Decision Making
for Integrated Pest Management
in Grain Crops

Crop establishment pests

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Why look at crop establishment?

- Crop establishment is the most susceptible growth stage of plant development to pests & can also be the challenging period for applying IPM
- Canola, medics and clovers are generally more susceptible to insect attack compared with cereals, grasses and pulses

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Key crop establishment pests

- > 40 invertebrate species threaten seedling establishment in crops and pastures
- Control tactics for these species presently relies heavily on the application of pesticides

Pest group	Example species
Earth mites	redlegged earth mite, blue oat mite
Lucerne flea	lucerne flea
Slugs, snails	grey field slug, black keeled slug; white and conical snails
Beetles & weevils	false wireworm, pasture cockchafers, mandalotus weevil
Caterpillars	common cutworm, pasture webworm
Other	earwigs, millipedes, slaters

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What are the IPM options for crop establishment?

- Cultural ✔
- Biological ?
- Chemical ✔ ….can we be more strategic?

Key principles :

- Paddock histories and managing pre-season risk
- Pest ID
- Cultural techniques
- Strategic use of pesticides
- Decisions underpinned by monitoring

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Paddock histories and managing pre-season risk

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Risk profiles for crop establishment

Example: Earth mites and lucerne flea

High risk	Reduced risk	Low risk
• Forecast for dry or cool, wet conditions that slow crop growth • Pasture going into crop • Susceptible crop being planted (canola, pasture, lucerne)	• Thin/sparse pasture in the previous spring • Low weeds in paddocks and along fence-lines • Higher sowing rate used • Optimal plant growing conditions during establishment	• Following a cereal or pulse • paddock with low weeds • Sandy soils (lucerne flea only)

Full Risk profile table in printed resources

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Make use of paddock histories

… helps with crop selection to reduce pest populations and negate the need for chemicals

- **'Resident'** pests are more predictable with paddock history information (e.g. mites, LF, slugs, snails, cockchafers, false wireworm)
- **'Transient'** pests (mobile across large distances) more difficult to predict (eg aphids, caterpillars)
- **Records** of paddock histories and soil type are particularly useful when planning to sow susceptible crops, such as canola

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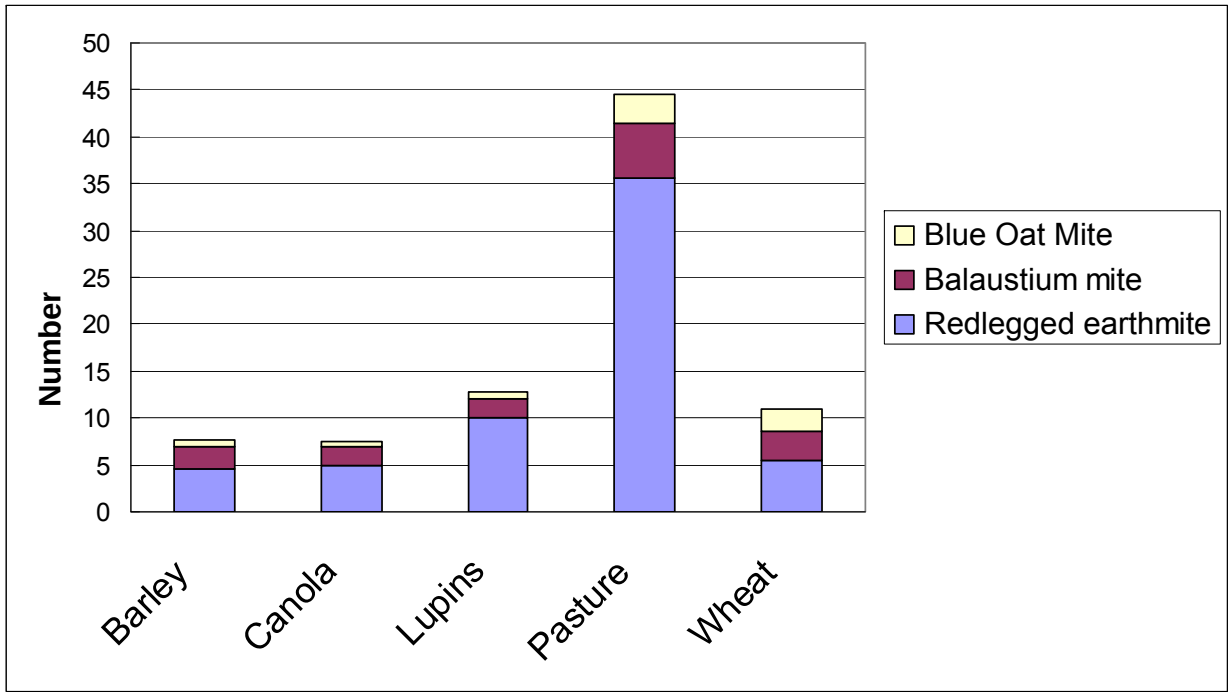
Example
Pre-season planning & crop selection

Number of **mites** in canola following 2 years of various crops



- Be careful following pastures, unless mite populations were controlled in the previous spring

Back

Micic *et al.* 2012. *GRDC WA Updates*

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Management of earth mites and lucerne flea

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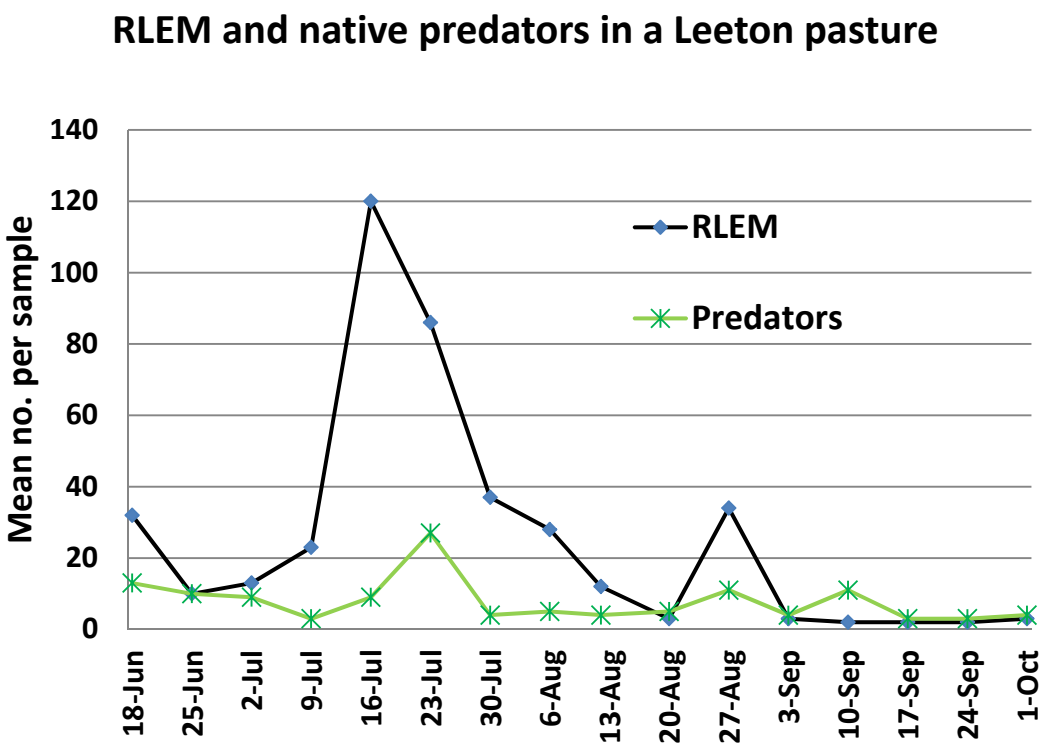
Beneficials / Natural enemies

Effectiveness

- Pastures
- Native predator complex suppress spring RLEM peak (James 1995)
- Anystis (RLEM) and Spiny snout (LF) mites most effective
  - 80% (RLEM) and 60% (LF) control (Michael 1995)
  - 93% LF in autumn with >25/m2 (Ireson 2006)
- But effectiveness is patchy!!



From James 1995

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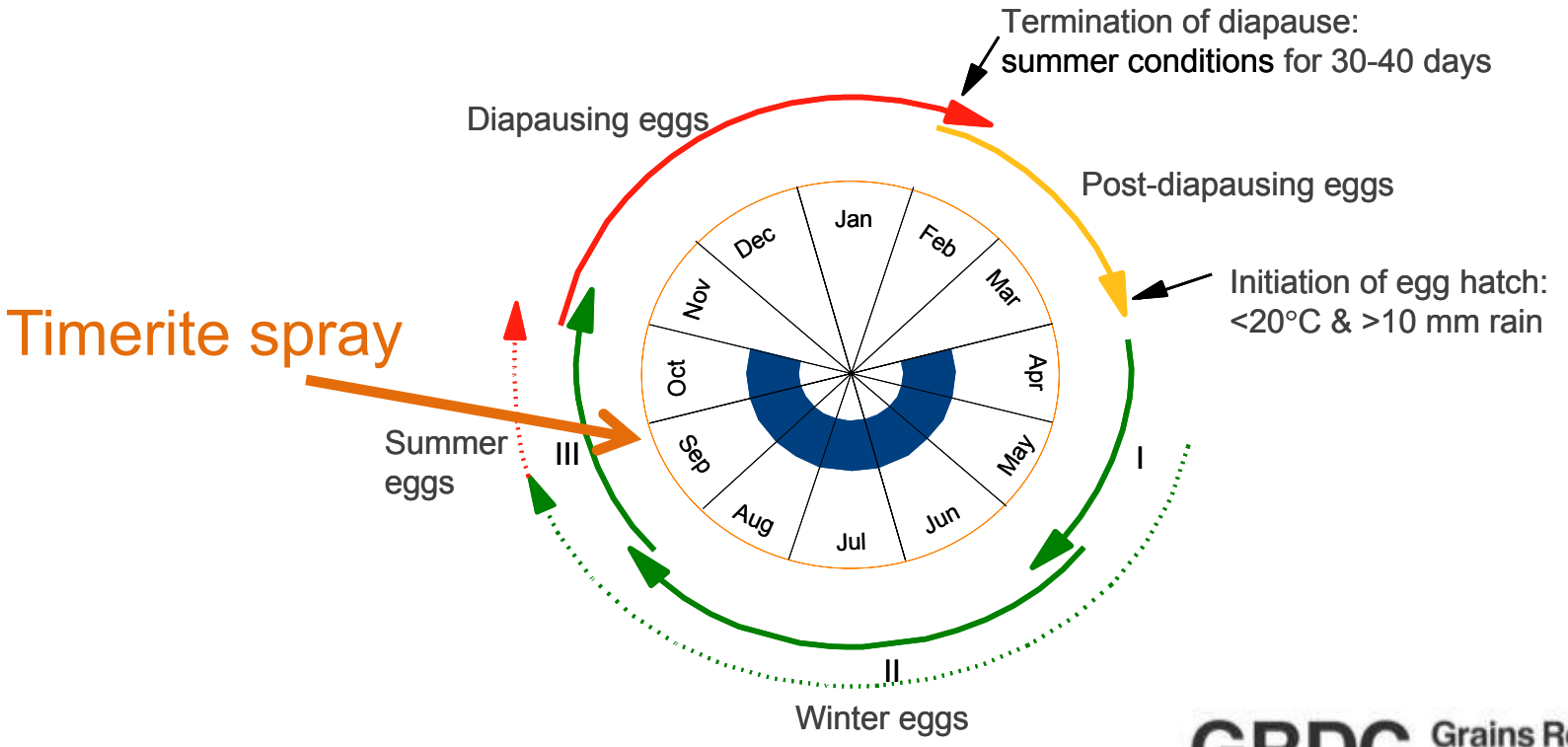
Pre-season control of RLEM

Timerite®

http://www.wodonga.com/Grow_Timerite.htm

- Reduces the carry-over of pest eggs (>95%)
- Timing of spray is critical
- Freely available tool



RLEM lifecycle

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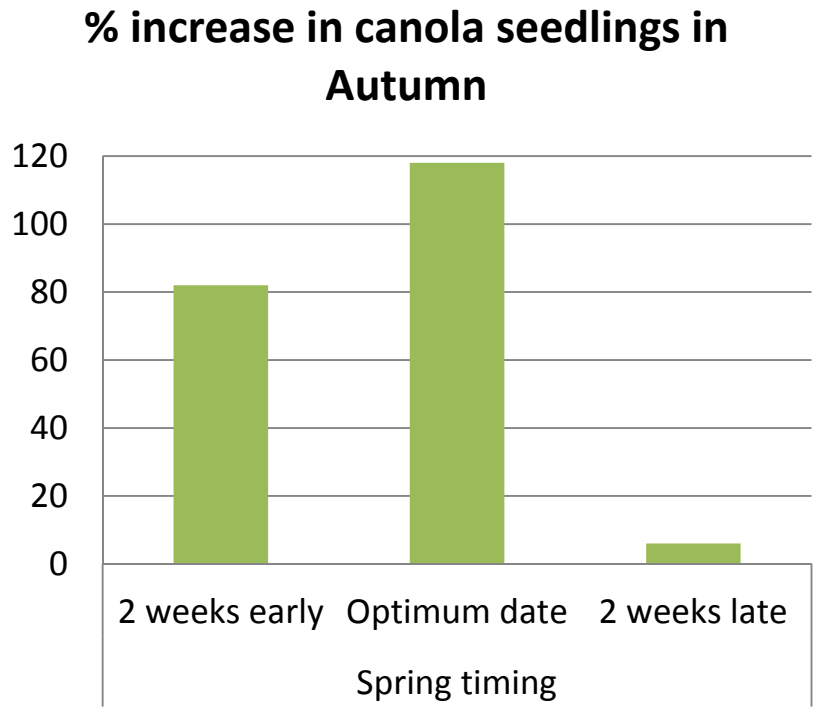
Timerite for RLEM (cont.)

- Residual chemicals needed to target later emerging eggs
- Timerite provides excellent control of RLEM, in autumn
- Not applicable to other mites and lucerne flea



Adapted from AWI Ltd: Timerite© Information Package (sourced from Bayer)

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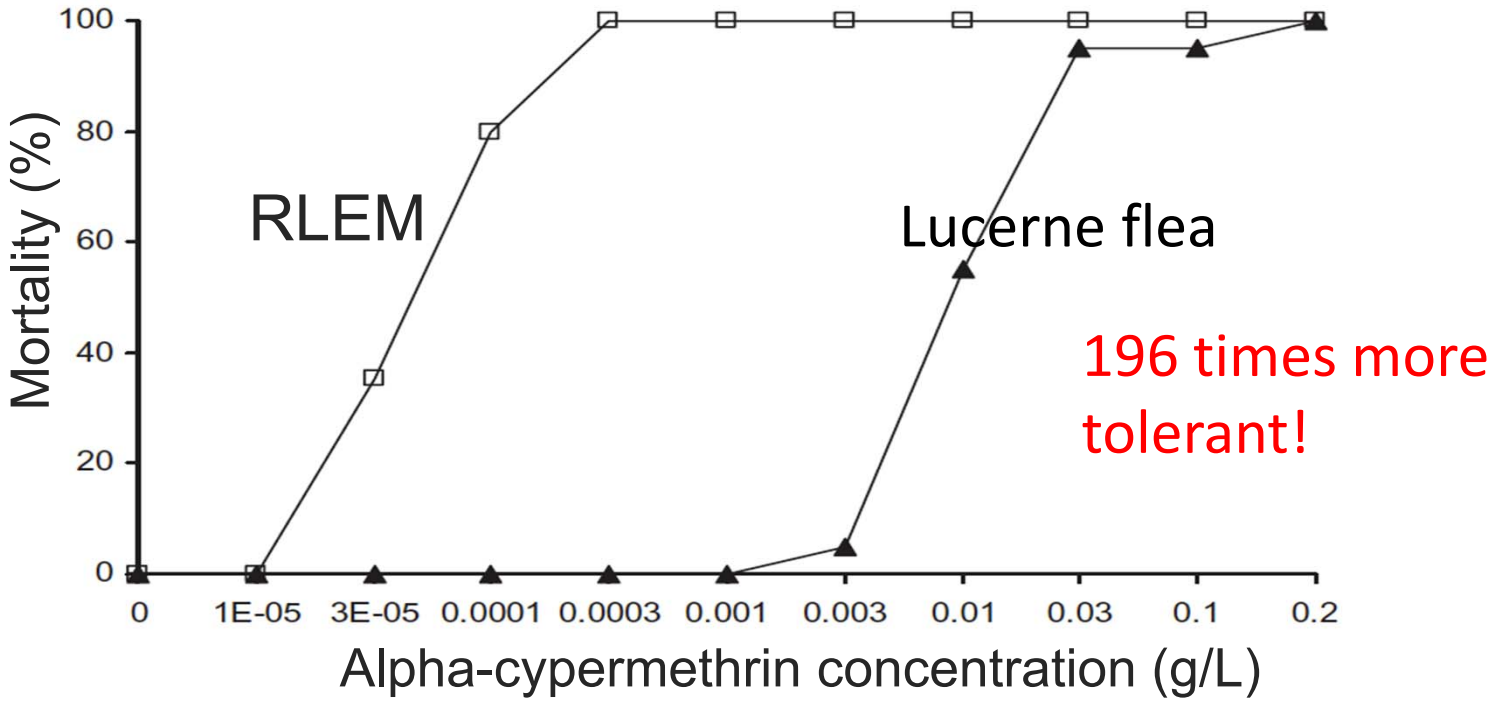
Tolerance to insecticides

Insecticide response curve: RLEM vs LF



Roberts *et al*. 2009. *Aust. J Entomol.*

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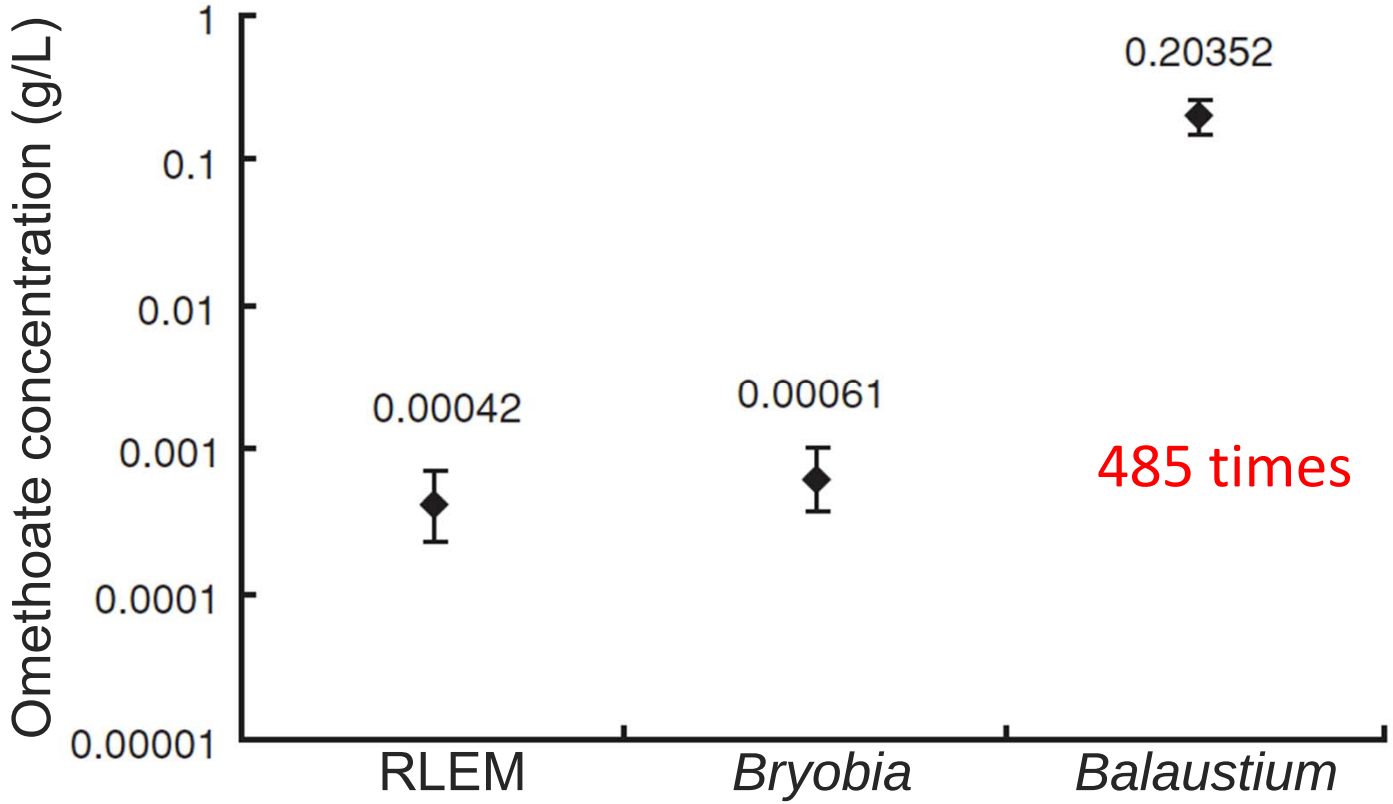
Tolerance to insecticides

Insecticide response curve: comparison of mites



Arthur et al. 2008. *Aust. J Exp. Agric.*

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cesar chemical testing (tolerance)

Chemical	RLEM*	BOM*	*Bal.*	*Bry.*	LF*
Omethoate (eg. LeMat)					
Dimethoate (eg Dimethoate)				?	
Chlorpyrifos (eg. Lorsban)					
Phosmet (eg. Imidan)					
Bifenthrin (eg. Talstar)					
Alpha-cypermethrin (e.g Fastac)					
Lambda-cyhalothrin (eg. Karate)					
Gamma-cyhalothrin (eg. Trojan)					
Esfenvalerate (eg. Sumi Alpha)				?	
Methidathion (eg. Suprathion)					
Imidacloprid (eg. Gaucho)**				?	?

** Other pesticide products are registered*

*** Tested as seed dressing only*

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Tolerance to insecticides chemical testing

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Research with unregistered chemicals does not constitute a recommendation for that particular pest species. Chemicals have been largely tested against g a.i./L rather than at recommended application rates. All pesticide applications must accord with the currently registered label for that particular pesticide, crop, pest and region.

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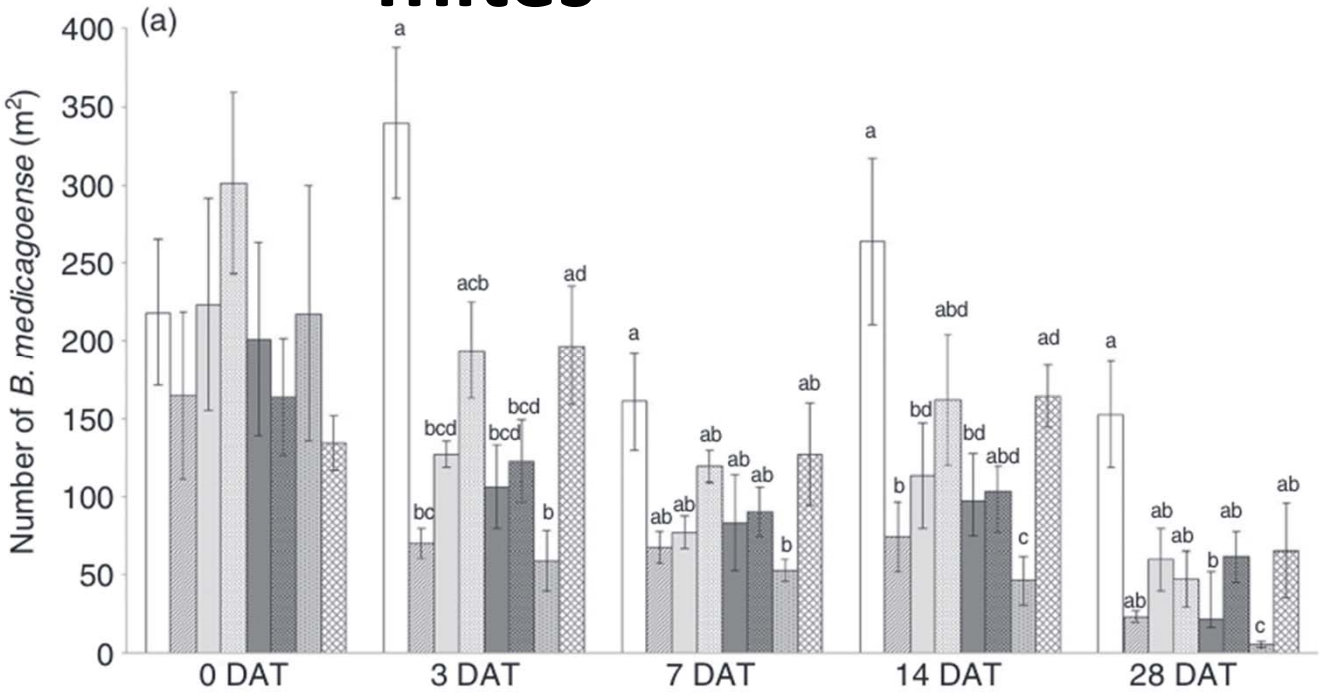
Latest on controlling *Balaustium* mites



Arthur, McColl & Umina, 2013

- The majority of chemical treatments have limited impact

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Insecticide resistance in RLEM

- RLEM have been controlled using chemicals for > 50 years in Australia
- In 2006, chemical control failures experienced at 1 location
- 4 separate applications over a period of 3 weeks
- Paddock history: repeated applications of synthetic pyrethroids > 5 years

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Insecticide resistance in RLEM

Chemical	Population	LC50 value	Resistance ratio
Bifenthrin	Control	0.03	
	WA	6881.97	243,027
	Control	0.03	
	WA (Gen 2)	7122.17	268,694
Alpha-cypermethrin	Control	0.02	
	WA	942.81	59,353
Omethoate	Control	0.10	
	WA	.26	---

- Resistance also found to be heritable
- Resistance located > 20 properties in WA (>900 km apart)
- Movement is known between WA & east coast
- Implications: need for careful management of insecticides

Adapted from Umina 2007. *Pestic. Sci*

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Current status of field resistance

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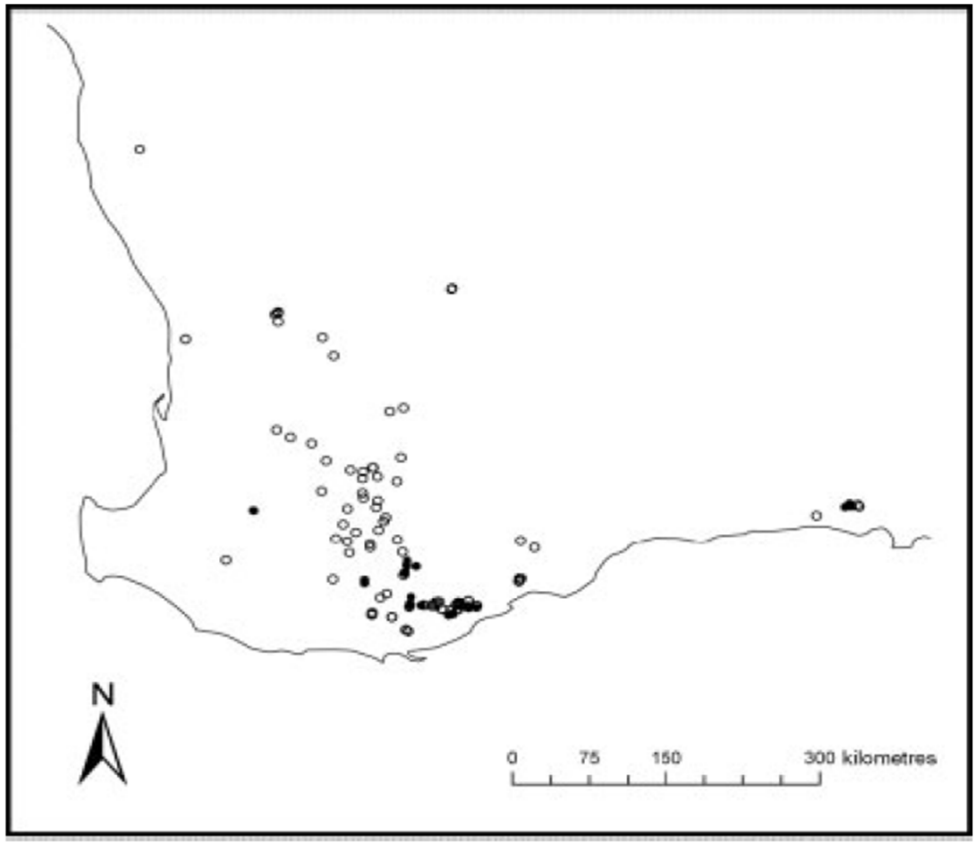

Umina, Weeks, Roberts, Jenkins, Mangano, Lord & Micic, 2012

- 26 paddocks (from 15 properties) identified with resistance between 2007-10
- Another 23 paddocks detected since 2011

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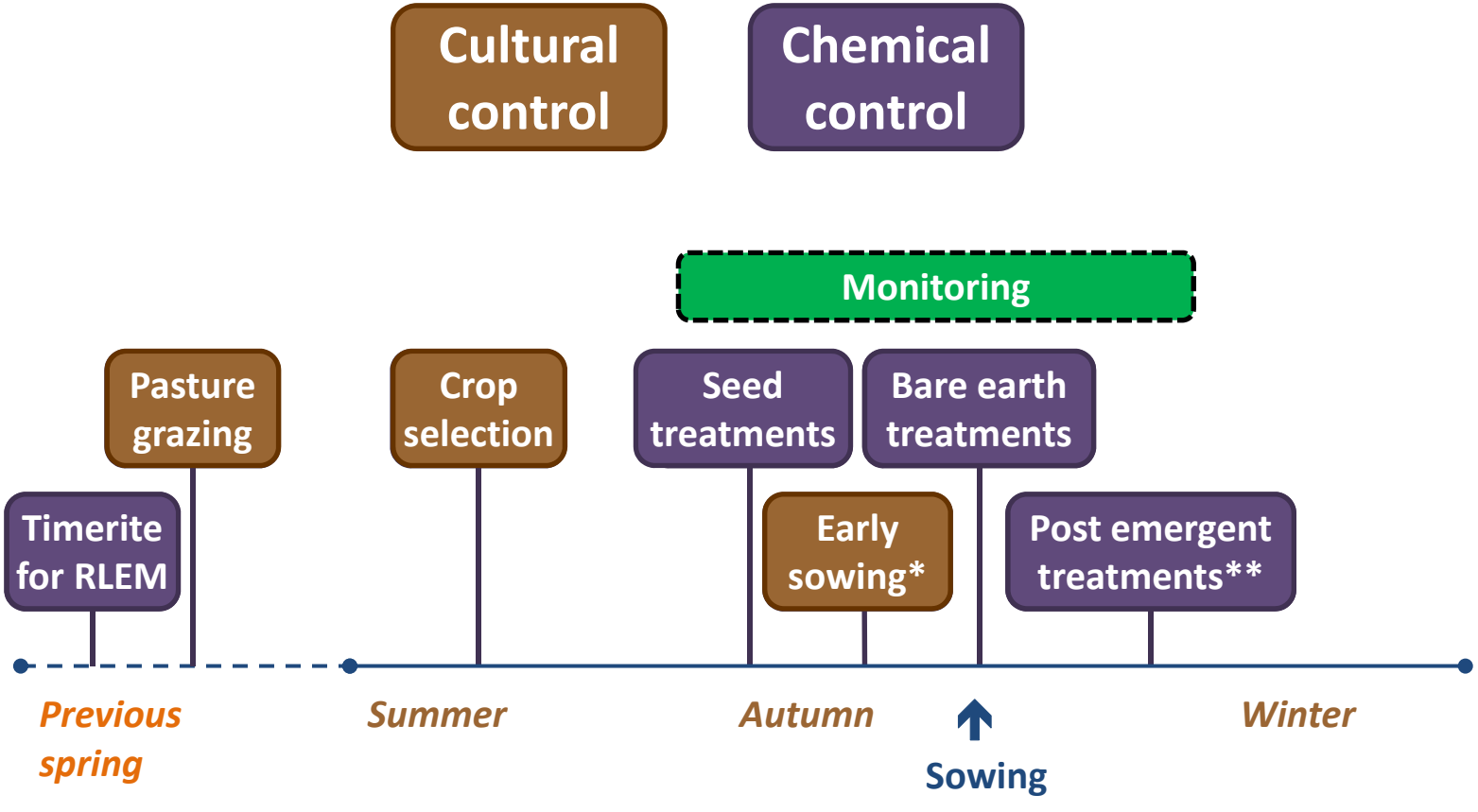
Decision timeline for earth mites & lucerne flea



** Also consider other sowing tactics (eg. increased seed density)*

*** Consider spot spraying for lucerne flea*

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'Best Bet' example: Earth mites and lucerne flea

Pre-season (previous spring/summer)	Pre-sowing	Emergence	Crop establishment
<u>Assess risk</u> High risk when: • History of high mite pressure • Pasture going into crop • Susceptible crop being planted (eg. canola, pasture) • Seasonal forecast is for dry or cool, wet conditions that slow crop growth. If risk is high: • Ensure accurate ID • Use Timerite (RLEM) • Heavily graze pastures in early-mid spring	If high risk: • Use seed dressing on susceptible crops • Plan to monitor more frequently until crop establishment • Use higher sowing rate to compensate for seedling loss • Consider scheduling a post-emergent insecticide treatment If low risk: • Avoid seed dressings (esp. cereals/pulses) & plan to monitor until crop establishment	• Monitor susceptible crops through to establishment (direct visual searches) • Be aware of edge effects; mites move in from weeds around paddock edges If spraying: • Ensure accurate ID before deciding on chemical • Consider border sprays (mites) and 'spot' sprays (lucerne flea) • Spray prior to the production of winter eggs to suppress populations and reduce risk in the following season	• As the crop grows, it becomes less susceptible unless growth is slowed by dry or cool, wet conditions

Full 'Best Bet' table in printed resources

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Millipedes, earwigs & slaters

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Increasing pest prevalence

- Earwigs, millipedes and slaters have increased in pest status over the last 4-5 years in SE Australia

Total pest reports received from *PestFacts* subscribers from SA, Vic and NSW since 2006

	2006	2007	2008	2009	2010	2011	2012	2013
Earwigs	1	0	0	0	4	5	7	5
Millipedes	3	1	0	1	7	8	2	2
Slaters	0	1	2	0	4	4	5	8

- This increase has been linked to stubble retention, no-till farming practices and improvements in soil organic matter, which have provided a more favourable habitat
- Damage has been reported mainly in the medium and high rainfall zones, including Wimmera and Western Districts in Victoria

European earwigs

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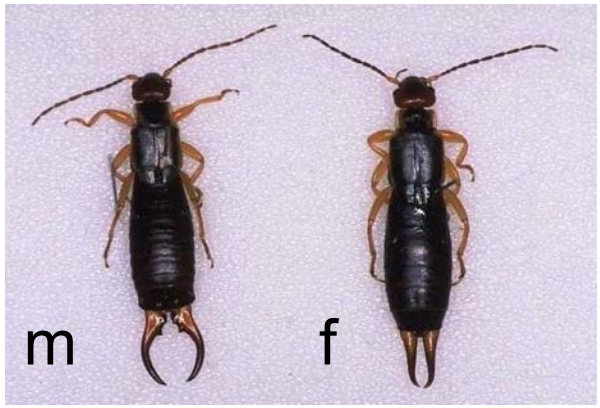
Lifecycle/description

- Adults 20 mm long
- Communal
- Easily confused with beneficial earwigs



Damage

- Adults and nymphs attack canola, lupins, cereals
- Associated with heavier soils, stubble
- Irregular chewing of leaves, cotyledons, stems (similar to slug damage)
- Can also chew through seed pods; and occasionally are a grain contaminant
- Nocturnal feeders (inspect at night)

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Earwigs: the good & the bad

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Forficula auricularia

EUROPEAN EARWIGS

PEST

- 12 – 24 mm long
- Uniform, dark colour body
- Legs & pincers lighter than the body

Gonolabis michaelseni

NATIVE EARWIG

BENEFICIAL

- Lighter fore body, darker abdomen
- Legs & pincers similar colour to other parts of the body

Labidura truncata

COMMON BROWN EARWIG

BENEFICIAL

- 35 mm long
- Dull brown with straw coloured markings
- Orange triangle on the back

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European earwigs - management

- **Cultural – removing the shelter**
  - Stubble burn
  - Weed control
  - Cultivation
  - Grazing pastures to <1.5 t/ha in Spring
- **Biological**
  - Carabid beetles
  - Birds & lizards
- **Chemical:**
  - Nothing registered in broadacre crops
  - Some chemicals registered in horticulture (carbaryl, chlorpyrifos)
  - Seed dressings may give some control

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Black Portuguese millipedes

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Lifecycle/description

- Active in autumn and spring
- 2 years to sexual maturity
- Easily distinguishable from native species

Damage

- Mainly organic matter feeder, attacks canola and cereals
- Associated with black organic soils (although damage has occurred on lighter soils)
- Foliar grazing, cotyledons/leaves (relatively rare)
- Nocturnal feeders
- Large numbers? Damage?

Slaters/ Pill bugs

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Lifecycle/description

- Crustations related to crabs and lobsters; terrestrial but moisture dependent
- Stubble provides a cool, moist habitat; crumbly clay soil surfaces aid their survival
- Feed on decaying vegetable and animal matter
- The flood bug (*Australiodillo bifrons)* slater species can swarm
- Prevention is best

Damage

- Cereals, canola and lentils
- Chew base or tips of seedlings

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Managing trash feeders: thinking ahead

Risk is increased in:

- Canola
- Heavy organic soils that retain moisture
- Stubble retention / high loads
- Wetter weather patterns
- Poor germination / slow plant growth
- High populations last spring

To reduce losses:

- Understand the culprit!
- Monitor prior to sowing (traps)
- Manage / burn stubbles (timing!)
- Sow other crops (not canola)
- Rapid establishment
  - High vigour varieties
  - Higher seeding rates
- Few registered insecticides
  - Difficult to control with SPs and OPs
  - Fipronil and imidacloprid some seed registrations (see Fact Sheet)
  - Methiocarb baits offer some control in horticulture

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False wireworms and beetles

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FWW and (adult) beetles species

		Size range	Larval colour
'Smaller' false wireworms and beetles			
Bronzed field beetle larvae	Adelium brevicorne	9-12 mm	Shiny grey
Grey false wireworm	Isopteron aversum	10-12mm	Grey green flattened
Vegetable beetle	Gonocephalum elderi	10 mm	Brown
'Larger' false wireworms and beetles			
Eastern false wireworm	Pterohelaeus spp.	50 mm	Light brown
Southern false wireworm	Gonocephalum misellum	20mm	Cream brown

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Bronzed field beetle (BFB)

Lifecycle/description

- Native species, soil dwelling
- Common in and on fine textured soils high in organic matter
- Favoured by stubble retention, trash (shelter/ breeding)
- Adult beetle lay eggs in late Feb/March

Damage

- >5 adults/m2 under carpet squares pre-sowing
- Larvae ringbark seedling & sever the hypocotyl of young seedlings
- Adults feed on decaying organic matter

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Bronzed field beetle

Cultural control

Remove plant residues / trash by late February (before eggs are laid)

Reducing harvest contamination

- Preventing/controlling the autumn population
- Avoid leaving windrows on the ground too long
- Harvest in the hottest part of the day

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Vegetable beetle

Lifecycle/description

- Larvae 10 mm (brown) rarely seen above the soil surface
- Adults 8 mm long, flattened, usually dull grey, but sometimes brown / black. Often with soil on their backs
- One generation per year

Damage

- Adults may attack emerging canola
- Larvae damage cereals
  - hollow out seeds
  - attack roots or ringbark seedling at or below the soil surface

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Managing false wireworm/beetles

Cultural

1. **Crop choice**
   - Sow less susceptible crops, e.g. cereals or pulses
2. **Seedbed preparation**
   - Remove crop residue in Feb
   - Monitor adult activity before sowing canola (carpet square or baits)
3. **Sowing**
   - Compaction - good soil/seed contact
   - Early seeding date
   - (if risk) - higher seeding rates

Insecticides

- Seed dressings have limited benefit for these pests

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Mandalotus weevils

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Mandalotus weevils (multiple spp.)

- Largest Australian weevil genus
  - 152 described species
- Endemic, mainly SE Australia
- Taxonomy not defined

Adults

- 3-5 mm long, flightless, dull grey-brown
- Attack seedlings of canola, cereals, pulses in autumn
- Mainly lighter soils

Damage - worst in canola

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- Adults chew stems, leaves, cotyledons, ringbark/ lop young seedlings
- Often first noticed 1 week after emergence
- Damage occurs rapidly - intervene immediately

Usually patchy (SA mallee 2013)

Damage in lentils, 2010

Typical ring-barking of canola seedlings

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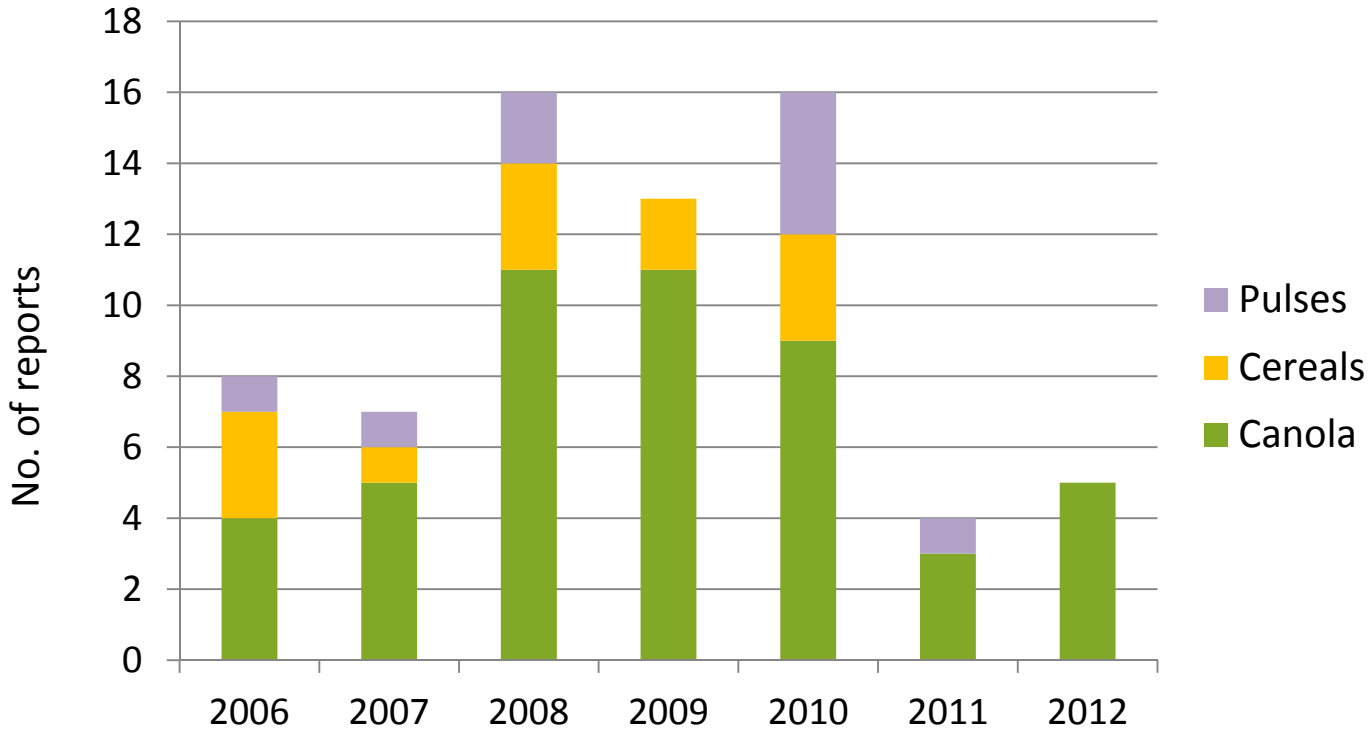
Crop damage

Sometimes large areas (Ardrossan SA 2009)

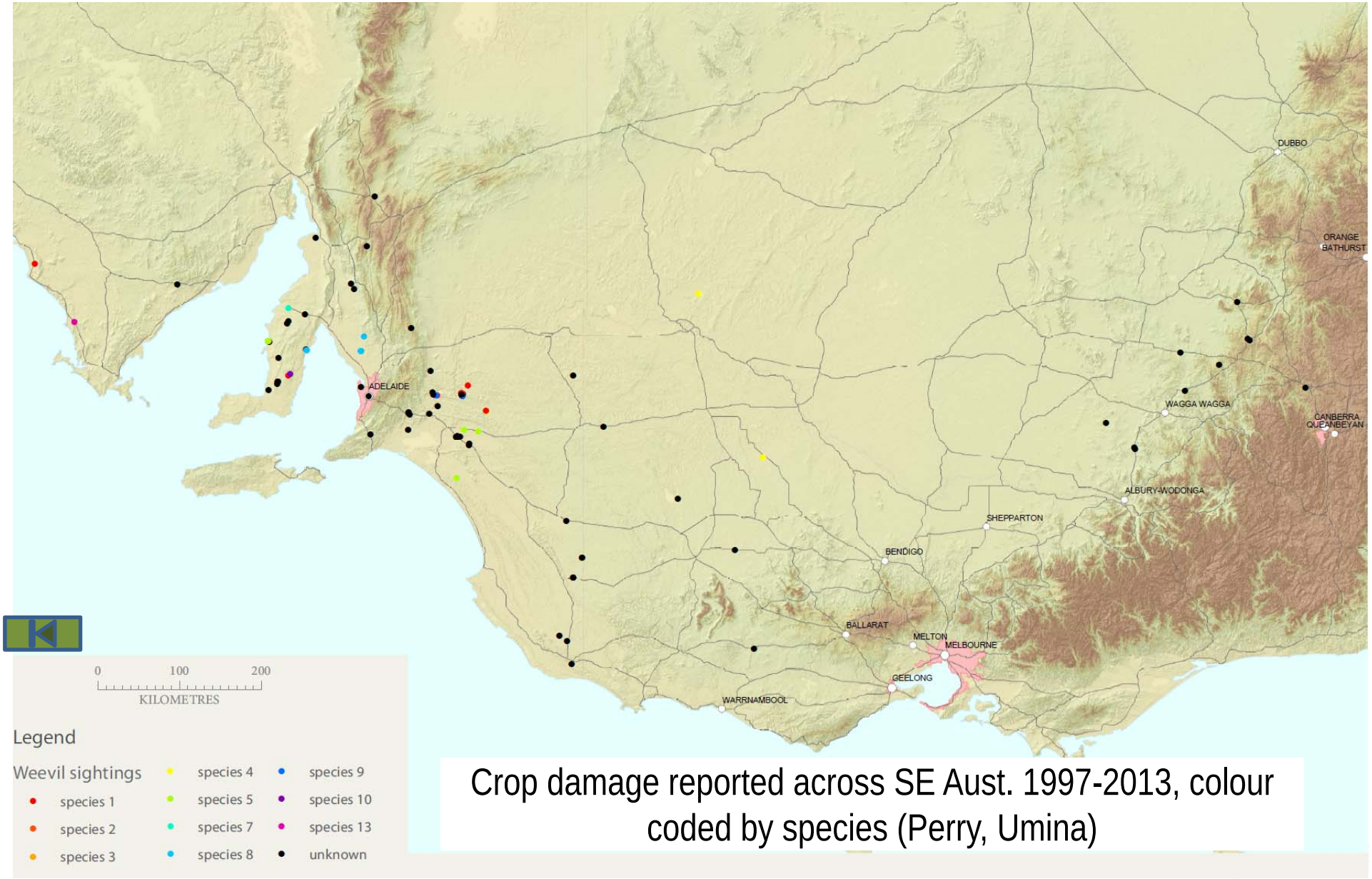
Canola destroyed at Bowhill, SA, 2003

Crop damage - # reports



Crop damage reports in SA, Vic and NSW 2006-2012 (Perry, Umina)

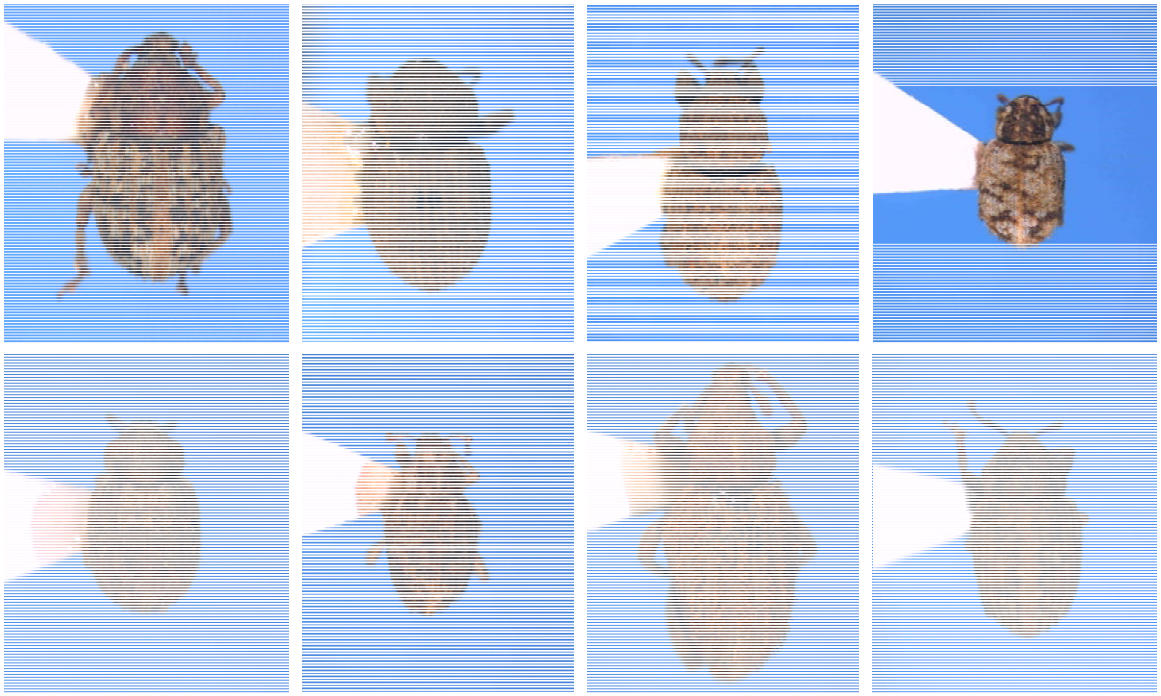
Mandalotus distribution

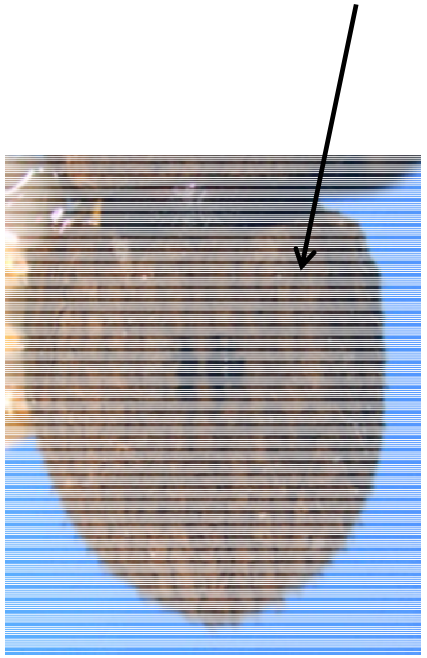


Crop damage reported across SE Aust. 1997-2013, colour coded by species (Perry, Umina)

Identification

- Over 10 species, only 2 currently identified, some undescribed
- 3-5mm, resemble clod of dirt, often rows of thick paddle-shaped hairs on the back





Identification

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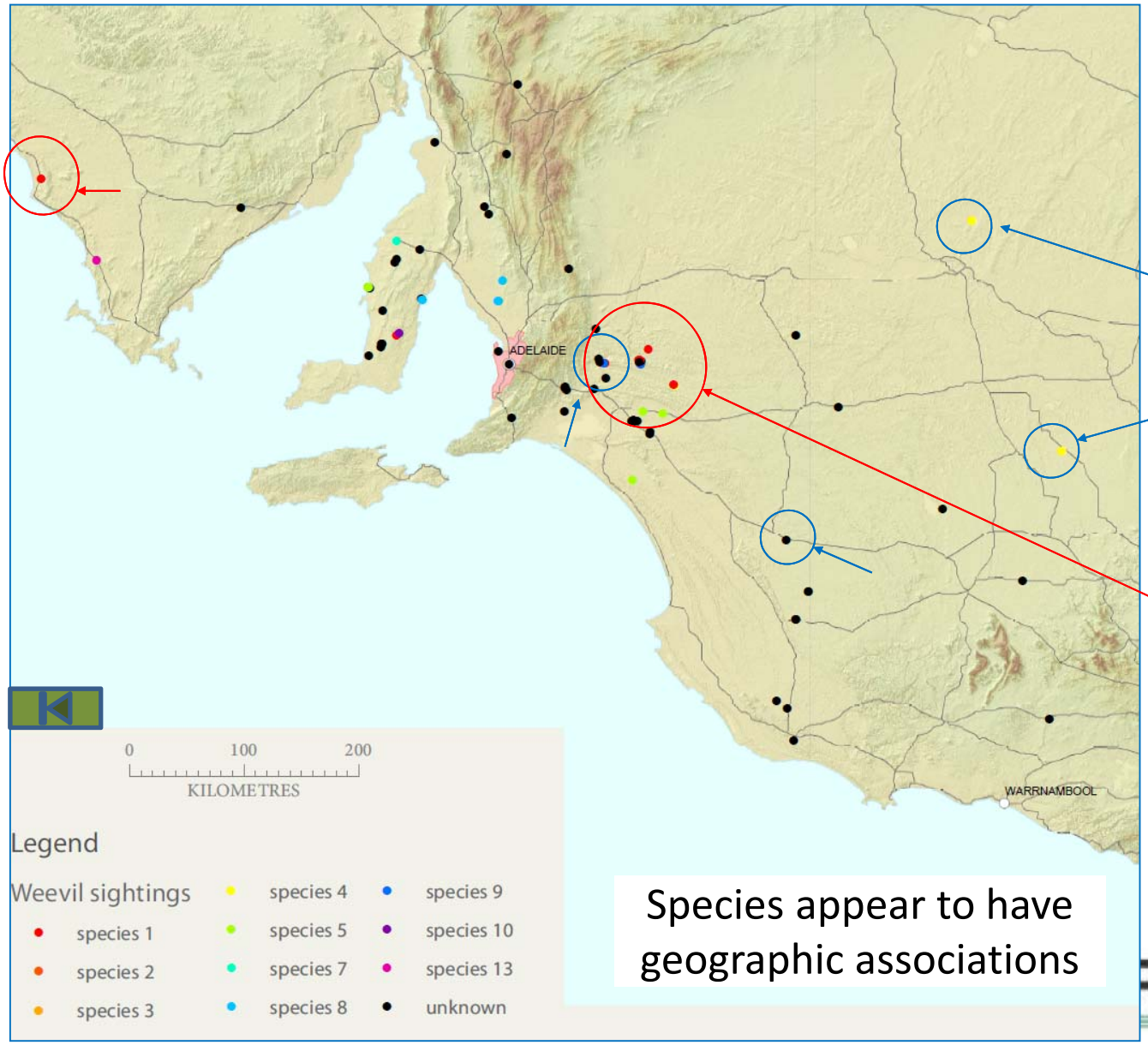
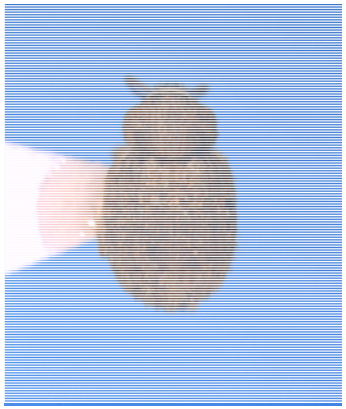
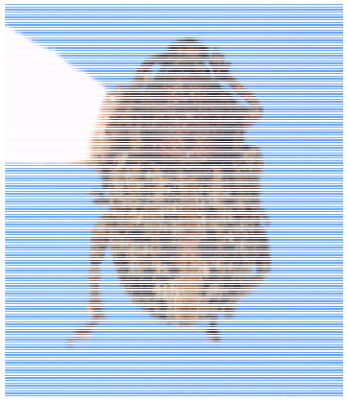


Species appear to have geographic associations



M. puncticollis (common in Vic)



M. crawfordi (common in SA mallee)

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Monitoring and assessing risk

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- Paddock history (areas of paddocks with previous problems, little insecticide use)
- Soil type/region – lighter calcareous
- Hard to find. Check under weeds and grasses from early April – best after rainfall

Biology - lifecycle

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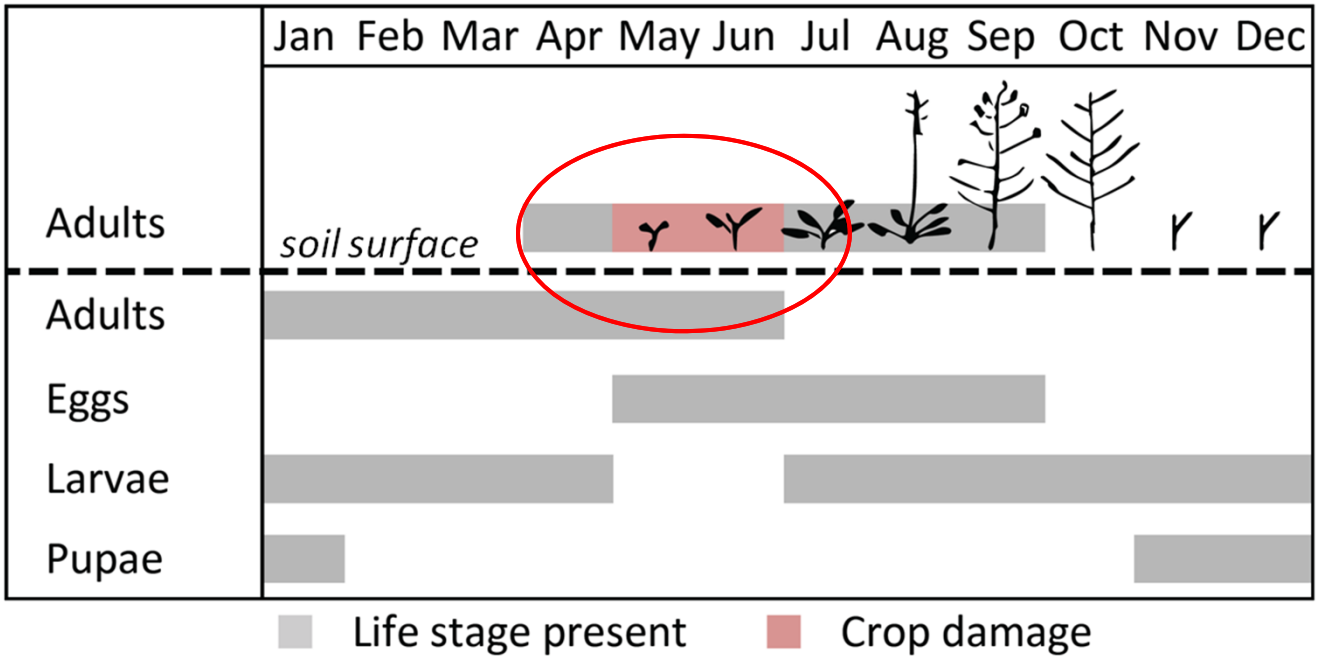
- Sexual reproduction, one generation per year
- Critical period is May/June (peak adult emergence)



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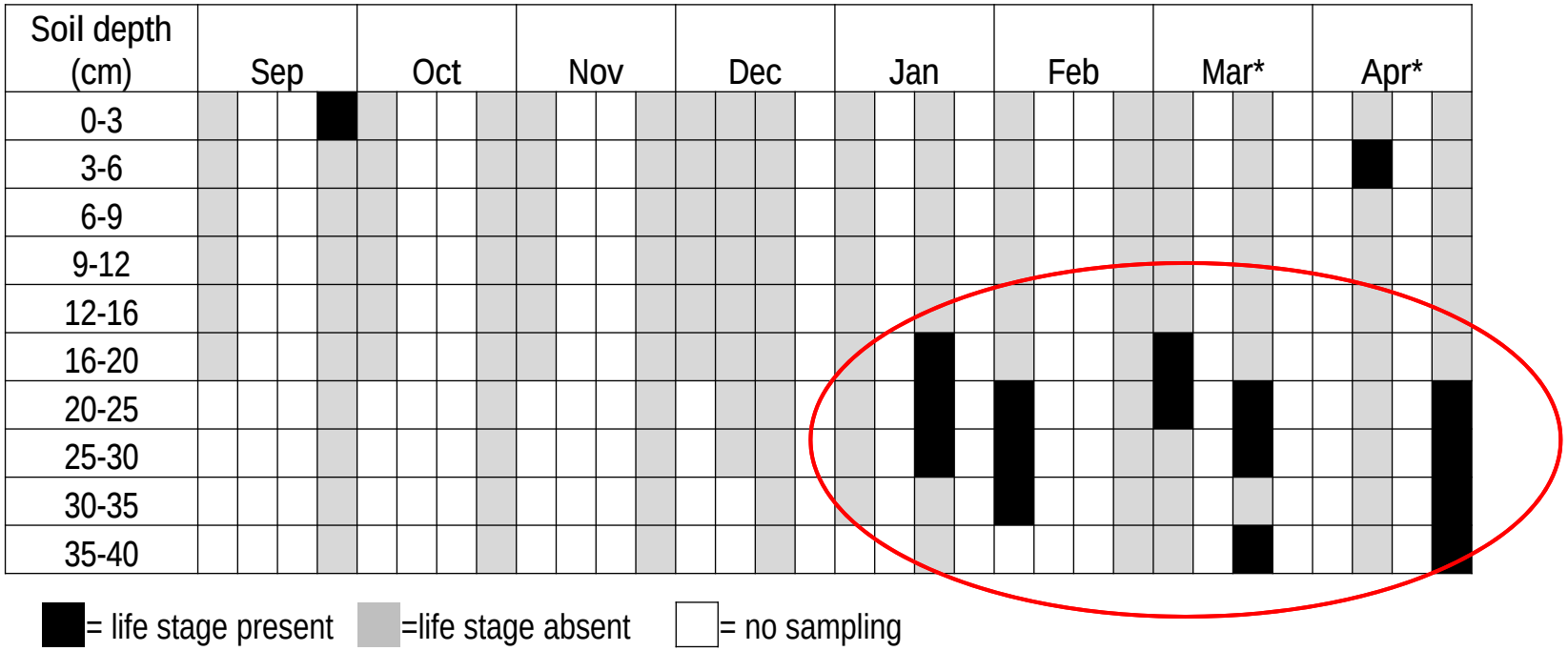
Biology - over-summering

Adults ‘hibernate’ deep in the soil over summer



Presence of adults in the soil profile (Perry, DeGraaf)

Management

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- Difficult – not practical during non-crop period (adults hibernate well below ground)
- Current best bet: Chemical control in high risk areas (see next slides)
  - Region/soil type
  - Paddock history
  - Canola not sown before!
- Monitor carefully at 1 week after emergence, check until 4 leaf stage

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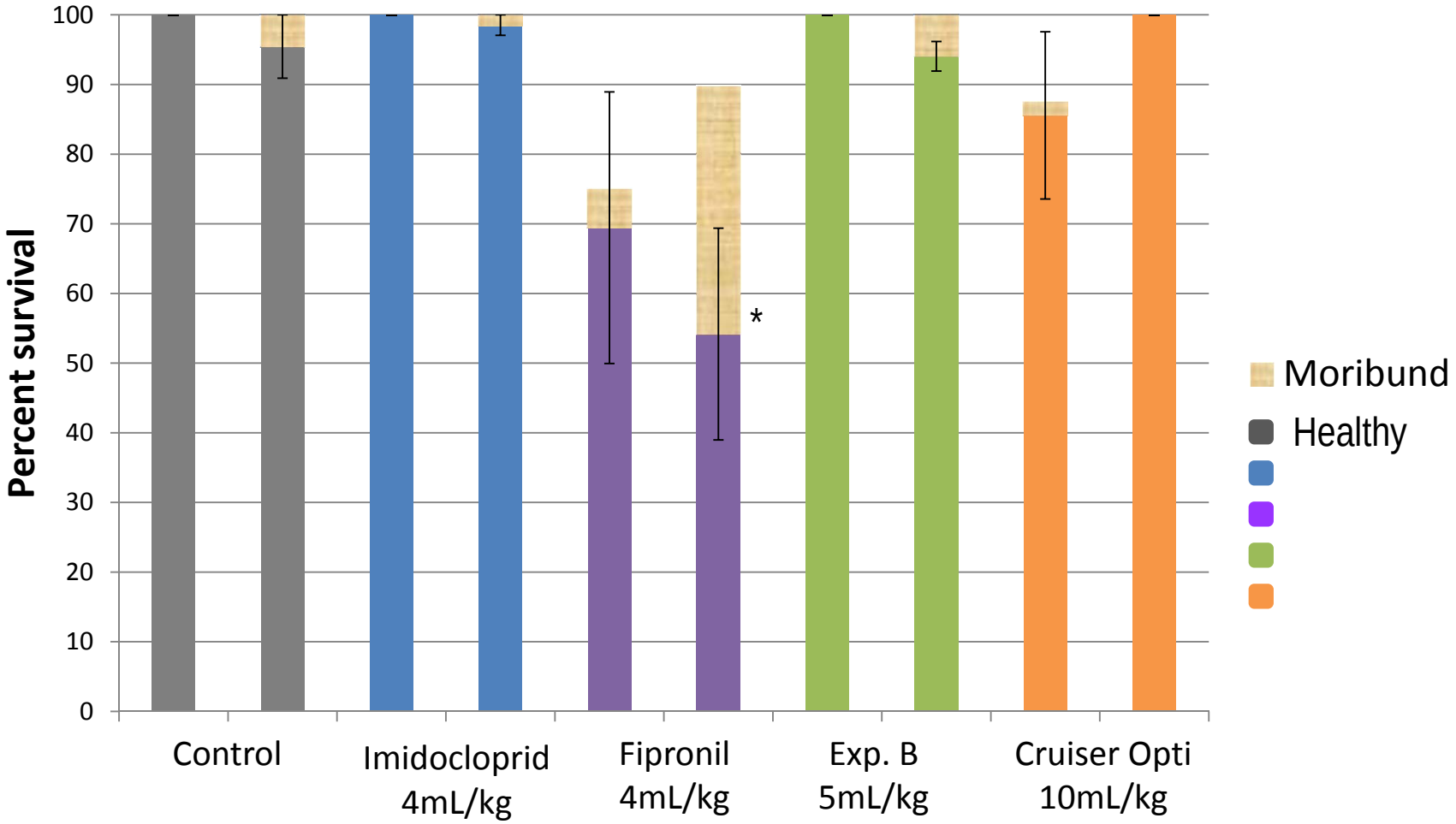
Chemical control - seed treatments

No products have good activity

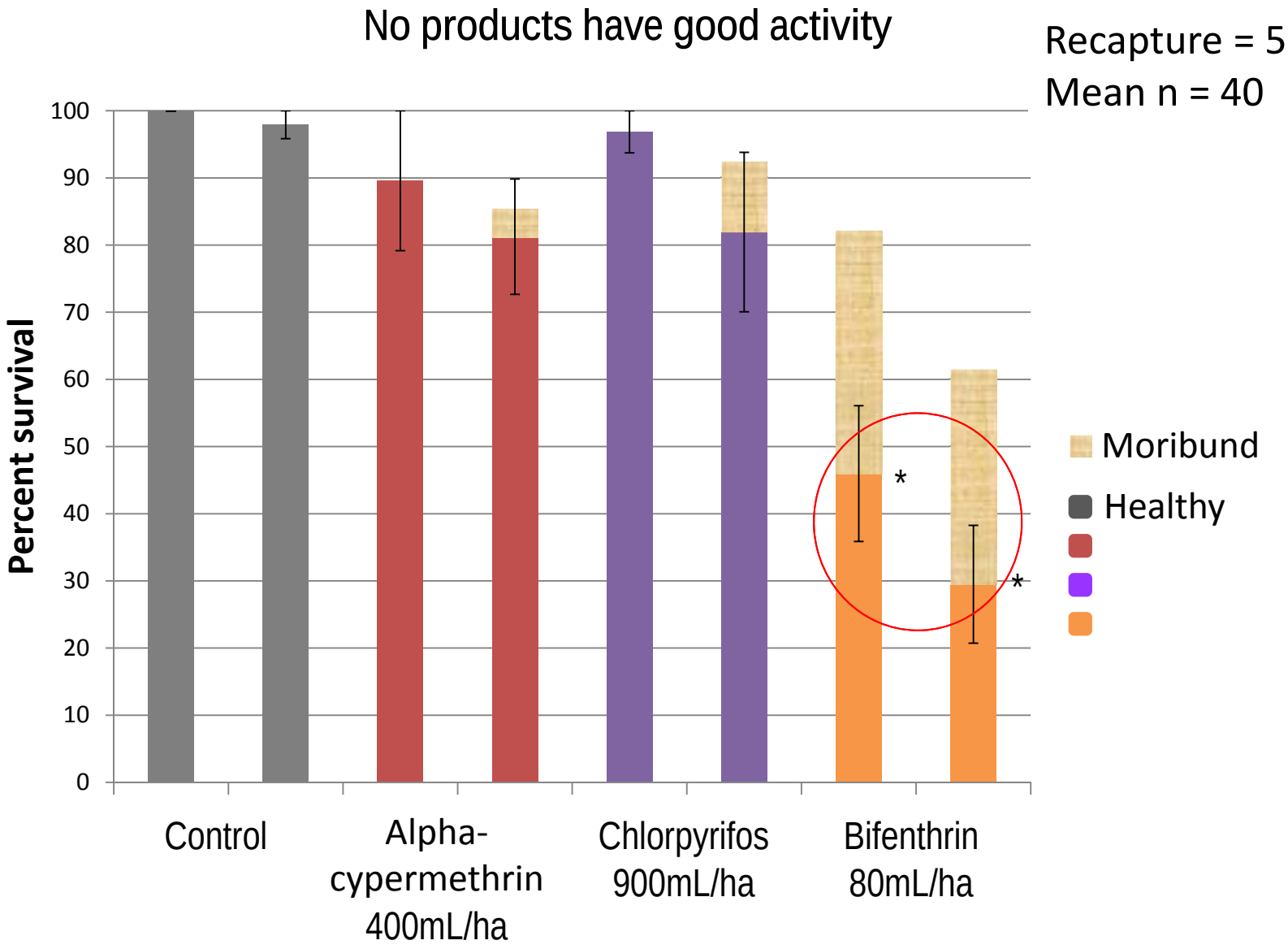
Recapture = 56%
Mean n = 40



K. Perry 2013

Means of 4 groups of weevils ± SE. LH bar = site 1, RH bar = site 2 * χ^2 $p < 0.05$ within site

Chemical control – bare earth sprays



Means of 4 groups of weevils ± SE. LH bar = site 1, RH bar = site 2 * χ^2 $p < 0.05$ within site

Decision Making
for Integrated Pest Management
in Grain Crops

Establishment pests ‘Best Bet’ IPM strategy

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Decision Making
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Take home messages

- Crops most **vulnerable** at establishment, esp. canola and medics
- Planning **pre-season** is important (time constraints to monitor sufficiently at establishment period)
- We have the ability to foresee many establishment pest issues before they happen… as they are '**residents**'
- **Monitoring & Pest ID** are vital (eg. mites, weevils, scarabs)
- **Early planting**, **stubble management, increasing sowing density** and **seedbed rolling** are common cultural strategies
- **Beneficial species** often only play a support role at crop establishment (difference b/w crops & pastures)

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