Resistance and Resistance Management

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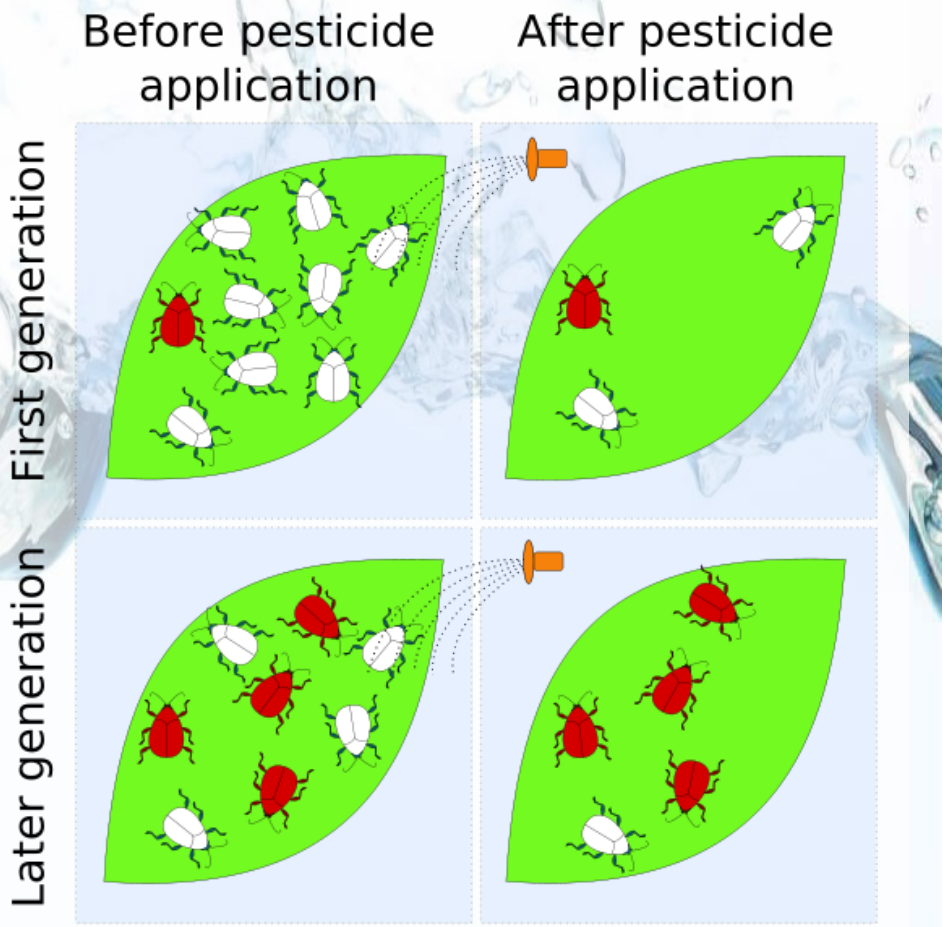
Scope

- What is Resistance
- How does resistance develop
- Measuring Resistance
- Interpreting field situations
- Management of Resistance
- Examples of Resistance management and Product Stewardship

Resistance

IRAC defines resistance as

- “a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species”
- The level of resistance is usually quantified by comparing the dosage required to kill a certain proportion of a previously unexposed population with the dosage required to kill the same proportion of the “resistant” or test population.



How does resistance develop

Strong selection pressure i.e. excessive use of a pesticide

Propensity of pest species to produce large numbers of offspring (some of which are naturally tolerant to the selection pressure)

- In some cases mutation in a single gene leads to the development of a resistant organism. In other cases, multiple genes are involved.
- Resistant genes are usually autosomal. As a result, resistance is inherited similarly in males and females.
- Generally resistance is inherited as an incompletely dominant trait. When a resistant and a susceptible individual mate with each other, their progeny has an intermediate level of resistance (more resistant than the susceptible parent, but not as resistant as the resistant parent).
- Adaptation to pesticides usually decreases relative fitness of organisms in the absence of pesticides. Resistant individuals often have reduced reproductive output, life expectancy, mobility, etc. Therefore, removing the selection pressure often returns the susceptibility of the population.

Measuring Resistance

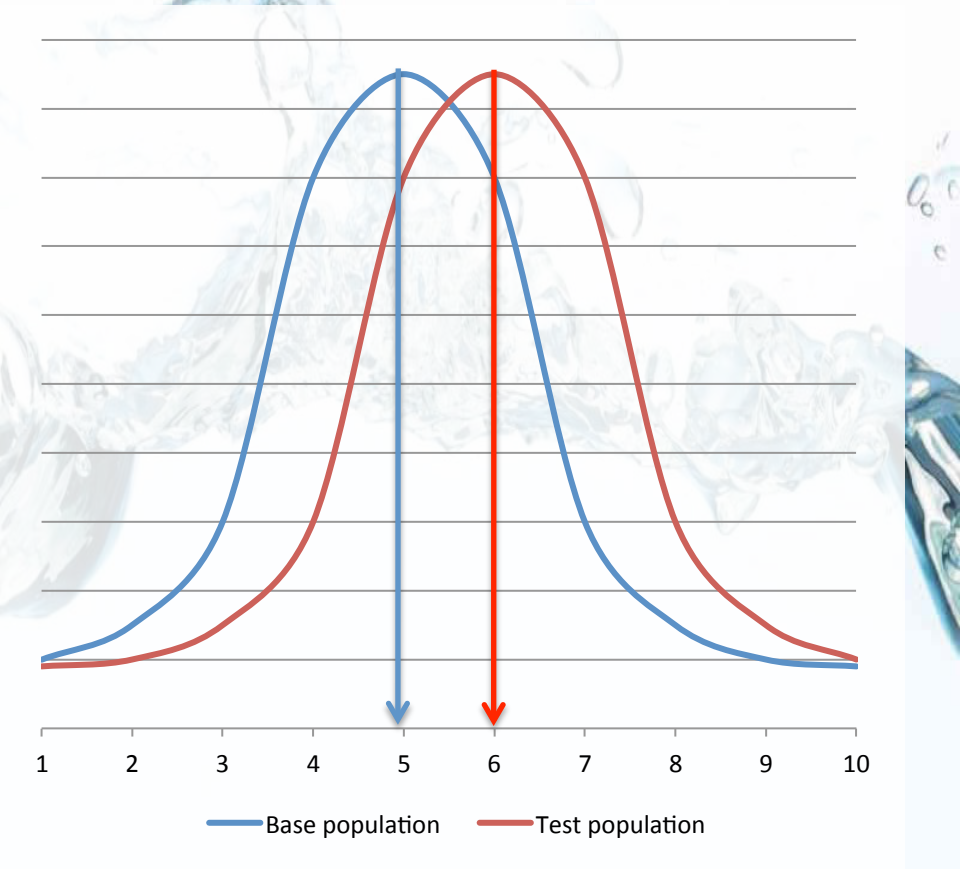
- LD 50 Base population = 5
- LD 50 Test population = 6

- Therefore
  Relative resistance = 6/5 = 1.2X

- Resistance is always relative, and measured against a known, susceptible population

- It is not useful or true to say a population is “Resistant” – there are always individuals present that are more or less “resistant” than others.

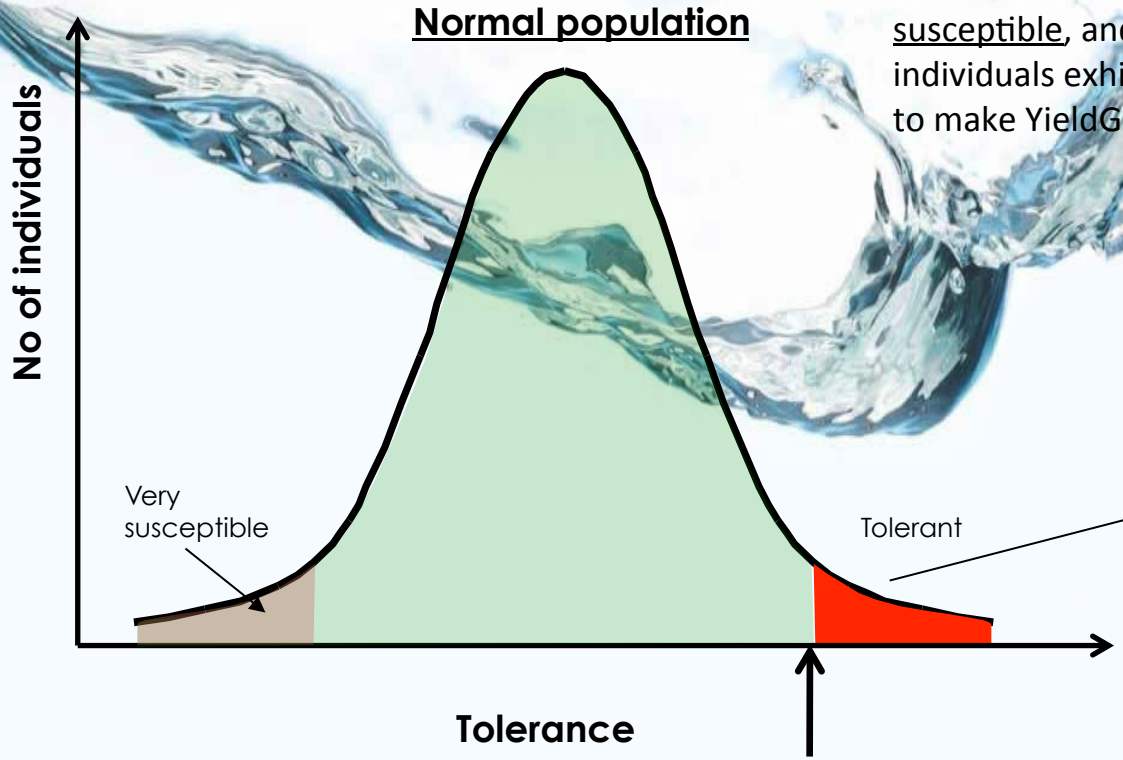
- It is more useful to say that “a particular population is e.g. 4 X more resistant than another population, in respect of a particular pesticide”



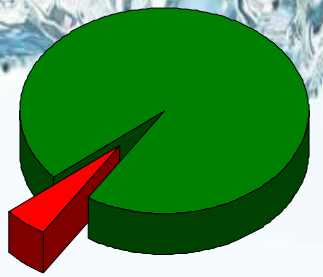
Interpreting Field Situations:
Normal situation

YieldGard® is approx 95% effective against *Busseola fusca*

Normal population



A normal population of *Busseola fusca* comprises individuals with a wide range of tolerances to the YieldGard® endotoxin. Some individuals are very susceptible, and some are more tolerant. Most of the individuals exhibit a high enough level of susceptibility to make YieldGard® very effective.



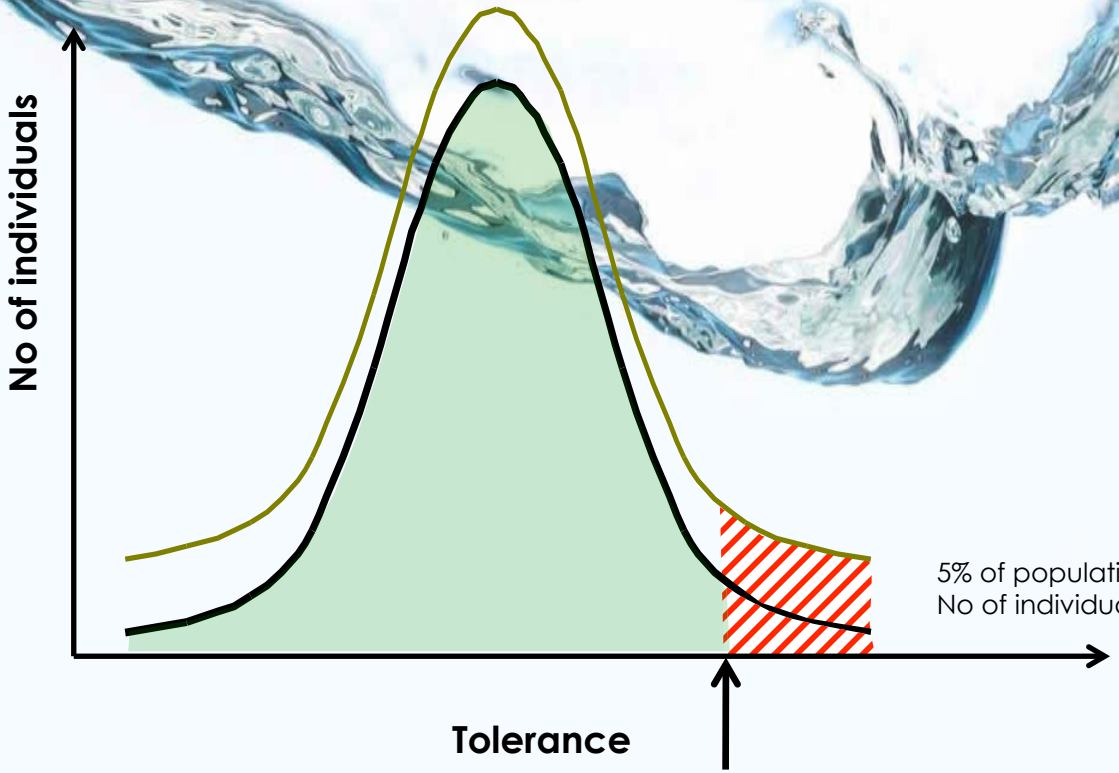
A small portion of the population survives on YieldGard®

Scenario 1

High populations of *Busseola*

YieldGard® is approx 95% effective against *Busseola fusca*

High population due to favourable weather conditions, increasing reduced till, early planting etc

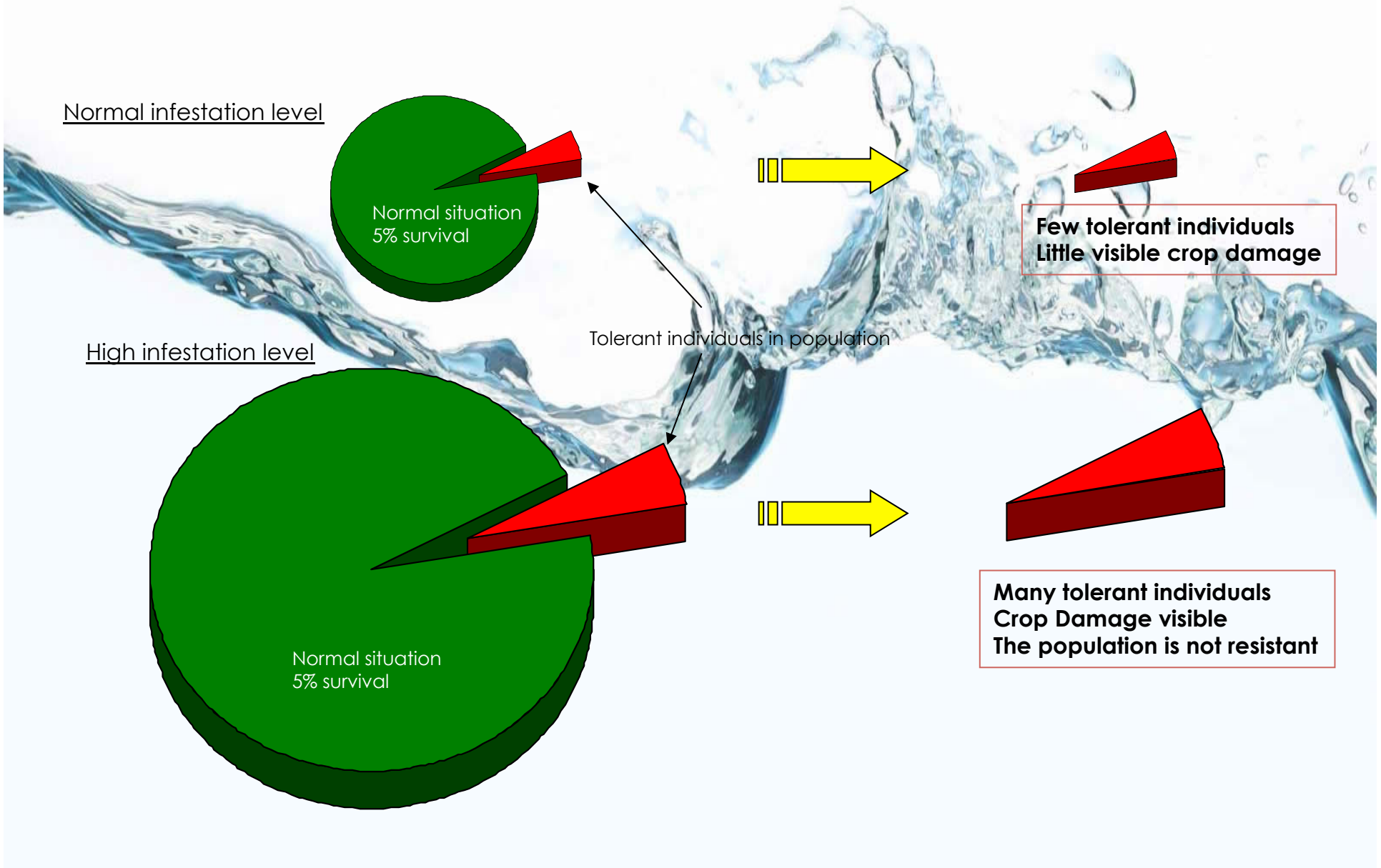


5% of population tolerant
No of individuals more than doubles

More than 10% of plants damaged
Spraying recommeded

Scenario 1

High infestation levels

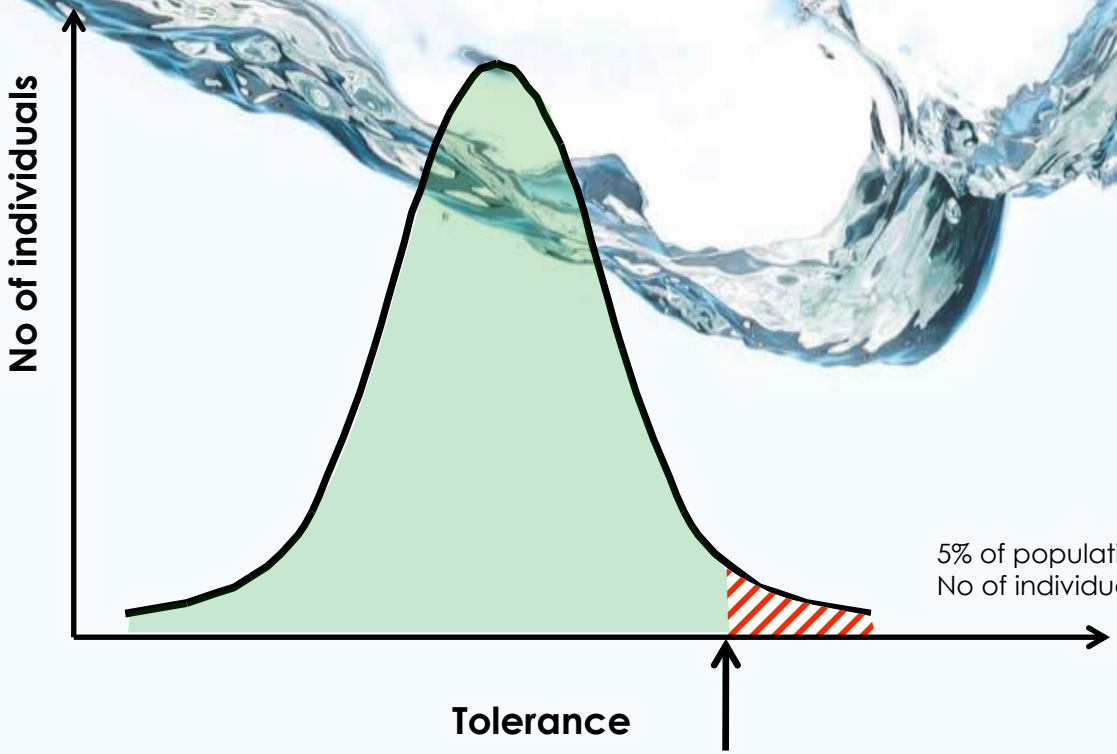


Scenario 2

Reducing sensitivity

YieldGard® is approx 95% effective against *Busseola fusca*

Normal population



5% of population tolerant
No of individuals low

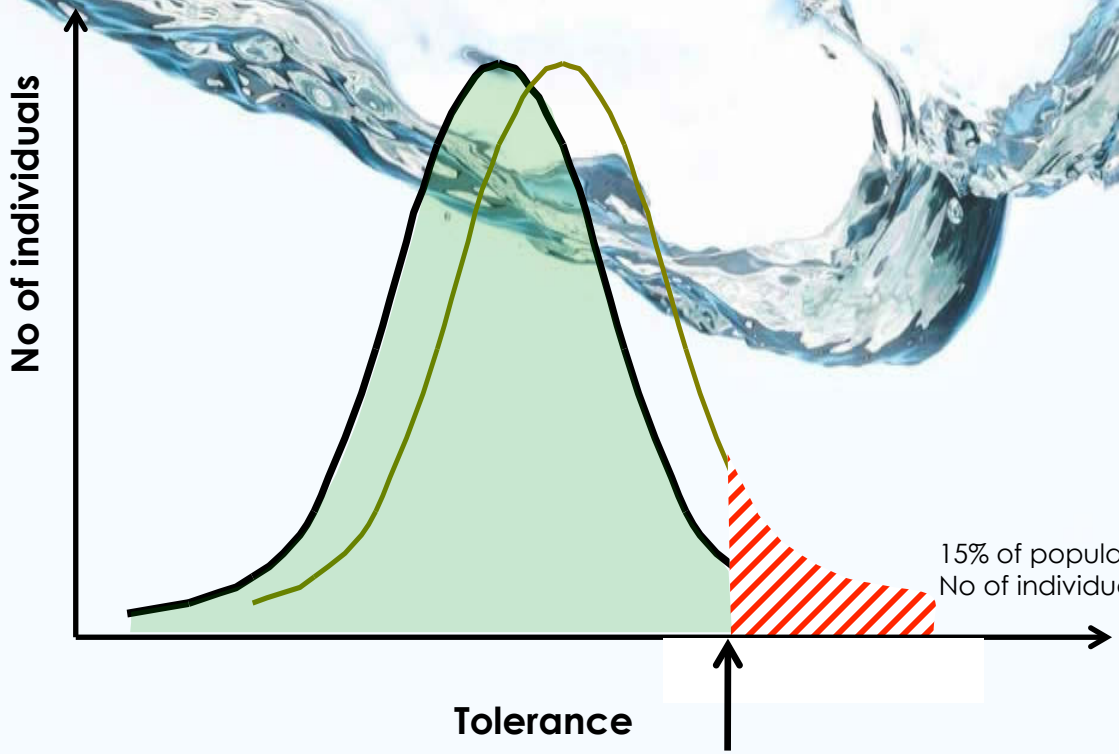
Less than 10% of plants damaged

Scenario 2

Reducing sensitivity

YieldGard® is approx 85% effective against *Busseola fusca*

Population shift as susceptibility decreases

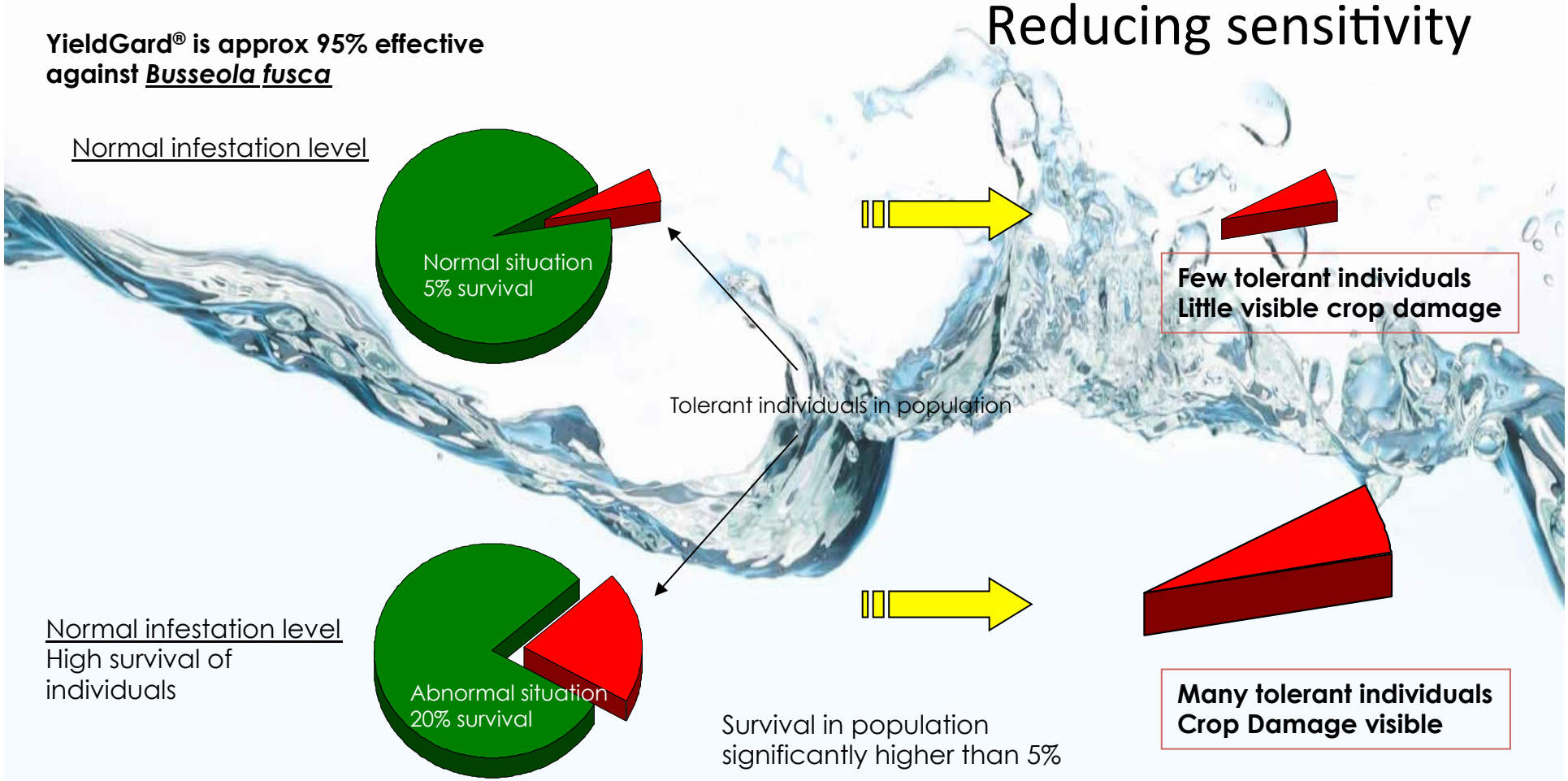


15% of population tolerant
No of individuals more than 3X more

More than 20%f plants damaged

Scenario 2
Reducing sensitivity

YieldGard® is approx 95% effective against *Busseola fusca*



Under these situations, we would consider resistance to be increasing

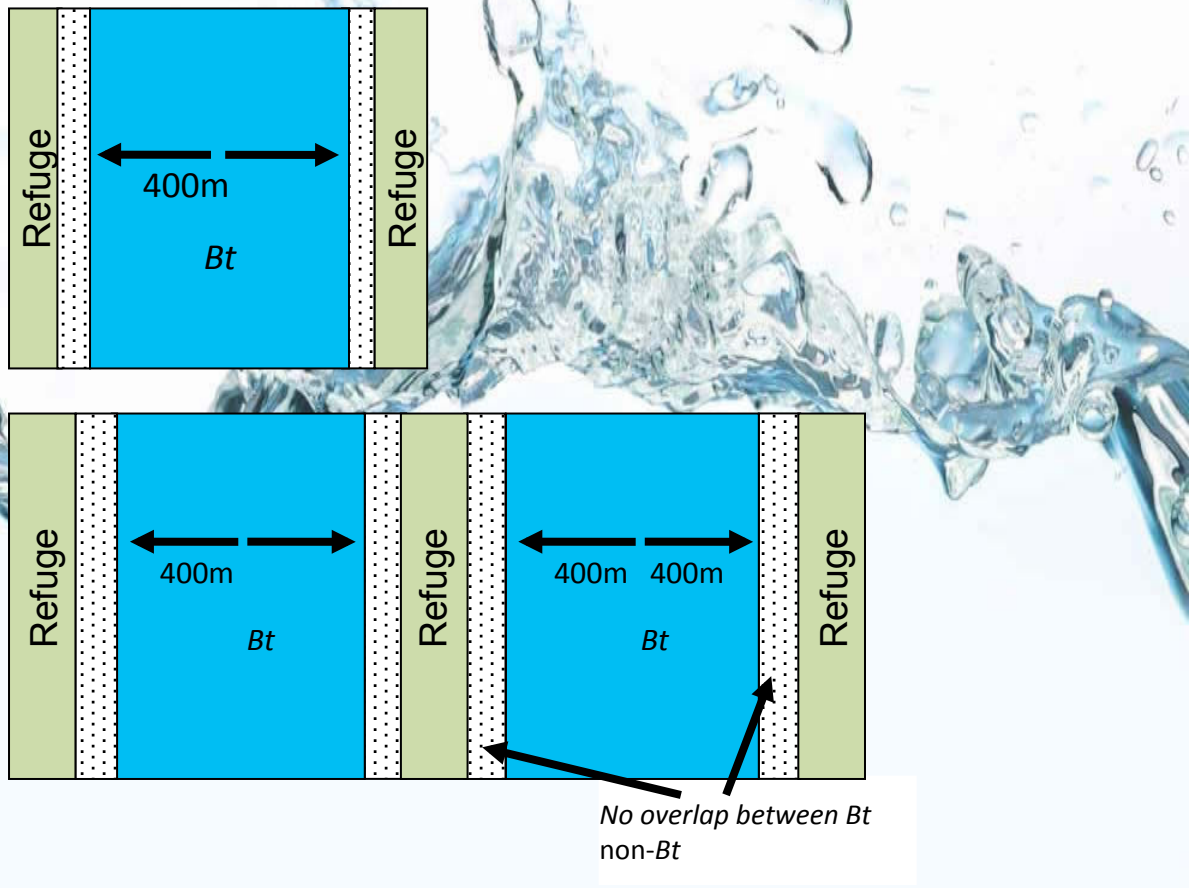
YieldGard® is significantly less than 95% effective

Managing Resistance

- reducing selection pressure by the pesticide on the pest population. i.e. avoid situations where all the pests except the most resistant ones are killed by a given chemical
- avoiding unnecessary pesticide applications,
- using non-chemical control techniques,
- leaving untreated refuges where susceptible pests can survive.
- Adopting the integrated pest management (IPM) approach usually helps with resistance management.
- Pesticide rotation where pesticides are the sole or pre-dominant method of control
  - alternating among pesticide classes with different modes of action to delay the onset of or mitigate existing pest resistance.
  - Different pesticide classes may have different effects on a pest.
  - IRAC has designated different classes of fungicides, herbicides and insecticides, based on different modes of action
  - Tank mixing pesticides is the combination of two or more pesticides with different modes of action in order to improve individual pesticide application results and delay the onset of or mitigate existing pest resistance.

IRM Strategy for Bt-Maize

- Monitoring of refuge compliance
- Training of compliant and non-compliant growers
- Programme ultimately prevents persistant non-compliant growers from accessing technology



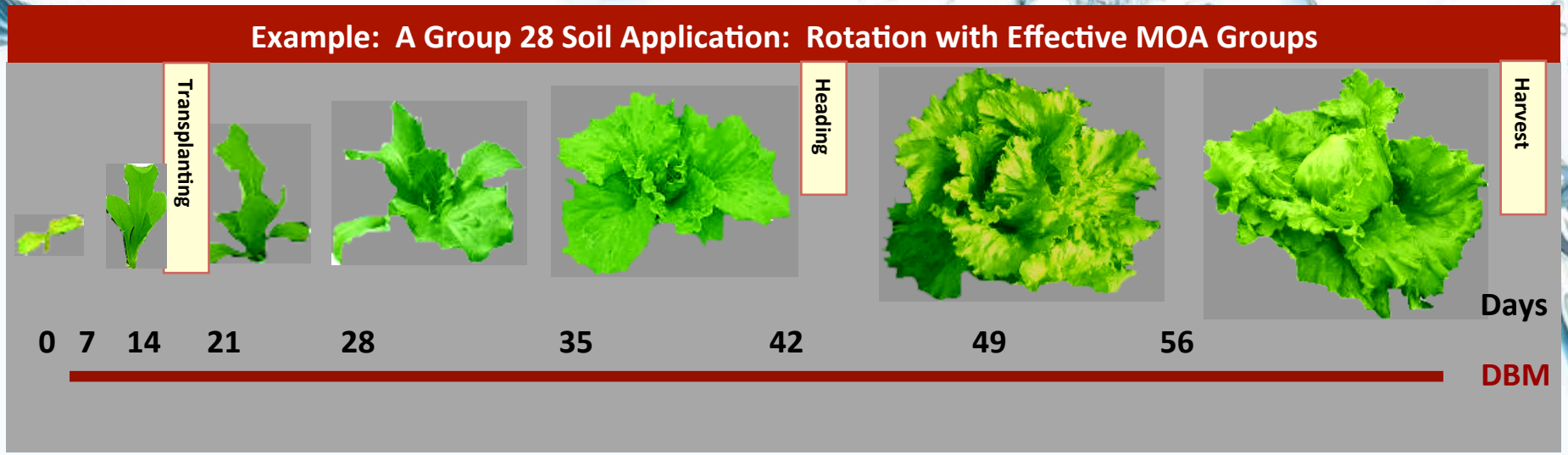
IRM Strategy for Diamide insecticides

- Development of Guidelines
  - Communicate MOA to users – label
  - Avoid excessive use of Diamides (Group 28 insecticides)
  - Use Treatment “windows”
  - Do not use in adjacent crop cycles for short cycle crops
  - Do not expose more than 50% of crop cycle to diamides

IRM Strategy for Diamide insecticides

<u>Example</u>: Leafy Vegetables – Soil Application:

Use treatment windows (approx 30 day windows) and <u>avoid exposure of > 50% of crop cycle</u>.



Group 28
1 soil application only
(drench, drip, seedling tray)

Non-Group 28 Insecticides
with different MOA's

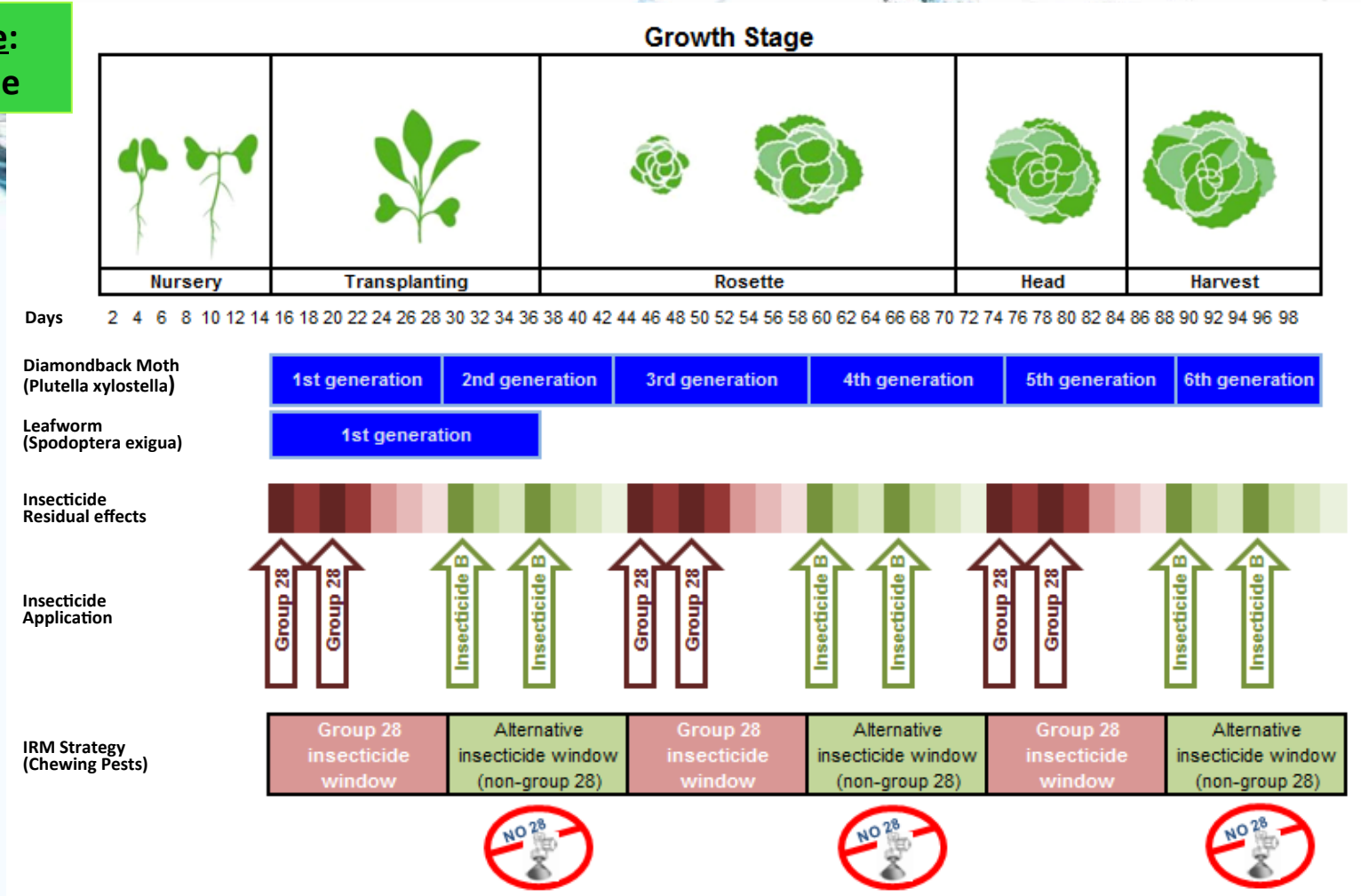
Active Window
< 50% of Crop Cycle =
5-35 days

Free Window
(at least 50% of Crop Cycle = 35-60 days)

IRM Strategy for Diamide insecticides

→ **Use "<u>Treatment Windows</u>" of approximately 30 days and rotate with different Insecticide Mode of Action (MOA) groups to avoid exposure of successive pest generations to the same MOA.**

<u>Example</u>: Brassicae



Conclusions

- Resistance development is about population responses to specific selection pressures.
- Resistance management is about manipulating the selection pressure to drive populations towards a state of susceptibility .
- These programmes make up part of the overall “Product stewardship” of a product, in which the “Life-cycle” of the product is managed from innovation through development, commercialisation and eventual withdrawal.