Crucifer Vegetable Insecticide Resistance Management Strategies and Issues in Australia

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The Australian Crucifer Vegetable Industry

- ~15-20,000 ha crucifer vegetables nationally
- Individual farms produce 20-200 ha crucifers per annum
- Insecticide spraying is the primary pest control tactic

The Key Pests of Australian Crucifer Vegetables

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- In subtropical Queensland a complex of pests occurs:
  - *Crocidolomia pavonana*
  - *Helicoverpa* spp.
  - *Hellula hydralis*
  - *Spodoptera litura*
  - *Bemisia tabaci* biotype B
  - *Thrips tabaci*
  - and DBM (12+ generations pa)

History of DBM Resistance in Australia

- SP/OP resistance
  - 1st documented in mid 1980's in Queensland
  - By mid 1990's widespread throughout southern States
- An IRM strategy was implemented in QLD in the late 1980's
  - Monthly rotation of SP-OP-Carbamate-Cyclodeine products
  - Summer crop break
  - Crop monitoring and *Bacillus thuringiensis* (*Bt*) use promoted
- No corresponding IRM response in southern States
  - Greater use of *Bt* in 1990's as SP/OP efficacy declined
- No new insecticide classes were registered in Australia from 1980-1998

The Late 1990's 'Renaissance'

- 1996-97: likely registration of 4 new DBM insecticides, each with a unique mode of action.
  - fipronil, chlorfenapyr, spinosad & emamectin benzoate
- Both a great opportunity and a great challenge.
- Researchers, CropLife Australia and the 4 chemical Co.'s devised an IRM strategy.
  - Agreed to a 'two-window' rotation strategy.
  - Based on modelling and limited experimental evidence likely to increase the effective life of the rotated chemistries.

The ‘2-window’ Rotation Strategy

Version I - 1998/99 (Windowed the first two registered products)

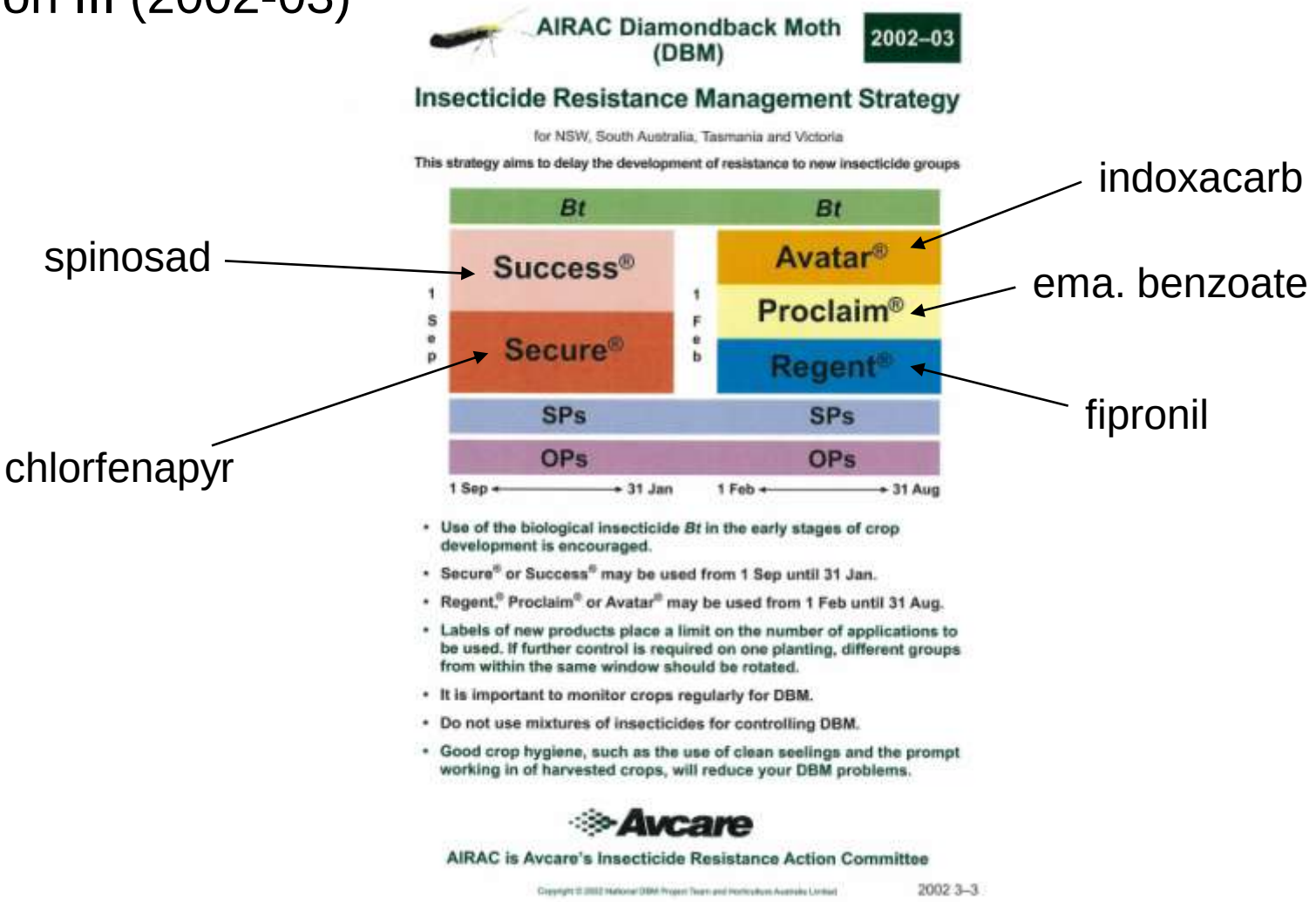
chlorfenapyr

fipronil

The ‘2-window’ Rotation Strategy

Progressively updated as new products registered:

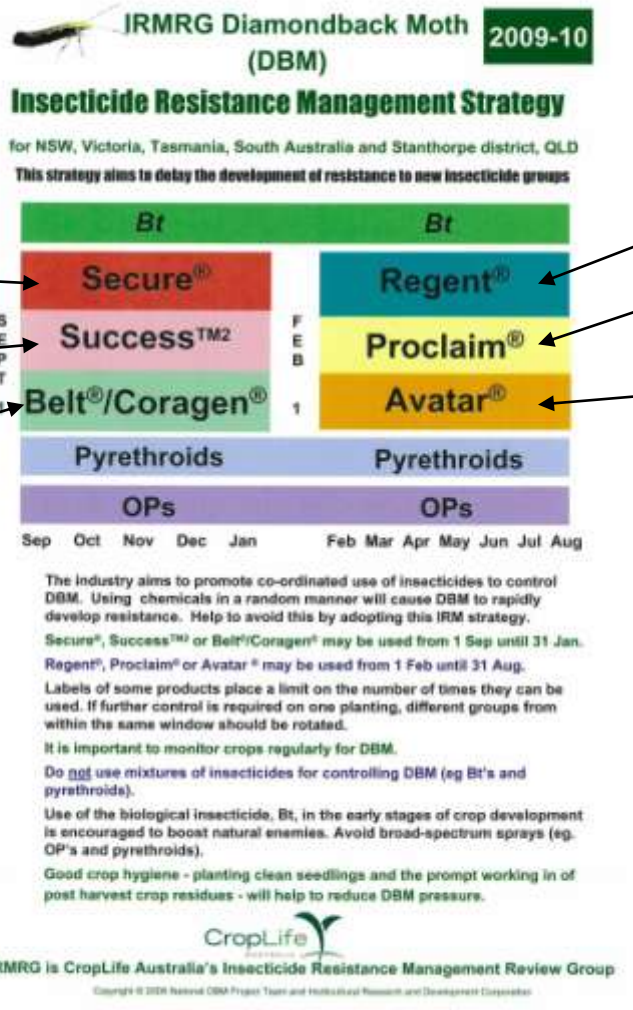
Version III (2002-03)



The ‘2-window’ Rotation Strategy

Progressively updated as new products registered:

Version IV (2009) – incorporates the Group 28 diamides



chlorfenapyr

spinosad

flubendiamide/
chlorantraniliprole

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ema. benzoate

indoxacarb

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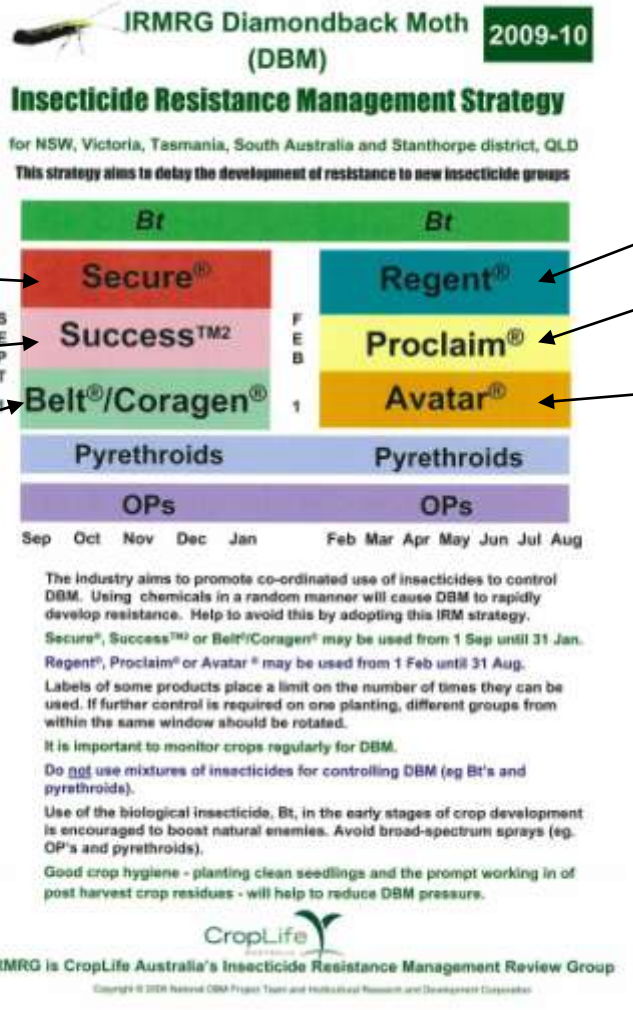

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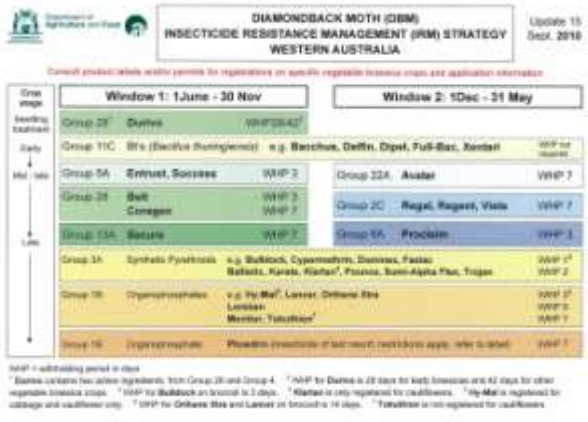
IRAC chemical groups & product names information.

The ‘2-window’ Rotation Strategy

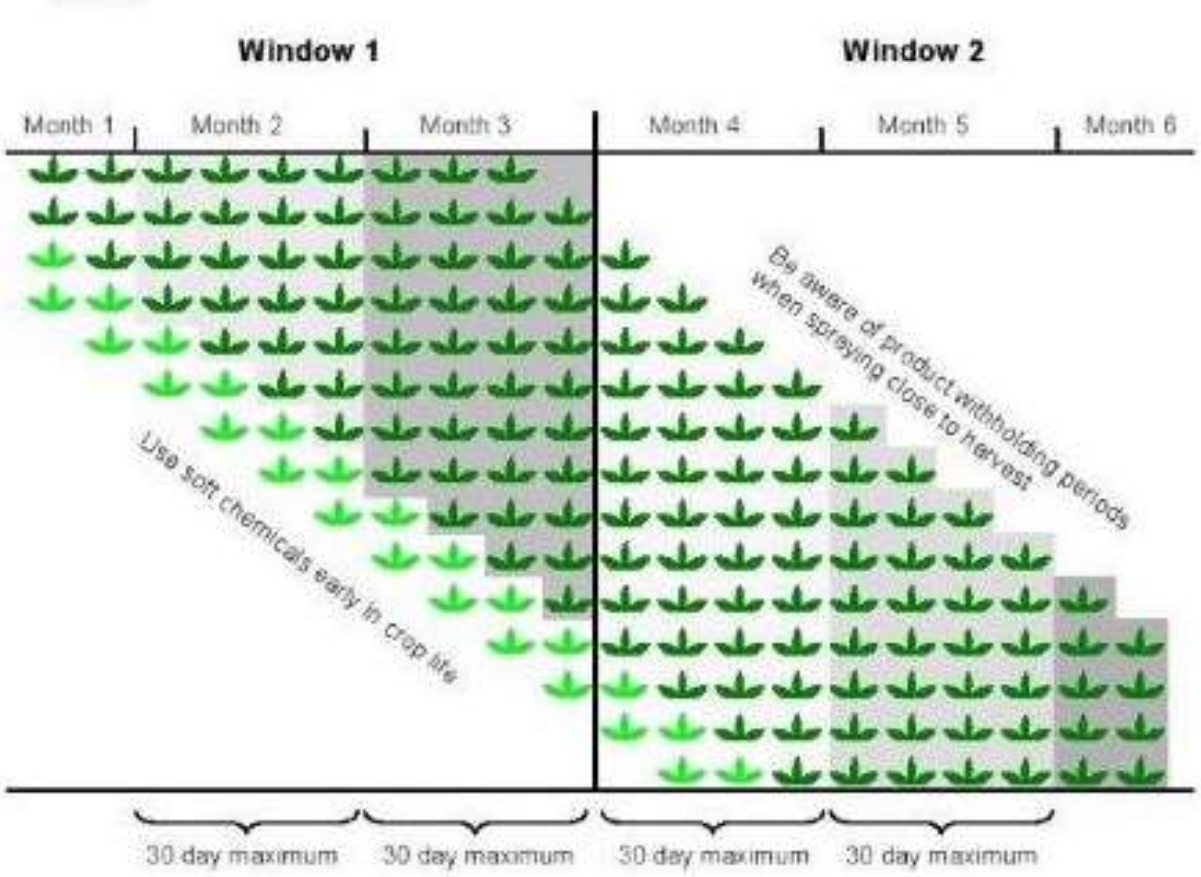
Three regionally-specific versions:

- take account of (i) seasonal differences in DBM pressure and spraying across the production regions, and (ii) the lepidopteran pest complex in Queensland.



The ‘2-window’ Rotation Strategy

Now considering the introduction of generation/calendar time windows within the 2 main Windows:



Grower Compliance with the Window Strategy

- The level of grower compliance is moderate.
  - 2006 survey: ~40% of growers claimed to follow the strategy.

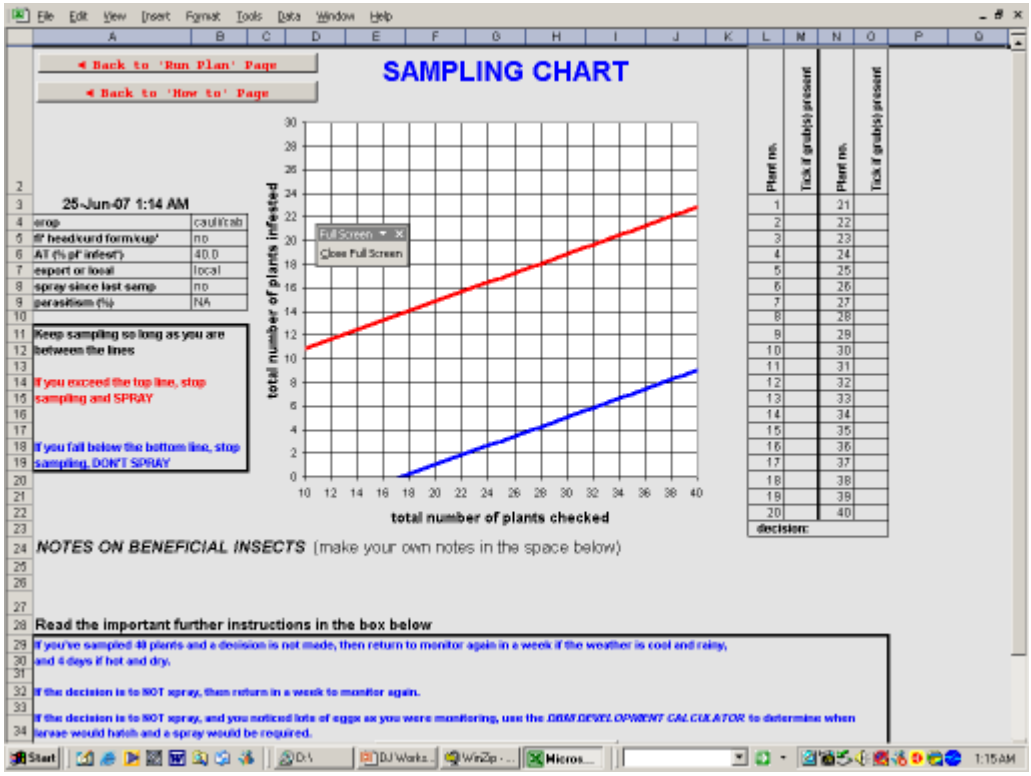
- However growers that do adhere to the strategy are still likely to benefit, because of DBM's limited property-to-property movement (Mo *et al*. (2003) Environmental Entomology 32, 71-79).

Other Key IRM Strategies

These aim to preserve susceptible individuals by reducing spray frequency:

1. Spray decision making based on crop monitoring and ETs

   Electronic sampling plan:



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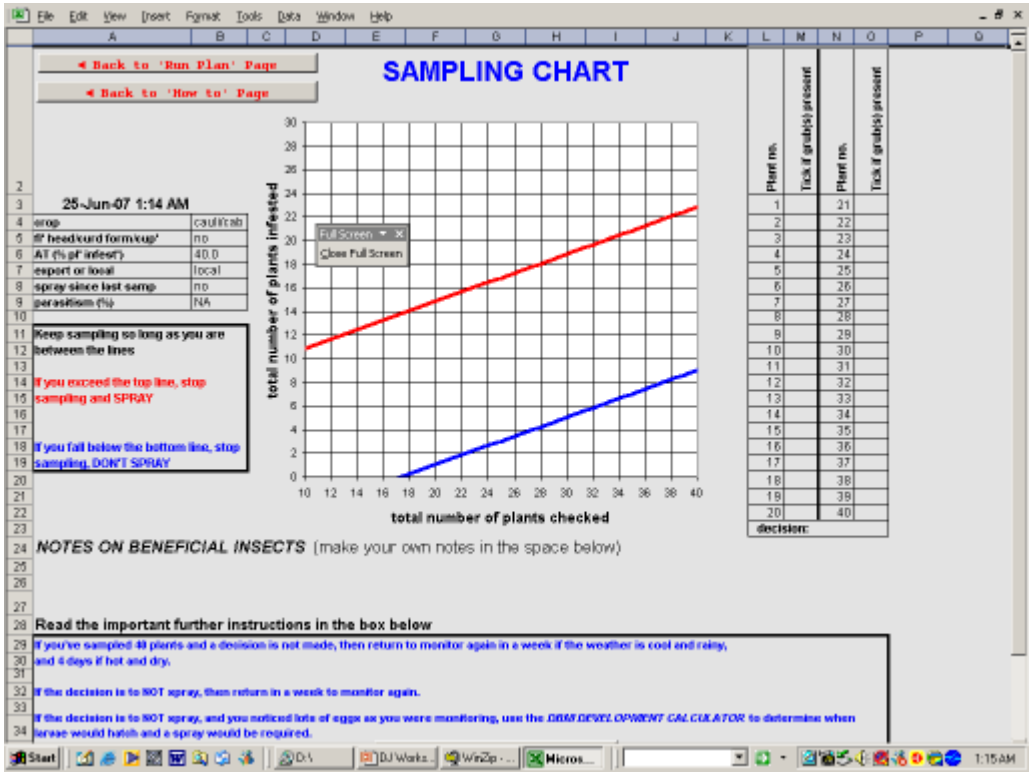

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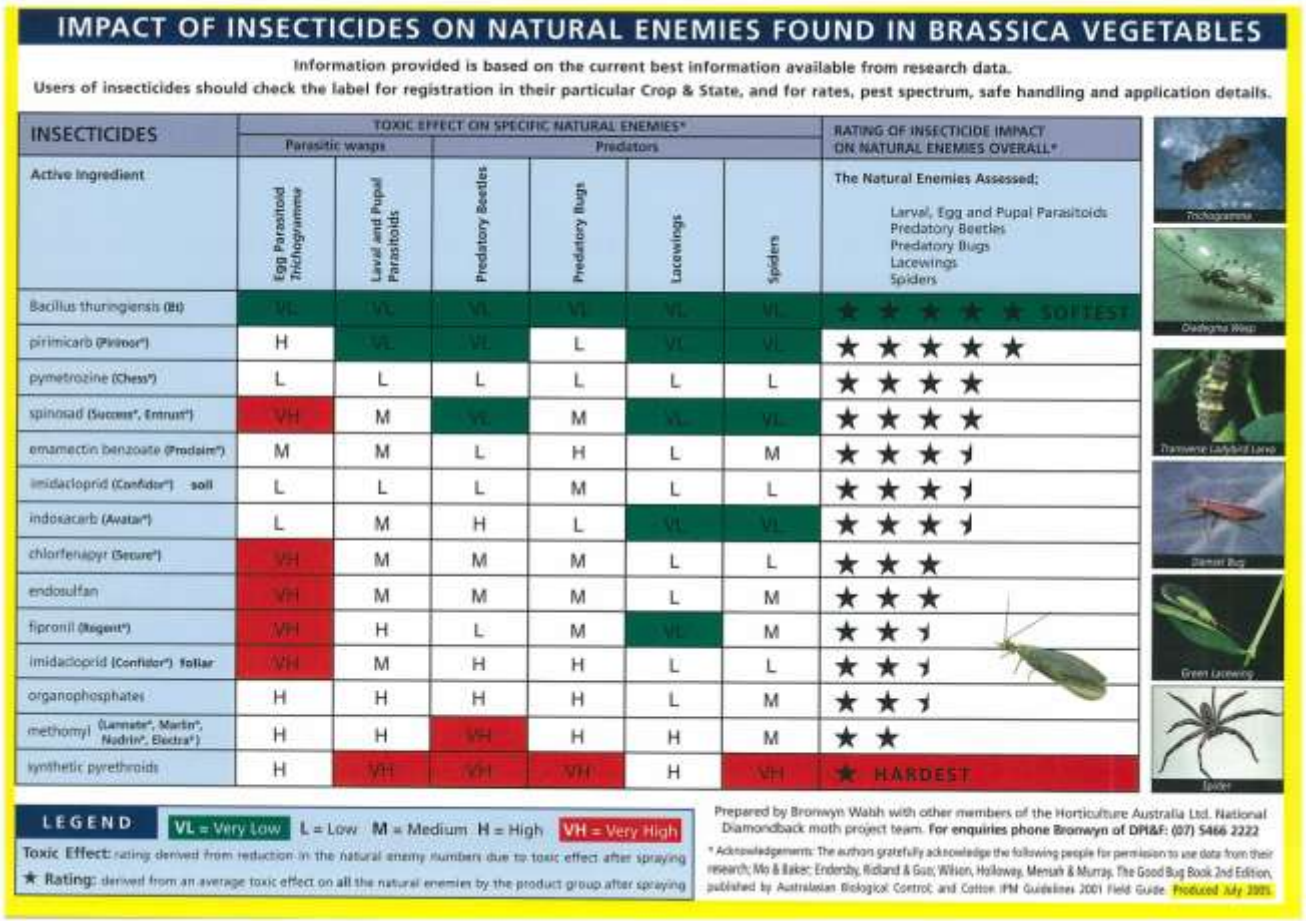
Other Key IRM Strategies

2. Natural enemy conservation

Encourage choice of soft chemistries:



IMPACT OF INSECTICIDES ON NATURAL ENEMIES FOUND IN BRASSICA VEGETABLES

Information provided is based on the current best information available from research data.
Users of insecticides should check the label for registration in their particular Crop & State, and for rates, pest spectrum, safe handling and application details.

INSECTICIDES	TOXIC EFFECT ON SPECIFIC NATURAL ENEMIES*						RATING OF INSECTICIDE IMPACT ON NATURAL ENEMIES OVERALL*
	Parasitic wasps		Predators				
Active Ingredient	Egg Parasitoid *Trichogramma*	Larval and Pupal Parasitoids	Predatory Beetles	Predatory Bugs	Lacewings	Spiders	The Natural Enemies Assessed: Larval, Egg and Pupal Parasitoids, Predatory Beetles, Predatory Bugs, Lacewings, Spiders
Bacillus thuringiensis (Bt)	VL	VL	VL	VL	VL	VL	★ ★ ★ ★ ★ SOFTEST
pirimicarb (Pirimor®)	H	VL	VL	L	VL	VL	★ ★ ★ ★ ★
pymetrozine (Chess®)	L	L	L	L	L	L	★ ★ ★ ★
spinosad (Success®, Entrust®)	VH	M	VL	M	VL	VL	★ ★ ★ ★
emamectin benzoate (Proclaim®)	M	M	L	H	L	M	★ ★ ★ ½
imidacloprid (Confidor®) soil	L	L	L	M	L	L	★ ★ ★ ½
indoxacarb (Avatar®)	L	M	H	L	VL	VL	★ ★ ★ ½
chlorfenapyr (Secure®)	VH	M	M	M	L	L	★ ★ ★
endosulfan	VH	M	M	M	L	M	★ ★ ★
fipronil (Regent®)	VH	H	L	M	VL	M	★ ★ ½
imidacloprid (Confidor®) foliar	VH	M	H	H	L	L	★ ★ ½
organophosphates	H	H	H	H	L	M	★ ★ ½
methomyl (Lannate®, Marlin®, Nudrin®, Electra®)	H	H	VH	H	H	M	★ ★
synthetic pyrethroids	H	VH	VH	VH	H	VH	★ HARDEST

LEGEND VL = Very Low L = Low M = Medium H = High VH = Very High

Toxic Effect: rating derived from reduction in the natural enemy numbers due to toxic effect after spraying

★ **Rating:** derived from an average toxic effect on **all** the natural enemies by the product group after spraying

Prepared by Bronwyn Walsh with other members of the Horticulture Australia Ltd. National Diamondback moth project team. **For enquiries phone Bronwyn of DPI&F: (07) 5466 2222**

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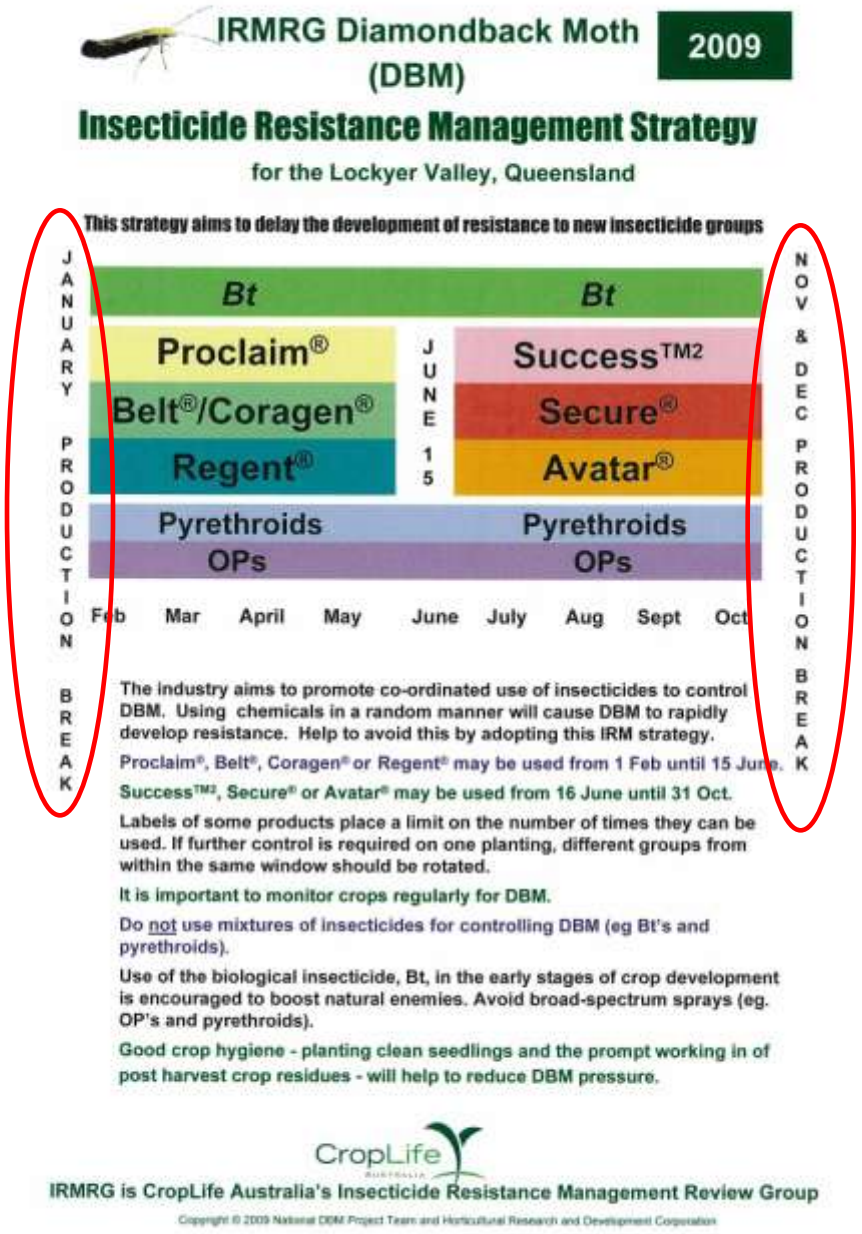
Other Key IRM Strategies

3. Crop break

   - promoted in Queensland



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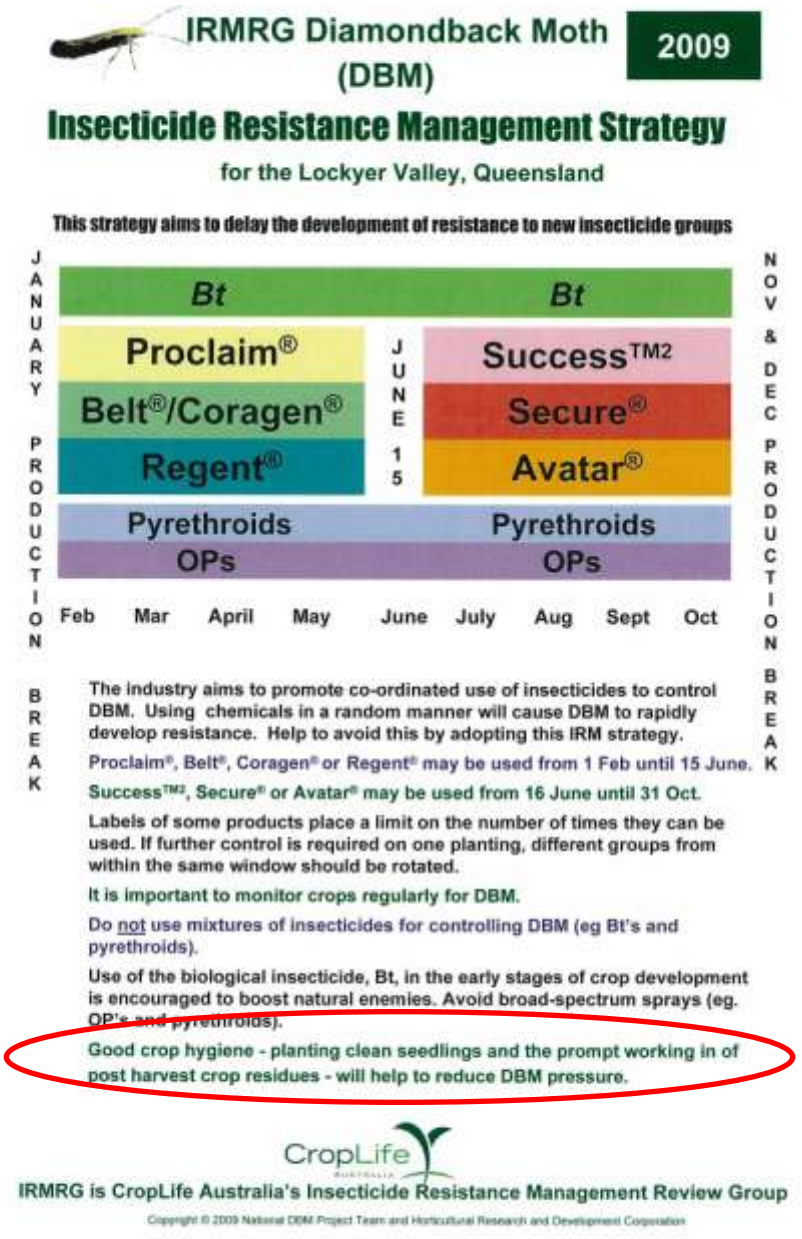
   - prompt post-harvest crop destruction



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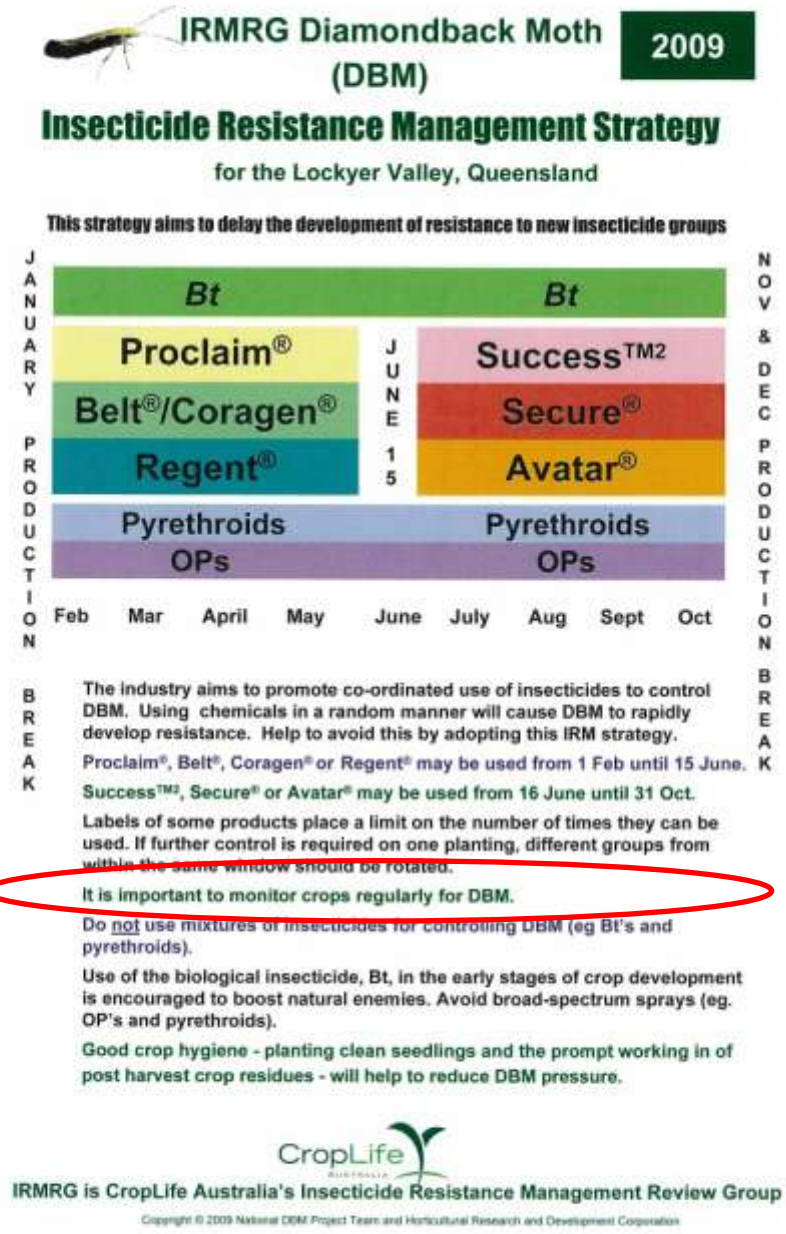

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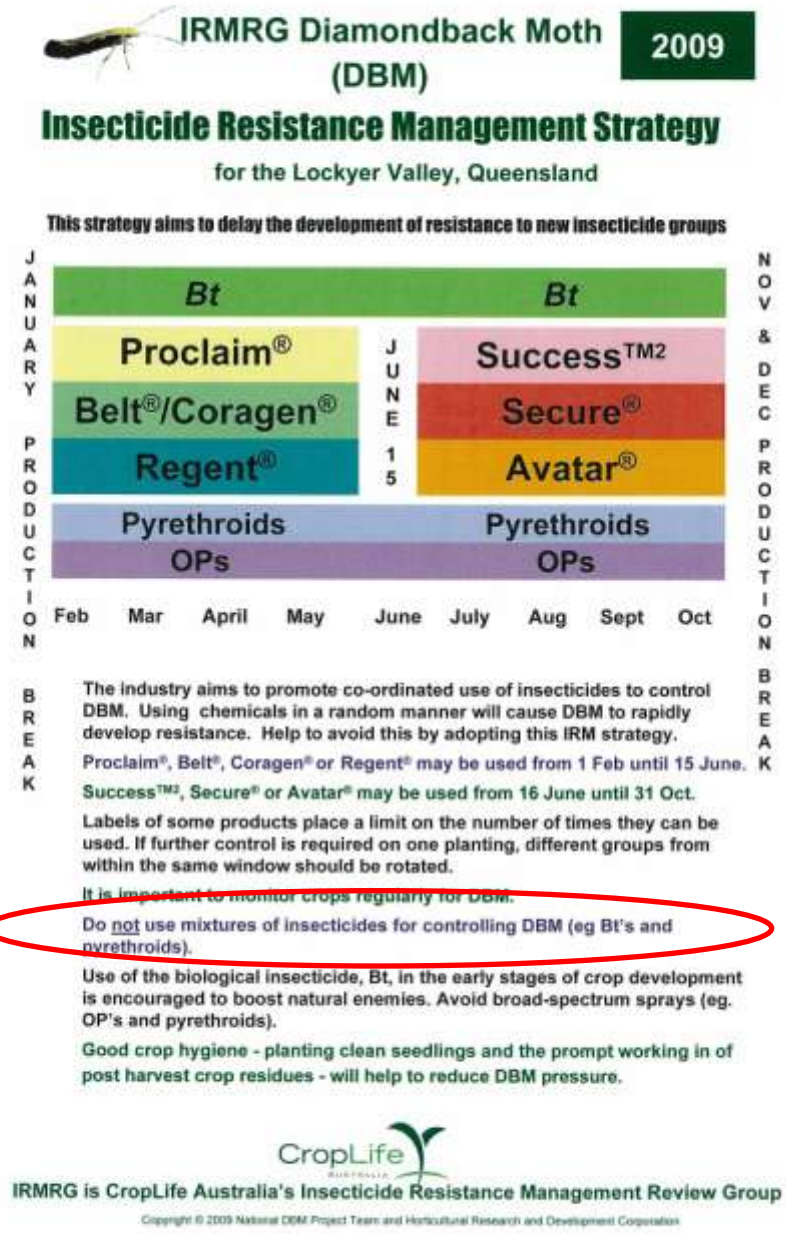

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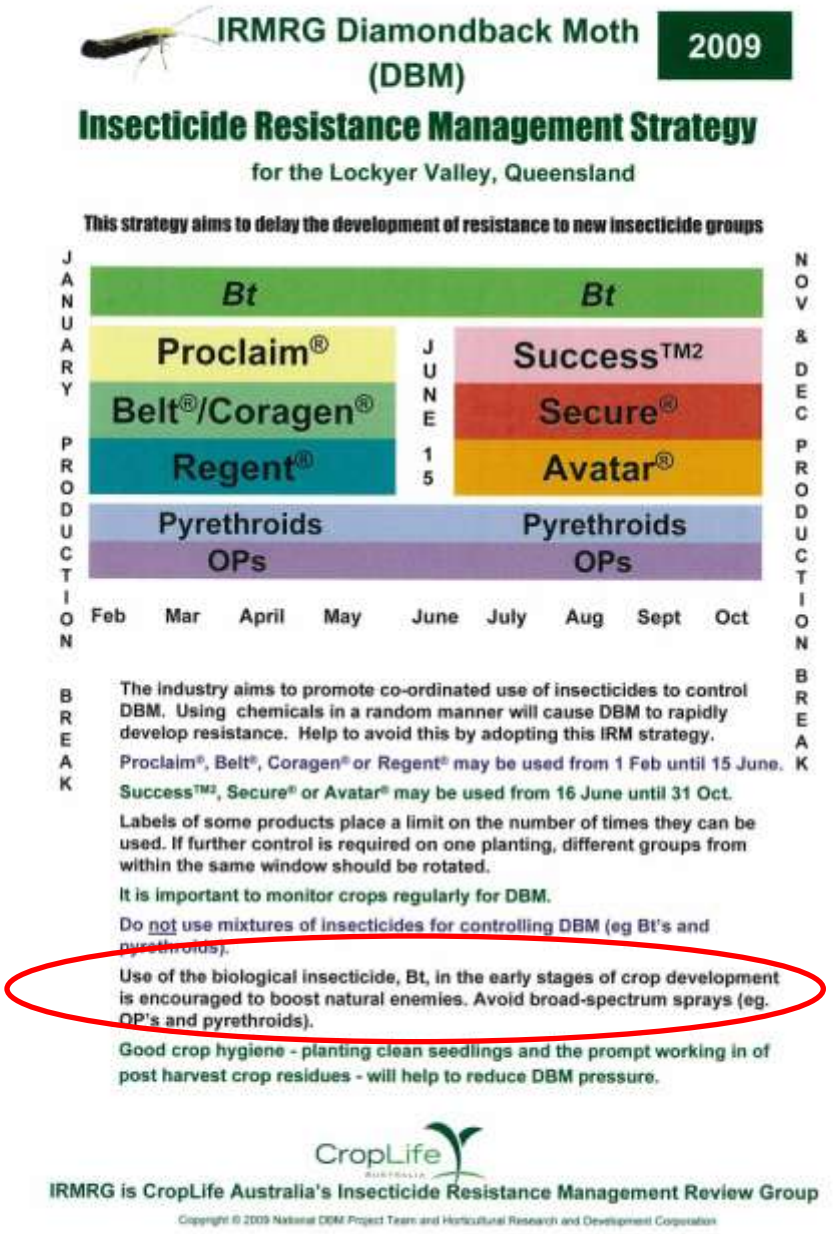

Resistance Screening

A national resistance screening program helps inform the IRM program.

- Potter tower application to 3rd instars on cabbage leaf discs.
- Four insecticides are being tested:
  - emamectin benzoate
  - indoxacarb
  - spinosad
  - Bt kurstaki
- Results:

1. Low-moderate resistance to the 3 synthetics, particularly in Queensland populations (highest RR's at LC_{50} ranging from 5.0–13.3).
2. No detectable shifts in Bt susceptibility.

Group 28 Diamide IRM

- The Group 28 Diamides - high lepidopteran larval activity
  - minimal impact on beneficials
  - low mammalian toxicity

- An Australian Diamide Working Group has formed to help preserve the Group 28 products against the resistance risk

- The national resistance screening program will be expanded to include the Group 28 products

Group 28 Diamide IRM Challenges

1. Immediate Challenge: Durivo™

This new diamide (chlorantraniliprole)–neonicotinoid (thiamethoxam) seedling drench mixture formulation presents a particular IRM challenge, due to:

1. formulation persistence
2. potential for successive crop treatment

To conserve the Diamides as effective DBM insecticides we advise:

1. restrict Durivo™ transplant use to the Window allocated for Diamides
2. work in Durivo™-treated crops immediately after harvest

2. Longer-term Challenge: registration of more Group 28 products

Future registrants may not wish to ‘window’ their products

Acknowledgments

- Dupont
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