

About This Issue

Welcome to the Issue 23 of the IRAC newsletter, eConnection. Following the launch of the new IRAC website in March, we now have a large number of additional readers of eConnection who have self-subscribed via the website home page. We welcome the new readers and look forward to your feedback.

A major event in the IRAC calendar is the IRAC International Annual Meeting which was held at the CropLife America headquarters in Washington DC at the end of April. A report on the meeting, along with some of the Working Group highlights are the main focus of this issue, but we also give details of some new IRAC publications. These include a MOA Classification mini-brochure, additional IRAC bioassay methods that have been developed and validated and a new poster on *Tuta absoluta*.

Remember 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.

Mode of Action Poster Translated

This popular poster showing MOA classification by group and chemical structure has now been translated into Chinese, Portuguese and Spanish. Although full size printed copies are only available in English the translated versions can be downloaded from the website for printing locally. Further translations are planned in the future. To view or download the files click on the appropriate link: [English](#), [Portuguese](#), [Chinese](#), [Spanish](#). Full information on the MoA scheme can be found in the [IRAC MOA Classification document](#).



### IRAC International holds its 45th Meeting

IRAC International held their 45<sup>th</sup> meeting in the CropLife America offices in Washington DC on April 26-29<sup>th</sup> 2010. The meeting was attended by around 40 participants and consisted of a mixture of concurrent IRAC working group meetings and reviews, a meeting of the Executive Committee, IRAC US and an International Session with discussions and presentations from invited guests including EPA, EPPO, CropLife international and the NAICC Consultant Association. There was an excellent exchange of information with around 35 presentations made during the course of the 4 days.

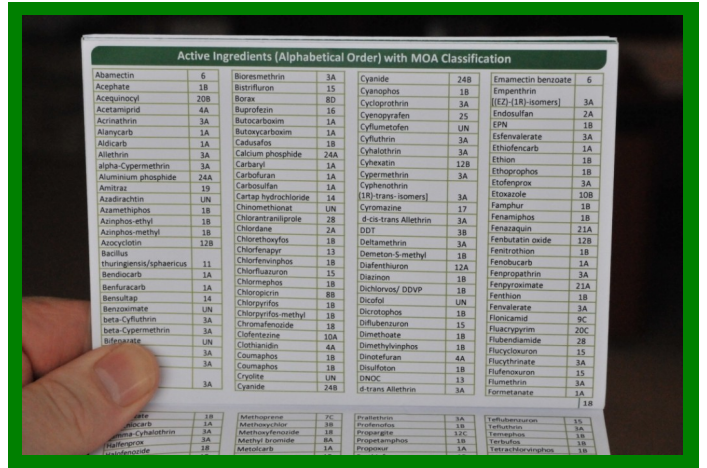
The progress by the various working groups during the last year was reviewed and the goals and smart objectives for the coming year agreed. A few of the highlights described by the Working Groups at the meeting are listed below:

- ◆ The merger of the Neonicotinoid and Sucking Pest WGs into one new team was very successful. The new team worked on the development of posters on the mechanisms of resistance in *Myzus persicae* and in *Frankliniella occidentalis*. A questionnaire on the resistance status in *Myzus persicae* was distributed and results of the survey should be available later in the year.
- ◆ The relatively new Diamide WG was very active during the year. They developed new bioassay methods in conjunction with the Methods WG and helped established 15 local Diamide Resistance Country Groups in priority pest/crop markets.
- ◆ The Pollen Beetle WG continued and expanded its monitoring work into 20 countries in Europe during 2009 with more than 800 populations tested for resistance. They also developed and validated new susceptibility test methods for pollen beetles with other chemistries.
- ◆ A regional survey on Codling Moth resistance was completed and initial evaluation of the results carried out by the Codling Moth WG. The team expanded during the year including members from other regions and they compiled a collection of relevant literature and details of experts active in the field of Codling Moth resistance.
- ◆ The Public Health Team drafted the second edition of the very popular "Vector Manual" which will be published later this year and provided expert input into a large multi-year/multi-country WHO run project.
- ◆ A significant White Paper on Biotechnology Resistance Management was published in Pest Management Science by the IRAC Biotech Team and a complimentary educational slide kit was developed.
- ◆ The Methods Team continued development and validation of different bioassays in conjunction with the other WGs and expanded the searchable eMethod tool to incorporate around 70 published references describing different methodologies.
- ◆ The MOA WG published the latest version of the classification scheme (v6.3), developed a second edition of the MOA Structures poster along with translations in different languages and produced a mini MOA classification brochure (see next page for details).
- ◆ The Communication & Education group was successful in establishing the new IRAC website and distributing 4 issues on eConnection.



New IRAC MOA Classification Brochure

IRAC International has just designed and printed a new pocket-sized guide to MOA classification. It includes an introduction to the importance of MOA for resistance management, a list of MOA groups in numerical order with corresponding active ingredients, pest specific lists of MOA by target site and an alphabetical list of active ingredients along with their MOA classification number. Copies are available from IRAC members and via the website or can be downloaded by clicking [IRAC MOA Brochure](#)



New IRAC Susceptibility Test Methods

The IRAC Methods WG in conjunction with the other IRAC teams have published on the website 3 new methods for [Codling Moth larvae](#), [Diamondback Moth larvae](#) and [aphid adults and nymphs](#). Further new methods for *Spodoptera*, *Helicoverpa* and *Heliothis* larvae, *Meligethis aeneus* adults and *Tuta absoluta* larvae are under review. Details can be found on the IRAC website using the links within the text.

**IRAC METHOD # 017:**  
**Codling moth larvae**

IRAC Susceptibility Test Methods Series  
Version: 3.3 Method No: 017

**Method:** IRAC No. 017  
**Status:** Approved  
**Species:** Codling Moth (*Cydia pomonella*)  
**Species Stage:** Larvae (L1)

This method is specifically recommended by the IRAC Diamond Working Group for evaluating the susceptibility status of diamide insecticides (IRAC MoA 2B).  
This method is also suitable for the following insecticide classes (IRAC MoA class):

**Product Class:** Organophosphate (1B)<sup>\*</sup>, Pyrethroid (3A)<sup>\*</sup>, Neonicotinoids (4A)<sup>\*</sup>, Spiroacetyl (5)<sup>\*</sup>, Avermectin (6)<sup>\*</sup>, Juvenile Hormone Mimics (7A)<sup>\*\*</sup>, Fenoxycarb (7B)<sup>\*\*\*</sup>, Benzyl urea (15)<sup>\*\*\*</sup>, Diazinyl (15)<sup>\*\*\*</sup>, Indoxacarb (22A)<sup>\*</sup>, Metathiazinone (22B)<sup>\*</sup>, Pyridyl (un)<sup>\*</sup>

**Comments:** Mortality assessment period may vary depending on insecticide mode of action. The following guidelines may be used:  
\*96 hour assessment period  
\*\*120 hour assessment period (Larvae should go through full molt before mortality assessment).  
For the purposes of this methodology the density of water is assumed to be 1.00g/ml

**Description:** Distilled water, mixing bowl, weighing scales (0.001g accuracy), syringes/pipettes and beakers/teal tubes for making dilutions, artificial diet (Storely Heliothis Premix Diet Formula)<sup>†</sup>, 10-20mm diameter well plates with sealable lid<sup>†</sup>, protective gloves, artist's paintbrush, the forceps or seeker, binocular microscope or hand lens (optional), maximum/minimum thermometer.

<sup>†</sup>Available from Wertz's Natural Science Establishment, LLC (www.wertz.com)  
<sup>\*\*</sup>De-Gen, 128 cell bio-assay tray recommended Product code : BAW128 (www.baw128.com)

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**IRAC METHOD # 018:**  
**Plutella larvae**

IRAC Susceptibility Test Methods Series  
Method No: 018

**Method:** IRAC No. 018  
**Status:** Approved  
**Species:** Diamondback Moth (*Plutella maculipennis*)  
**Species Stage:** Larvae (L1)

This method is specifically recommended by the IRAC Diamond Working Group for evaluating the susceptibility status of insecticides (IRAC MoA 2B)<sup>\*\*</sup>.  
This method is also suitable for the following insecticide classes (IRAC MoA class):

**Product Class:** Organophosphate (1B)<sup>\*</sup>, Pyrethroid (3A)<sup>\*</sup>, Diamide (2B)<sup>\*\*</sup>, Spiroacetyl (5)<sup>\*</sup>, Avermectin (6)<sup>\*</sup>, Juvenile Hormone Mimics (7A)<sup>\*\*</sup>, Fenoxycarb (7B)<sup>\*\*\*</sup>, Benzyl urea (15)<sup>\*\*\*</sup>, Diazinyl (15)<sup>\*\*\*</sup>, Indoxacarb (22A)<sup>\*</sup>, Metathiazinone (22B)<sup>\*</sup>, Pyridyl (un)<sup>\*</sup>

**Comments:** Mortality assessment period may vary depending on insecticide mode of action. The following guidelines may be used:  
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<sup>†</sup>Available from Wertz's Natural Science Establishment, LLC (www.wertz.com)  
<sup>\*\*</sup>De-Gen, 128 cell bio-assay tray recommended Product code : BAW128 (www.baw128.com)

**IRAC METHOD # 019:**  
**Aphid adults & nymphs**

IRAC Susceptibility Test Methods Series  
Method No: 019

**Method:** IRAC No. 019  
**Status:** Approved  
**Species:** Potato Aphid (*Aphis persicae*), Green Peach Aphid (*Melanocorypha brassicae*)  
**Species Stage:** Adults and Nymphs

This method is specifically recommended by the IRAC Diamond Working Group for evaluating the susceptibility status of insecticides (IRAC MoA 2B)<sup>\*\*</sup>.  
This method is also suitable for the following insecticide classes (IRAC MoA class):

**Product Class:** Organophosphate (1B)<sup>\*</sup>, Pyrethroid (3A)<sup>\*</sup>, Diamide (2B)<sup>\*\*</sup>, Spiroacetyl (5)<sup>\*</sup>, Avermectin (6)<sup>\*</sup>, Juvenile Hormone Mimics (7A)<sup>\*\*</sup>, Fenoxycarb (7B)<sup>\*\*\*</sup>, Benzyl urea (15)<sup>\*\*\*</sup>, Diazinyl (15)<sup>\*\*\*</sup>, Indoxacarb (22A)<sup>\*</sup>, Metathiazinone (22B)<sup>\*</sup>, Pyridyl (un)<sup>\*</sup>


**Comments:** Mortality assessment period may vary depending on insecticide mode of action. The following guidelines may be used:  
\*96 hour assessment period  
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For the purposes of this methodology the density of water is assumed to be 1.00g/ml

**Description:** Distilled water, mixing bowl, weighing scales (0.001g accuracy), syringes/pipettes and beakers/teal tubes for making dilutions, artificial diet (Storely Heliothis Premix Diet Formula)<sup>†</sup>, 10-20mm diameter well plates with sealable lid<sup>†</sup>, protective gloves, artist's paintbrush, the forceps or seeker, binocular microscope or hand lens (optional), maximum/minimum thermometer.

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**New *Tuta absoluta* poster from the IRAC Lepidoptera WG**

As described in the poster, *Tuta absoluta* is a pest of great economic importance in a number of countries. Its primary host is tomato, although potato, aubergine, common bean, and various wild solanaceous plants are also suitable hosts. Pests like *Tuta absoluta*, with high reproduction capacity and short generation cycle, are at higher risk of developing resistance to insecticides. This risk increases significantly when management of the pest relies exclusively on chemical control with a limited number of effective insecticides available. The new *Tuta absoluta* poster gives some background to the development of this pest as a major problem and outlines recommendations for integrated control measures and the management of resistance.



**IRAC**  
Insecticide Resistance Action Committee

## The Tomato Leafminer, *Tuta absoluta*

### Recommendations for Sustainable and Effective Resistance Management


[www.ircac-online.org](http://www.ircac-online.org)

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#### Tuta absoluta, an Aggressive Pest with High Risk of Insecticide Resistance Development

*Tuta absoluta* (Meynrick) (Lepidoptera: Gelechiidae) is a pest of great economic importance in a number of countries. Its primary host is tomato, although potato, aubergine, common bean, and various wild solanaceous plants are also suitable hosts. *T. absoluta* is characterized by high reproduction potential. Each female may lay up to 300 eggs and 10-12 generations can be produced each year. In tomato, it attacks all plant parts and crop developmental stages, although the larvae prefer apical buds, tender new leaflets, flowers, and green fruits and can cause up to 100% crop destruction.


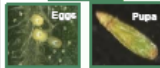
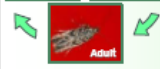
This pest is crossing borders and devastating tomato production in protected and open fields. Originally from Latin America, *T. absoluta* has recently spread to Europe, North Africa and the Middle East. Given its aggressive nature and crop destruction potential, it has quickly become a key pest of concern in these new geographies.



**Risk for Insecticide Resistance Development:** Pests like *Tuta absoluta*, with high reproduction capacity and short generation cycle, are at higher risk of developing resistance to insecticides. This risk increases significantly when management of the pest relies exclusively on chemical control with a limited number of effective insecticides available. This situation usually leads to increase in the frequency of use and thus, increase in the selection pressure. In fact, field populations of *T. absoluta* resistant to a range of mode of action groups are already known from L. America countries, where this has been a key pest for decades.

**Local Evaluation of Insecticidal Efficacy:** *T. absoluta* populations in Europe, Middle East and N. Africa were most likely imported from L. America and thus, may already express high level of resistance to one or multiple mode of action groups. It is therefore essential to first evaluate the efficacy of each insecticide for the control of *Tuta absoluta* in each geography before specific recommendations are made for their use within IPM (Integrated Pest Management) and IRM (insecticide Resistance Management) programs.

#### Insect Description and Life Cycle

*Tuta absoluta* is a micro lepidopteran insect. The adults are silvery brown, 5-7 mm long. The total life cycle is completed in an average of 24-40 days, with the exception of winter months, when the cycle could be extended to more than 60 days. The minimal temperature for biological activity is 9°C.

After oviposition, females lay individual small (0.35 mm long) cylindrical creamy yellow eggs. Recently hatched larvae are light yellow or green and only 0.5 mm in length. As they mature, larvae develop a darker green color and a characteristic dark band posterior to the head capsule. Four larval instars develop. Larvae do not enter diapause when food is available. Pupation may take place in the soil, on the leaf surface or within mines. *Tuta absoluta* can overwinter as eggs, pupae or adults depending on environmental conditions.

Larval Developmental Time at Different Temperatures	
14°C	76 days
20°C	49 days
27°C	24 days

#### Insecticide Resistance Management

**Resistance status in L. America vs. Europe, N. Africa, and Middle East:** In L. America, high level and widespread resistance is known to exist in field populations of *T. absoluta* mainly to organophosphates (MoA group 1B), synthetic pyrethroids (MoA group 3), and benzoylureas (MoA group 15). However, resistance has also developed to newer classes of insecticides. Because it is likely that resistant populations from L. America may have spread to Europe, N. Africa and the Middle East, it is urgent that regional technical experts understand the susceptibility profile of *T. absoluta* field populations to the available insecticides so that local recommendations can be made.

**Evaluation of Insecticide Susceptibility:** IRAC has a standard "leaf dip" larval bioassay method to assess susceptibility of field populations to insecticides. Please, refer to IRAC method No. 022 on the IRAC Website (<http://www.ircac-online.org/teams/methods>).

**Insecticide Resistance Management (IRM):** The recommendations for sustaining the effectiveness of available insecticides is centred on integration of as many pest management tools as possible, use of insecticides only when needed and based on established thresholds, and rotation of effective insecticides with different modes of action.

**Mode of Action (MoA) Window Approach:**

- The basic rule for adequate rotation of insecticides by MoA is to avoid treating consecutive generations of the target pest with insecticides in the same MoA group, by using a scheme of "MoA treatment windows".
- A treatment window is here defined as a period of 30 consecutive days, based on the minimum duration of single generation of *T. absoluta*.
- Multiple applications of the same MoA may be possible within a particular window (follow label for maximum number of applications within a window and per crop cycle).
- After a first MoA window of 30 days is completed and if additional insecticide applications are needed based on established thresholds, a different and effective MoA should be selected for use in the next 30 days (second MoA window). Similarly, a third MoA window should use yet another MoA for the subsequent 30 days etc.
- The proposed scheme seeks to minimize the selection of resistance to any given MoA group by ensuring that the same insecticide MoA group will not be re-applied for at least 60 days after a window closes, a wise measure given the potential of a longer life cycle based on temperature fluctuations throughout the growing season.
- This scheme requires a minimum of three effective insecticide MoA groups but ideally more MoA groups should be included. If locally registered and effective against *T. absoluta*.

Example: Insecticide Mode of Action (MoA) "Window" Approach – 150 day cropping cycle			
0-30 days	30-60 days	60-90 days	90-120 days
Insecticide MoA x	Do not apply MoA x	Insecticide MoA x	Do not apply MoA x
Do not apply MoA y	Insecticide MoA y	Do not apply MoA y	Insecticide MoA y
Do not apply MoA z	Insecticide MoA z	Do not apply MoA z	Insecticide MoA z


Sequence of Mode of Action (MoA) Windows throughout the season

Note: For a comprehensive list of existing insecticides classified by MoA group visit the IRAC website (<http://www.ircac-online.org/teams/methods>). In the "window rotation scheme", use as many effective MoA groups as locally registered available and always follow product labels for specific directions of use.

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#### Key Management Strategy Integration of Control Measures

The basis for an effective and sustainable management of *Tuta absoluta* is the integration of preventive sanitary measures with effective non-chemical and chemical tools.




**Key Management Tactics**

- Use pest-free transplants
- Prior to transplanting, install yellow sticky traps
- Monitor pest using data pheromone indicator traps
- Between planting cycles, cultivate the soil and cover with plastic mulch or perform solarisation
- Allow a minimum of 6 weeks from crop destruction to next crop planting
- Seal greenhouse structure with high quality nets (screen size = 9x6 cm<sup>2</sup>)
- Inspect the crop regularly to detect the first signs of damage
- For massive trapping, use water + oil traps (20-40 traps/ha)
- Constantly, remove and destroy attacked plant parts and all plant refuse
- Control weeds to prevent multiplication in alternative host
- Establish populations of effective biological control agents (e.g. *Nesidiocoris tenuis*)
- Use locally established thresholds to trigger insecticide applications
- Select insecticides based on known local effectiveness and selectivity
- Rotate insecticides by mode of action group (MoA), using a window approach
- Use only insecticides registered for control of *T. absoluta*
- Always follow the directions for use on the label of each product

#### Damage and Symptoms

Infestation of tomato plants occurs throughout the entire crop cycle. Feeding damage is caused by all larval instars and throughout the whole plant. On leaves, the larvae feed on the mesophyll tissue, forming irregular leaf mines which may later become necrotic. Larvae can form extensive galleries in the stems which alter the general development of the plants. Fruits are also attacked by the larvae, forming galleries which represent open areas for invasion by secondary pathogens, leading to fruit rot. Potential yield loss (quantity & quality) is significant and if the pest is not managed, can reach 100% in tomatoes.



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This poster is for educational purposes only. Details are accurate to the best of our knowledge but IRAC and its member companies cannot accept responsibility for how this information is used or interpreted. Advice should always be sought from local experts or advisors and health and safety recommendations followed.

Designed & produced by the IRAC Lepidoptera Working Group. Also refer to IRAC Spain brochure "Prevención de resistencias en *Tuta absoluta* (April 2009) [http://www.ircac-online.org/ircac\\_spain](http://www.ircac-online.org/ircac_spain)

May 2010, Poster Version 1.0 For further information visit the IRAC website: [www.ircac-online.org](http://www.ircac-online.org)  
 Photographs courtesy: Bayer CropScience, DuPont Crop Protection & M. Shepard, GR-Camer, PACO Co., Insects & their Nature Enemies Associated with Vegetables & Soybean in SE Asia, Dagwood.org

**Proposed Integration of IRAC and the other RACs into CropLife International**

IRAC is an inter-company organisation operating as a Specialist Technical Group under the umbrella of CropLife International. It was formed in 1984 to provide a coordinated crop protection industry response to prevent or delay the development of resistance in insect and mite pests. As resistance management has become increasingly important as an integral part of IPM and Good Product Stewardship, IRAC has grown in terms of numbers of member companies and scope of activities and projects undertaken. It has now been proposed that IRAC along with the other RACs should be fully integrated with CropLife International under the Product Stewardship Committee to ensure that there is a proper legal and financial structure for operation and full compliance to processes and procedures such as rules on anti-trust. Discussions are ongoing but the IRAC Executive Committee have voted in favour of the change which will most likely come into force in 2011.

### Conferences & Symposia

- IUPAC Pesticide Chemistry, Melbourne, Australia, July 4-8, 2010
- 55<sup>th</sup> Am. Assoc. Veterinary Parasitologists, Atlanta, GA, August 8-13th, 2010
- IXth European Congress of Entomology (ECE2010), Budapest, Hungary, August 22-27, 2010
- XIII International Congress of Acarology, Recife, Brazil, August 23 - 27, 2010
- Entomological Society of Israel, Israel, October 7th, 2010
- Entomological Society of Canada & British Columbia, Vancouver, October 11-14, 2010
- British Crop Protection Council "CropWorld" Congress, London, UK, November 1-3, 2010
- Entomological Society of America, San Diego, CA, December 12-16, 2010

### Feedback

The eConnection is prepared by the IRAC Communication & Education WG and supported by the 15 member companies of the IRAC Executive. If you have information for inclusion in the next issue of eConnection or feedback on this issue please email [aporter@intraspin.com](mailto:aporter@intraspin.com).

### IRAC Executive Member Companies



#### Disclaimer:

The Insecticide Resistance Action Committee (IRAC) is a specialist technical group of CropLife. Information presented in this newsletter is accurate to the best of our knowledge but IRAC and its member companies cannot accept responsibility for how this information is used or interpreted. Advice should always be sought from local experts or advisors and health and safety recommendations followed.