Insecticide Resistance Action Committee

IRAC SPWG Spring Meeting

Session 4b Thursday 21st March

Chairman, Stephen Skillman





Agenda

9.30 – 10.30

Review of SPWG achievements in 2012

Emerging sucking pest resistance problems, reports, publications

10.30-10.45 Coffee break

10.45-12.30

Objectives 2013 and accents for IRM in 2014

IRAC website documentation and updating

SPWG Team membership 2012

Current SPWG team	Company		Departing members	Company
Alan Porter	IRAC			
Alejandro Arevalo	BASF			
Dan Vincent	DuPont			
Eric Andersen	Cheminova			
James Thomas	Dow			
Jean-Paul Genay	Nufarm			
Luis Gomez	Dow			
Michael Klueken	Bayer CS	replacing	**Matthias Haas**	**Bayer CS**
Ralf Nauen	Bayer CS			
Russell Slater	Syngenta			
Steve Skillman	**Syngenta**			
Tamar Danon	MAI	replacing	**Jonathan Henen**	**MAI**
Tatjana Sikuljak	BASF			
			Shuvash Bhattarai	Chemtura

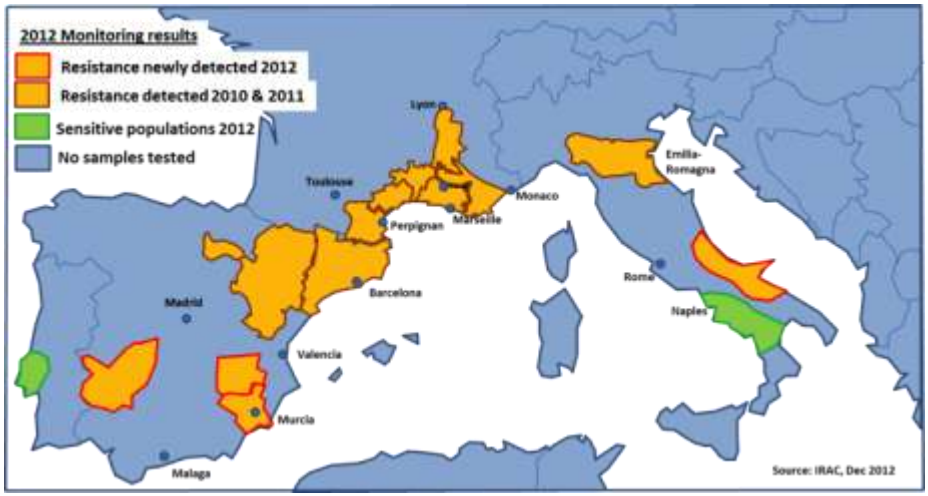
- Welcome to Alejandro, Michael and Tamar!
- Thanks to Jonathan, Matthias and Shuvash
- Team questions/discussion:
  - MOA coverage for sucking pests?
    - Groups 7C, 9C, 21: ISK/FMC/BELCHIM/NIHON NOHAYAKU/SUMITOMO?
  - Independent advisor/observer on team?
  - Vice chairman?

IRAC

Objectives and achievements 2012

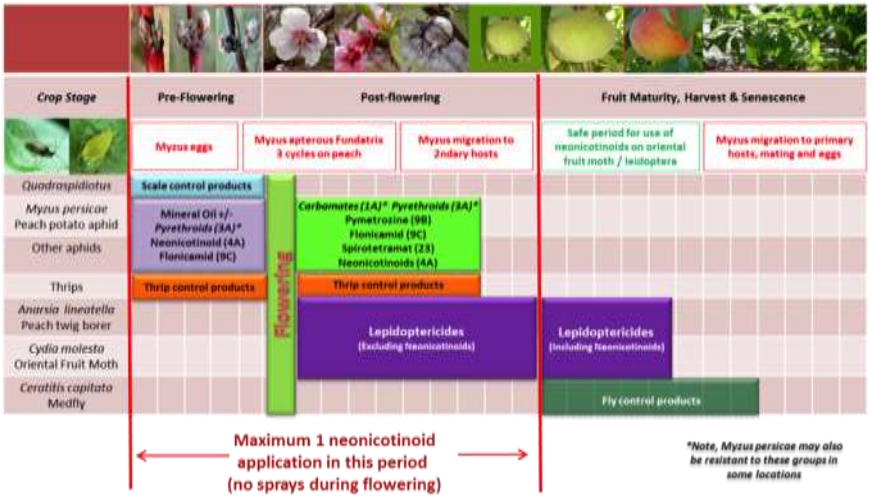
Goals	Objectives	Timeline	Status March 2013
Short term actions to minimise spread of resistant pests	• Focus on Neonicotinoid resistance management in *Myzus persicae* in peaches in Southern Europe	2012	Done
	• Develop and agree 2012 recommendations for *Myzus* IRM in Europe at Jan. Barcelona meeting	Q1 2012	Done
	• Distribute E-Newsletter with *Myzus* IRM recommendations in English	Q1 2012	Done
	• Translate E-Newsletter with *Myzus* IRM recomendations into French, Italian and Spanish with help from local IRAC representatives and distribute to IRAC member organisations & authorities	Q2 2012	Done
	• Publish 2011 monitoring results – (Rothamsted Research, Ian Denholm)	Q3 2012	Pending
	• Check new areas in peaches for *Myzus* resistance – eg Greece, Valencia (Bayer, others)	Q3 2012	Done, except Greece
	• To study the spread of resistant *Myzus* from peaches to neighbouring crops		
	○ Collect *Myzus* from crops other than peaches in summer 2012, Fr, It, Es (all members)	Q3 2012	Partially done Italy
	○ Screen for NNI target site resistance in *Myzus* (Bayer, Syngenta)	Q3 2012	Ongoing
	• Based upon the above findings compile *Myzus* recommendations for the 2013 season in collaboration with IRAC Spain and other National WGs. (SPWG meeting in S. Europe)	Q4 2012	Done
Prepare IRM guidelines for pests with, or at risk of developing resistance in the mid term	• *Myzus persicae* (update poster) to reflect new NNI findings (Ralf Nauen)	Q3 2012	Pending
	• Mites (new poster) (Fergus Early (MOA team) with & Ralf Nauen/Michael Klueken)	Q3 2012	Done
	• *Nilapavarta lugens,* Brown Plant Hopper (new poster) (Russell Slater + IRAC SE ASIA)	Q3 2012	Done
	• *Diaphorina citri,* Asian Citrus Psyllid (new poster) (Alejandro Arevalo + IRAC Brazil)	Q3 2012	Done
	• *Euschistus heros*, Brown Stink Bug (new poster) (Russell Slater)	Q4 2012	Pending
Prepare for future Sucking Pest problems long term	• Action plans for specific key pests/chemistries that may be developing resistance.		
	○ *Sitobium avenae* (pyrethroid target site resistance, UK)		
	▪ Obtain monitoring results from UK (Dewar) and Germany (JKI-Heimbach)	Q4 2012	Done
	▪ Collaborate with IRAG (UK-20.11.2012) and JKI (DE) to establish IRM guidelines	Q4 2012	(Done by IRAG)
	○ *Diaphorina citri* (neonicotinoids, pyrethroids, Florida, USA, Brazil)		
	▪ Elaborate specific methodology for *Diaphorina* (Tatjana Sikuljak – MOA group)	Q3 2012	Pending
	▪ Obtain results of monitoring in Florida (Lucas Stallinski Univ Florida)	Q4 2012	Pending
	▪ Establish baselines for AIs using agreed method (IRAC members responsibility)	Ongoing	Pending
	○ *Aphis gossypii* (neonicotinoid target site resistance, Korea)		
	▪ Publication expected in Korean Congress of Entomology (Russell Slater)	Q3 2012	Pending
	▪ Vigilance for field complaints (all members)	Ongoing	Ongoing

Review 2012: Myzus resistance alert 2012 & 2013



- Detections further south in Spain and Italy
- Gaps filled in France, vegetable population in Italy
- IRAC EU guideline adapted to proposals of IRAC Spain
- IRAC SPWG guideline issued eConnection 31 Jan 2013. Main recommendation for peaches:
  - Avoid NNI use if decline in activity noticed
  - If still working, only 1 NNI application, any timing but not during flowering
  - Rotate with other MOAs
- Earlier timing of announcements and WOW improvements (involvement of IRAC Spain)

IRAC management recommendations for Neonicotinoid-resistant *Myzus persicae*:
Example 2013: Peaches, Nectarines in Southern Europe



- Special credits and thanks –
  IRAC Spain, Josep Isquierda, Italy Univ Piacenza Dr. E. Mazzoni

IRAC

Review 2012: *Myzus persicae* other publications

- Sustaining the effectiveness of new insecticides against aphid pests in the UK (August 2012)
  - Dr Steve Foster, Prof Rod Blackshaw. Three year Project 2009-2012
  - Joint funded AHDB, (HDC,HGCAPotato Ocuncil), DEFRA, BBRO, Bayer, Belchim, Certis, Syngenta
  - No NNI target site resistance in UK populations of Myzus persicae
  - There is no association between resistance to neonicotinoids and other resistance mechanisms: MACE (pirimicarb), kdr and super-kdr (pyrethroids) in *M. persicae*.
  - MACE resistance (to pirimicarb) continues to be common and widespread in *M. persicae* in the UK and in many mainland European countries.
  - Since 2003, continued decline in frequency of *M. persicae* carrying kdr resistance to pyrethroids even though pyrethroid usage has not fallen. However, this species carries a new super kdr resistance mechanism which may be present in the majority of *M. persicae* in the UK.
- Dispersal behaviour of susceptible vs neonicotinoid-resistant *Myzus persicae* clones (April/August 2012)
  - Lucy Fray, Syngenta AG, SIG Aphid interests group April 2012, Int Congr. Ent. Aug 2012
  - Suggestions that NNI-target site resistant aphids may avoid treated surfaces, improving their survival chances

Review 2012: ACP poster

Integrated ACP Management Guidelines

- Protect nursery plants under netting and use only HLB free certified stock.
- Transport infected nursery stock according to government regulations.
- Protect young and non-bearing trees with soil applied systemic insecticides. In older trees, soil applied systemic insecticides may not satisfactorily work on the pest.
- Rotate soil-applied insecticides with foliar sprays of other modes of action. Rotation of different modes of action is key to resistance management.
- Management of adults during dormant season is key to maintain low populations for the rest of the year.
- Use locally defined monitoring methods and intervention thresholds to make spray decisions. Notify to manufacturers any product performance failures immediately.
- Use and protection of bio-control agents is encouraged as part of the IPM programs and to reduce the risk of insecticide resistance development.

Photo: David Hall USDA

Management Plan Example

Figure 2: Management plan and opportunities for MoA rotation used for citrus psyllid based on plant phenology. The rotation uses various MoA which are registered and labeled for control of citrus psyllids. The rotations and number of MoA might vary according to the number of products registered in each country.

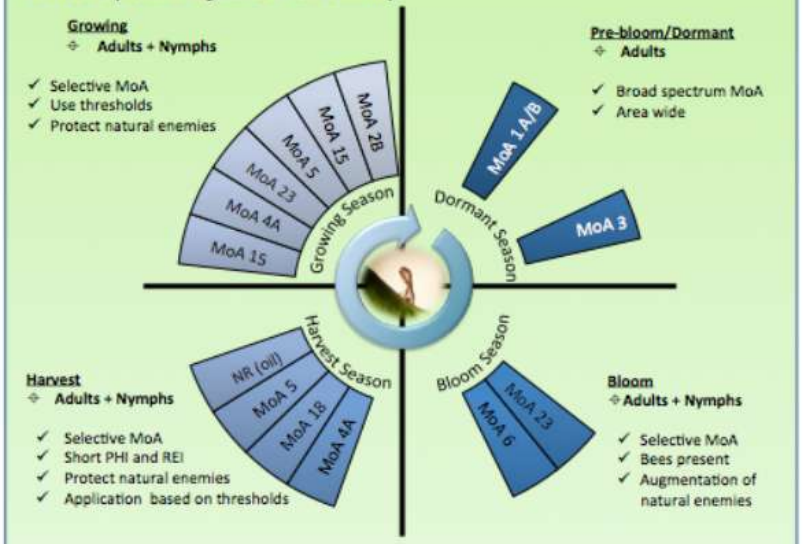


Table2: Modes of action registered for ACP management. Pest and Resistance management should be based on an appropriate rotation of these MoA

Modes of action registered for ACP management			
1 A&B: AChE Inhibitors	4: nAChR agonist	15: Inhibitors of chitin biosynthesis type 0	NR: Horticultural oils
2B: GABA antagonists	5: nAChR allosteric activators	18: Ecdysone receptor agonist	
3: $Na^{[+]}$ Chanel modulator	6: $Cl^{[-]}$ channel activator	23: Inhibitor of aCoA carboxylase	

- Asian Citrus Psyllid still susceptible to NNI's, but under intensive selection pressure
- Strong adherence to IRM programs is KEY to fight the pest and Greening disease
- Acknowledgments to Alejandro Arevalo for designing this poster

IRAC

Review 2012: Rice Hopper poster

Table 1: Insecticide modes of action to which field collected rice hoppers have been reported in literature as being (1960-2010).

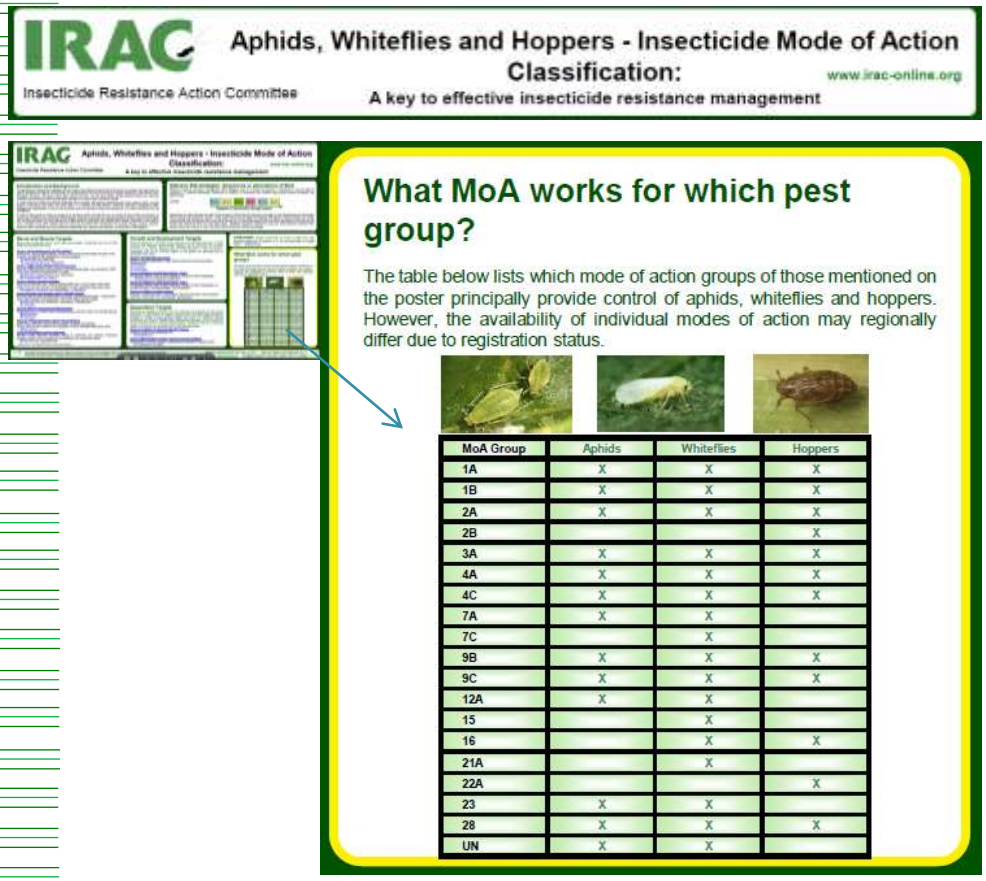
Insecticide Chemistry	Mode of Action	*Nilaparvata lugens*	*Laodelphax striatellus*	*Sogatella furcifera*	*Nephotettix virescens*	*Nephotettix cincticeps*
Carbamates	1A	X	X	X	X	X
Organophosphates	1B	X	X	X	X	X
Cyclodiene organochlorines	2A	X	X			
Phenylpyrazoles (Fiproles)	2B	X	X	X		
Pyrethroids	3A	X	X	X		
Neonicotinoids	4A	X	X	X		
Selective Feeding Blockers	9B & 9C					
Chitin Biosynthesis Inhibitor	16	X	X	X		

- **FEW GROUPS left to control rice hoppers!**
- **IRM is critical to retain insecticides and control the pests**

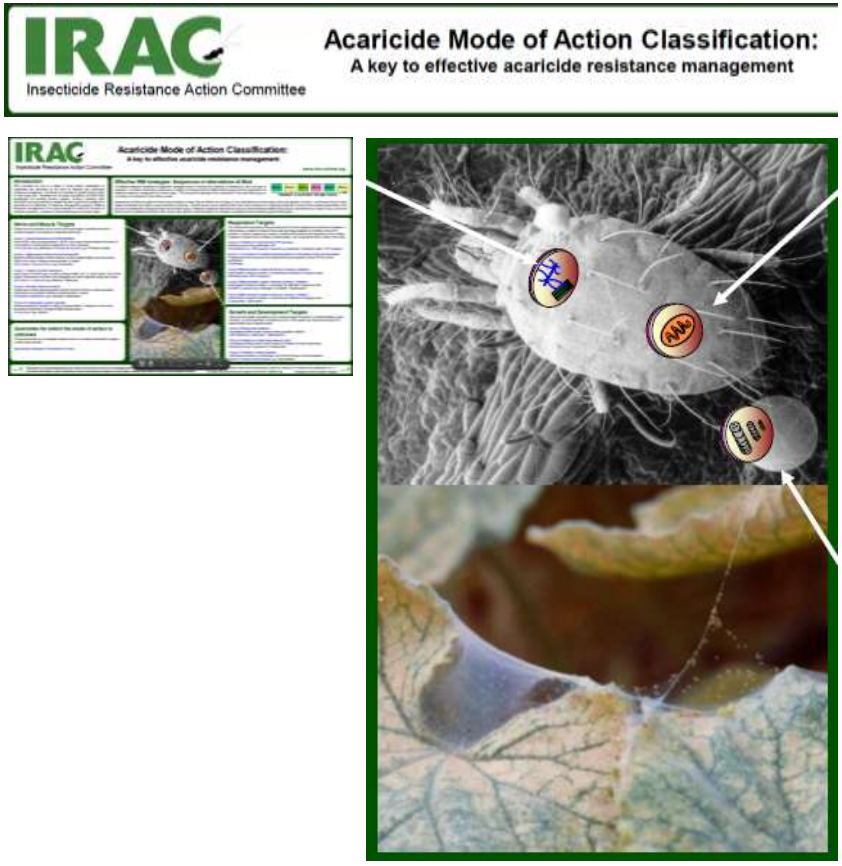
- **Rotation of products** and selection of locally effective products is key to fight resistance
- **Reducing non-selective insecticides** in the early season can prevent loss of natural enemies and prevent hopper resurgence
- Local monitoring programmes are important to identify **immigrating resistant insects**

- Acknowledgements to Russell Slater for designing this poster

Review 2012: MOA posters



MoA Group	Aphids	Whiteflies	Hoppers
1A	X	X	X
1B	X	X	X
2A	X	X	X
2B			X
3A	X	X	X
4A	X	X	X
4C	X	X	X
7A	X	X	
7C		X	
9B	X	X	X
9C	X	X	X
12A	X	X	
15		X	
16		X	X
21A		X	
22A			X
23	X	X	
28	X	X	X
UN	X	X	



- Sucking Pests MOA – Jan 2012 – general guidelines for sucking pest MOAs
- Mites MOA – March 2012 – highlights site of action of different acaricides
  - Thanks to MOA Team for updating posters

Review 2012: Cereal, UK, *Sitobium avenae* pyrethroid resistance monitoring

		Original Field collected population		Surviving insects sent for further testing		Survivors from discriminating dose assay	
		Discriminating Dose assay % Mortality				% kdr heterozygotes (genotypic characterisation)	
		3ng/cm2	0.3ng/cm2		LC50 (ppm)	Syngenta	Rothamsted
Luton	Bedfordshire	95	40	→			
Prickwillow	Cambridgeshire	95	85	→			75%
Whittlesea	Cambridgeshire	100	100				0%
Takeley	Essex	100	95	→			100%
Sutton Scotney	Hampshire	100	93				0%
Baldock	Hertforshire	100	88				
Newton on Trent	Lincolshire	90	35	→	12.1	100%	100%
Elveden	Norfolk	95	75	→	11.9	100%	100%
Fair Green	Norfolk	90	65	→	8.6	100%	100%
Feltwell	Norfolk	95	90	→			
Morley	Norfolk	100	80	→			100%
Narborough	Norfolk	95	80	→			100%
Oxborough	Norfolk	80	35	→			100%
Collingham	Nottinghamshire	90	70	→			100%
Chedburgh	Suffolk	100	35	→		100%	100%
Welnetham	Suffolk	100	95				
Wickhambrook	Suffolk	80	55	→		100%	100%
Susceptible lab strain		100	100		0.4	0%	

- Monitoring shows individual resistant aphids are widespread in UK cereals.
- Impact of resistance variable depending on frequency of resistant individuals.
- High impact after selection with multiple pyrethroid sprays. Heterozygotes only
- No evidence of resistance in German populations tested (limited number)
- IRM implementation needed to stop spread, but few alternatives registered.

– Acknowledgements to Alan Dewar, DCP UK and M. Andrews, J. Elias , M. Tait Syngenta CP for support and funding

IRAC

Review 2012: Cereal, UK, *Sitobium avenae* IRM recommendations by IRAG UK

Sitobion avenae (grain aphid)
Key pest in both summer and autumn when virus transmission is significant

Integrated management of BYDV

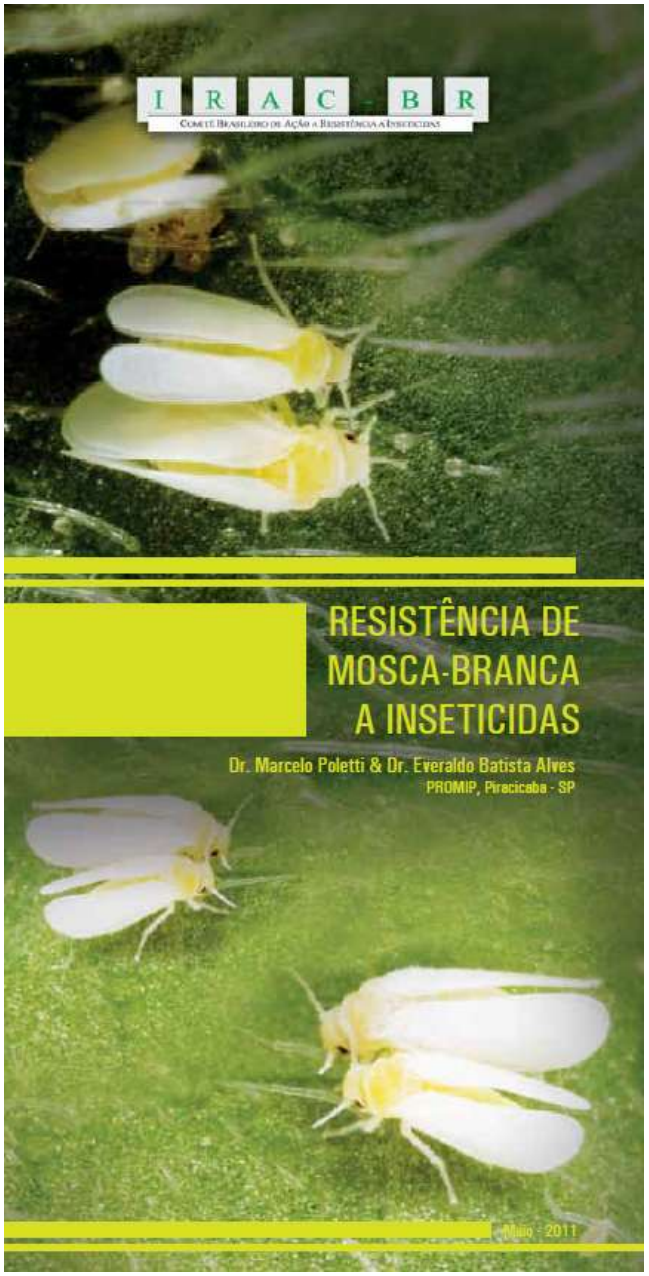
- Seed treatments with neonicotinoids
- Grass weed and cereal volunteer control
- Avoid early sowing in September
- Monitor aphids flying into cereal crops in Autumn
- Effective timing of foliar insecticide applications
- Use full rates of insecticides
- Control failures: send aphid samples to Rothamsted/Dewar CP
- If pyrethroid control was poor, then switch to other mode of action
- Alternatives registered in Autumn include pirimicarb (1A) and chlorpyrifos (1B)

Adobe Acrobat Document

Acknowledgements to Dr B. Parker and IRAG UK

IRAC

Review 2012: *Bemisia tabaci* / Brazil



ANEXO – QUADRO 1

Sítio de Ação Primário	Grupo Químico ou Ingrediente Ativo	Ingrediente Ativo
Agonistas de receptores nicotínicos da acetilcolina	Neonicotinóide (4A)	Acetamiprido
		Clotianidina
		Imidacloprido
		Tiametoxam
		Tiacloprido
Inibidores de acetilcolinesterase	Organofosforado (1B)	Acefato
		Clorpirifós
		Dimetoato
		Malationa
		Metamidofós
		Piridafentiona
		Profenofós
		Terbufós
	Carbamato (1A)	Carbofurano
		Carbosulfano
Moduladores de canais de sódio	Piretróides (3A)	Bifentrina
		Beta-ciflutrina
		Beta-cipermetrina
		Deltametrina
		Esfenvalerato
		Fenpropatrina
		Lambdacialotrina
	Éter difenílico	Etofenproxi
Inibidores da formação de quitina	Buprofezina (16)	Buprofezina
Mímicos do hormônio juvenil	Piriproxifen (7C)	Piriproxifem
Inibidor da síntese de lipídeos	Cetoenol (23)	Spiromesifeno
Inibidor de ATP sintetase mitocondrial	Diafentiuron (12A)	Diafentiurom
Desacopladores da fosforilação oxidativa via disrupção do gradiente de próton H	Clorpenapir (13)	Clorfenapir
Bloqueadores seletivos da alimentação	Piridina azometina	Pimetrozina
Composto com modo de ação desconhecido ou incerto	Tetranortriterpenóide	Azadiractina

- New Leaflet from IRAC / BR issued in May 2011 – could whiteflies reach epidemic status in Brazil?

- Special thanks to IRAC Brazil and Consultants: Prof. Dr. Celso Omoto – ESALQ/USP, Prof. Dr. Raul Narciso C. Guedes – UFV

IRAC

Arising sucking pest resistance problems: *Aphis gossypii*

WFL Publisher
Science and Technology
Meri-Rastilantie 3 B, FI-00980 Helsinki, Finland
e-mail: info@world-food.net

Journal of Food, Agriculture & Environment Vol.10 (2): 1227-1230. 2012 www.world-food.net

The mutation in nicotinic acetylcholine receptor β1 subunit may confer resistance to imidacloprid in *Aphis gossypii* (Glover)

Xu-Gen Shi [1], Yu-Kun Zhu [1], Xiao-Ming Xia [1], Kang Qiao [1], Hong-Yan Wang [2] and Kai-Yun Wang [1*]

[1] *Department of Plant Protection, Shandong Agricultural University, Taian, Shandong 271018, P.R. China.* [2] *Cotton Research Center, Shandong Academy of Agricultural Sciences, Jinan, Shandong 250100, P.R. China.* *e-mail:wky@sdau.edu.cn

Received 18 February 2012, accepted 30 April 2012.

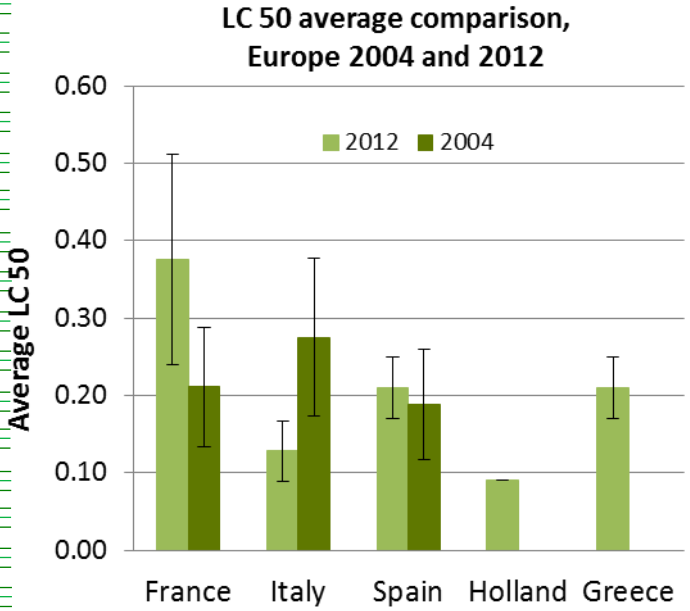
Abstract

Neonicotinoid insecticides, such as imidacloprid, are selective agonists on the insect nicotinic acetylcholine receptors - their molecular target site, which are used extensively to control a variety of different pest species. Just like other classes of insecticides, resistance to neonicotinoids is a significant threat, which has been identified in several pest species, including the cotton aphid, *Aphis gossypii* (Glover), a major cotton pest in many parts of Asia. A 66.49-fold imidacloprid-resistant *Aphis gossypii* strain was established in our work after selection for 60 generations. Analysis of the cDNA sequence of the nicotinic acetylcholine receptor (nAChR) α1, α2, α3, α4-1,α4-2, β1 subunits and the functional extracellular region (ranging from loop A to the 1st transmembrane domain) of the nicotinic acetylcholine receptor α5 subunit from the resistant strain revealed a single point mutation in the loop D region of the nAChR β1 subunit causing an arginine to threonine substitution (R81T). This mutation has been identified to be a key determinant of neonicotinoid binding to nAChRs and this amino acid change results in reduced sensitivity to neonicotinoids, which confers a vertebrate-like character to the insect nAChRs. This result indicated that in cotton aphids the single mutation (R81T) might confer imidacloprid resistance.

- **China** – R81T subsititution (like in Myzus) **produced in the lab** after 60 generations exposure to IMIDACLOPRID in *Aphis gossypii*
- **Japan** – Miazaki, Southern Kyushu, 3 *Aphis gossypii* populations from Cucumber and Pepper with signifcant **loss of control** to 5 neonicotinoids but less to ACETAMIPRID and THIACLOPRID Dr Matsuura, July 2012. Mechanism of resistance not yet defined.
- **Korea – NNI failure reports** from Syngenta internal trials on Peppers, Cucumbers
- **Australia** - Grant Heron – *Aphis gossypii* resistance to NNIs has **not increased in 2011/2012 season**
  - **Action for 2013** – Monitor NNI performance in all countries, new Guidelines in December

IRAC

Special report: Pear Psylla sensitivity to Group 6 (abamectin) in Europe, 2012



- 19 populations from 5 countries
- Leaf dip tests with L1-L3 stages
- Mortality at 24h
- Results showed no significant shift in sensitivity of *Cacopsylla pyri* to Group 6 insecticide (abamectin) since 2004

Special thanks to Celine Hirn, Syngenta Cp AG, Stein, Switzerland

IRAC

Further events in 2012

- New in 2012: Group 4 sub classes. New clauses for IRM on MOA poster:
  - Successive generations of a pest should not be treated with compounds from the same MoA Group.
  - In the absence of other alternatives it may be possible to rotate compounds between sub-groups if it is clear that cross-resistance mechanisms do not exist in the target populations.
  - Neonicotinoids: 4A, 4B & 4C - Although these compounds are believed to have the same target site, they have been sub-grouped because they are chemically distinct, and current evidence indicates that the risk of metabolic cross-resistance is low. If there are no other alternatives, compounds from groups 4A & 4C may be rotated in situations where cross-resistance mechanisms are known to be absent in the insect population to be treated.
- IRM and mixture products
  - Insecticide mixtures are primarily for improving pest control and not managing resistance
  - Single AI rotation is best, but mixtures may be rotated with single AIs as well in a program
  - Both AIs should be full dose and have similar residual effects
- Resistance Statements for EU Re-registration.
  - Is there an opportunity for collaboration via IRAC to harmonise recommendations?
  - Can monitoring or baselines be run in collaboration?

SPWG Team membership 2013

Current SPWG team	Company
Alan Porter	IRAC
Alejandro Arevalo	BASF
Dan Vincent	DuPont
Eric Andersen	Cheminova
James Thomas	Dow
Jean-Paul Genay	Nufarm
Luis Gomez	Dow
Michael Klueken (VC)	**Bayer CS**
Ralf Nauen	Bayer CS
Russell Slater	Syngenta
Steve Skillman (CH)	**Syngenta**
Tamar Danon	MAI
Tatjana Sikuljak	BASF

Companies not represented	MODE of ACTION
ISK/FMC/Belchim	9C
Sumitomo	7C
Meiji /Nihon Nohayaku	UN/Flometoquin
Nissan	UN/bifenazate

- Team questions/discussion:
  - Does team represent all key MOAs for sucking pests?
  - Should we invite an independent advisor/observer on team?
  - Proposals, suggestions

Objectives 2013: Draft proposal 21st March

Goals	Objectives	Timeline	Comments
Short term actions to minimise spread of resistant pests	• ***Myzus persicae*** NNI resistance in Europe – follow regulatory events and new monitoring results and adapt NNI IRM recommendations according to future legislation. Reissue new guidelines in Dec 2013 • ***Sitobium avenae*** PYR target site resistance in UK – Communicate guidelines of IRAG to member companies	Dec 2013 Q1 2013	
Prepare IRM guidelines for pests with, or at risk of developing resistance in the mid term	• ***Myzus persicae*** update poster to reflect new situation in 2013 • ***Diaphorina citri,*** Asian Citrus Psyllid – Brazil specific poster IRAC Brazil • ***Sitobium avenae*** support IRAG UK as necessary	Q4 2013 Q2 2013 Q3 2013	
Prepare for future Sucking Pest problems long term (avoiding resistance development)	• Action plans for pests that are at risk of developing resistance. ○ ***Diaphorina citri*** (ACP) (neonicotinoids, pyrethroids, Florida, USA, Brazil) ▪ Elaborate methodology for ACP (Tatjana Sikuljak – MOA group) ▪ Obtain results of monitoring in Florida (Lucas Stallinski Univ Florida) ▪ Establish baselines using agreed method (IRAC members responsibility) ○ ***Euschistus heros***, Brown Stink Bug: (neonicotinoids, pyrethroids, Florida, USA, Brazil) poster and guidance on baselines and monitoring methods ○ ***Aphis gossypii*** (neonicotinoid target site resistance) ▪ Monitor complaints globally and report liaise with researchers ○ ***Bactericera cokerelli*** Potato Zebrachip Psyllid? ○ ***Other pests?***	2013 Q1 2013 Q4 2013 Q2 2013 Q3 2013 Q4 2013	

- Additional proposals? Project? Funding?
- Teleconferences 2013
  - April: Finalise objectives, June: Posters, September: Posters, December: Myzus update

IRAC

Website document status 5.3.2013

Still valid

No new version available

No new version available

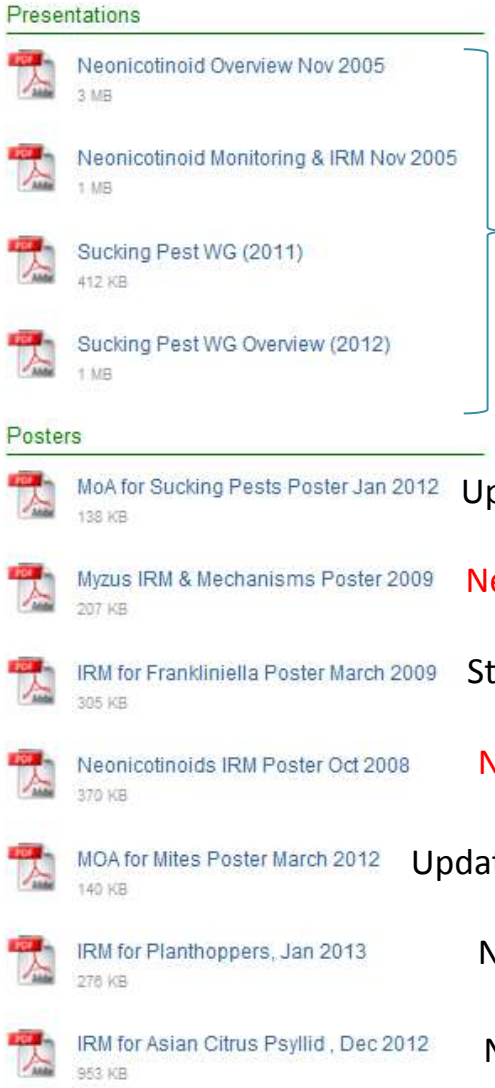
Replace with 2013 version

No new version available

Replace with 2013 version

Survey document 2010 can be removed

Published by IRAC Brazil in May 2011. Still valid



Presentations made at IRAC International Meetings

Updated Jan 2012 MOA team

Needs updating

Still valid

Needs reviewing

Updated March 2012 MOA team

New still valid

New still valid

- Discuss and agree needs

IRAC

Insecticide Resistance Action Committee

Thanks to the IRAC SPWG team members and external consultants for their support to manage global Sucking Pest Resistance!