IRAC Update

EPPO WG on Resistance

15th-17th September 2021

Changes to the Mode of action classification

- Biologicals added
  - Groups with known MoAs (Baculovirus G31)
  - UN groups for active ingredients with unknown mode of action
- New MoA groups
  - Group 30 – Meta-diamides & Isoxazolines
  - Group 33 - Acynonapyr
  - Group 34 – Flumetoquin
- New MoA sub-groups
  - Group 4F – Flupyrimin
- New posters, booklets, etc, being produced with listed changes.

New IRAC Resources

- IRM Guidelines for lepidoptera
- IRM guidelines for sucking pests
- IRM guidelines for Fall Armyworm (*Spodoptera frugiperda*)
- Update pest posters, info sheets and pest pages.
- Guidelines for mode of action and labelling and label IRM language.
- Basic IRM training module

IRM Guidelines


IRAC
Insecticide Resistance Action Committee

Insecticide Resistance Management Guidelines for Lepidopteran Pests
2019 v.2.4

IRAC Lepidopteran Working Group

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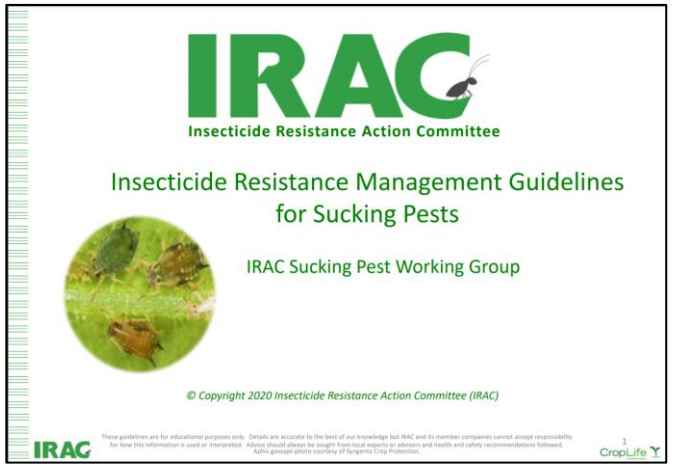
IRAC
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Insecticide Resistance Management Guidelines for Sucking Pests

IRAC Sucking Pest Working Group

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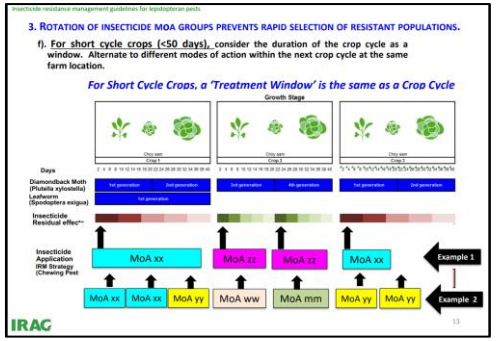

3. ROTATION OF INSECTICIDE MOA GROUPS PREVENTS RAPID SELECTION OF RESISTANT POPULATIONS.

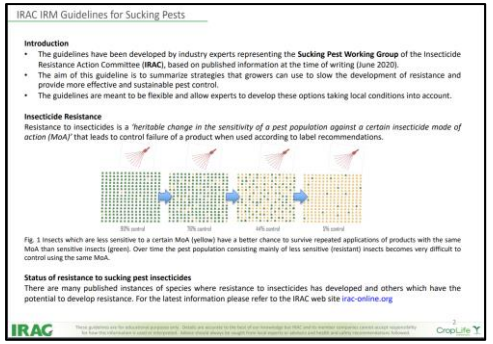
f). For short cycle crops (<50 days), consider the duration of the crop cycle as a window. Alternate to different modes of action within the next crop cycle at the same farm location.

For Short Cycle Crops, a 'Treatment Window' is the same as a Crop Cycle


4. Plan and utilize Integrated Pest management (IPM) practices to protect crops from pest damage and reduce the risk of insecticide resistance.

IPM considers all available techniques which are economic, safe, and environmentally-sound to reduce pest populations. IPM practices do not exclusively rely on insecticides, hence insecticide resistance selection pressure is reduced and the risk of resistance minimized.

IPM


IRAC IRM Guidelines for Sucking Pests

Introduction

- The guidelines have been developed by industry experts representing the **Sucking Pest Working Group** of the Insecticide Resistance Action Committee (**IRAC**), based on published information at the time of writing (June 2020).
- The aim of this guideline is to summarize strategies that growers can use to slow the development of resistance and provide more effective and sustainable pest control.
- The guidelines are meant to be flexible and allow experts to develop these options taking local conditions into account.

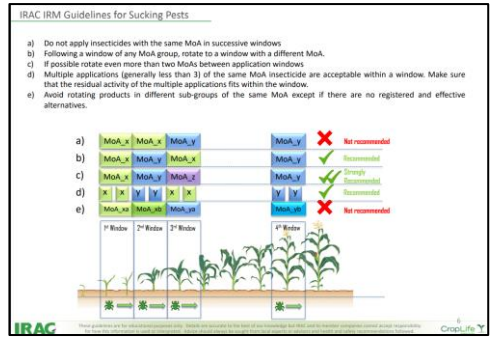
Insecticide Resistance

Resistance to insecticides is a *'heritable change in the sensitivity of a pest population against a certain insecticide mode of action (MoA)'* that leads to control failure of a product when used according to label recommendations.

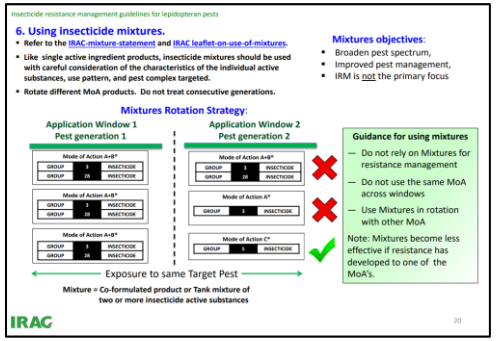
Fig. 1 Insects which are less sensitive to a certain MoA (yellow) have a better chance to survive repeated applications of products with the same MoA than sensitive insects (green). Over time the pest population consisting mainly of less sensitive (resistant) insects becomes very difficult to control using the same MoA.

Status of resistance to sucking pest insecticides

There are many published instances of species where resistance to insecticides has developed and others which have the potential to develop resistance. For the latest information please refer to the IRAC web site irac-online.org


IRAC IRM Guidelines for Sucking Pests

a) Do not apply insecticides with the same MoA in successive windows
b) Following a window of any MoA group, rotate to a window with a different MoA.
c) If possible rotate even more than two MoAs between application windows
d) Multiple applications (generally less than 3) of the same MoA insecticide are acceptable within a window. Make sure that the residual activity of the multiple applications fits within the window.
e) Avoid rotating products in different sub-groups of the same MoA except if there are no registered and effective alternatives.


6. Using insecticide mixtures.

- Refer to the IRAC-mixture-statement and IRAC leaflet-on-use-of-mixtures.
- Like single active ingredient products, insecticide mixtures should be used with careful consideration of the characteristics of the individual active substances, use pattern, and pest complex targeted.
- Rotate different MoA products. Do not treat consecutive generations.

Mixtures objectives:

- Broaden pest spectrum,
- Improved pest management,
- IRM is not the primary focus

Mixtures Rotation Strategy:

Application Window 1 Pest generation 1

Application Window 2 Pest generation 2

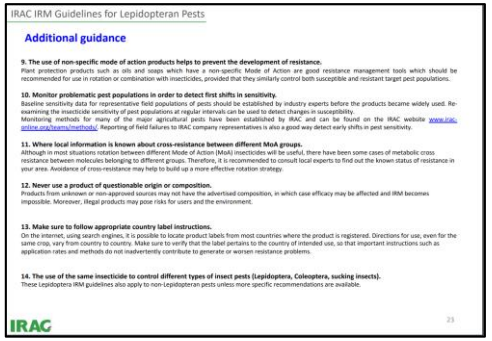
Guidance for using mixtures

- Do not rely on Mixtures for resistance management
- Do not use the same MoA across windows
- Use Mixtures in rotation with other MoA

Note: Mixtures become less effective if resistance has developed to one of the MoA's.

Exposure to same Target Pest

Mixture = Co-formulated product or Tank mixture of two or more insecticide active substances


IRAC IRM Guidelines for Lepidopteran Pests

Additional guidance

9. The use of non-specific mode of action products helps to prevent the development of resistance.
Plant protection products such as oils and soaps which have a non-specific Mode of Action are good resistance management tools which should be recommended for use in rotation or combination with insecticides, provided that they similarly control both susceptible and resistant target pest populations.

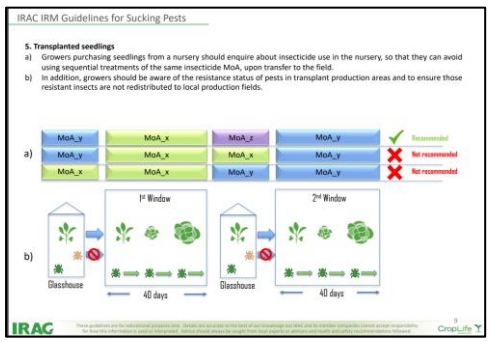
10. Monitor problematic pest populations in order to detect first shifts in sensitivity.
Baseline sensitivity data for representative field populations of pests should be established by industry experts before the products became widely used. Re-examining the insecticide sensitivity of pest populations at regular intervals can be used to detect changes in susceptibility.
Monitoring methods for many of the major agricultural pests have been established by IRAC and can be found on the IRAC website www.irac-online.org/teams/methods/. Reporting of field failures to IRAC company representatives is also a good way detect early shifts in pest sensitivity.

11. Where local information is known about cross-resistance between different MoA groups.
Although in most situations rotation between different Mode of Action (MoA) insecticides will be useful, there have been some cases of metabolic cross resistance between molecules belonging to different groups. Therefore, it is recommended to consult local experts to find out the known status of resistance in your area. Avoidance of cross-resistance may help to build up a more effective rotation strategy.

12. Never use a product of questionable origin or composition.
Products from unknown or non-approved sources may not have the advertised composition, in which case efficacy may be affected and IRM becomes impossible. Moreover, illegal products may pose risks for users and the environment.

13. Make sure to follow appropriate country label instructions.
On the internet, using search engines, it is possible to locate product labels from most countries where the product is registered. Directions for use, even for the same crop, vary from country to country. Make sure to verify that the label pertains to the country of intended use, so that important instructions such as application rates and methods do not inadvertently contribute to generate or worsen resistance problems.

14. The use of the same insecticide to control different types of insect pests (Lepidoptera, Coleoptera, sucking insects).
These Lepidoptera IRM guidelines also apply to non-Lepidopteran pests unless more specific recommendations are available.

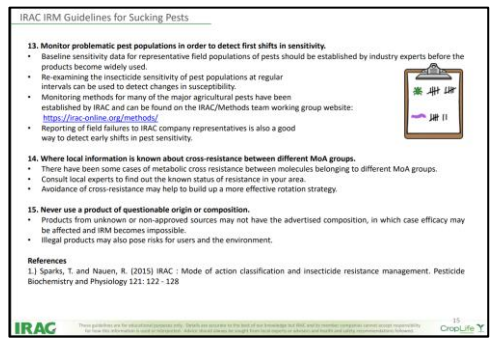

IRAC IRM Guidelines for Sucking Pests

5. Transplanted seedlings

a) Growers purchasing seedlings from a nursery should enquire about insecticide use in the nursery, so that they can avoid using sequential treatments of the same insecticide MoA, upon transfer to the field.
b) In addition, growers should be aware of the resistance status of pests in transplant production areas and to ensure those resistant insects are not redistributed to local production fields.

Recommended
Not recommended
Not recommended

1st Window
2nd Window
Glasshouse
40 days
Glasshouse
40 days


IRAC IRM Guidelines for Sucking Pests

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- Baseline sensitivity data for representative field populations of pests should be established by industry experts before the products become widely used.
- Re-examining the insecticide sensitivity of pest populations at regular intervals can be used to detect changes in susceptibility.
- Monitoring methods for many of the major agricultural pests have been established by IRAC and can be found on the IRAC/Methods team working group website: https://irac-online.org/methods/
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14. Where local information is known about cross-resistance between different MoA groups.

- There have been some cases of metabolic cross resistance between molecules belonging to different MoA groups.
- Consult local experts to find out the known status of resistance in your area.
- Avoidance of cross-resistance may help to build up a more effective rotation strategy.

15. Never use a product of questionable origin or composition.

- Products from unknown or non-approved sources may not have the advertised composition, in which case efficacy may be affected and IRM becomes impossible.
- Illegal products may also pose risks for users and the environment.

References

1.) Sparks, T. and Nauen, R. (2015) IRAC : Mode of action classification and insecticide resistance management. Pesticide Biochemistry and Physiology 121: 122 - 128

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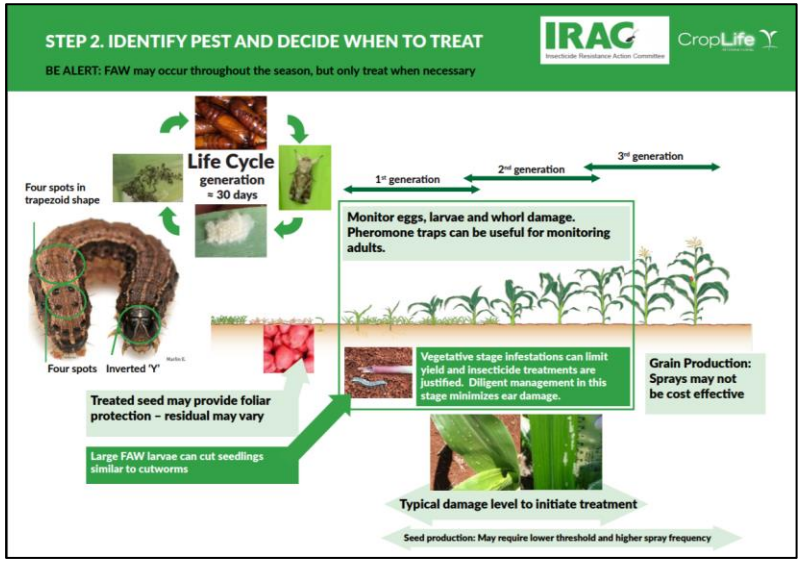
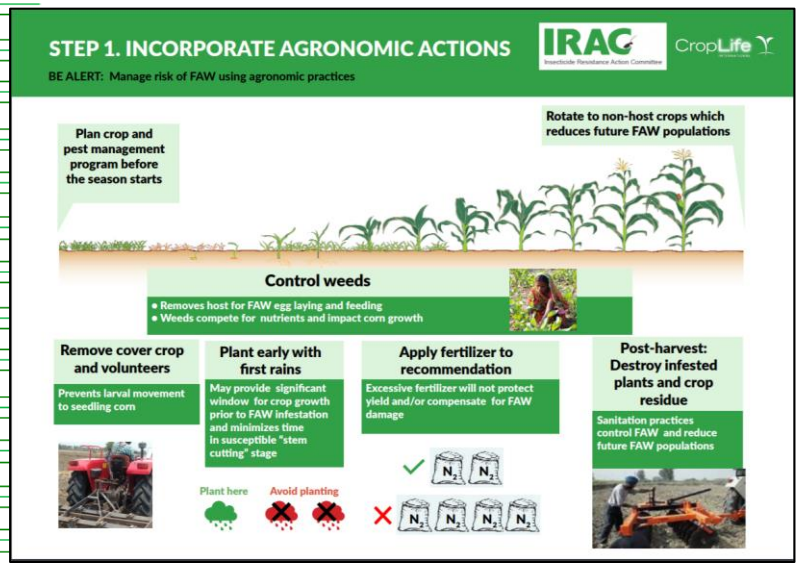
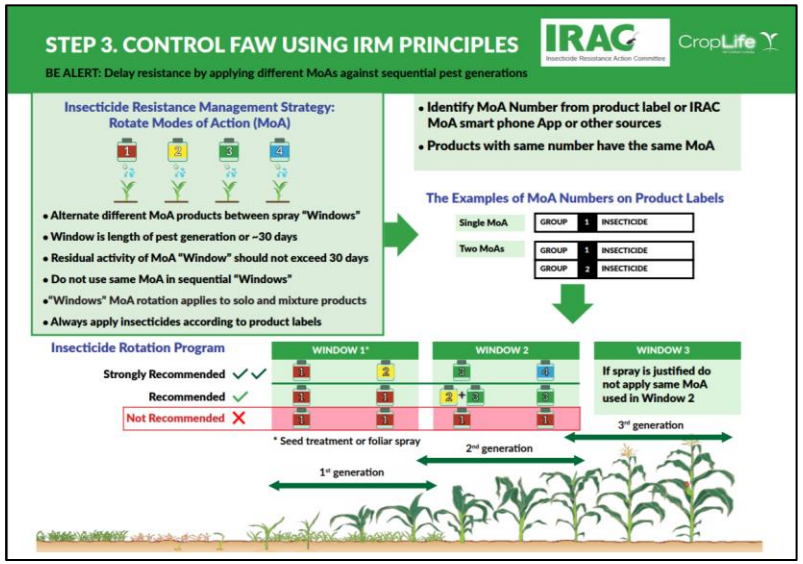
Fall Armyworm IRM Guidelines







Fall Armyworm IRM Guidelines
V1.0, Mar '21

Puerto Rico IRM FAW Training Workshop Report
V1.0, May '19

Lepidoptera MoA Poster
V6.2, Feb '20

Spodoptera frugiperda poster
V2.1, Nov '19

Brazil IRM Recommendations, Corn, Soybean, Cotton
V1.1, Jul '17

IPM & IRM for Fall Armyworm in S. African Maize
V1.1, Jan '20

CropLife International & CropLife Asia Position on Fall Armyworm
V4.0, Feb '19

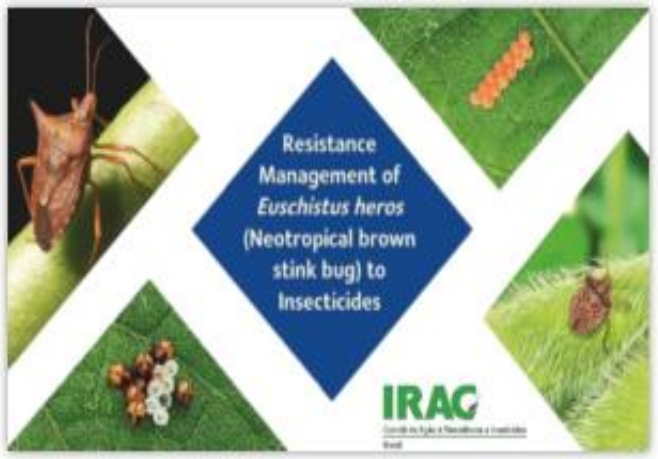
Resistência de Spodoptera frugiperda
V1.0, Jun '13

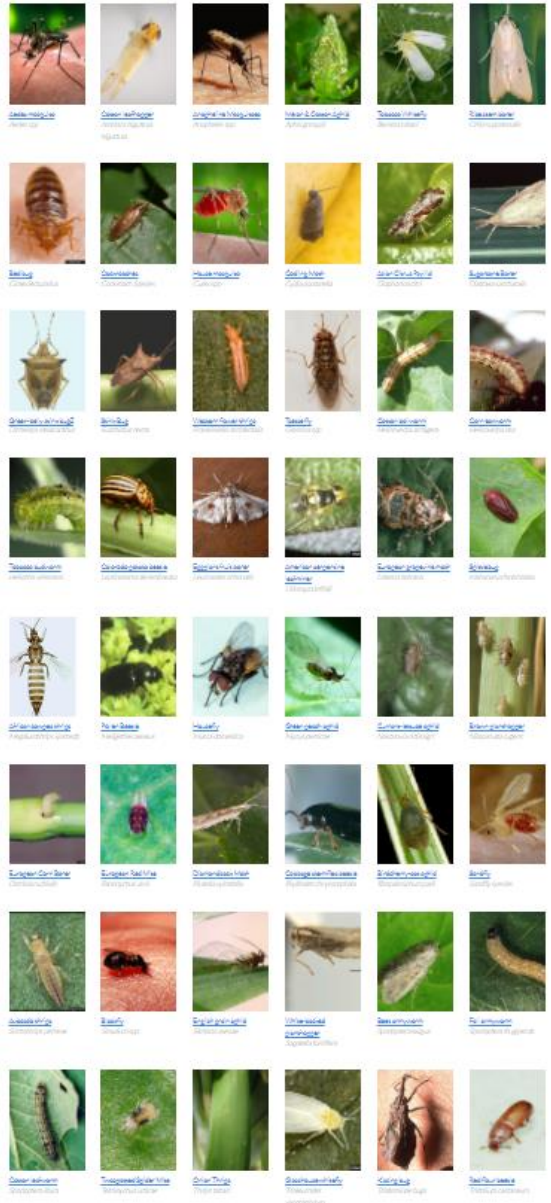
Report on IRM for fall armyworm in corn in Puerto Rico

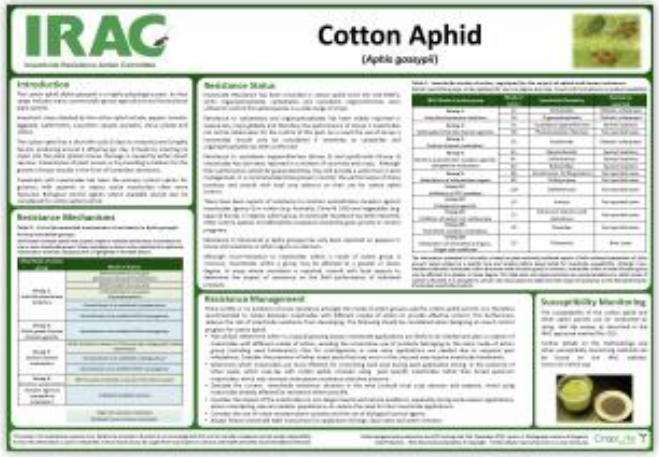
India FAW IRM
V1.0, Aug '20

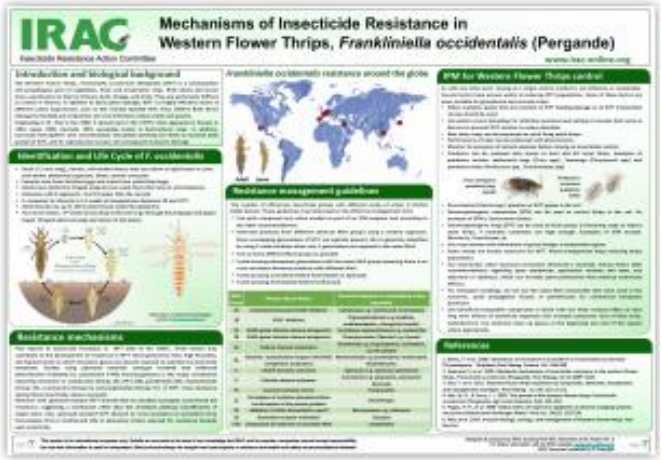
India FAW Invasion
V1.0, Aug '20

New pest information









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IRM training Module

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Insecticide Resistance Action Committee

Insecticide Resistance Training

Basic Module: Crop Protection

This module is designed to introduce the basic concepts behind the development and management of insecticide resistance in agricultural and horticultural crops. The presentation is targeted to those that may be being exposed to the concept of insecticide resistance for the first time or simply wishing to refresh their knowledge. More detailed information on the factors which influence resistance development and its management will be provided in future modules produced by IRAC International.

1

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How does an insect become resistant ?

- Resistance occurs through **mutations** in the genetic make-up of the insect.
- DNA which is made up of a chain of paired nucleotides is often described as the genetic 'instruction book' for constructing living organisms.
- However, the replication of DNA is not a perfect process and errors can occur. These errors are called mutations.
- As the DNA provides the instructions for the development and function of the insect, a mutation can result in a change in insect physiology or biochemistry.
- Sometimes a mutation may have no impact on the insect, sometimes the mutation can be lethal. However, on occasion the mutation may result in the insect becoming less susceptible to an insecticide and this provides it with a competitive advantage when the same insecticide is applied again.

Mutation rate: Is the a measure of the frequency at which new mutations occur in a gene or organism over time.

Mutations can occur in different forms, there can be a change in a single nucleotide, deletion of part of the DNA sequence or even a multiplication of some sections of the DNA sequence.

3

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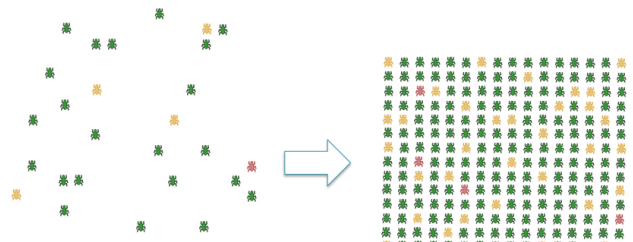
How does insecticide resistance become a problem ?

- The surviving resistant insects continue to live and breed and passing on their mutation to their offspring.
- Eventually the population may increase to a point where control will be once again necessary.



NOTE: For the purposes of this demonstration some simple assumptions are made:

1. The insecticide has no effects on the resistant insects.
2. The resistance is always inherited by the insects offspring (dominant inheritance).
3. Resistant insects live and reproduce normally (no fitness costs).

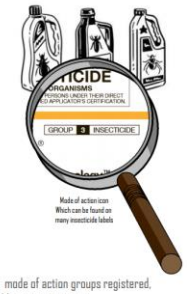
This is not always the case and these topics will be covered in other IRAC modules.

6

IRAC

Insecticide modes of action

- In this presentation we have talked about insecticide modes of action.
- Most insecticides registered for use to control insects, work through an identified biochemical pathway or interact with a specific target site in insects. This is called the **mode of action (MoA)**.
- All insecticides which work in the same way are grouped together in the internationally recognized IRAC mode of action classification scheme.
- Each group is represented by a number code and in many countries this number is displayed on product labels to help users to differentiate between products with the same and different modes of action.



Mode of action icon Which can be found on many insecticide labels

There are some registered insecticides where the exact biochemical mode of action is unknown. These are classified by IRAC as UN (Unknown) until a time that the mode of action can be determined.

To learn more about IRAC mode of action classification follow the link

- There are over 30 different mode of action groups registered, but not all groups are available in every country.
- There are also sub-groups which are denoted by a letter after the number, but these will be covered in another module.

10

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Cross-resistance & multiple-resistance

- The mode of action classification is designed to help growers identify different modes of action in order to avoid repeated use of similar insecticide products and select for resistance.
- It is based on the most common observation, which is that there is **cross-resistance within a mode of action** group, but **not between mode of action groups.**
- Cross-resistance
  - Cross resistance is defined as resistance to two or more insecticides via a single mechanism of resistance.
- Cross-resistance within a mode of action group.
  - In most cases resistance to an insecticide also confers resistance to insecticides from the same group.
  - However, there can be differences in the level of resistance between insecticides even within the same group. This is called **partial cross-resistance**.
  - In very rare cases there may be no cross-resistance within a group, but this is often only restricted to a single pest.
- Cross-resistance between mode of action groups.
  - In rare cases insecticides which don't have the same mode of action, but have similar molecular structural components may be metabolised by a single enzyme.
  - Insects which over-express that enzyme may therefore be resistant to all the insecticides metabolised by the enzyme.
- Multiple resistance
  - Multiple resistance is defined as resistance to two or more insecticides via multiple mechanisms of resistance in a single insect. It is often confused for cross-resistance.

Cross-resistance: Protection from two or more insecticides through a single mechanism

Multiple-resistance: Protection from two or more insecticides through multiple mechanisms

12

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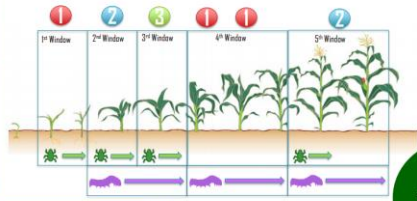
Managing insect pest resistance: Multiple Pests

- A resistance management strategy for a single pest can be easy to design and implement, but the reality is that there is often more than one pest present in a crop.
- In a multi-pest environment, application windows have to be modified to include each pest.
- It is important to note that more than one application of the same mode of action can be made within a window, as long as the residual effects of the insecticide do not exceed the length of the window.



IPM Integrated Pest Management Use of IPM techniques, such as crop rotation, preservation of natural predators, removal of the previous crops residues, etc., can also help to manage resistance.

NOTE: In cases where pest species overlap in the cropping cycle and have different generation times. The shortest generation time is used as the basis of the window.

15

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