Decision Making
for Integrated Pest Management
in Grain Crops

Improved Snug Management

Slides from Michael Nash SARDI

GRDC Grains Research & Development Corporation
Your GRDC working with you

Decision Making for Integrated Pest Management in Grain Crops

Contents

GRDC Grains Research & Development Corporation
Your GRDC working with you

Know your enemy

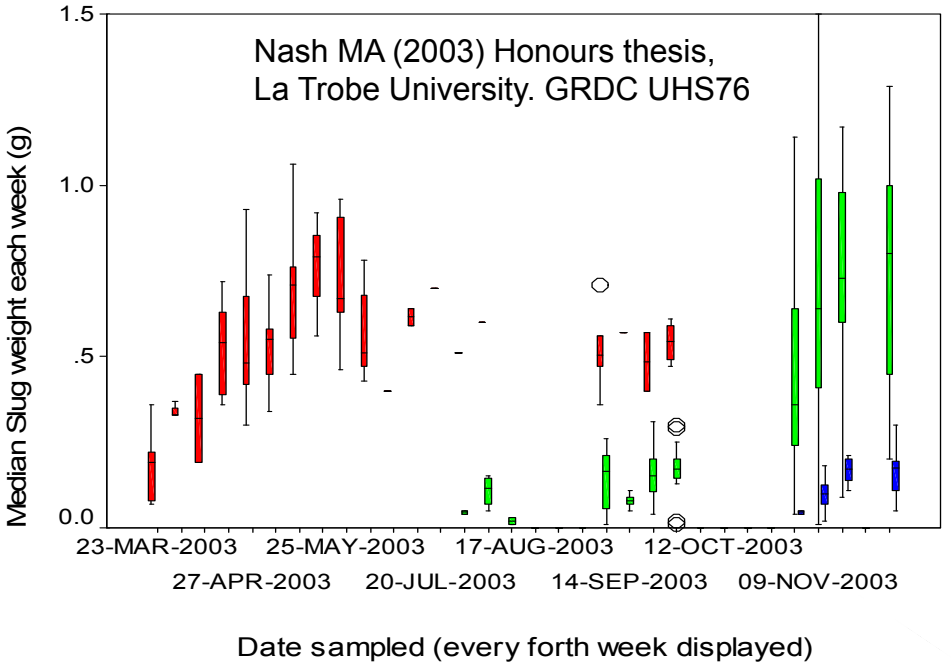
Decision Making for Integrated Pest Management in Grain Crops

Grey field slug

(Deroceras reticulatum)

What is known:

- Light grey to fawn colour
- Dark brown markings
- Up to 50 mm long
- Mainly surface active
- Milky-white mucus
- Reproductive maturity 138 days
- 21-22 days for eggs to hatch
- Optimum 18 C°
- Soil water >20%
- Opportunistic annual life cycle
- 0.5 – 1.5 m^2 damaging to canola
- 5 damaging to cereals????



Decision Making
for Integrated Pest Management
in Grain Crops

Black keeled slug

(Milax gagates)

- Black / dark grey in colour
- Sharp ridge (keel) along back
- 40 – 60 mm long
- Reproductive maturity 240 days
- 40 days for eggs to hatch
- Optimum 17-18 C°
- Annual or Biannual lifecycle
- Burrows underground
- Tolerant of Metaldehyde ???
- Feeds at surface AND below ground
- < 1/m^2 damaging to canola ??
- 1-2 damaging to cereals????

GRDC Grains Research & Development Corporation
Your GRDC working with you

Decision Making for Integrated Pest Management in Grain Crops

Conclusions slugs

- *Milax gagates* are excellent bio-indicators of soil moisture availability
  - wider distribution
  - drier areas i.e. >450mm rainfall
  - heavy soils are an indirect factor
  - heavy autumn rainfall
- *D. reticulatum* distribution has shifted up in elevation (Nash 2013)
  - temperature the key factor
  - prefers colder conditions
  - requires more moisture i.e. 500mm
- Brown field slug distribution has increased
  - increased summer rainfall?
  - over use of metaldehyde ?

Snails

Round:

Vineyard or common white

Cernuella virgata

White Italian snail

Theba pisana

Conical:

Small conical snail

Cochlicella barbara

Conical or pointed snail

Cochlicella acuta

Chance of slug problem

Field

Previous outbreaks

National

What species do I have

Monitor problem areas

See identification guide

Will they be a problem

Moisture

Soil type (clay)
Stubble (retained)
Summer volunteers
Previous crop type (canola, beans)

Climate
Rainfall > 450mm

Yes to > 1 of the above factors

Control options

Chemical: Bait

Cultural

Biological

Are they going to be controlled by one method? Unlikely

Temperature

Moisture

Rainfall, Evaporation, Soil conditions

Decision Making for Integrated Pest Management in Grain Crops

GRDC Grains Research & Development Corporation
Your GRDC working with you

Factors for increased snail risk

Decision Making for Integrated Pest Management in Grain Crops

Variable	*common white*	*pointed*	*small pointed*	*white Italian*
Temperature - annual mean (Bio01)	X		X	
Temperature - diurnal range mean (Bio02)		X	X	X
Temperature – min coldest qrt. (Bio6)		X	X	X
Precipitation - seasonality (Bio15)			X	
Precipitation - warmest quarter (Bio18)	X	X	X	X
Radiation - seasonality (Bio23)	X		X	X
Moisture Index - annual mean (Bio28)		X		X
Moisture Index - seasonality (Bio31)	X			
Moisture Index - coldest quarter mean (Bio35)	X	X	X	X
pH	X			
ASRIS 0-30cm Clay Content	X			
Substrate Calcrete	X	X		X

GRDC Grains Research & Development Corporation
Your GRDC working with you

Identifying slug risk: Paddock level

Decision Making for Integrated Pest Management in Grain Crops

High risk	Reduced risk	Low risk
Irrigated and/ or > 500mm	500mm -450mm	<450mm
Above average spring – autumn rainfall	Dry spring hot finish	Drought
Cold wet establishment conditions	Warm dry conditions	
No till stubble retained	Burnt only	Tillage and Burnt stubbles
Presswheels, raised beds, cloddy seed bed		Full disturbance sowing compacted seedbed
No sheep in enterprise	Sheep on stubbles	
Soil with improved **moisture** holding capacity; i.e. increased clay content and organic matter		Poor moisture holding capacity; i.e. Sand no OM
Summer volunteers		No volunteers
Slow crop establishment	Quick establishment by earlier sowing of hybrid varieties	
Conventional TT varieties		
Previous paddock history		No slugs
Slug damage	Clean cereal crops	No sclerotinia
Rotation: Beans/ canola		Poor Cereal crop
sclerotinia		No weeds

GRDC Grains Research & Development Corporation
Your GRDC working with you

Decision Making for Integrated Pest Management in Grain Crops

Monitoring: surface refuges

Note: Monitoring is not going to provide absolute assessment of slug density

9 refuges placed in a 'W' shape in each field (13 > 20ha) HGCA Topic sheet no. 85

- 30 cm x 30 cm approx. slugs / m^2
- 50 sampling points 40ha
- Effected by moisture > 20% activity
- Check susceptible crops regularly
- Concentrate on areas known to suffer from slug damage
- Check in the mornings when moist

GRDC Grains Research & Development Corporation

Decision Making
for Integrated Pest Management
in Grain Crops

Snail monitoring

GRDC Grains Research & Development Corporation
Your GRDC working with you

Chance of slug problem

Field — National

Previous outbreaks

What species do I have

Monitor problem areas — See identification guide

Will they be a problem

Moisture

Soil type (clay)
Stubble (retained)
Summer volunteers
Previous crop type (canola, beans)

Climate
Rainfall > 450mm

Yes to > 1 of the above factors

Control options

Chemical: Bait | **Cultural** | **Biological**

Are they going to be controlled by one method? Unlikely

Decision Making for Integrated Pest Management in Grain Crops

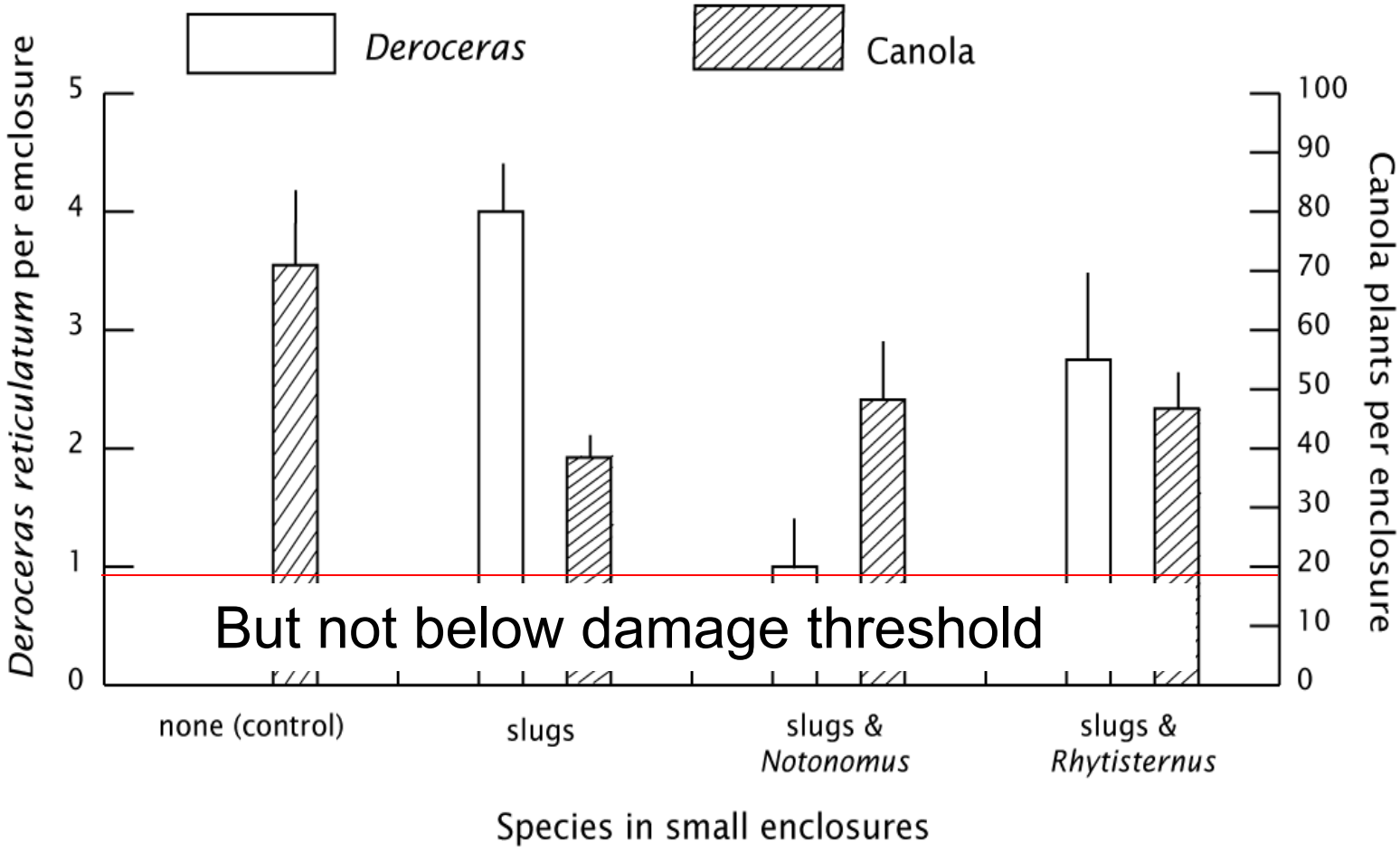
GRDC Grains Research & Development Corporation
Your GRDC working with you

Biological control – conserving natural enemies

Notonomus gravis eating Deroceras reticuialtum
D Paul©

Decision Making for Integrated Pest Management in Grain Crops

Native generalist predators limit slug populations



Nash et al 2008; Biological Control **47**:328–334. GRDC GRS80

GRDC Grains Research & Development Corporation
Your GRDC working with you

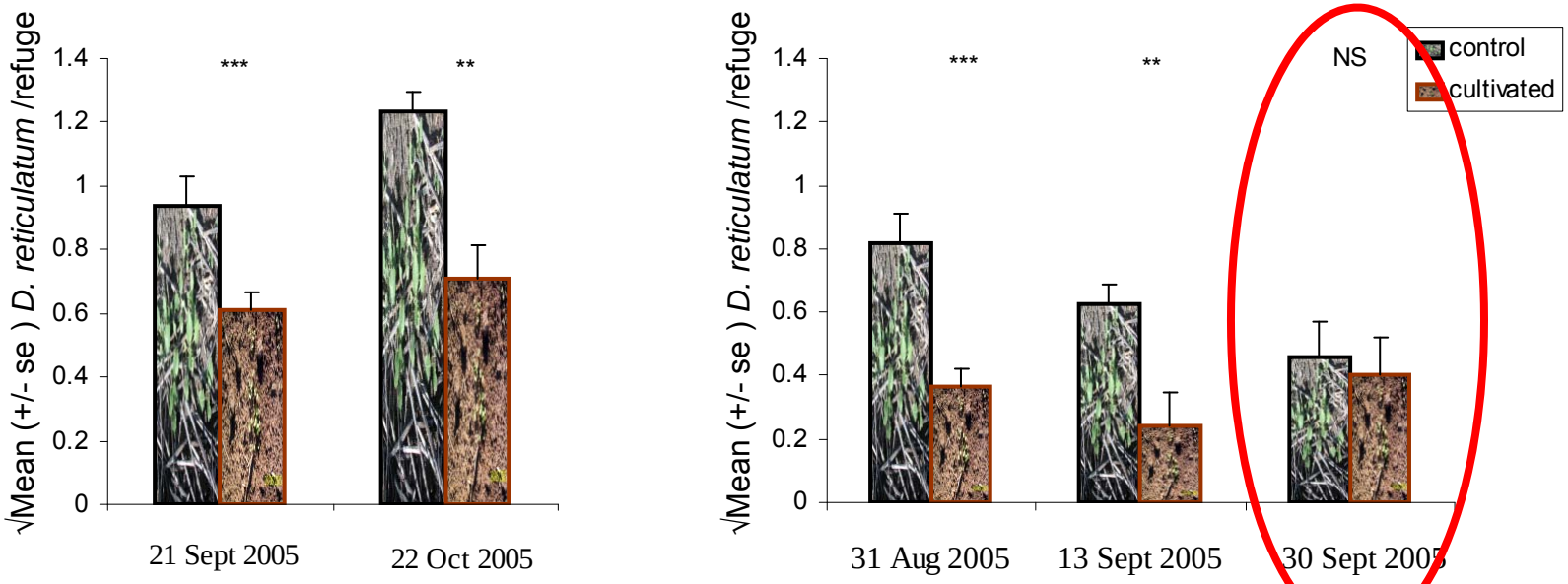
Cultural control

Decision Making for Integrated Pest Management in Grain Crops

- Traditional burning
  - Even hot burn required to kill 80-100% of round snails
  - Patch burn 50-80% of snails killed
  - Wild fire reduced grey field slugs by 50%
  - But increase in black keel slugs by 300%
- Cultivation
  - Shallow disking reduced grey slugs by 40-60%
- Rolling reduces snail and slug habitat
- Remove summer volunteers
- Flog paddocks with Sheep

GRDC Grains Research & Development Corporation
Your GRDC working with you

Cultivation to control grey field slugs



NB: Error bars Standard Error of mean (n =108). Symbols above paired columns represent:

NS, P > 0.05; ** P < 0.01; *** P < 0.001 (ANOVA's within date with predator as covariables)

Shallow cultivation in March reduced grey field slug numbers late into the growing season

Cultural control - cultivation

Decision Making

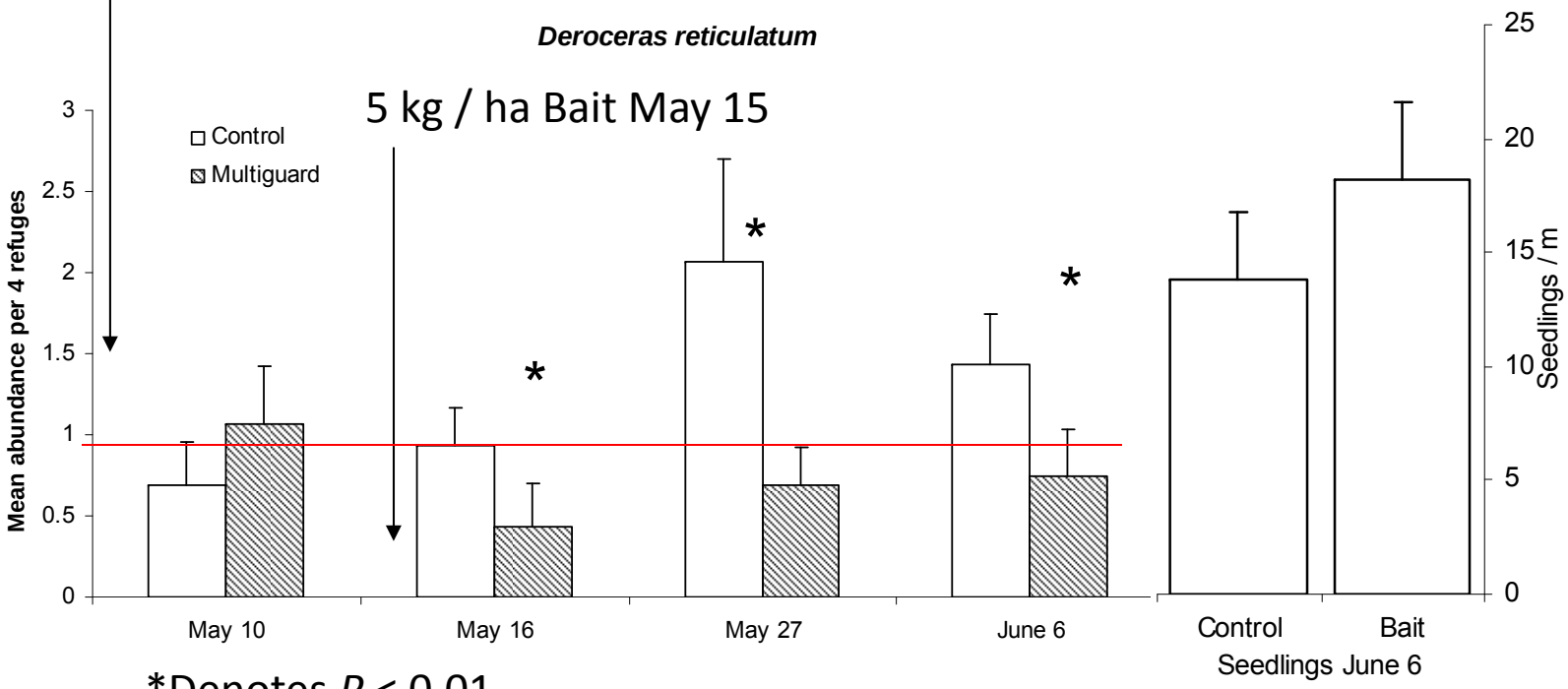
Development Corporation
Your GRDC working with you

Cultural control – healthy crop

Decision Making for Integrated Pest Management in Grain Crops

Establish crop before slugs become active

Hybrid sown 6 May



*Denotes $P < 0.01$,

Nash unpublished data 2009

Canola 4 leaf stage

GRDC Grains Research & Development Corporation
Your GRDC working with you

Bait Basics

Decision Making for Integrated Pest Management in Grain Crops

Dry Process → **Steam Process** → **Wet Process**

Bran (Chook food)

Flour (pasta)

Before 1980

1990' -2000's

cost
rain fastness
palatability
[metaldehyde]

Dust &
size

GRDC Grains Research & Development Corporation
Your GRDC working with you

Improving chemical control

Decision Making for Integrated Pest Management in Grain Crops

"The chief obstacle to improving chemical control of slugs is not the lack of molluscicidal materials but the difficulty of getting them into the animal" (Briggs and Henderson, 1987)

Chance of encounter:

1. slug activity
2. attractiveness of bait (slugs)
3. number of baits per unit area
4. complexity of habitat (snails)

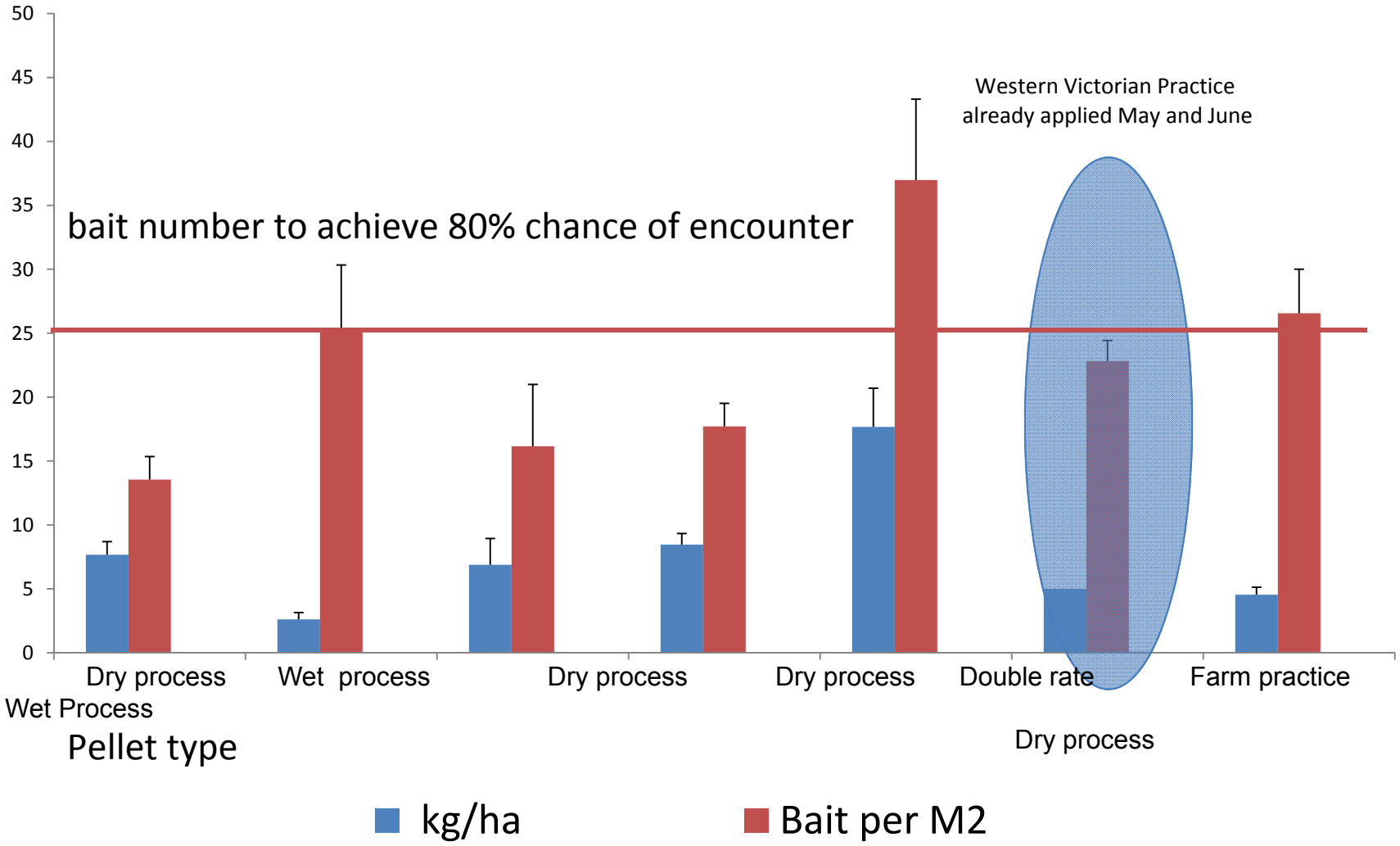
Consumption of active:

1. enough bait
2. enough toxicant in the bait
3. palatability

GRDC Grains Research & Development Corporation
Your GRDC working with you

Number of baits per unit area

Decision Making for Integrated Pest Management in Grain Crops



GRDC Grains Research & Development Corporation
Your GRDC working with you

Comparing products @ 13 d

Decision Making for Integrated Pest Management in Grain Crops

META
15 g Metaldehyde

Improve bait efficacy

Decision Making for Integrated Pest Management in Grain Crops

- How cost effective are bran based baits
- all baits are not equal comparative table @

http://www.sardi.sa.gov.au/__data/assets/pdf_file/0003/217164/Snail_and_slug_bait_comparison_-_Feb_2014.pdf

- Concentration of Metaldehyde needs to be increased to ≥ 3%
- Increase field life of products
- Apply bait evenly

Apply bait evenly

Decision Making for Integrated Pest Management in Grain Crops

Calibrate spreader for specific bait

- Consider narrower passes (bout width)
- Consider the spreader being used
  - Single disk lopsided spread of bait
  - >1000 rpm breaks up bait
- Consider product size and density
- Does the bait break up easily
- Look at the end results

GRDC Grains Research & Development Corporation
Your GRDC working with you

Product	A.I.	Rate	kg / ha	Baits / m²	g a.i./ kg	Pellet	Rain Fast	Spreader
Delica Sluggoff	Metaldehyde	label	3	30	30	flour	Yes	Poor
MetaKill		label	4 - 8	40-81	50	flour	Yes	Good
METAREX		label	5 - 8	30-50	50	flour	Yes	Good
META		label	5 - 7.5	13-24	15	bran	No	Poor
Slugger 2.5mm		farmer	5	13.5	15	bran	No	Fair
Pestmaster 4mm		farmer	5	4	15	bran	No	Poor
Pestmaster 2.5mm		farmer	5	13	15	bran	No	Fair
Bran based 2.5mm (optimal)			**11**	**30**	15	bran		
SlugOut		farmer	5	43-47	18	granule	??	Good
Multiguard	Iron chelate	label	5 - 16	9-38	60	bran	No	Fair?
Mesurol bait	Methiocarb	label	5.5	17	20	bran	No	Poor

Products should always be applied as per label recommendations where these are available. This table is provided as a guide only. Some rates vary du of pellets / kg. Rates (kg / ha) that result in optimal bait densities for slugs (>25 / m2) are in **Bold. Bran bait rates results in sub optimal bait densities based values.** Label recommendations for bran based baits can be misleading (e.g. Slugger rate 500 kg/ha) hence the rate used in broad acre is often 5 - 7.5 kg / ha.

http://www.sardi.sa.gov.au/__data/assets/pdf_file/0003/217164/Snail_and_slug_bait_comparison_26_Mar_2014.pdf

Decision Making
for Integrated Pest Management
in Grain Crops

No one control method will work

Slugs - Bait to protect seedlings

Snails – bait early on Autumn rains on bare ground, follow up bait at sowing

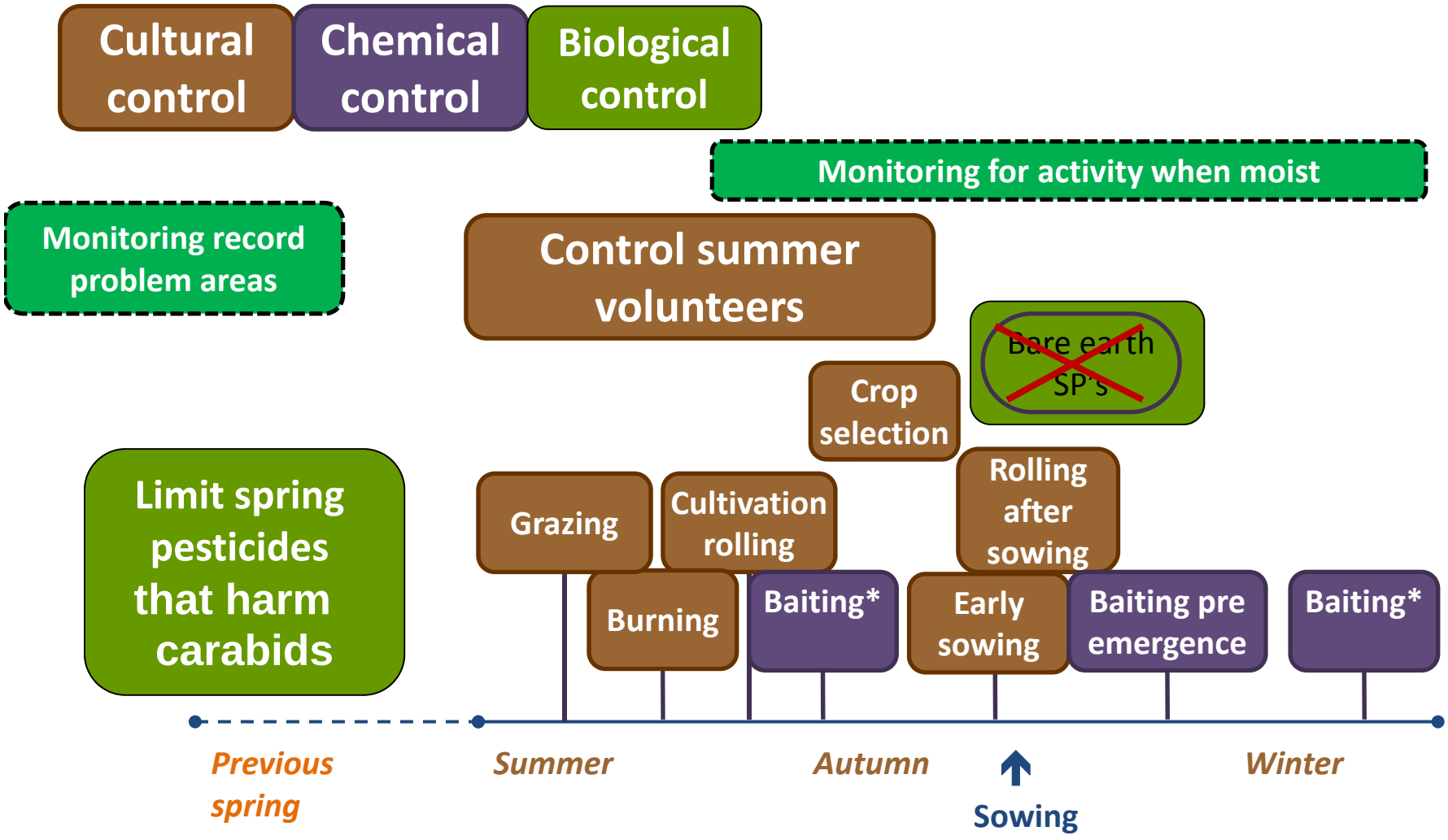
<u>Assess bait application</u>

- Evenness of spread
- Number of bait points
- Enough for the number of snugs

GRDC Grains Research & Development Corporation
Your GRDC working with you

Decision Making for Integrated Pest Management in Grain Crops

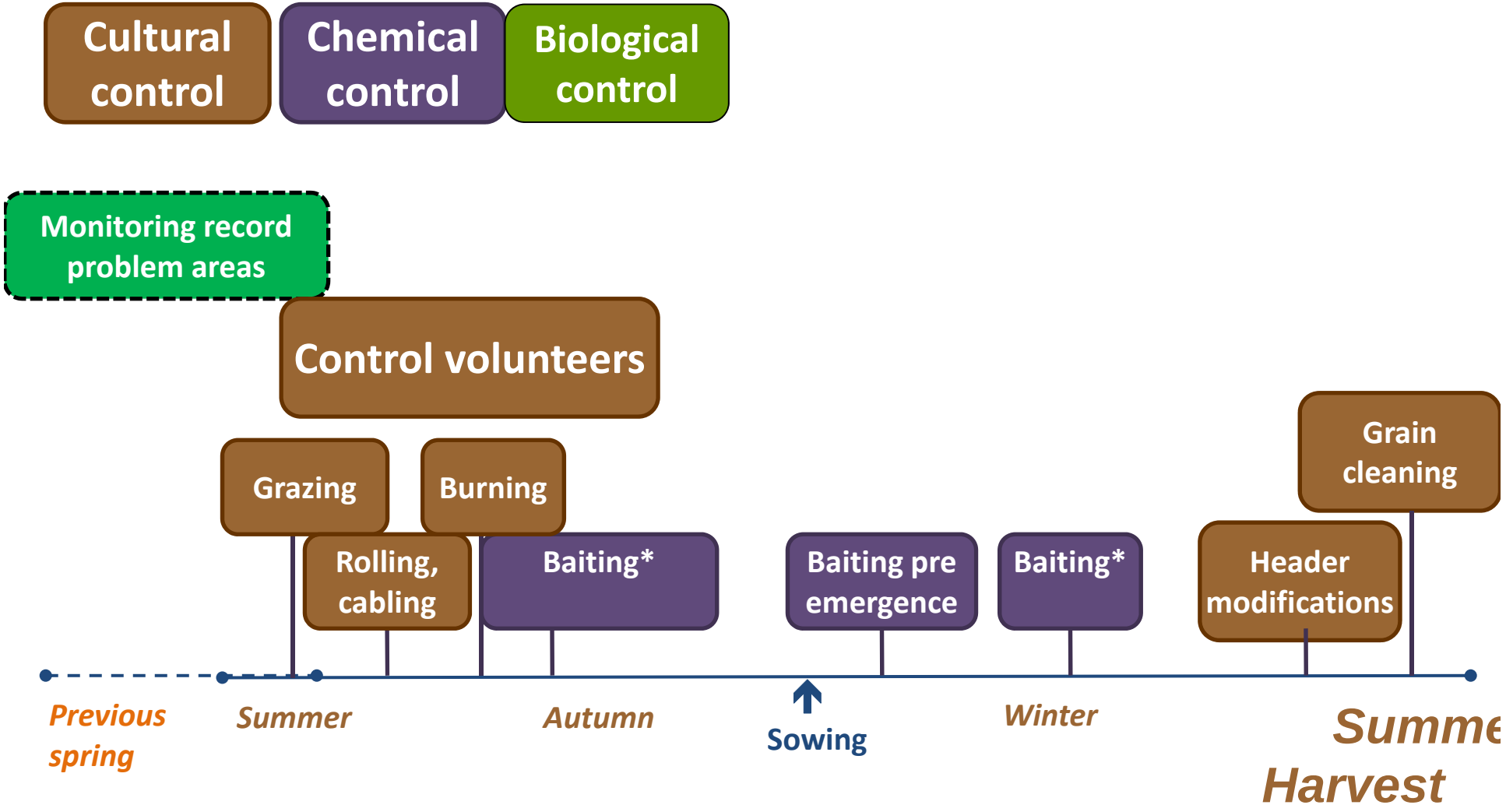
Decision timeline for slugs



* *Pending monitoring results and moisture*

GRDC Grains Research & Development Corporation
Your GRDC working with you

Decision timeline for snails



* *Pending monitoring results and moisture*

SEPTEMBER 2012

GRDC
Grains
Research &
Development
Corporation
Your GRDC working with you

SNAIL MANAGEMENT
FACT SHEET

SOUTHERN AND WESTERN REGIONS

ALL-YEAR-ROUND ATTACK ON SNAILS REQUIRED

A run of wet winters and moist summers have resulted in snail numbers increasing in many regions. While snails cause problems at crop emergence and harvest, integrated management needs to occur across the seasons.

KEY POINTS

- Snail numbers can explode in seasons with wet springs, summers and autumns.
- There are currently no means to control juvenile snails (less than seven millimetres) after sowing.
- A rule of thumb is if snail numbers are above 20 per square metre in cereals and 5/m² in pulses and oilseeds, be prepared to deal with grain contamination at harvest.
- Use header modifications and grain cleaning to eliminate snail contamination of grain.
- Snails appear to build up most rapidly in canola, field peas and beans. However, they can feed and multiply in all crops and pastures.
- Baiting before egg laying is vital. Timing and choice of controls will depend on the season. Understand the factors that determine control effectiveness.
- Stop baiting eight weeks before harvest to avoid bait contamination in grain.
- Monitor snails regularly to establish numbers, types, activity and success of controls.
- To control snails, you will need to apply a combination of treatments throughout the year.

PHOTO: EMMA LEONARD

Summer rain can trigger activity and where crops have been harvested it can provide an early baiting opportunity, if snails stay down for a few days.

Avoid rejection due to snail contamination

Greater use of conservation farming practices, continuous cropping and a run of wet winters and moist, cool summers have

Knowing the species and sizes of snails present in your paddocks helps when selecting management options. More details of the differences between species are found in the publication *Bash 'Em, Burn 'Em, Bait 'Em* (see Useful resources).

eliminate snails, but if round snail numbers increase above 80/m² in pastures, 20/m² in cereals and 5/m² in pulses and oilseeds, integrated management and regular monitoring are essential. Thresholds for small pointed snails are higher (pastures 100/m²,

on bait, many of the controls or cleaning techniques are less effective on juvenile snails.

in cool, moist seasons, snail numbers can still remain high at harvest. The target is to

this information, growers can not make appropriate management decisions.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au

MARCH 2013

GRDC
Grains
Research &
Development
Corporation

SLUG CONTROL
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

SLUG IDENTIFICATION AND MANAGEMENT

In the higher rainfall zones where zero till and stubble retension is practiced, slugs are an increasing problem. As no single control method will provide complete protection, an integrated approach is best.

KEY POINTS

- Slugs need moisture and shelter to thrive. Cool wet summers and an abundance of stubble provide ideal conditions.
- Moisture availability is a key regulator of slug populations.
- The grey field slug, or reticulated slug, and black keeled slug are the main pest species, but brown field slugs can also pose a serious threat.
- No single control method will be completely effective; an integrated approach is needed.

Australian growers spend an average $8.7 million annually on slug control.

The incidence of slugs has coincided with changes to cropping practices. Cultivation and stubble-burning previously kept numbers down, but the widespread adoption of minimum till and stubble retention has provided slugs with more favourable habitat.

Surface-active slug species such as the grey and brown field slug find crevices in the soil during dry summer conditions to avoid heat and drying out. They emerge when conditions are moist to breed and feed. Grey field slugs are most active at temperatures between 4° C and 20 °C.

Life cycle

Slugs are hermaphrodites, therefore, both individuals of a mating pair lay eggs.

They will breed whenever moisture and temperature conditions are suitable – generally from mid-autumn to late spring. Each pair will lay eggs in batches.

Eggs are laid in moist soils and will hatch within three to six weeks, dependent on temperature. Juveniles look like smaller versions of the adult.

The eggs of the black keeled slug, laid in a cluster of moist soil. Slug eggs hatch within three to six weeks. A pair of black keeled slugs can lay up to 200 eggs per year, but some species are able to

Pest species

The main pest species in Australia are the grey field slug and the black keeled slug, but the brown field slug has also been recorded in high numbers. More than one species may be present within a single paddock.

Grey field slug or reticulated slug (*Deroceras reticulatum*)

The grey field or reticulated slug is 35 to 50 millimetres long and light grey to fawn in colour with dark brown mottling. There are up to three generations a year. It will generally breed in autumn and spring, however, if conditions are favourable this species will breed any time – a pair can produce up to 1 000 eggs a year. It is mainly surface active and is a major pest of crops and pastures.

Black keeled slug (*Milax gagates*)

The black keeled slug is 40 to 60mm long and black or brown with a ridge down its back. This species can burrow up to 20 centimetres underground to escape the heat. It is more problematic in drier environments, such as South Australia, although it is widespread throughout south-eastern and Western Australia. A breeding pair can lay up to 200 eggs a year.

Brown field slug (*Deroceras panormitanum*)

The brown field slug is 25 to 35mm long, and usually brown all over with no distinct markings. It is mainly surface active but can burrow to shallow depths. It is more common when pastures is a frequent part of the crop rotation. A breeding pair can lay

Download copies from GRDC Media Centre Bookshop website
https://www.grdc.com.au/~/media

GRDC Grains Research & Development Corporation
Your GRDC working with you

Acknowledgements

Growers and Agros that have provided information and allowed field access

In particular those who ran trials:
Gorst/Tatyoon Rural, Zwar Consulting, Dave & Pete McInnes, Chris & Nick Shady, Colin Golsworthy

Industry support:
ACTA, AgNOVA, AGnVET, IK Caudwell, ORM, YPAG

Literature review:
Isabel Valenzuela, Verity Fyfe

SARDI:
Greg Baker, Kym Perry, Helen DeGraaf

GRDC Grains Research & Development Corporation
Your GRDC working with you