



Insecticide Resistance Action Committee: What does it do?

Joint RAC & RAG Open Forum
Combating Pesticide Resistance
BCPC International Congress
Crop Science & Technology 2005

Alan McCaffery



- IRAC formed in 1984 to provide a co-ordinated industry response to the development of resistance in insect and mite pests
- Currently 6 IRAC International members:

BASF	Bayer CropScience
Dow AgroSciences	DuPont
FMC	Syngenta
- Industry changes led to changing priorities
- IRAC Coordinator – Alan Porter



IRAC Mission:

- Facilitate communication and education on insecticide and acaricide resistance
- Promote the development of resistance management strategies in crop protection and vector control to maintain efficacy and support sustainable agriculture and improved public health

Role of IRAC

Actively promote and support IRAC Country groups

Help to identify the scope and nature of resistance problems

Provide methods for detecting and monitoring resistance

Interact effectively with and support IRAG groups

IRAC International

Provide key resources to aid in developing effective IRM

Interact with regulatory authorities responsible for insecticide registration

Devise sound, effective IRM programmes to prevent resistance or regain susceptibility

Disseminate information on resistance and its management

A comprehensive approach to tackling resistance

Teams within IRAC International tackle specific areas of IRAC's current work:

- Communication and Education team (Nigel Armes)
- Regulatory Team
- Neonicotinoid Team (Ralf Nauen)
- Codling Moth Team (Max Angst)
- Methods Team (Nigel Armes)
- Biotech Team (being formed) (Nick Storer)

Individual responsibilities within IRAC

- Vice-chairman and Treasurer (Ralf Nauen)
- IRAC Mode of Action Classification (Alan McC)
- MSU Database and *Resistant Pest Management Newsletter* (Gary Thompson)



- IRAC Country groups deal with key resistance issues at local level – supported by IRAC International
- IRAC Country groups often include additional companies not involved in IRAC International
- Country groups may include or involve others from Academia and Research Institutes
- Current IRAC Country groups:
 - IRAC Australia (AIRMG)
 - IRAC Brazil
 - IRAC India
 - IRAC South Africa
 - IRAC Spain
 - IRAC US
 - IRAC China (proposed)
- Country projects – e.g. BPH in India



Communication and Education is vital ! A key role of IRAC





IRAC Resistance Management for Sustainable Agriculture & improved Public Health

Home | Diary | FAQ | Links | Contact | Site Map

Insecticide Resistance Action Committee

Search: Go

About IRAC | **Resources** | **IRAC International** | **Country Groups** | **Growers**

Resistance Management from IRAC

The Insecticide Resistance Action Committee (IRAC) is an inter company group formed in 1984 to provide insecticide and acaricide resistance management strategies to help reduce the development of resistance in insect and mite pests. IRAC believes that Resistance Management should be an integral part of Integrated Pest Management and provides for Sustainable Agriculture and improved Public Health.

We would encourage you to further explore the site using the drop-down menus at the top of the page or via the other links. Further background on IRAC, its Constitution and Mission along with the IRAC newsletter eConnection can be located under the About IRAC heading. The majority of the IRAC documents can be located under Resources. This includes Mode of Action Classification, Test Methods, Resistance Management Guidelines, Posters and Publications along with other Educational and Regulatory Material. The headings, IRAC International and IRAC Country Groups, provide information on these different Teams some of which is only available to Team Members. The final drop-down menu provides Grower information in the form of links to Publications, Associations and Magazines. We hope you find the site a useful resource.

Links to New Resistance Management Information

- General Principles of Insecticide RM from IRAC
- IRAC Test Methods - Overview and Summary
- IRAC Paper and Poster on MOA at ICE Meeting Brisbane, August 2004
- Neonicotinoid IRM Guidelines, September 2004
- New IRAC Logo and Branding material - September 2004
- BWSN Meeting, Croatia 5-9th October 2004 - Whitefly MOA Poster
- IRAC eConnection - Issues 5, December 2004
- IRAC Intl. Conference Call - Action Log, January 2005 (Members only)
- Website Traffic and Activity Report March 2005
- Latest IRAC eConnection - Issues 6, April 2005
- IRAC US Meeting Minutes, April 2005 (Members only)
- IRAC Intl. Spring Meeting Minutes, Florence, April 2005 (Members only)
- Work on resistance in Italy on Codling Moth and the new Italian group GIRIF
- JUST RELEASED - New IRAC MoA Classification Scheme (ver 4.2, May 2005)
- IRAC Website - Update and Review, May 2005

quicklinks

- MOA Scheme 05
- New Group Guide
- EPPC Guidelines
- IRAC Methods
- IRAC Posters
- IRAC Website
- FRAC Website
- MSU Database
- RAG Website
- PM Newsletter

upcoming events

- IRAC Conf Calls
- IRAC C & E Team
- IRAC CM Team
- IRAC US Meeting
- IRAC Intl. Meetings
- IRAC ZA Meeting
- ESA Meeting
- BCPC, Glasgow

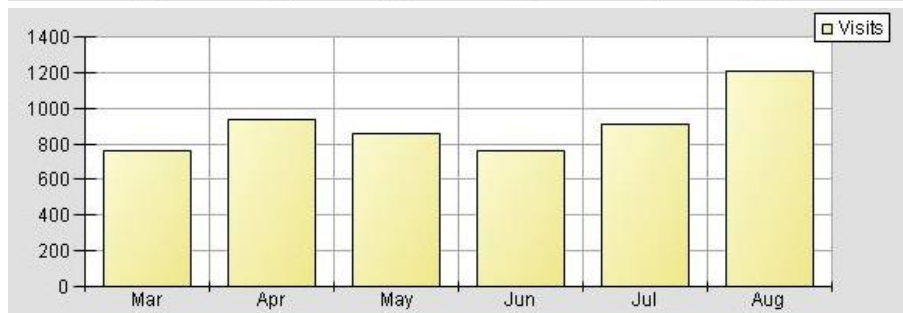
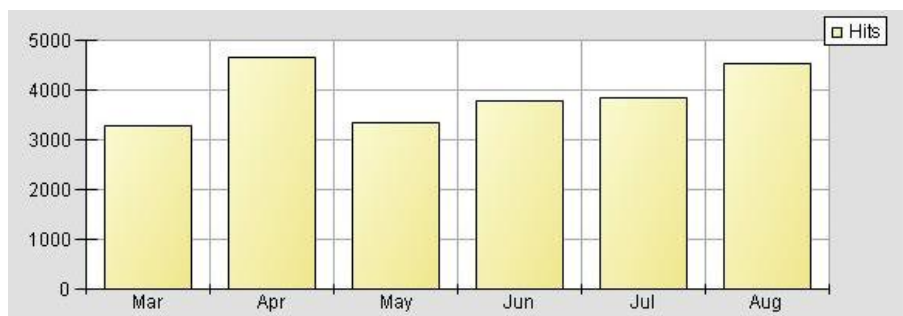
CropLife INTERNATIONAL

© 2003 intraspin.com

- IRAC's key communication vehicle
- Designed and managed by Alan Porter
- 190 pages including public, protected & utility pages
- 160 docs. & 92 image files
- Information on IRAC, Mode of Action, advice on IRM
- Education modules
- Resources incl. key papers, documents, posters
- Links for growers
- IRAC Country group information

Accessed by over 80 countries

- Averages 150 hits, 30 visits / day**



Top Docs

Rank	Page Name	% Visits
1	/documents/moa/moa.doc	31.7
2	/documents/moa/icepaper2004.doc	25.0
3	/documents/info/rmarticle2.pdf	8.6
4	/documents/info/rmarticle2.doc	8.4
5	/documents/posters/moaposter.pdf	7.5

- No 1 in Google & Yahoo for Key Terms**

Top SE

Rank	Engine	% Visits
1	Google	70.5
2	Yahoo!	15.9
3	Microsoft Network	6.7
4	AOL NetFind	2.2
5	Netscape	1.6

Top Search Terms

Rank	Phrases	% Visits
1	irac	52.3
2	insecticide resistance	16.3
3	insecticide	8.0
4	insecticide mode of action	5.8
5	thiamethoxam	4.3



Issue 8
September, 2005
[Subscribe](#) | [Unsubscribe](#)

- News Categories this Issue:**
- eConnection and Website update
 - IRAC News
 - Conferences and Symposia

eConnection Update

■ **Issue 8 of eConnection**
Welcome to the latest eConnection, a free newsletter prepared in conjunction with the IRAC website. In this issue we report on the response from the IRAC International Regulatory Team to a recent ECPA release outlining the impact of reduced numbers of products for the treatment of minor crops. Also included is an article on the control of the brown plant hopper with neonicotinoids describing initiatives such as those being taken by IRAC India to monitor the resistance status. Finally there is a brief report on the recent IRAC International Meeting at CropLife International in Brussels and advance notice of an IRAC Symposium in the US on Neonicotinoid Sustainability. We hope you find the information interesting.

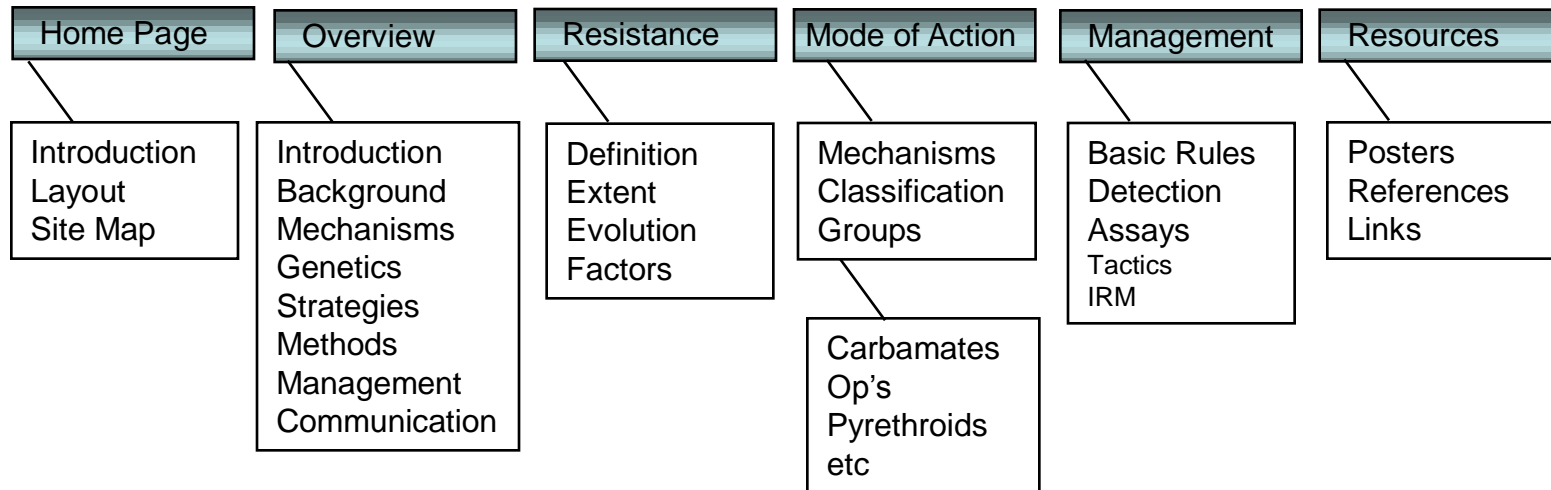
Past issues of eConnection and further details of the items reported can be found on the IRAC website. [More »](#)

eConnection #8 September 2005	
Welcome	Website Update
Spread the Word	MoA New Version
Comment on ECPA Release	BPH India
IRAC Meeting, Brussels	Diary

- Free IRAC Newsletter
- Distributed by e-mail
- ~4 issues a year
- Distribution list 500+ and growing
- Raises awareness of IRM
- Raises awareness of country groups & topical resistance issues
- Improves profile of IRAC
- Positive effects on website traffic



- New IRAC resource still under development
- Education and Training modules on resistance & IRM
- Graphic provides a diagrammatic representation of layout and content
- Currently education material is available on the website under the “Resources” section





Insecticide Resistance Action Committee
www.irc-online.org

IRAC Mode of Action Classification

Fully revised & re-issued, September 2005

Version: 5.1

The IRAC Mode of Action (MoA) classification provides farmers, growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of insecticides or acaricides for use in an effective and sustainable insecticide or acaricide resistance management (IRM) strategy. In addition to presenting the MoA classification, this document outlines the background to, and purposes of, the classification list and provides guidance on how it is used for IRM purposes. The list is reviewed and re-issued at intervals as required.

What is resistance

Resistance to insecticides may be defined as '*a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species*' (IRAC). This definition differs slightly from others in the literature, but IRAC believes it represents the most accurate, practical definition of relevance to farmers and growers. Resistance arises through the over-use or mis-use of an insecticide or acaricide against a pest species and results in the selection of resistant forms of the pest and the consequent evolution of populations that are resistant to that insecticide or acaricide.

MoA, Target-site resistance and Cross-resistance

In the majority of cases, not only does resistance render the selecting compound ineffective but it often also confers cross-resistance to other chemically related compounds. This is

- Definitive scheme developed and endorsed by IRAC in consultation with key researchers
- Worldwide distribution
- All current insecticides allocated to a Mode of Action group or sub-group
 - MoA groups 1-28
- A key tool for selection of insecticides in effective IRM programs
- Updated as required
- Latest version Sept 2005

IRAC Mode of Action Classification Version: 5.1

IRAC Mode of Action Classification v5, September 2005¹

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
1 Acetylcholine esterase inhibitors	1A Carbamates	Aldicarb, Alanycarb, Bendiocarb, Benfuracarb, Butocarboxim, Butoxycarboxim, Carbaryl, Carbofuran, Carbosulfan, Ethiofencarb, Fenobucarb, Formetanate, Furathiocarb, Isoprocarb, Methiocarb, Methomyl, Metolcarb, Oxamyl, Pirimicarb, Propoxur, Thiodicarb, Thiofanox, Trimethacarb, XMC, Xylcarb
	Triazemate	Triazemate
	1B Organophosphates	Acephate, Acamethiphos, Acinphos-ethyl, Acinphos-methyl, Cadusafos, Chloranoxlyfos, Chlorfenvinphos, Chlormephos, Chlorpyrifos, Chlorpyrifos-methyl, Coumaphos, Cyanophos, Demeton-S-methyl, Diazinon, Dichlorvos/ DDVP, Dicrotophos, Dimethoate, Dimethylvinphos, Disulfoton, EPN, Ethion, Ethoprophos, Famphur, Fenamiphos, Fenitrothion, Ferthion, Fosthiazate, Heptenophos, Isofenphos, Isopropyl O-methoxyaminothio-phosphoryl salicylate, Isoxathion, Malathion, Mecarbam, Methamidophos, Methidathion, Mevinphos, Monoerotophos, Naled, Omethoate, Oxydemeton-methyl, Parathion, Parathion-methyl, Phenthoate, Phorate, Phosalone, Phosmet, Phosphamidon, Phoxim, Pirimiphos-ethyl, Profenofos, Propetamphos, Prothiofos, Pyraclofos, Pyridaphenthion, Quinalphos, Sulfotep, Tebupirifos, Temephos, Terbufos, Tetrachlorvinphos, Thiometon, Triazophos, Trichlorfon, Vamidathion
2 GABA-gated chloride channel antagonists	2A Cyclodiene organochlorines	Chlordane, Endosulfan, gamma-HCH (Lindane)
	2B Phenylpyrazoles (Fiproles)	Ethiprole, Fipronil
3 Sodium channel modulators	DDT	DDT
	Methoxychlor	Methoxychlor
	Pyrethroids	Acinathrin, Allethrin, d-cis-trans Allethrin, d-trans Allethrin,

Example pages

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
4 Nicotinic Acetylcholine receptor agonists / agonists	4A Neonicotinoids	Acetamiprid, Clothianidin, Dinotefuran, Imidacloprid, Nitenpyram, Thiacloprid, Thiamethoxam
	4B Nicotine	Nicotine
	4C Bensultap	Bensultap
5 Nicotinic Acetylcholine receptor agonists / agonists (not group 4)	Cartap hydrochloride	Cartap hydrochloride
	Nereistoxin analogues	Thiocyclam, Thiosultap-sodium
6 GABA-gated chloride channel antagonists	Spinosyns	Spinosad
7 GABA-gated chloride channel antagonists	Avemectins, Milbemycins	Abamectin, Enamectin benzoate, Milbemectin
8 Juvenile hormone mimics	7A Juvenile hormone analogues	Hydroprene, Kinoprene, Methoprene
	7B Fenoxycarb	Fenoxycarb
	7C Pyriproxyfen	Pyriproxyfen
9 Compounds of unknown or non-specific mode of action (fumigants)	8A Alkyl halides	Methyl bromide and other alkyl halides
	8B Chloropicrin	Chloropicrin



Insecticide Mode of Action Classification:

A Key to Effective Insecticide Resistance Management in Whiteflies

Introduction

IRAC has developed a Mode of Action (MoA) classification for insecticides. Insecticides that share the same MoA are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure. Insecticides that share the same MoA are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure. Insecticides that share the same MoA are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure.

Insecticides acting on the nervous system

The nervous system is the target for many current insecticides. Insecticides that act on the nervous system are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure. Insecticides that share the same MoA are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure.

Insecticides interfering with metamorphosis

Metamorphosis is controlled by hormones including juvenile hormone and diapausing hormone. Insecticides that interfere with these hormones are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure.

Insecticides inhibiting metabolic processes

A number of metabolic processes are the target of whitefly insecticides. Insecticides that inhibit these processes are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure.

Effective IRM strategies: Alternations or sequences of MoA

Effective IRM strategies involve the use of insecticides with different MoAs. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure. Insecticides that share the same MoA are classified as belonging to the same MoA group. This MoA classification is based on the mode of action of the insecticide, not on its chemical structure.

Insecticide classes for which IRAC lists 20 mode of action groups

Group	Mode of Action	Target
1	Acetylcholinesterase inhibitors	Neurotransmission
2	GABA-gated chloride channel antagonists	Neurotransmission
3	Sodium channel modulators	Neurotransmission
4	Fast sodium channel activators	Neurotransmission
5	Fast sodium channel activators	Neurotransmission
6	Fast sodium channel activators	Neurotransmission
7	Fast sodium channel activators	Neurotransmission
8	Fast sodium channel activators	Neurotransmission
9	Fast sodium channel activators	Neurotransmission
10	Fast sodium channel activators	Neurotransmission
11	Fast sodium channel activators	Neurotransmission
12	Fast sodium channel activators	Neurotransmission
13	Fast sodium channel activators	Neurotransmission
14	Fast sodium channel activators	Neurotransmission
15	Fast sodium channel activators	Neurotransmission
16	Fast sodium channel activators	Neurotransmission
17	Fast sodium channel activators	Neurotransmission
18	Fast sodium channel activators	Neurotransmission
19	Fast sodium channel activators	Neurotransmission
20	Fast sodium channel activators	Neurotransmission



Insecticide Mode of Action Classification: A key to effective insecticide resistance management

Insecticide Resistance Action Committee

IRAC website: www.irc-online.org



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.



Effective IRM strategies: Alternations or sequences of MoA

All effective insecticide (and acaricide) resistance management (IRM) strategies seek to minimize 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 minimized. 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. Metabolic resistance mechanisms may give cross-resistance between MoA groups, and where this is known to occur, the above advice must be modified accordingly.

Moulting & Metamorphosis

Group 16: Ecdysone agonists/disruptors
Group 17: Juvenile hormone analogues
Group 18: Juvenile hormone agonists
Group 19: Juvenile hormone antagonists
Group 20: Juvenile hormone agonists

Midgut

Group 11: Microtubule disruptors of insect midgut
Group 12: Microtubule disruptors of insect midgut
Group 13: Microtubule disruptors of insect midgut
Group 14: Microtubule disruptors of insect midgut
Group 15: Microtubule disruptors of insect midgut

Nervous System

Group 1: Acetylcholinesterase inhibitors
Group 2: GABA-gated chloride channel antagonists
Group 3: Sodium channel modulators
Group 4: Fast sodium channel activators
Group 5: Fast sodium channel activators
Group 6: Fast sodium channel activators
Group 7: Fast sodium channel activators
Group 8: Fast sodium channel activators
Group 9: Fast sodium channel activators
Group 10: Fast sodium channel activators
Group 11: Fast sodium channel activators
Group 12: Fast sodium channel activators
Group 13: Fast sodium channel activators
Group 14: Fast sodium channel activators
Group 15: Fast sodium channel activators
Group 16: Fast sodium channel activators
Group 17: Fast sodium channel activators
Group 18: Fast sodium channel activators
Group 19: Fast sodium channel activators
Group 20: Fast sodium channel activators

Non-specific MoA

Group 9: Compounds of non-specific mode of action
Group 10: Compounds of non-specific mode of action
Group 11: Compounds of non-specific mode of action
Group 12: Compounds of non-specific mode of action
Group 13: Compounds of non-specific mode of action
Group 14: Compounds of non-specific mode of action
Group 15: Compounds of non-specific mode of action
Group 16: Compounds of non-specific mode of action
Group 17: Compounds of non-specific mode of action
Group 18: Compounds of non-specific mode of action
Group 19: Compounds of non-specific mode of action
Group 20: Compounds of non-specific mode of action

Cuticle Synthesis

Group 15 and 18: Inhibitors of chitin biosynthesis
Group 19: Inhibitors of chitin biosynthesis
Group 20: Inhibitors of chitin biosynthesis

Metabolic Processes

Group 12: Inhibitors of oxidative phosphorylation
Group 13: Inhibitors of oxidative phosphorylation
Group 14: Inhibitors of oxidative phosphorylation
Group 15: Inhibitors of oxidative phosphorylation
Group 16: Inhibitors of oxidative phosphorylation
Group 17: Inhibitors of oxidative phosphorylation
Group 18: Inhibitors of oxidative phosphorylation
Group 19: Inhibitors of oxidative phosphorylation
Group 20: Inhibitors of oxidative phosphorylation


Non-specific MoA

Group 10: Compounds of non-specific mode of action
Group 11: Compounds of non-specific mode of action
Group 12: Compounds of non-specific mode of action
Group 13: Compounds of non-specific mode of action
Group 14: Compounds of non-specific mode of action
Group 15: Compounds of non-specific mode of action
Group 16: Compounds of non-specific mode of action
Group 17: Compounds of non-specific mode of action
Group 18: Compounds of non-specific mode of action
Group 19: Compounds of non-specific mode of action
Group 20: Compounds of non-specific mode of action

Metabolic processes

Group 21: Mitochondrial complex III electron transport inhibitors
Group 22: Mitochondrial complex III electron transport inhibitors
Group 23: Mitochondrial complex III electron transport inhibitors
Group 24: Mitochondrial complex III electron transport inhibitors
Group 25: Mitochondrial complex III electron transport inhibitors
Group 26: Mitochondrial complex III electron transport inhibitors
Group 27: Mitochondrial complex III electron transport inhibitors
Group 28: Mitochondrial complex III electron transport inhibitors
Group 29: Mitochondrial complex III electron transport inhibitors
Group 30: Mitochondrial complex III electron transport inhibitors





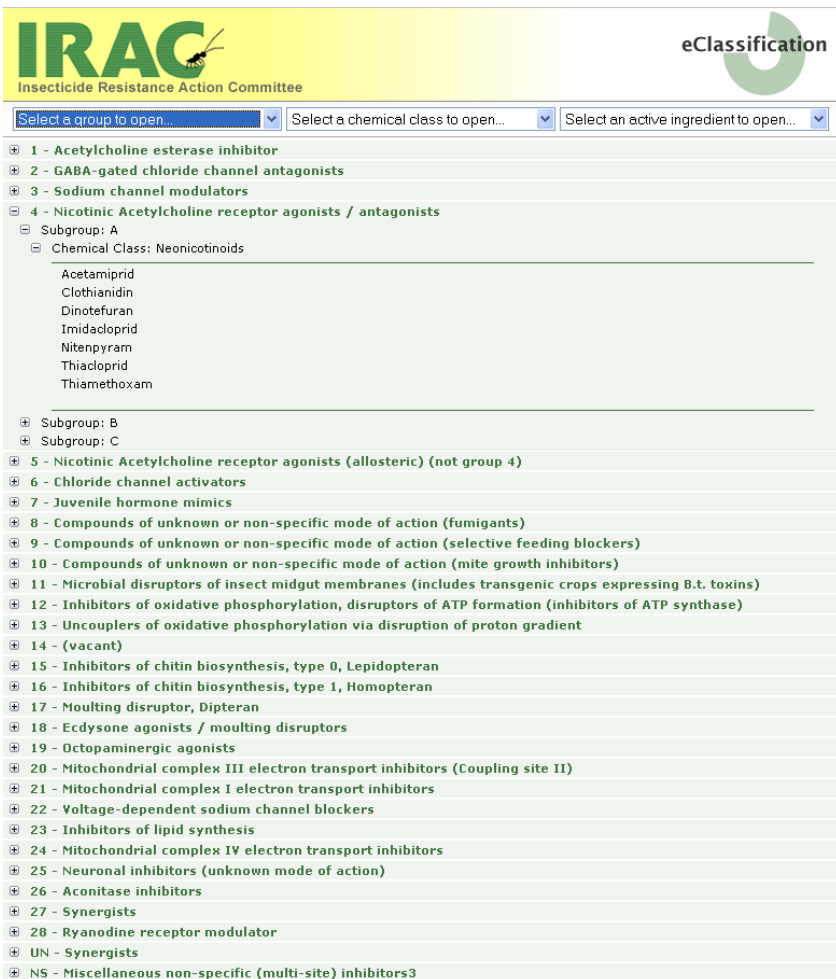
IRAC
Mode of Action Classification
The key to Insecticide Resistance Management

<p>Group 1: Acetylcholine esterase inhibitors*</p> <p>1A: Carbamates</p> <p>1B: Organophosphates</p>	<p>Group 2: Unknown or non specific – fumigants</p> <p>2A</p> <p>2B</p> <p>2C</p>	<p>Group 16: Inhibitors of chitin biosynthesis, type 1, <i>Hydroxamate</i></p> <p>16A</p>	<p>Group 17: Moulting disruptor, <i>Oothecins</i></p> <p>17A</p>	
<p>Group 2: GABA-gated chloride channel antagonists</p> <p>2A: Cyclopyrimetholates</p> <p>2B: Phthalic (or Phthalate) esters</p>	<p>Group 3: Unknown or Non specific – selective feeding blockers</p> <p>3A</p> <p>3B</p> <p>3C</p>	<p>Group 18: Ecdysone agonists Moulting disruptors</p> <p>18A: Diacylglycerols</p> <p>18B</p>	<p>Group 19: Octadecanoyl acyl CoA synthase</p> <p>19A</p>	<p>Group 20: Coupling site II electron transport inhibitors (Complex III)</p> <p>20A</p> <p>20B</p> <p>20C</p>
<p>Group 3: Sodium channel modulators*</p> <p>3A: Pyrethroids</p>	<p>Group 10: Unknown or Non specific – Mitochondrial inhibitors</p> <p>10A</p> <p>10B</p>	<p>Group 21: Coupling site I electron transport inhibitors</p> <p>METHYLCHLOR & Rotenone</p>	<p>Group 22: Voltage dependent Sodium Channel blockers</p> <p>22A</p>	<p>Group 23: Inhibitors of lipid synthesis</p> <p>Tetronic acid derivatives</p>
<p>Group 4: Nicotinic acetylcholine receptor agonists/antagonists</p> <p>4A: Neonicotinoids</p> <p>4B</p> <p>4C: Receptor & channel</p>	<p>Group 11: Microbial disruptors of insect mid-gut membranes – Includes transgenic crop expressing Bt toxin, <i>Bt, Vap, Clostridia</i></p> <p>11A1</p> <p>11A2</p> <p>11B1</p> <p>11B2</p> <p>11C</p>	<p>Group 24: Mitochondrial complex IV electron transport inhibitors</p> <p>24A</p> <p>24B</p> <p>24C</p>	<p>Group 25: Neuronal inhibitors (unknown mode of action)</p> <p>25A</p>	
<p>Group 5: Nicotinic Acetylcholine Receptor Agonists (not 4)</p> <p>5A</p>	<p>Group 12: Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitor of ATP synthase)</p> <p>12A</p> <p>12B</p> <p>12C</p>	<p>Group 26: Acetylcholine inhibitors</p> <p>26A</p>	<p>Group 27: S-mergits</p> <p>27A: Esterase inhibitors</p> <p>27B: P450 mono-oxygenase inhibitors</p>	<p>Group 28: Serotonin receptor modulators</p> <p>28A</p>
<p>Group 6: Chloride Channel activators</p> <p>6A</p>	<p>Group 13: Uncouplers of oxidative phosphorylation via disruption of H proton gradient</p> <p>13A</p>	<p>Group 14: Unallocated</p> <p>14A</p>	<p>Group UN: Compounds with unknown mode of action</p> <p>UNA</p> <p>UNB</p> <p>UNC</p> <p>UND</p>	<p>Group NS: Miscellaneous non specific (multi-site) inhibitors</p> <p>NSA</p> <p>NSB</p>
<p>Group 7: Juvenile hormone mimics</p> <p>7A: Analogs</p> <p>7B: Estrogens</p> <p>7C: Pyriproxyfen</p>	<p>Group 15: Inhibitors of chitin biosynthesis, type II, <i>Lipidopolymers</i></p> <p>15A</p> <p>15B</p> <p>15C</p> <p>15D</p> <p>15E</p> <p>15F</p> <p>15G</p> <p>15H</p> <p>15I</p> <p>15J</p> <p>15K</p> <p>15L</p> <p>15M</p> <p>15N</p> <p>15O</p> <p>15P</p> <p>15Q</p> <p>15R</p> <p>15S</p> <p>15T</p> <p>15U</p> <p>15V</p> <p>15W</p> <p>15X</p> <p>15Y</p> <p>15Z</p>	<p>Group 15: Inhibitors of chitin biosynthesis, type II, <i>Lipidopolymers</i></p> <p>15A</p> <p>15B</p> <p>15C</p> <p>15D</p> <p>15E</p> <p>15F</p> <p>15G</p> <p>15H</p> <p>15I</p> <p>15J</p> <p>15K</p> <p>15L</p> <p>15M</p> <p>15N</p> <p>15O</p> <p>15P</p> <p>15Q</p> <p>15R</p> <p>15S</p> <p>15T</p> <p>15U</p> <p>15V</p> <p>15W</p> <p>15X</p> <p>15Y</p> <p>15Z</p>	<p>Group 15: Inhibitors of chitin biosynthesis, type II, <i>Lipidopolymers</i></p> <p>15A</p> <p>15B</p> <p>15C</p> <p>15D</p> <p>15E</p> <p>15F</p> <p>15G</p> <p>15H</p> <p>15I</p> <p>15J</p> <p>15K</p> <p>15L</p> <p>15M</p> <p>15N</p> <p>15O</p> <p>15P</p> <p>15Q</p> <p>15R</p> <p>15S</p> <p>15T</p> <p>15U</p> <p>15V</p> <p>15W</p> <p>15X</p> <p>15Y</p> <p>15Z</p>	

* Only major representatives of the groups are shown
 More information on the Insecticide Resistance Action Committee and the Mode of Action Classification is available from www.irac-online.org or from Alan Porter e-mail: aporter@intra.spin.com
 Structures are reproduced from the Pesticide Manual with permission from the British Crop Protection Council

IRAC Mode of Action Classification Groups and Structures
A1 printed versions available soon!

New MoA interactive online tool

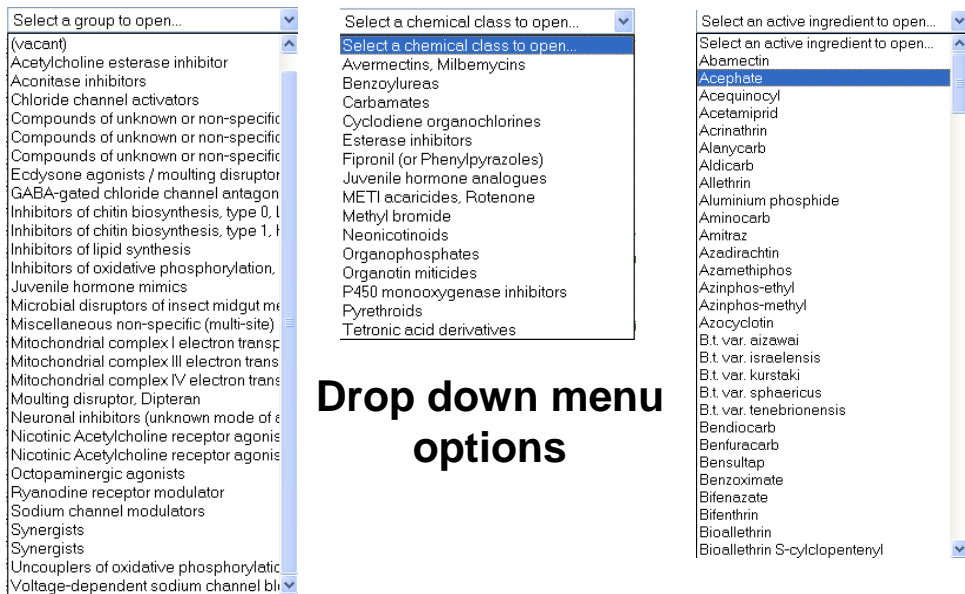


IRAC Insecticide Resistance Action Committee

eClassification

Select a group to open... Select a chemical class to open... Select an active ingredient to open...

- 1 - Acetylcholine esterase inhibitor
- 2 - GABA-gated chloride channel antagonists
- 3 - Sodium channel modulators
- 4 - Nicotinic Acetylcholine receptor agonists / antagonists
 - Subgroup: A
 - Chemical Class: Neonicotinoids
 - Acetamiprid
 - Clothianidin
 - Dinotefuran
 - Imidacloprid
 - Nitenpyram
 - Thiacloprid
 - Thiamethoxam
 - Subgroup: B
 - Subgroup: C
- 5 - Nicotinic Acetylcholine receptor agonists (allosteric) (not group 4)
- 6 - Chloride channel activators
- 7 - Juvenile hormone mimics
- 8 - Compounds of unknown or non-specific mode of action (fumigants)
- 9 - Compounds of unknown or non-specific mode of action (selective feeding blockers)
- 10 - Compounds of unknown or non-specific mode of action (mite growth inhibitors)
- 11 - Microbial disruptors of insect midgut membranes (includes transgenic crops expressing B.t. toxins)
- 12 - Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)
- 13 - Uncouplers of oxidative phosphorylation via disruption of proton gradient
- 14 - (vacant)
- 15 - Inhibitors of chitin biosynthesis, type 0, Lepidopteran
- 16 - Inhibitors of chitin biosynthesis, type 1, Homopteran
- 17 - Moulting disruptor, Dipteran
- 18 - Ecdysone agonists / moulting disruptors
- 19 - Octopaminergic agonists
- 20 - Mitochondrial complex III electron transport inhibitors (Coupling site II)
- 21 - Mitochondrial complex I electron transport inhibitors
- 22 - Voltage-dependent sodium channel blockers
- 23 - Inhibitors of lipid synthesis
- 24 - Mitochondrial complex IV electron transport inhibitors
- 25 - Neuronal inhibitors (unknown mode of action)
- 26 - Aconitase inhibitors
- 27 - Synergists
- 28 - Ryanodine receptor modulator
- UN - Synergists
- NS - Miscellaneous non-specific (multi-site) inhibitors3



Select a group to open...
 (vacant)
 Acetylcholine esterase inhibitor
 Aconitase inhibitors
 Chloride channel activators
 Compounds of unknown or non-specific mode of action (fumigants)
 Compounds of unknown or non-specific mode of action (selective feeding blockers)
 Compounds of unknown or non-specific mode of action (mite growth inhibitors)
 Ecdysone agonists / moulting disruptors
 GABA-gated chloride channel antagonists
 Inhibitors of chitin biosynthesis, type 0, Lepidopteran
 Inhibitors of chitin biosynthesis, type 1, Homopteran
 Inhibitors of lipid synthesis
 Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)
 Juvenile hormone mimics
 Microbial disruptors of insect midgut membranes (includes transgenic crops expressing B.t. toxins)
 Miscellaneous non-specific (multi-site) inhibitors3
 Mitochondrial complex I electron transport inhibitors
 Mitochondrial complex III electron transport inhibitors
 Mitochondrial complex IV electron transport inhibitors
 Moulting disruptor, Dipteran
 Neuronal inhibitors (unknown mode of action)
 Nicotinic Acetylcholine receptor agonists / antagonists
 Nicotinic Acetylcholine receptor agonists (allosteric) (not group 4)
 Octopaminergic agonists
 Ryanodine receptor modulator
 Sodium channel modulators
 Synergists
 Synergists
 Uncouplers of oxidative phosphorylation via disruption of proton gradient
 Voltage-dependent sodium channel blockers

Select a chemical class to open...
 Avermectins, Milbemycins
 Benzoylureas
 Carbamates
 Cyclodiene organochlorines
 Esterase inhibitors
 Fipronil (or Phenylpyrazoles)
 Juvenile hormone analogues
 METI acaricides, Rotenone
 Methyl bromide
 Neonicotinoids
 Organophosphates
 Organotin miticides
 P450 monooxygenase inhibitors
 Pyrethroids
 Tetrionic acid derivatives

Select an active ingredient to open...
 Select an active ingredient to open...
 Abamectin
 Acephate
 Acequinocyl
 Acetamiprid
 Acrinathrin
 Alaryncarb
 Aldicarb
 Allethrin
 Aluminium phosphide
 Aminocarb
 Amitraz
 Azadirachtin
 Azamethiphos
 Azinphos-methyl
 Azinphos-methyl
 Azocyclotin
 B.t. var. aizawai
 B.t. var. israelensis
 B.t. var. kurstaki
 B.t. var. sphaericus
 B.t. var. tenebrionensis
 Bendiocarb
 Benfuracarb
 Bensultap
 Benzoximate
 Bifenazate
 Bifenthrin
 Bioallethrin
 Bioallethrin S-cyclopenteryol

Drop down menu options

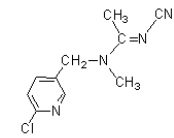


IRAC Insecticide Resistance Action Committee

eClassification

[Back to Group Index](#)

Cas No	135410-20-7
Common Name	Acetamiprid
Chemical Class	Neonicotinoids
Primary Site of Action	Nicotinic Acetylcholine receptor agonists / antagonists
MOA Group Number	4A
Relevant Pests	Control of Hemiptera, especially aphids, Thysanoptera and Lepidoptera
Relevant Crops	Wide range of crops, especially vegetables, fruit and tea
Use Patterns	Soil or foliar
Comments	





Insecticide Resistance Action Committee

www.ircac-online.org

Resistance Management for Sustainable Agriculture and Improved Public Health

IRAC Susceptibility Test Methods Series

Method No: 3

Version: 2

Details:

Method:	No: 3	
Status:	Approved	
Species:	Panonychus ulmi Tetranychus spp	
Species Stage:	P. ulmi (summer eggs) Tetranychus (egg)	
Product Class:	clofentazine hexythiazox tetrarfon	
Comments:	None	

Photograph Courtesy of
Witney Cepeda, Colorado State University
~~Tetranychus spp~~

Description:

Materials:

Petri dishes (9-cm diameter), filter paper to fit Petri dishes, cotton wool, ~~untreated~~ apple or plum leaves, small scissors, small forceps, fine pointed brush or cocktail stick, beakers or glass jars (ca. 100-ml capacity) for test liquids, 1-ml disposable plastic syringes for liquids for weighing balance for solids, hand lens (minimum 10 x) or binocular microscope, maximum/minimum thermometer.

Methods:

- Cut square sections about 1.5 x 1.5 cm from chemically untreated apple or plum leaves. Use young leaves, but not before they are fully expanded. Leaves must be in good condition. Use a minimum of four replicates (leaf sections) per treatment.
- Place these sections, upper surface uppermost, on a sheet of moist filter paper on moist cotton wool in open Petri dishes.
- Collect apple leaves with adult mites, and with the fine pointed brush or cocktail stick transfer 10 – 15 females onto each leaf section. Maintain at a minimum temperature of 20°C, minimum photoperiod 16 h and a high light intensity, but not in direct sunlight.
- After 24 h, check that the female mites have laid eggs. Aim for at least 20 eggs per leaf section. If there are not enough eggs, leave for a further 24 h. Do not leave longer than 48 h.
- When sufficient egg numbers have been obtained, remove the mites with the fine pointed brush or cocktail stick. Record the time when this is done.
- Prepare appropriate test dilutions of formulations in water. The use of a wetter is not

For further information please contact: Alan Porter, IRAC International Coordinator
www.ircac-online.org, email: aporter@ircac-pln.com

IRAC Susceptibility Test Methods Series

Version: 2

Method No: 3

- recommended.
- Agitate test liquids and then dip the leaf sections for 5 s. Dip equal number of control leaf sections in water only.
 - Record the number of eggs per leaf section.
 - Return leaf sections to Petri dishes and maintain in conditions described above. Record maximum and minimum temperatures. Moisten cotton wool daily.
 - Using a hand lens or binocular microscope observe leaf sections daily until there has been complete (or nearly complete) hatch on the untreated (water only) leaf sections. Record numbers of un-hatched eggs on treated and untreated leaf sections.
 - Express results as percentage mortality and correct for untreated mortality using Abbott's formula. Untreated mortality should be recorded.

Precautions & Notes:

If the lids are left off, the leaf sections may dry out and, unless the cotton wool can be moistened at least daily, the test may be invalidated by excessive control mortality. In such circumstances, the method may have to be modified to suit the local conditions, e.g. use lids with holes cut in them to reduce water loss without creating a condensation problem.

For ~~Tetranychus spp.~~ which live mainly on the lower leaf surface, the leaf sections may need to be placed lower surface uppermost. Leaves of kidney beans are particularly suitable.

References & Acknowledgements:

None

New methods will include biochemical and molecular methods – additions for validated methods welcome

To finish

- IRAC has a key focus on Communication and Education – a major effort in recent years
- The completely updated and redesigned IRAC website is central to this effort – resources, education, advice
- IRAC is supporting the Country group network with appropriate resources to tackle local resistance problems
- IRAC is working with regulatory bodies to represent and champion effective IRM
- IRAC has key projects to support worldwide IRM for major MoA groups like Neonicotinoids
- IRAC will become more involved in IRM in insect-control transgenic crops

