies.

### Insecticides interfering with metamorphosis

Metamorphosis is controlled by hormones including juvenile hormone and disruption of this system is insecticidal

#### Group 7 Juvenile hormone mimics

Pyriproxyfen (7C) acts as a mimic of JH and when applied to juvenile stages disrupts and prevents metamorphosis

### Insecticides inhibiting metabolic processes

A number of metabolic processes are the target of whitefly insecticides:

#### Group 12A Inhibitors of oxidative phosphorylation, disruptors of ATP formation: Diafenthiuron

Diafenthiuron is a mitochondrial respiration inhibitor for whitefly control in some countries

#### Group 23 Inhibitors of lipid synthesis: Spiromesifen

In this new MoA group, the tetrionic acid derivative Spiromesifen inhibits lipid synthesis, leading to insect death.

### Effective IRM strategies: Alternations or sequences of MoA

All effective insecticide resistance management (IRM) strategies seek to minimise the selection for resistance from any one type of insecticide.

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.

Cross-resistance between MoA groups can arise through metabolic mechanisms and users should be aware of local issues in this regard. In the absence of such information alternations or sequences of MoA will always minimise selection pressures.

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 are not treated with compounds from the same MoA group.

### Insecticides acting on the nervous system

The nervous system is the target for many current insecticides, but within this system are many target sites. Insecticides with specific mode of action act at these targets:

#### Group 1 Acetylcholinesterase (AChE) inhibitors

Carbamates (1A) and Organophosphates (1B) act as inhibitors of AChE at nerve synapses. This results in hyperactivity in the nervous system

#### Group 2 GABA-gated chloride channel antagonists

Cyclodiene organochlorines (2A) bind to the GABA-gated chloride channel receptor complex and inhibit the action of GABA causing neuronal hyperactivity

#### Group 3 Sodium channel modulators

Sodium channels are involved in the propagation of action potential along nerves. Pyrethroids rapidly interfere with their action, causing hyperactivity and nerve block

#### Group 4 Acetylcholine receptor agonists

The neonicotinoids (4A) act as agonists of acetylcholine at the post-synaptic nicotinic Acetylcholine receptor (nAChR). This leads to overstimulation and hyperactivity

### Insecticides inhibiting cuticle synthesis (Type 1)

New cuticle is synthesised during the moult cycle and insecticides which interfere with this process disrupt the molt cycle leading to death of the insect

#### Group 16 Inhibitors of chitin biosynthesis (Homoptera): Buprofezin

This compound inhibits chitin synthesis in a number of insects including whiteflies

### Insecticides acting as feeding blockers

#### Group 9 Compounds of unknown action: Pymetrozine

Pymetrozine (9B) has a non-specific mode of action which appears to involve a selective inhibition of whitefly feeding. Insects die as a result of starvation

### Insecticide classes for whitefly control

IRAC lists 26 mode of action groups (42 including sub-groups); 10 of these are commonly used for whitefly control

| Group | Mode of Action   | Chemical sub-group or exemplifying active ingredient |
|-------|--|--|
| 1A    | Acetylcholinesterase inhibitors  | Carbamates   |
| 1B    |  | Organophosphates                                     |
| 2A    | GABA-gated chloride channel antagonists                                  | Cyclodiene organochlorines                           |
| 3     | Sodium channel modulators  | Pyrethroids  |
| 4A    | Nicotinic Acetylcholine receptor agonists                                | Neonicotinoids                                       |
| 7C    | Juvenile hormone mimics  | Pyriproxyfen   |
| 9B    | Compounds of unknown or non-specific action (selective feeding blockers) | Pymetrozine  |
| 12A   | Inhibitors of oxidative phosphorylation, disruptors of ATP formation     | Diafenthiuron  |
| 16    | Inhibitors of chitin biosynthesis, type 1, Homopteran                    | Buprofezin   |
| 23    | Inhibitors of lipid synthesis  | Tetrionic acid derivative: Spiromesifen              |