IRAC

Insecticide Resistance Action Committee

TUTA TASK TEAM UPDATE

International IRAC Mtg

Philadelphia, PA USA

March 2017

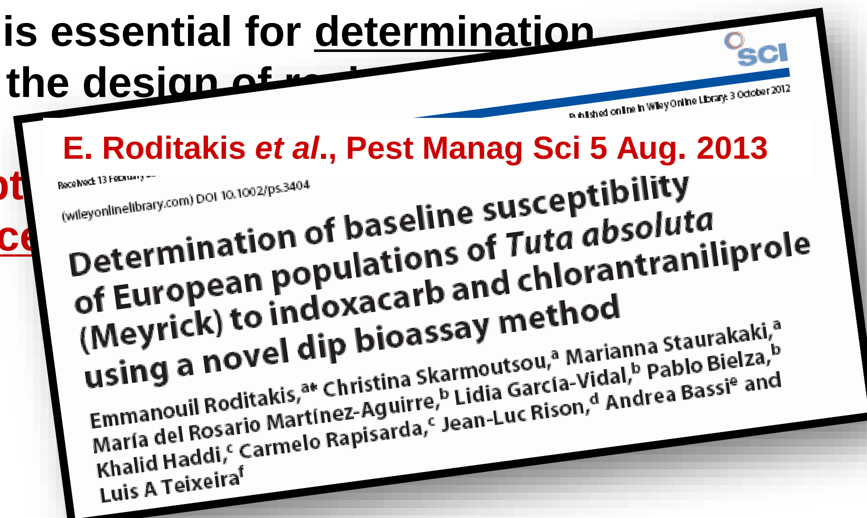
Abundant, Good-Quality Technical Info Available

Early years:
Focus on Spain and Italy

Sensitivity bioassays results (IRAC method 022)

Sensitivity bioassays (*T. absoluta* baseline)

- The development of a robust bioassay is essential for <u>determination of baseline toxicity</u> of insecticides and the design of re… monitoring surveys.
- <u>Determine the product baseline suscept… populations from Spain, Italy and Greece</u>


SCI

Published online in Wiley Online Library: 3 October 2012

E. Roditakis *et al*., Pest Manag Sci 5 Aug. 2013

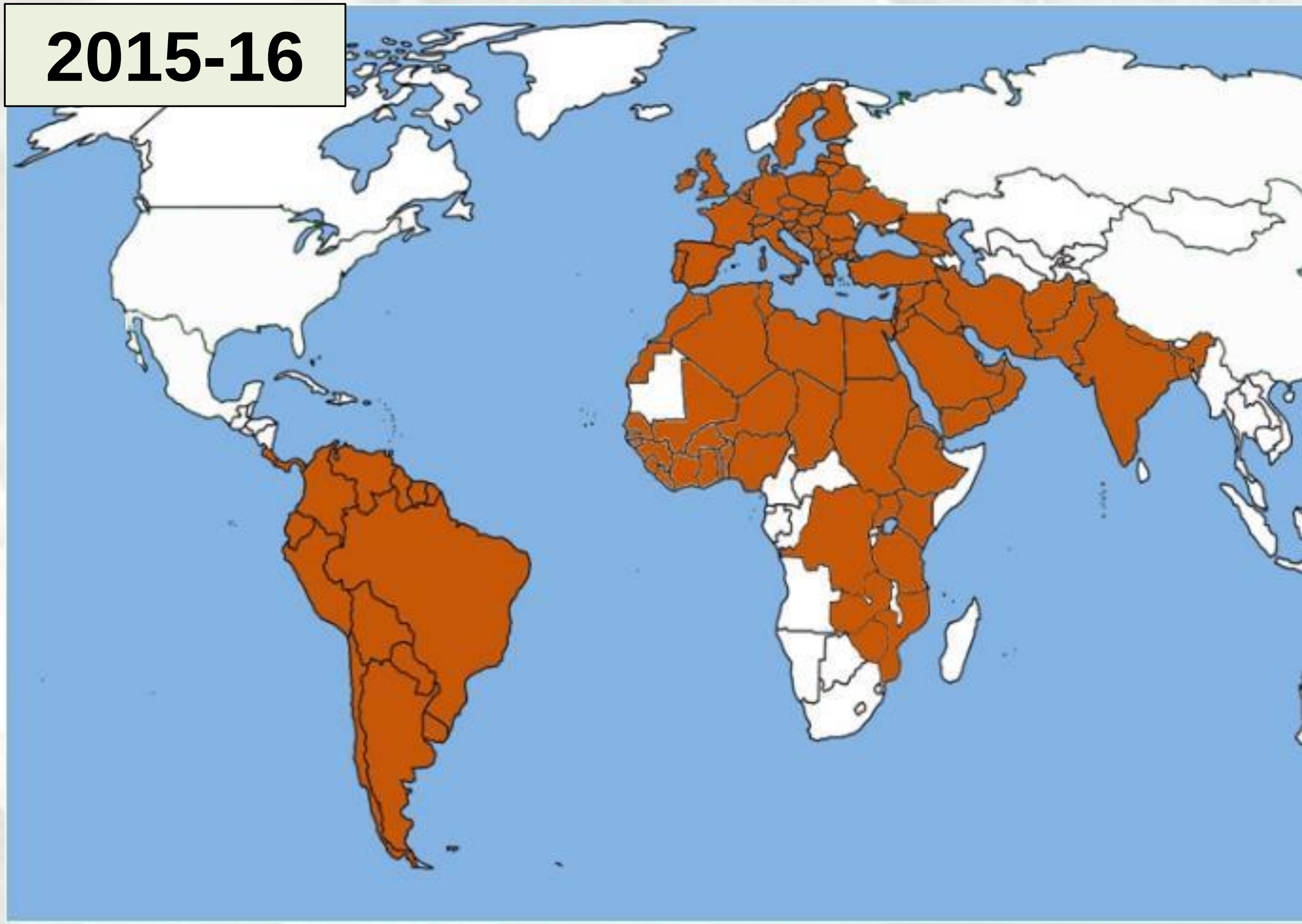
Received: 13 February …
(wileyonlinelibrary.com) DOI 10.1002/ps.3404

Determination of baseline susceptibility of European populations of *Tuta absoluta* (Meyrick) to indoxacarb and chlorantraniliprole using a novel dip bioassay method

Emmanouil Roditakis,[a*] Christina Skarmoutsou,[a] Marianna Staurakaki,[a] María del Rosario Martínez-Aguirre,[b] Lidia García-Vidal,[b] Pablo Bielza,[b] Khalid Haddi,[c] Carmelo Rapisarda,[c] Jean-Luc Rison,[d] Andrea Bassi[e] and Luis A Teixeira[f]

Tuta presence and pest status globally.

2015-16



Antonio BIONDI, Lucia Zappalà, Giovanna Tropea Garzia, Gaetano Siscaro; University of Catania, ITALY antonio.biondi@unict.it

In 10 years from 3% to 60% of tomato crops

2.8 million hectares

IRAC

2014-15

J Pest Sci
DOI 10.1007/s10340-015-0643-5

RAPID COMMUNICATION

First report of *Tuta absoluta* resistance to diamide insecticides

Emmanouil Roditakis · Emmanouil Vasakis · Maria Grispou · Marianna Stavrakaki · Ralf Nauen · Magali Gravouil · Andrea Bassi

Tuta Resistance: Tale of Two Countries

Grower Practices Determine Pest Susceptibility

- growers trained on similar IRM recommends and training materials

SPAIN	SICILY-ITALY
Dedicated technicians who scout and advise	Few advisors
Mandated release of bio control agents	Uncommon Practice
Extensive use of physical/cultural control measures: adult traps, solarization, sanitation	Mostly ignored
Attention to renovating GH's to exclude Tuta	Apathetic - Passive
Depend on multiple Modes of Action	Highly dependent on diamides
More effective different MoA products available	Fewer product available (lost to "R")

2016 Lepidoptera Working Group Company Team Members

10 Crop Protection Company Members Represented: 4 Companies Volunteered – Core Team

NAMES	COMPANY
Adeline Bertrand, Sebastian Coggiol	ADAMA
Werner Heck, Lixin	BASF
Nigel Godley, Ralf Nauen	Bayer
Jim Dripps, Maria Torne	Dow
Luis Teixeira, John Andaloro, Andrea Bassi	DuPont
Eric Andersen	FMC
Nobuyuki Nonaka	Nihon Nohyaku
Brian Duggan	Nufarm
Robert Senn, Jan Elias	Syngenta
Daniel Zommick	Sumitomo

IRAC Tuta Task Team

Overall Objective of the Tuta Task Team Project:

Provide cross-industry advice for best practice Tuta insect control in selected Europe, Middle East, and African countries by designing a regional Tuta pest control program that will be adapted, communicated and implemented locally to influencers, growers, and the industry supply chain.

- **Tuta Pest Management Practices**
- **Tuta IRM Recommends**

2016 Core and Extended Tuta Task Team

COMPANY	CORE MEMBERS	EXTENDED MEMBERS
BASF	Cesar Blanco Ruiz	
Dow	Maria Torne	Aris Chloridis Enzo Tescari
DuPont	Luis Teixeira John Andaloro Stefano Pasquini	Jean-Luc Rison Ümit Ersöz David de Scals Christos Theocharis
Syngenta	Robert Senn Stefano Ramella	Desiree van Heerden Pedro Vega Radwan Ftayeh Sinisa Jelovcan
Experts - Spain	Antonio Monserrat Pablo Bielza	

IRAC Tuta Task Team Project:
Focus Countries

Local Help from CRAG Teams

Existing Country IRAC and Resistance Action Groups (former Diamide teams) in Focus Countries

Spain	IRAC/CRAG
Italy	CRAG
Turkey	CRAG
Israel	CRAG
Morocco	CRAG
Rep S. A.	IRAC/CRAG

IRAC Tuta Task Team Project

PROCESS

- ✓ Numerous teleconferences throughout 2016
- ✓ Collected, collated, and wrote Tuta pest management, IPM, and IRM recommendations
- ✓ Identified and involved team leaders for focus countries.
- ✓ Two day organizing mtg in Malaga Spain
  - visited Spain greenhouses for clarity
  - developed a plan for local implementation in 2017/18
  - finalized educational/technical documents – Jan 2017
- ✓ ***Now developing a country interaction and audit plan***

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Insecticide Resistance Action Committee

Best Management Practices to Control *Tuta absoluta* and Recommendations to Manage Insect Resistance

IRAC *Tuta* IRM Task Team

2017 Version 6





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JTA 2017

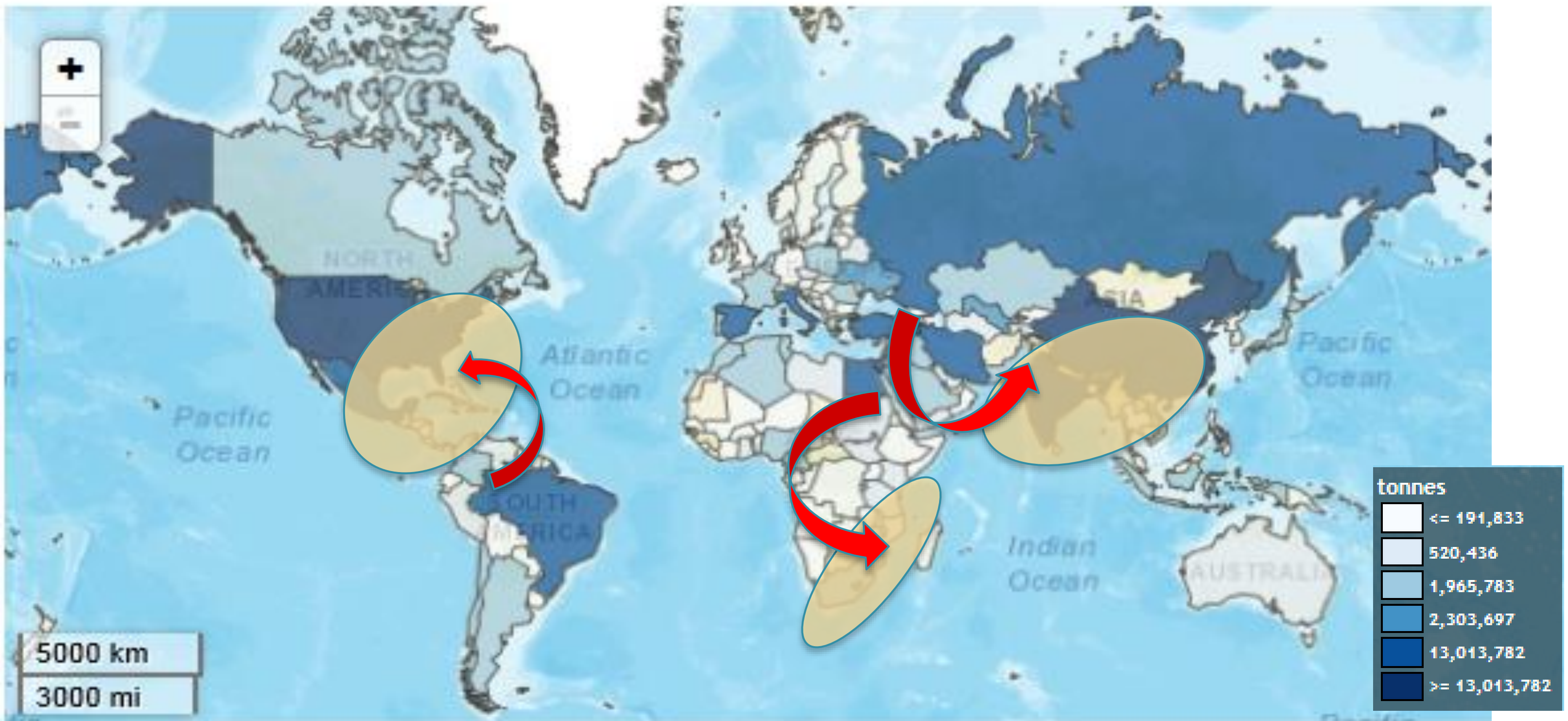
TABLE OF CONTENTS (140 page slide set)

1. Update Tuta presence and pest status globally.

Possible areas under risk of pest spread

Main world tomato production areas at risk

Production quantities by country   Average 2008 - 2014



FAO stats2016

- **Confirmation of presence in India and Middle east makes Afganistan, Pakistan, India, Nepal and China as risk areas (**Nepal: "Sensitizing workshop on *Tuta absoluta*: An impending threat to tomato production" 2015 Sponsored by IAPPS)
- **Actions at OIRSA (International Regional Organization for Agricultural Health) Including : El Salvador, Costa Rica Honduras, Guatemala, Mexico, Belice, Nicaragua and Panamá**
- **Presence in Kenia and Tanzania makes that Mozambique, Malawi, Zimbabwe, Zambia, Botswana as well as South Africa are at risk**

2.

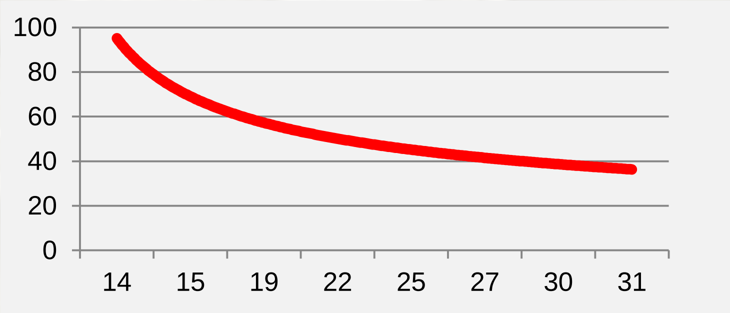
Tuta aboluta Life Cycle

Egg
3 - 8 d

Larva
9 - 30 d

Pupa
6 - 20 d

Adult
6 - 15 d ♂
10 - 25 d ♀



- *Egg to adult*: 25 - 80 days
- *Thermal threshold for juvenile development*
  - lower: 10 > x < 13 °C
  - upper: 30 > x < 35 °C

(Various authors;Cuthbertson et al. 2013)

- *Up to 13 generations per year*
- *Good cold resistance*
  - supercooling points: larvae (-18.2°C), pupae (-16.7 °C), adults (-17.8°C)
  - the lower lethal temps for adults at 0°C (17.9 d), 5°C (27.2 d)

(Van Damme et al. 2015)

Antonio BIONDI, Lucia Zappalà, Giovanna Tropea Garzia,
Gaetano Siscaro University of Catania, ITALY; antonio.biondi@unict.it

2.

Tuta absoluta: Typical Damage

***Leaf damage* up to 100%)**
Decrease photosynthesis and yields

***Tuta absoluta* Fruit Damage**

Antonio BIONDI, Lucia Zappalà, Giovanna Tropea Garzia, Gaetano Siscaro University of Catania, ITALY; antonio.biondi@unict.it

3. Tuta control products, resistance publications, and method to evaluate efficacy.

IRAC Susceptibility Test Methods Series

Version: 3

Method No: 022

Details:

Method:	**No: IRAC No. 022**
Status:	**Approved**
Species:	***Tuta absoluta***
Species Stage	**Larvae L2 (size: 4-5 mm)**
Product Class:	**Oxadiazins (IRAC MoA 22), anthranilic diamides (IRAC MoA 28), spinosyns (IRAC MoA 5)**

***Tuta absoluta* larva**

Photograph Courtesy of: DuPont Crop Protection

Comments:

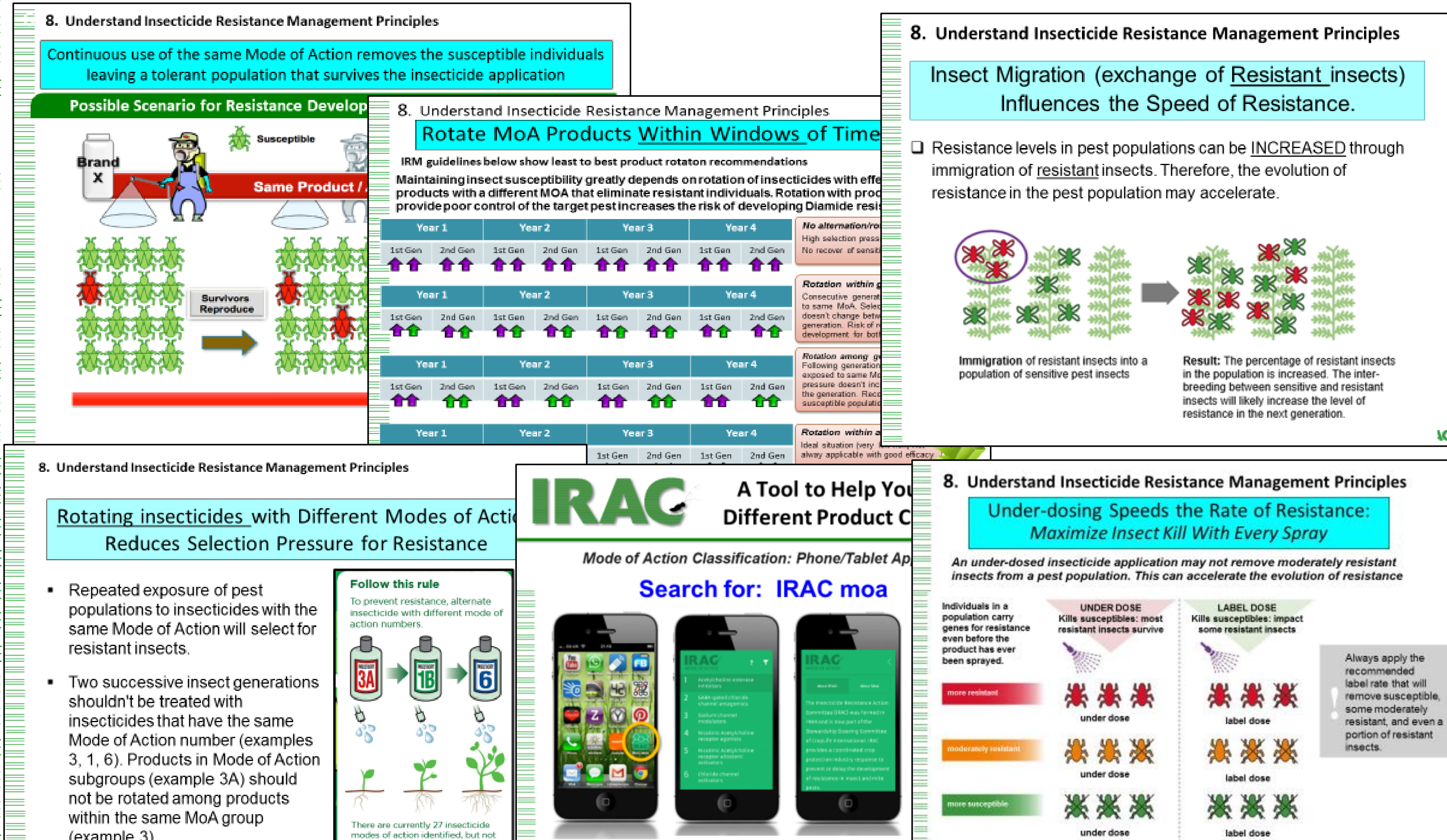
In order to obtain homogeneous *Tuta absoluta* larvae (same age, nutritional and general health condition), it is highly recommended that insects collected from the field (F_0 generation) are brought to a laboratory and reared to the F1 generation for evaluation of insecticide susceptibility.

5. Integrate key Tuta control strategies

Integrated Pest Management – non chemical key tactics:

1. **GH cleaning and sanitation**
   - Prevent carry over of the pest from the previous crop; sanitation of the GH for a better start; use pest-free transplants; remove and destroy attacked part plants
2. **Physical control - Insect exclusion**
   - GH modern structures; insect netting; double doors; climate control
3. **Cultural control - Mass trapping**
   - Water/oil based and sticky traps pheromone-baited
4. **Biocontrol – Natural enemies**
   - Establish populations of effective biological control agents; select crop protection spray programs safe vs beneficials
5. **Mating disruption**
   - Mating disruption contribution when low density population of *T. asboluta*

8. Understand Insecticide Resistance Management PRINCPLES



Implementing IPM Removes Resistant Individuals from the Population and Improves Level of Pest Control

Reproductive Capacity Influences the Speed of Resistance

Acquiring the highest level of pest control within a generation removes Resistant genes.

IRM Recommendations for Tuta absoluta on Tomato - 1

- **Practice Integrated Pest Management**
  - Remove and destroy infested cull tomatoes and plant material
  - Remove all wild Solanaceous and other host plants near greenhouse
  - Rennovate greenhouse to exclude Tuta adults
  - Use phermones and sticky traps to monitor and mass trap adults
  - Augment and conserve natural enemy populations
  - Apply entomopathic nematodes (*Steinernema feltiae*) in a foliar spray
  - Use optimal spray volume, maintain and calibrate spray equipment
  - Treat large areas to same MoA
  - CALIBRATE/ MAINTAIN sprayers. Clean/replace nozzles.

- **Apply insecticides at economic pest thresholds**
  - Follow locally established economic pest thresholds for the application of foliar insecticides in order to optimize insecticide use.
  - Always use labeled rates and water volumes.

- **Use windows of insecticide application**
  - Use windows of application to minimize exposure of sequential generations of a insect pest species to the same insecticide modes of action.
  - Each window should be approximately 30 days.

- **Rotate insecticides with different MoA.**
  - If more than one insecticide application is required during an application window then it is recommended to use an insecticide with a different MoA.
  - Multiple applications of insecticides with the same mode of action within a single window are acceptable as long as combined effects (residual activity) of the applications do not exceed approximately the 30-day window.

- **Maximum Number of MoA Applications**
  - It is preferred to use the same MOA products in only 2 windows per seasn
  - Aoid using the same Mode of Action products in more than 3 windows.

- **Insecticide mixtures**

  Tank mixing products:
- Do not tank-mix insecticide products with the SAME MoA.
- When tank-mixing insecticide products with DIFFERENT MoA's, follow label rates for each insecticide.
- Respect maximum number of applications, PHI and REI stated in the label of each product.
- Product(s) applied on subsequent window/pest generation should have an MoA that is different from both tank-mix partners.

- **Avoid insecticides with Tuta resistance**

  Consult with local experts to determine which insecticides are affected by resistance in your locality. A preference to insecticides which are not affected by resistance should be given.

- **Preserve non-target & beneficial organisms**

  The use of selective insecticides with reduced impact on non-target and beneficial organisms is recommended whenever possible.

- **Manage the removal of in-season infested stems and fruit**

  In addition to practicing clean sanitation pre and post season it is critical to remove and destroy plant stems pruned during the season and all cull/waste tomato after each harvest.

- **Rotate crops and Incorporate a Host Free Period**
  - Subsequent crop plantings should be of a different crop type, which is not a host to the insects which are pests of Tuta.
  - Institute an area-wide fallow period where only non-host crops to Tuta can be planted disrupting the life cycle of Tuta.

IRM Recommendations for Tuta absoluta on Tomato - 2

MULTIPLE MoA PRODUCTS AVAILABLE
Different MoA products can be used in the **same** window but they must be rotated to different MoA products in the next window.

Gen 1	Gen 2	Gen 3
MoA **A & B**	MoA **C & D**	MoA **A & D**

FEW MoA PRODUCTS AVAILABLE
Apply products with the same MoA in the **same** window.

Gen 1	Gen 2	Gen 3
MoA **A & A**	MoA **B & B**	MoA **C & C**

- **Rotating products with different Modes of Action delays resistance.** Don't apply the same Mode of Action continuously:
  - Rotate insecticides with different modes of action using the window approach to minimize exposure of sequential generations of a pest species to the same insecticide MoA.
  - Each "treatment window" should be approximately 30 days.
  - Multiple applications can be made in a window:
    - If more than one insecticide application is required then attempt to use an insecticide with a different mode of action.
    - Multiple applications of insecticides with the same mode of action within a single window are acceptable if their combined residual activity does not exceed approximately the 30-day window.
  - After a "treatment window" of approximately 30 days rotate to a window with different MoA products for approx 30 days.. Allow at 30-60 days before applying the same mode of action again.
- For crops longer than approx. 100 days, use the same MoA products in only 2 windows per season
- For crops less than approx 100 days then use same MoA products in only one window within the crop cycle.
  A short cycle crop (< 50 days) is a "treatment window". Rotate products with different MoA in the next planting.
- Don't treat the crop for more than approximately 50% of the cropping season or 50% of the total number of applications with same MoA

IRM Recommendations for Tuta absoluta on Tomato - 3

- **Select insecticides based on known local effectiveness and selectivity to beneficials**.
    - Know the attributes of your pest control products (adulticide, ovicide, larvicide, safety to beneficials, residual, spectrum)
    - Use larvicides to treat young larvae
    - Do not underdose. Follow label rates and intervals
    - Use surfactants (wetting agents) to assure better coverage or methylated seed oil to acquire leaf cuticle penetration. Surfactants may be important to improve the activity of some insecticides.
    - In high populations combine larvicide with adulticide or ovicidal product

- **Use sufficient spray volume.**
    - Maximize coverage to maximize pest kill

- **Whenever possible, use products and mixes that are selective and conserve natural enemies and pollinators**
    - Conserve natural enemies early season so they can assist in pest control season-long.
    - Use B.t's and non-chemical products against low Tuta populations.

- **Stop using products that are not providing good efficacy. Try that product again next season.**
- **Ideal to treat large areas with the same mode of action product and follow the same window rotation strategy**
- **Tank mix insecticides to control different life stages and manage pest populations.**
- **Rotate solanaceous crops with crops that are not a host to Tuta**.

9. Implement Insecticide Resistance Management Strategies

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Insecticide Resistance Action Committee

Example: Application Windows for Tuta absoluta on Tomato

Do not to use the same insecticide MoA used in a previous window

	Window 1	Window 2	Window 3	Window 4	Window 5	Window 6
	Insecticides A....A or A....B or A.....B....C	Insecticide D....D or D....E or D....E.....F	Insecticide A....A or A....B or A....B....C	Insecticide D....D or D.....E or D....E....F	Insecticide A....A or A....B or A....B....C	Insecticides D....D or D....E or D....E....F
DAP	0 10 20 30	40 50 60	70 80 90	100 110 120	130 140 150	160 170 180
Crop Stage	11-19	51-59	61-69	71-79	81-83	84-86

Rotation of different MoA Groups

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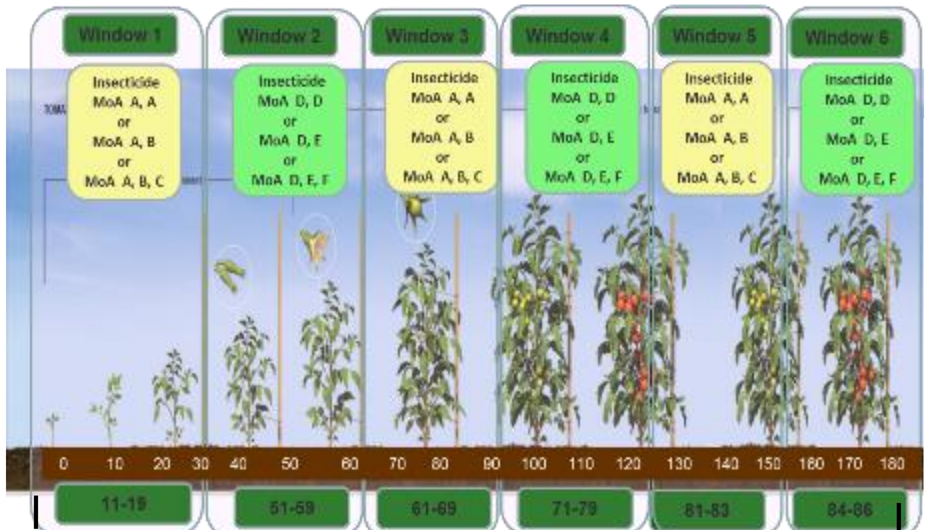
9. Implement Insecticide Resistance Management Strategies

Pest Population Control and IPM Activities



Pre-Season

- Remove cull piles
- Kill weed hosts
- Renovate GH
- Moth-proof GH (fix screens)
- Monitor adults-Ph Traps
- Choose tolerant varieties
- Use pest free transplants

During-Season

- Manage the removal of in-season infested pruned stems and fruit
- Use phermones and sticky traps to monitor and mass trap adults.
- Use phermone dispensers for Mating Disruption
- Spray entomopathic nematodes and nonchemical products that will not select for insecticide resistance.
- Augment and conserve natural enemy populations
- Use optimal spray volume, maintain and calibrate spray equipment

Post-Season

- Remove cull piles
- Kill weed hosts
- Renovate GH
- Moth-proof GH
- Solarize soil
- Rotate to non-host crop & Incorporate a host free period:
  - subsequent crop plantings should be of a different crop type, which is not a host to the insects which are pests of Tuta.
  - Institute an area-wide fallow period where only non-host crops to Tuta can be planted disrupting the life cycle of Tuta

11. Examples of country MoA alternation programs:

IRAC Spain

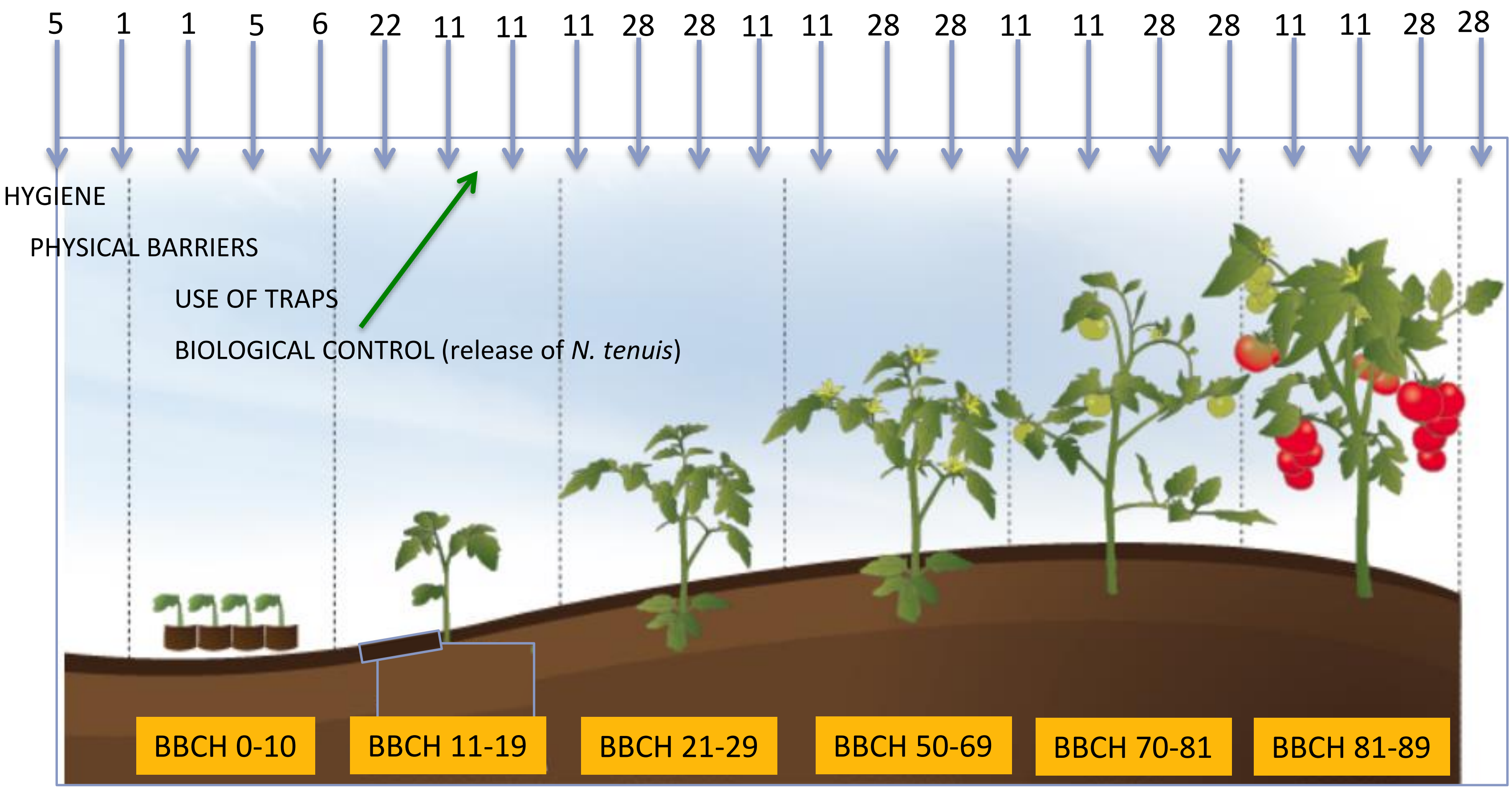
Pest control practices **(worse case scenario example):**

Example from Murcia: planting 3rd Sep 14 and crop removal 10th July 15

23 applications: 9 BT; 8 Diamides, 2 Spinosad, 1 Emamectine, 1 Indoxacarb and 2 Methomyl.

Up to 11 generations/crop cycle => shorter intervals with warm Tª and longer day light.

Product rotation in this case (by MoA):



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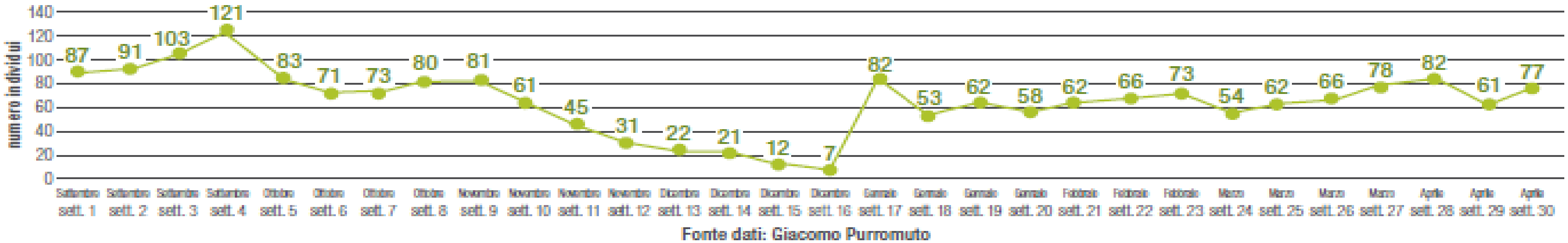
11. Examples of country MoA alternation programs:

Italy (Syngenta)

Flight example

SPRING-SUMMER CYCLE: example of sustainable program



0-30 giorni	30-60 giorni	60-90 giorni	90-120 giorni	120-150	150-180
2 applications of clorantraniliprole	2 applications of Indoxacarb	2 applications of emamectine	2 applications of *B. thuringensis*	2 applications of Indoxacarb	1 application of emamectine
			In case of more consistent infestation, make 1-2applications of *metaflumizone*		In case of persistant infestation, make also 1 application with *Spinosad*

- ➢ In case of high Tuta pressure, and with applications made with short spray interval (7-10 days), integrate the spray calendar with *B. thuringensis*)
- ➢ In case of control of other Lepidopteran species, consider insecticides with different Moz (e.g. Lufenuron – IGR)

DO NOT APPLY INSECTICIDES WITH SAME MoA WITHIN 60 DAY FROM THE LAST APPLICATION

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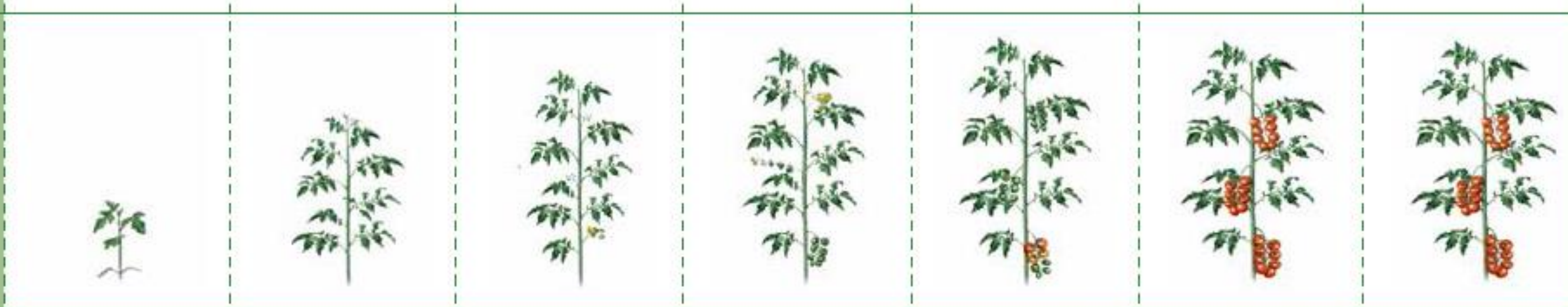
11. Examples of country MoA alternation programs:

Italy DuPont™ Greenhouse fall cycle

Descrizione stadio	Post-trapianto (prime foglie sviluppate)	Fase di preparazione palchi fiorali	Fase di fioritura	Continua fioritura e comparsa prime bacche	Colorazione bacche e inizio primi stacchi	Termine fioritura e proseguimento raccolta	Raccolta
Periodo indicativo per trapianti campagna autunnale	1 - 20 sett.	20 sett. - 10 ott.	10 - 31 ott.	1 - 30 nov.	1 dic. - 28 febb.	1 - 31 marzo	1 - 30 aprile
Caratteristiche periodo	Pianta in attiva crescita, elevata pressione *Tuta*	Pianta in attiva crescita, elevata pressione *Tuta*	Immissione bombi nelle serre	Presenza bombi nelle serre e calo pressione *Tuta*	Calo temperatura e quiescenza *Tuta*	Ripresa pressione *Tuta*	Ripresa pressione Tuta
							
Stadio BBCH	11 - 19	51 - 59	61 - 69	71 - 79	81 - 83	84 - 86	87 - 89
Prodotti e dosi per ettolitro	2 trattamenti con Steward® 12.5 g + bagnante (intervallo 10-12 gg fra primo e secondo tratt.)	2 trattamenti con Spinosad 25 ml (intervallo 10 gg fra primo e secondo tratt.)	2 trattamenti con Altacor® 12 g + Codacide® (intervallo 7-10 gg fra primo e secondo tratt.)	2 trattamenti con ememectinabenzo-ato® 150 g (intervallo 7-10 gg fra primo e secondo tratt.)	Trattamenti con *Bacillus thuringensis* (intervallo 8-10 gg fra i tratt.)	2 trattamenti con Steward® 12.5 g + bagnante (intervallo 10-12 gg fra primo e secondo tratt.)	Trattamenti con *Bacillus thuringensis* (intervallo 8-10 gg fra i tratt.) o con Spinosad in caso di infestazioni perduranti

x2	x2	x2	x2	x2/3	x2	x2/3
Group 22A Oxadiazine	Group 5 Spynosins	Group 28 Diamides	Group 6 Avermectines	Group 11 Bacillus	Group 22A Oxadiazine	Group 11 Bacillus

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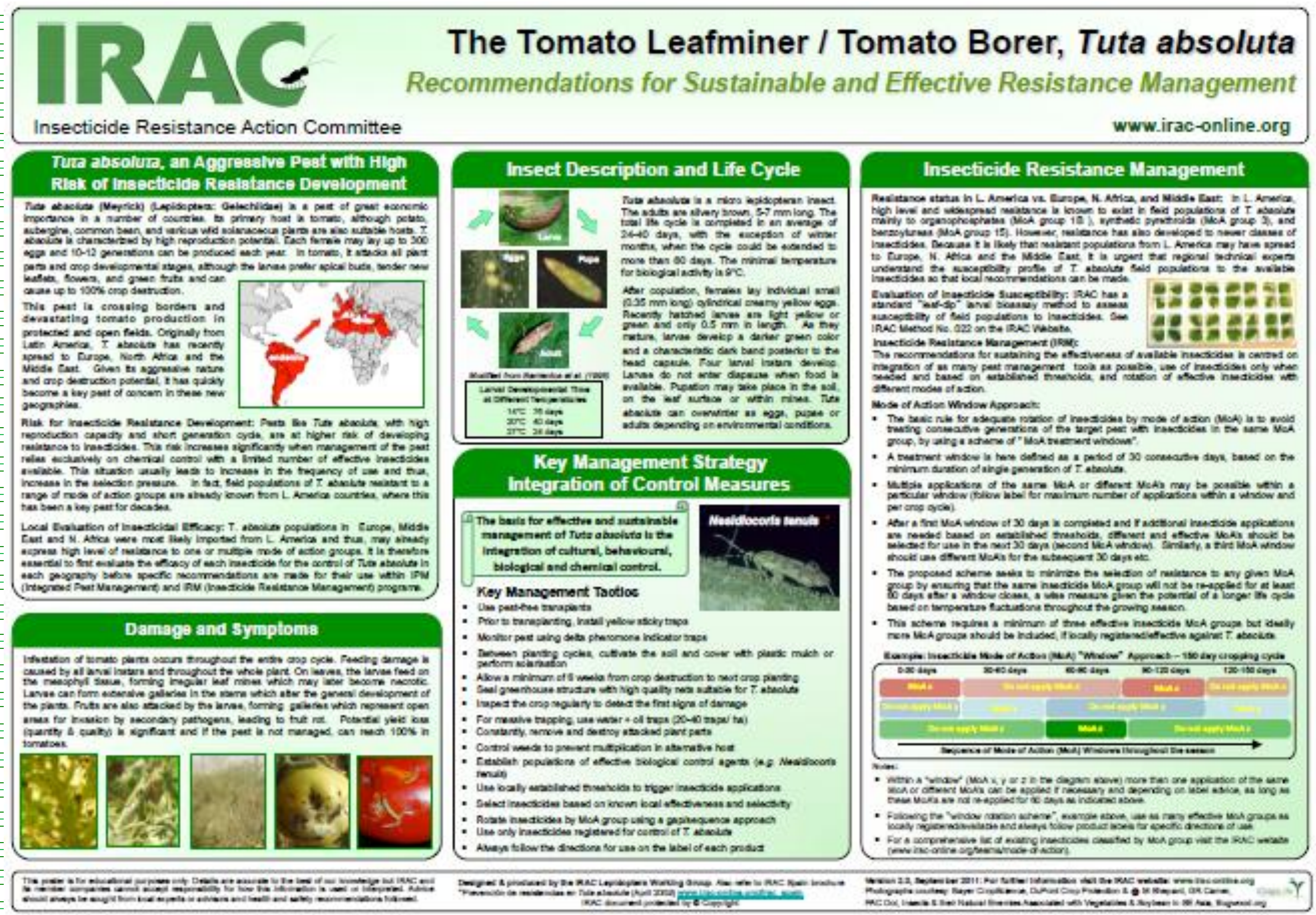
11. Examples of country MoA alternation programs:

IRAC Training Tuta Poster



12. Guidance for Locally Adapting and Implementing IRM Strategies

Checklist for country implementation teams to initiate and maintain IRM plan

Step I Organize-Meet-Align: A team of industry, university, local experts, and consultants

Step II Understand the common objectives and expectations of the team – Pick a Leader

Step III Review IRAC's Code of Conduct & Antitrust Rules

Step IV Select target locations/growers/areas of common farming practices to focus effort

Step V Adapt regional Tuta IRM BMP guidelines to local area

Step VI Develop a plan to implement the IRM BMP strategies to focus areas

Step VII Develop plan to best communicate MOA to growers and Tuta industry

Step VIII Develop plan to educate growers & the ag community

Step IX Communicate advantages of IRM & grower's responsibility to practice IRM

Step X Implement MoA communication, IRM strategies, grower/influencers education plans

Step XI Plan to take a leadership role once resistance occurs