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IRAC

Insecticide Resistance Action Committee

eConnection

FEATURED IRAC MEMBER:

Andrew Crossthwaite (Syngenta) is a member of IRAC International and currently leads the very active and influential IRAC Mode of Action Working Group.

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RECENT UPDATES TO THE IRAC MOA CLASSIFICATION SCHEME.

IRAC COUNTRY GROUP NEWS.

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About This Issue

Welcome to another IRAC eConnection Newsletter, it has been a while since the last issue. As always we try to bring you interesting and informative articles about the work of IRAC and insecticide resistance news from around the world.

In this issue we provide details on some significant changes to the IRAC Mode of Action Classification, notably the incorporation of non-chemical and biological products with insecticidal activity into the scheme. We also have three new groups added, 30, 31 and 32, a new subgroup 9D as well as some changes in the positioning of actives and group names.

IRAC, with its mission to promote and facilitate the implementation of global resistance management strategies, continues to grow, often through the establishment of national and regional IRAC Country Groups (CG). In addition to the many well established groups, a number of new teams have been formed over the last 18 months. Details of these new teams are provided in this issue as well as brief updates on the ongoing work of some of the existing CGs.

The IRAC International Working Groups (WG) and Task Teams (TT) continue to carry out monitoring work and develop Resistance Management Guidelines along with educational outreach materials. Website links to some updated posters, and new Lepidoptera IRM Guidelines provide some examples. Also included is a report from the *Tuta absoluta* TT, a position statement on IRM modelling and news of the recently formed IRAC Nematode WG.

At the end of the eConnection is a graphic of the current IRAC International Executive member companies. This has changed recently as a result of the mergers and acquisitions but it is important to recognise that many smaller companies also contribute to individual IRAC WGs, TTs and CGs.

If you have any news or resistance topics of interest, please let us know so that we can inform others in the IRAC Network. We hope you enjoy the issue.

Updates to the IRAC Mode of Action Classification Scheme

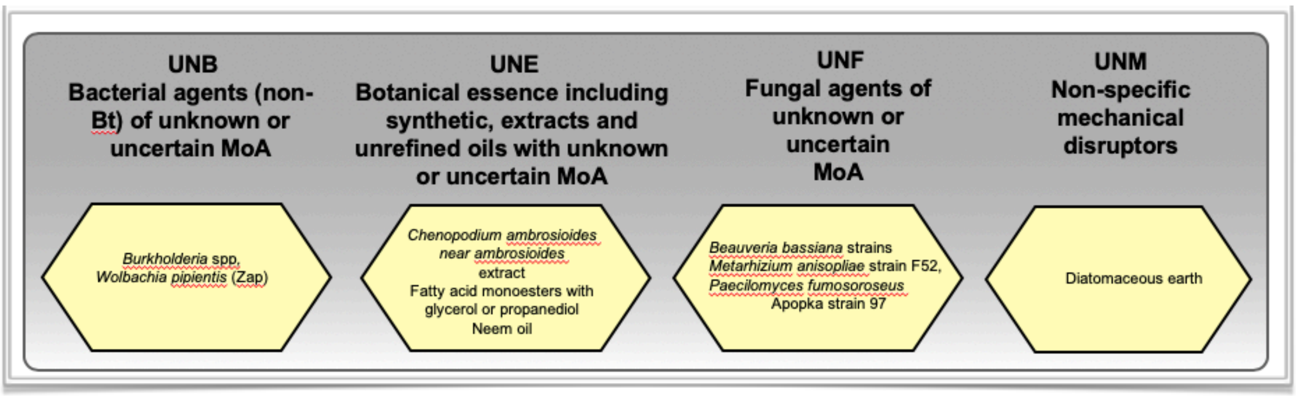

IRAC Mode of Action Classification Scheme
Issued, December 2018
Version 9.1
Prepared by: IRAC International MoA Working Group
Approved by: IRAC Executive

The IRAC Mode of Action (MoA) Classification Scheme is one of the key outputs from IRAC International and is recognised globally as the authoritative reference for defining the MoA of commercial insecticides. This information provides growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of acaricides or insecticides for use in an effective and sustainable acaricide or insecticide resistance management (IRM) strategy. IRAC International recognises the increasing diversity and value of non-chemical and biological control solutions which are extensively used in IRM and integrated pest management (IPM) programs. As the diversity and use of non-chemical and biological control products expands, it is important that the IRAC MoA Classification also evolves. Detailed below is a summary of recent key changes.

1. Inclusion of Bioinsecticides in the MoA Classification Scheme:

IRAC has taken the step to systematically integrate non-chemical and biological products with insecticidal activity into the IRAC MoA Classification Scheme. This is one of the most significant updates to the scheme since its creation. Now included are bacterial agents, plant-derived extracts and unrefined plant oils, fungal agents, non-specific mechanical disruptors, peptides and viral agents. Products which do not have direct insecticidal activity such as behaviour modifying agents or live macro-biologicals such as predatory insect/mites, are not included in the revised scheme. The basis for classification will remain the same, with all active ingredients which have a defined biochemical or biomechanical process arranged in individual numbered groups.

Active ingredients or products where the biochemical or biomechanical MoA is not yet defined, will still be listed in the classification scheme but they will be shown as unknown (UN) MoA until the MoA can be defined in accordance with the classification guidelines. Insecticidal bacterial agents, extracts and crude oils, fungal agents, mechanical disruptors, peptides and viruses of unknown MoA are classified in groups UNB, UNE, UNF, UNM, UNP and UNV, respectively. Both UNP and UNV are placeholders and not included in the latest MoA classification poster as currently there are no representatives for either group.



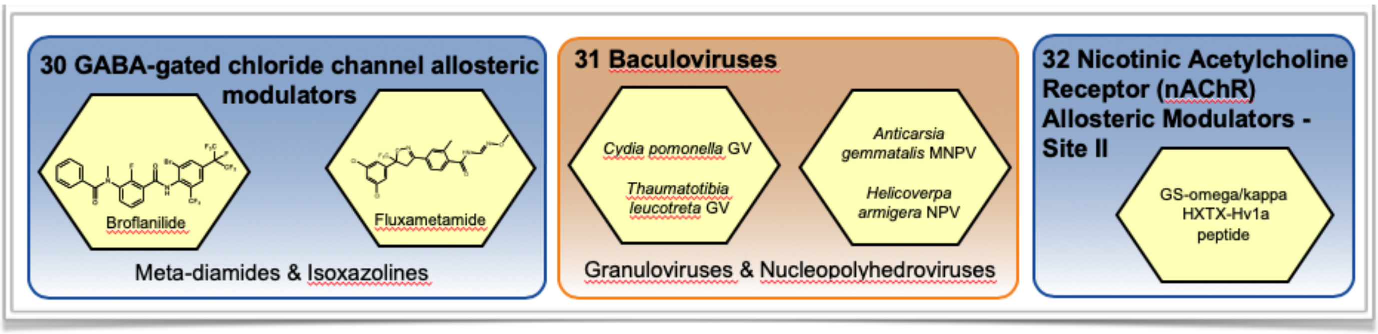
2. New Groups Added to the Classification Scheme:

Three new groups have been added to the latest version of the MoA Classification Scheme.

Group 30 contains two novel active ingredients that interact at the GABA-gated chloride channel at a site that is distinct to that of existing Group 2 chemistry with no evidence of target-site cross resistance risk. The meta-diamides exemplified by broflanilide, and isoxazolines exemplified by fluxametamide, are distinct chemistry classes but interact at the same allosteric binding site on the GABA-gated chloride channel. Therefore, to delay the onset of resistance to Group 30, meta-diamide and isoxazoline insecticides should not be used in rotation or sequence. Please consult the MoA Classification Scheme for further advice on MoA groups and spray application strategies for implementing effective insecticide resistance management (IRM).

Group 31 is the new group for baculoviruses, a family of large circular double-stranded DNA viruses specific to insects. The baculovirus-unique Per os Infectivity Factor (PIF) protein complex on the virus, promotes insect-specific infection by binding to PIF targets on midgut cells that are unknown but believed to be unique for each baculovirus type. Infection is ultimately lethal. Since different baculoviruses target different insect orders, representatives from Group 31 under certain circumstances may be used together without compromising IRM principles. Please consult product-specific recommendations for application guidance.

Group 32 nicotinic acetylcholine receptor (nAChR) allosteric modulators - Site II, represents a novel allosteric-binding site at the nAChR distinct to that of Group 5. The exemplifying active GS-omega/kappa HXTX-Hv1a is a peptide derived from spider toxin venom. There is no evidence of target-site cross-resistance risk between Group 5 and Group 32 and where appropriate insecticides from these groups may be used in sequence or rotation in spray application programmes according to IRM principles.



3. New Subgroups

Group 9D - A new subgroup has been added into Group 9 Chordotonal organ TRPV channel modulators. Group 9D pyropenes represents a novel structural chemistry class exemplified by afidopyropen.

4. Other changes

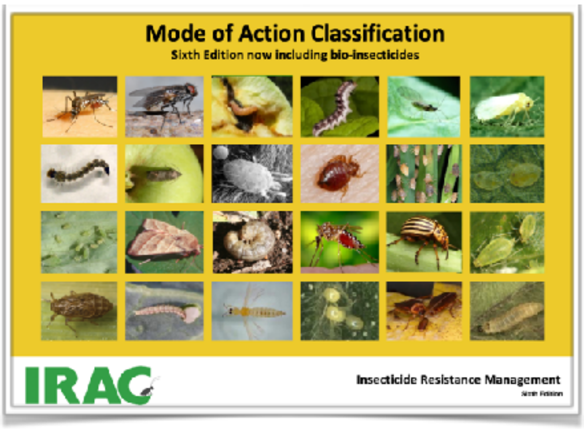
Group 28 ryanodine receptor modulators. Cyclaniliprole has been added to the list of active ingredients.

Group 10 contains compounds used specifically for control of mites. New evidence has demonstrated that the target-site for Group 10 is chitin synthase (CHS1) and as a result has been renamed mite growth inhibitors affecting CHS1.

Group 15 contains the benzoylureas. Actives from this group are used to control lepidopteran pests. The target-site is now known to be chitin synthase and as a result Group 15 has been renamed Inhibitors of chitin biosynthesis affecting CHS1.

Group 5 has been renamed nicotinic acetylcholine receptor (nAChR) allosteric modulators – Site I. This change was necessary as a result of the creation of Group 32 nicotinic acetylcholine receptor (nAChR) allosteric modulators which became - Site II,

Mancozeb, a dithiocarbamate, is registered for control of mites. Its mode of action as a miticide is currently unknown and hence it has been added into the UN Group.



IRAC has now updated the MoA Classification Scheme, the corresponding MoA poster with the chemical structures and the MoA Booklet in order to include these changes. The MoA App. will be revised in due course. We believe these updates reflect an evolving insect pest management landscape and provide a useful tool in implementing effective insecticide resistance management. For further information on MoA and details on how to request IRAC classification of actives, please refer to the MoA Classification Scheme and the IRAC website.

Updates from Existing IRAC Country Groups

IRAC Spain

During 2018 IRAC España celebrated the 18th Anniversary of the foundational meeting. Most of the original participants have changed positions or retired and hence no longer members of IRAC Spain, but thanks go to the two remaining people in the group, Josep Izquierdo (Bayer Crop Science) and Ana Salamero (Nufarm), for their valuable contribution throughout the 18 years.

During the last year IRAC Spain's focus has been the participation in scientific and technical events including presenting the work on "Insecticide Resistance Management of Myzus persicae on stone Fruits". These have been published as a paper in the proceedings of the XXIII Jornadas fruticolas IRTA (Pablo Bielza, 2018) and is under internal review for further publication in scientific papers and events in 2019.

IRAC Spain has a Resistance Risk Analysis WG which, during 2018, has developed an internal country-related comprehensive ranking of pests susceptible to resistance development. The criteria used for the ranking took into account the importance of the pest's biological aspects, such as the number of generations, and other intrinsic characteristics of the pest in Spain. This comprehensive analysis has been agreed by the full IRAC Spain Team.

In 2018 IRAC Spain also started a collaboration agreement with IVIA (Instituto Valenciano de Investigaciones Agrarias) to run lab tests to evaluate the susceptibility and response of *Eutetranichus banskii* populations in Spanish citrus orchards to representative active ingredients from the mode of action groups with registrations in Spain. The aim is to test samples from 2018 and 2019 with results expected after summer 2019.

An updated MoA classification for registered active ingredients in Spain will be issued in the near future in aligned with the latest version of the IRAC International MoA Classification Scheme. This new version of the Spanish MoA classification will be printed and eventually available as an App. for Android and Apple devices.

IRAC Argentina

IRAC Argentina has been operating as a group for 3 years and have been very successful in running a series of technical workshops on pest management in corn and soybean during this time. Comprehensive Recommendations for the Management of Pests in Corn have been developed which have been published on the IRAC Argentina website. A MoA brochure in Spanish has been printed and distributed and the MoA classification added to the website. During 2018 IRAC Argentina made presentations at the Argentinean Monitor Congress and the Brazilian and Latin-American Entomology Congress.

IRAC Brazil

During the 2017/2018 season IRAC-BR has conducted studies with several Lepidoptera species such as *Spodoptera frugiperda, Helicoverpa armigera, Chrysodeixis includens* and *Anticarsia gemmatalis*, stink bugs (*Euschistus heros),* whitefly (*Bemisia tabaci)* and mites (*Tetranychus urticae)*. A high survivorship was observed for *S. frugiperda* and *C. includens* for IGR´s products and with *H. armigera*, for the Groups 1A, 3A and 22A. The stink bugs are still showing high susceptibility for the main commercial products, and the same is observed for the new MoAs used for whitefy control. The data is detailed in IRAC-BR presentations. The group have also just started a *Tuta absoluta* monitoring program with both phenotypic and molecular analysis.

IRAC-BR has just published a new leaflet with IRM recommendations for the Lepidoptera complex (*Spodoptera frugiperda, Helicoverpa armigera, Chrysodeixis includens)* in soybean, corn and cotton and updated the corresponding MoA leaflet. Furthermore, there has been participation in 5 events (Workshops, Congress, and Trainings), with lectures, talks and training sessions. This will be followed with regional workshops with the technical teams, consultants and researchers from the region in order to teach and validate the IRM recommendations.

The IRAC-BR group have now successfully included the MoA icon on products labels for all the phytosanitary products (insecticides, fungicides, herbicides and biologics - baculovirus).

New IRAC Country/Regional Groups

There has been a lot of interest over the last couple of years in forming new IRAC Country and Regional Teams to facilitate local Insecticide Resistance Management programmes with support from IRAC International. All IRAC Teams are run under the IRAC Constitution and CropLife International Antitrust Guidelines. Initial progress and initial objectives of the new teams are summarised below:

IRAC Europe

A first planning session was held towards the end of 2018 where initial membership and scope for a new Europe Team was agreed. The first official full audio meeting is due to take place on March 20th this year.

IRAC Israel

IRAC Israel is made up of 7 local companies along with Adama and Syngenta and the group met up on December 24th. Initial objectives are to identify the resistance situation in Israel and to produce educational materials for publication in local agricultural magazines and bulletins.

IRAC Asia

The IRAC Asia group met November 21-22nd, 2018 when topics included priorities on regional crop protection and traits, progress on MoA labelling and an update on an IRM Indonesia project.

IRAC Japan

IRAC Japan (J IRAC) is a new group evolved from the local Diamide/Lepidoptera WG but has now formed a full IRAC Country Group by broadening their remit to include other pest species and chemistries as well as inviting membership from other companies. Currently there are 8 member companies of the new IRAC Japan and other national and local authorities, researchers and advisors may participate as observers in meetings held by the Committee with the approval of the Group members.

The activities of IRAC Japan will include :

- Exchange of information between manufacture, public research institute, national and local authority and IRAC International on the management and counter-measures for insecticide resistance.
- Organising and participating in meetings, symposiums, lectures and seminars
- Distribution of documents (printed and electronic materials etc.) prepared by the Committee to relevant organizations and parties to disseminate and promote Insecticide Resistance Management (IRM). Documents will also be made available on the IRAC website.
- Promotion of Integrated Pest Management (IPM) and Integrated Crop Management (ICM) incorporating IRM through the use of crop protection technologies such as physical and biological control) as well as chemical control.

IRAC India

In the past IRAC India was an active Country Group but changes in company personnel and the IRM situation meant that the team gradually disbanded. However, increasing resistance issues in India has resulted in the India Country Group reforming with a kick-off Workshop in Delhi in February 2019. In addition to the members of the IRAC India team, there was active participation from IRAC International, IRAC Asia and Croplife India.

The goals of the workshop were to establish working priorities for IRAC India in both the short and long term, ensuring that prioritised insecticide resistance issues are being addressed and to ensure that IRAC India is providing key technical information to support the implementation of insecticide resistance management.

The IRAC India team agreed that development of supporting materials for resistance management in rice and cotton as well as specifically for the invasive pest, fall armyworm (*Spodoptera frugiperda*) were the key priorities and therefore an action plan was developed.

The inclusion of mode of action icons on product labels and the development of effective communication pathways to growers and retailers were also identified as key priorities that the team will work upon.

On the second day of the workshop the group were joined by representatives of the Ministry of Agriculture & Farmer Welfare, the Farmers' Federation, Indian Agricultural Research Institute and Central Institute for Cotton Research to gain further insights on how to support and communicate the implementation of insecticide resistance management.

IRAC International Working Group & Task Team News

IRAC *Tuta Absolute* Task Team

Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) is a pest of great global economic importance and IRAC Member Companies and Lepidoptera Country Resistance Action Groups have been actively monitoring populations for resistance, promoting IRM rotation strategies in customer communications, and recommending the integration of IPM practices into tomato greenhouse production since 2007 when *Tuta absoluta* was first found in the Mediterranean basin. Once diamide resistance occurred on a large scale in Italy and *Tuta* invasion into African countries continued to escalate, IRAC International agreed to coordinate a regional Tuta Task Team (TT).

The objective of the *Tuta* TT was to provide cross-industry advice for *Tuta* pest management practices and IRM recommendations in selected European, Middle East, and African countries. Regional country IRAC teams worked with IRAC International and key academic influencers to design a regional *Tuta* pest control program complete with IRM recommendations that would be communicated and implemented locally to the industry

The core *Tuta* TT included around 20 global and country representatives and the academic researchers from Spain, Antonio Monserrat and Pablo Bielza, provided additional expertise to the team. The countries where the *Tuta* TTs decided to focus implementing best management pest control recommendations were Spain, Italy, Greece, Turkey, Israel, Morocco, and the Republic of South Africa. Six of these countries have organised active IRAC *Tuta* TTs that aided in coordinating communication and training programs for the final recommendations.

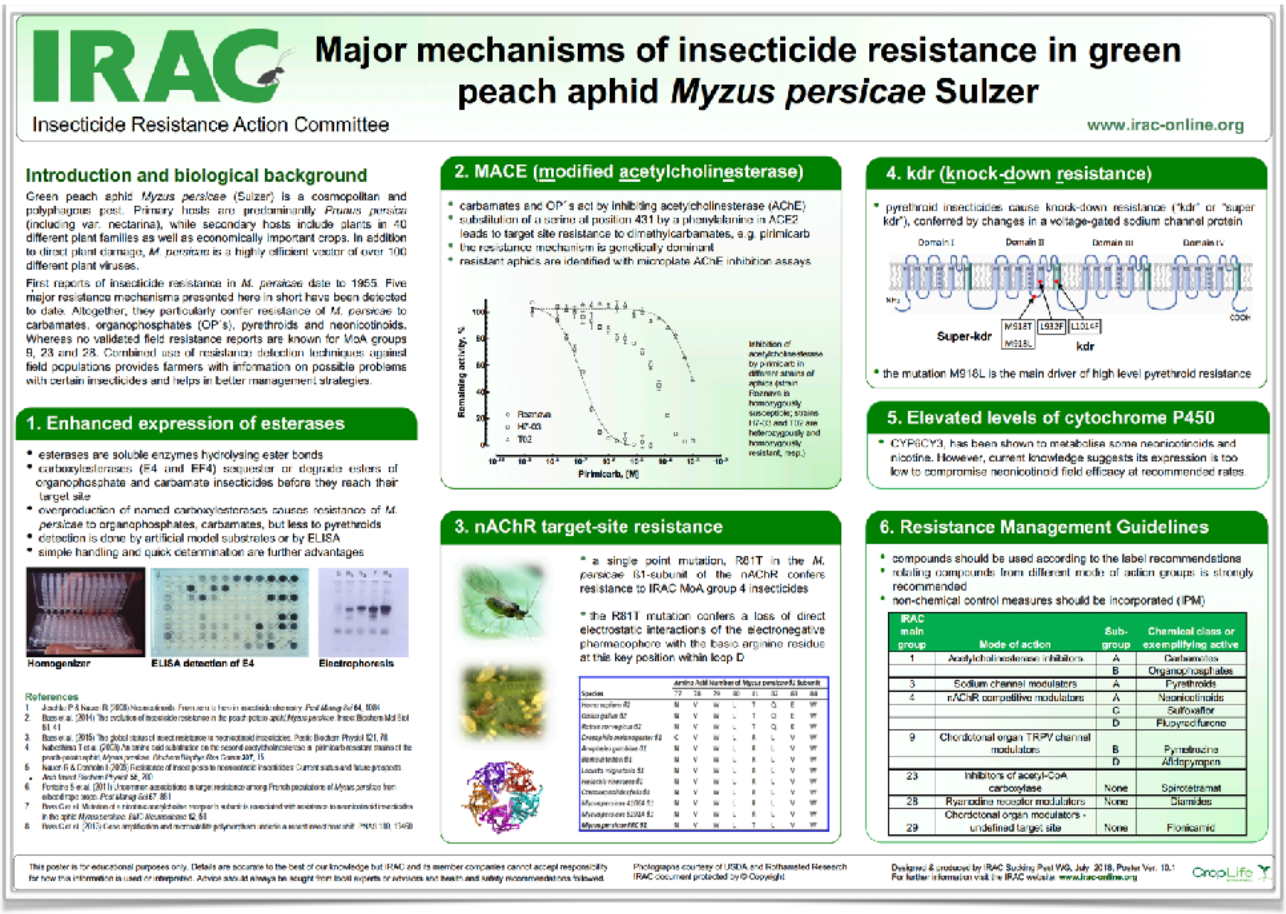
The core team met in Malaga, Spain in October 2016 to complete the project plan. Country and global IRAC members identified country leaders, target audiences, and country-specific organisations and opportunities to communicate and educate growers. The technical training document was also finalised as a 140-page slide set titled "Best Management Practices to Control Tuta absoluta Recommendations to Mange Insect Resistance".

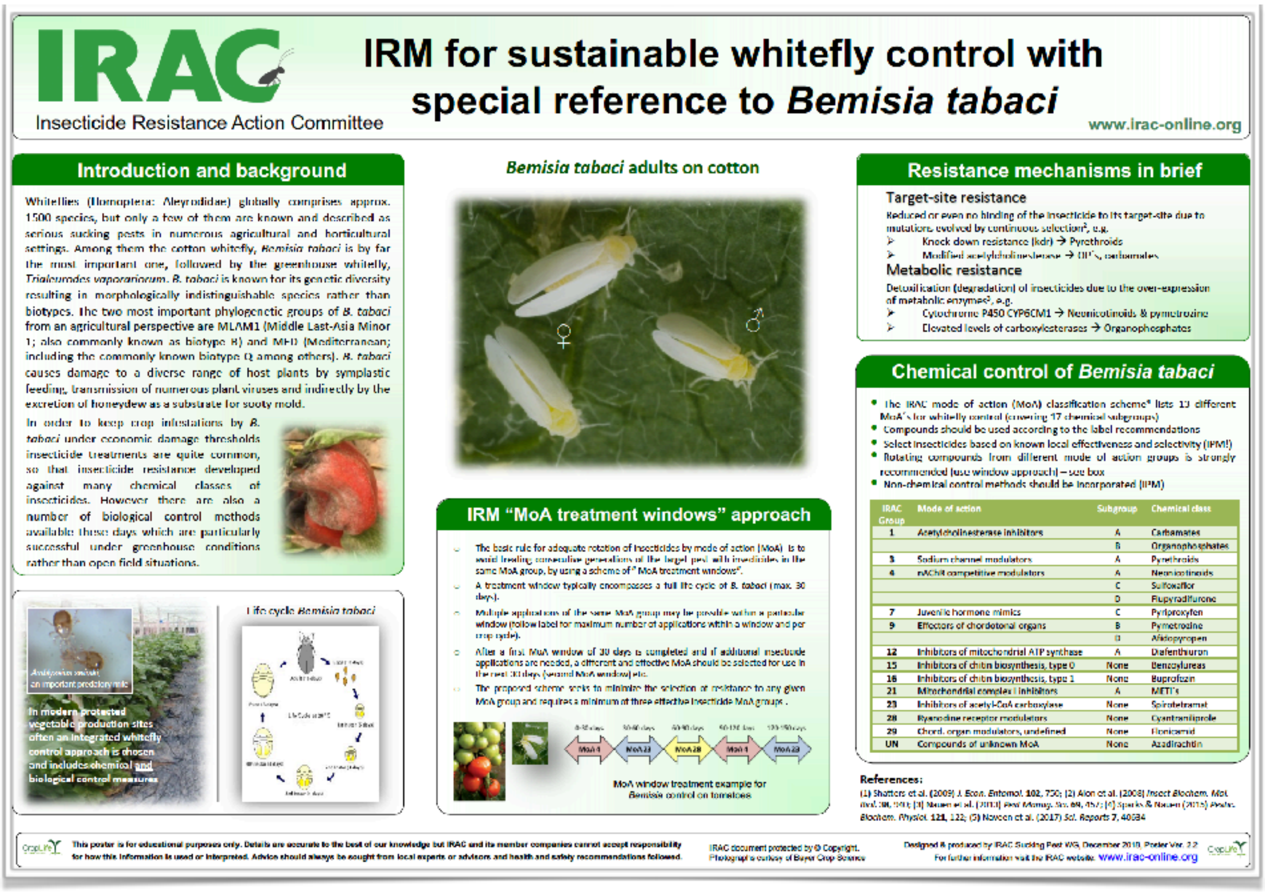
Throughout 2017 and 2018, audio meetings were scheduled to ensure inter-company and inter-country interactions. Progress, issues, and ideas were shared.

At the end of 2018 it was considered that the *Tuta* TT had achieved their objectives with seven countries implementing updated pest control practices in compliance with IRM principles. There is no plan to continue coordination at the IRAC International level however a technical training document (slide set) is available with numerous examples of how country teams can coordinate training for grower implementation.

Based on experiences from this project, IRAC International plans to produce a publication that documents differences in grower practices that greatly accelerated or delayed *Tuta* resistance. Additionally, learnings from the *Tuta TT* will guide the update of the IRAC *Tuta* brochure, last published in 2011 (*Tuta* absoluta – The Tomato Leafminer: Recommendations for Sustainable and Effective Resistance Management). Read the full Project Closure Report

Updated Sucking Pest WG Posters - Myzus Persicae & Bemisia Tabaci





Lepidoptera WG - Insecticide Resistance Management Guidelines

Download the Lepidoptera IRM Guidelines from the IRAC website

IRAC International - Position Paper on Computer Models Applied to IRM

In a situation in which running real-world experiments is impractical (or even impossible), computer simulations offer a powerful solution to understand complex problems. This is exactly the case of resistance-evolution prediction: Although fast from an evolutionary perspective, the time and spatial scales involved in this process are simply too large to be dealt with experimentally. The underlying evolutionary processes of resistance development are relatively well known, however. With this knowledge, researchers can build mathematical models to describe and mimic the actual systems. These models can also be calibrated based on real-world cases that have already occurred, improving their precision and accuracy. Download the full paper from the IRAC website.

IRAC Nematode WG

The IRAC Nematode Working Group is one of the more recently established IRAC International teams. The initial objective of the team was to investigate the resistance risk of nematicides and this has now been published as a Resistance Risk. The group concluded that there are no substantiated examples in the scientific literature from the last century documenting cases of significant tolerance shifts or suspected resistance leading to failure of commercial agricultural nematicides against plant parasitic nematodes (PPN) under natural field conditions. Instances of these phenomena occurring have only been reported for some products under controlled laboratory conditions. Product usage approaches and nematode ecology reduce the potential that sustained selection pressure on PPN populations occurs under field conditions. Thus overall, it can be considered that the development of resistance in PPN species to nematicides under natural field conditions is currently unconfirmed, theoretically unlikely, and poses a low risk. The full IRAC Nematicide Resistance Risk Statement can be viewed on the IRAC website.

The team are now working on their second objective to develop a mode of action classification scheme for nematicides comparable to that for insecticides and acaricides.

IRAC Executive Member Companies

The eConnection is the newsletter of IRAC International.
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