Decision Making
for Integrated Pest Management
in Grain Crops

Improved Snug Management

Slides from Michael Nash SARDI

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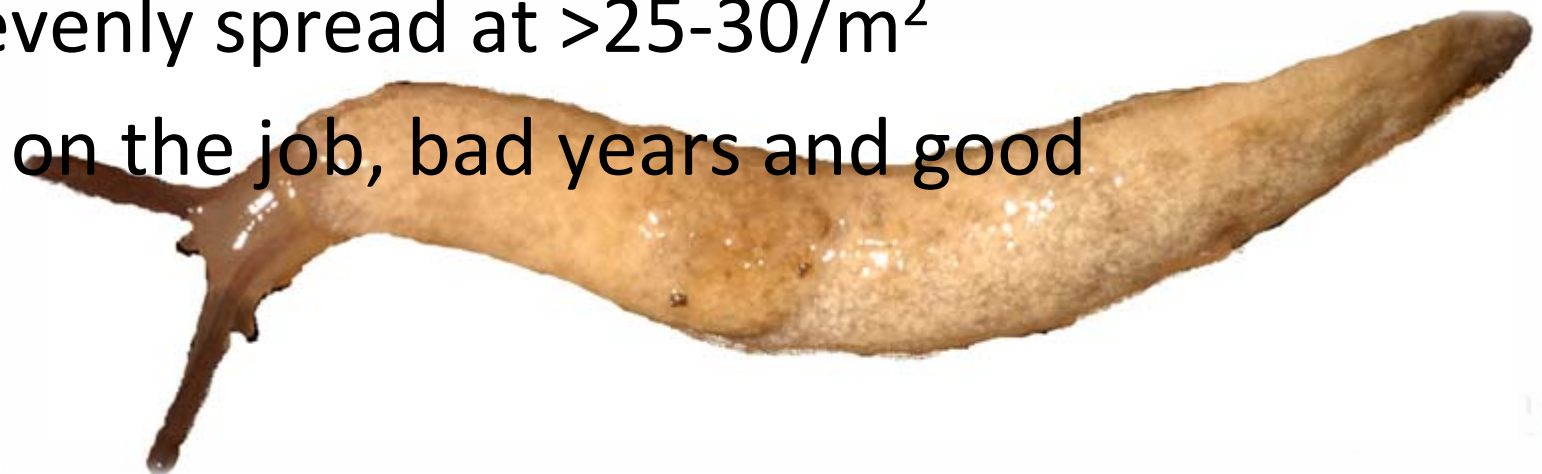
Important messages

- Slugs are excellent bio-indicators of moisture!
- Slug and snail identification is crucial
- No silver bullets: need to use all IPM tactics
- Beneficials and cultural practices reduce load
- Good baits are expensive, need to be rainfast and evenly spread at >25-30/m^2
- Keep on the job, bad years and good



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Contents

- Know your enemy
- Assessing risk of slugs and snails
- Monitoring
- Control options
  - Biological
  - Cultural control
  - Chemical (baits)

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	Grey field slug	Black keeled slug
Colour	Light grey to fawn colour	Black / dark grey in colour
	Dark brown markings, milky-white mucus	Sharp ridge (keel) along back
Habit	Mainly surface active	Burrows & surface
Lifecycle	Opportunistic Annual (1-3/yr)	Annual or Biennial
Egg hatch	21-22 days	40 days
Egg - Adult	138 days	240 days
Soil water	>20% (egg hatch)	
Damage	0.5 – 1.5 / m^2 canola 5 / m^2 cereals????	< 1/ m^2 canola ?? 1-2 / m^2 cereals????

Snails

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Round:

Vineyard or common white

Cernuella virgata

White Italian snail

Theba pisana

Conical:

Small conical snail

Cochlicella barbara

Conical or pointed snail

Cochlicella acuta

Assessing risk

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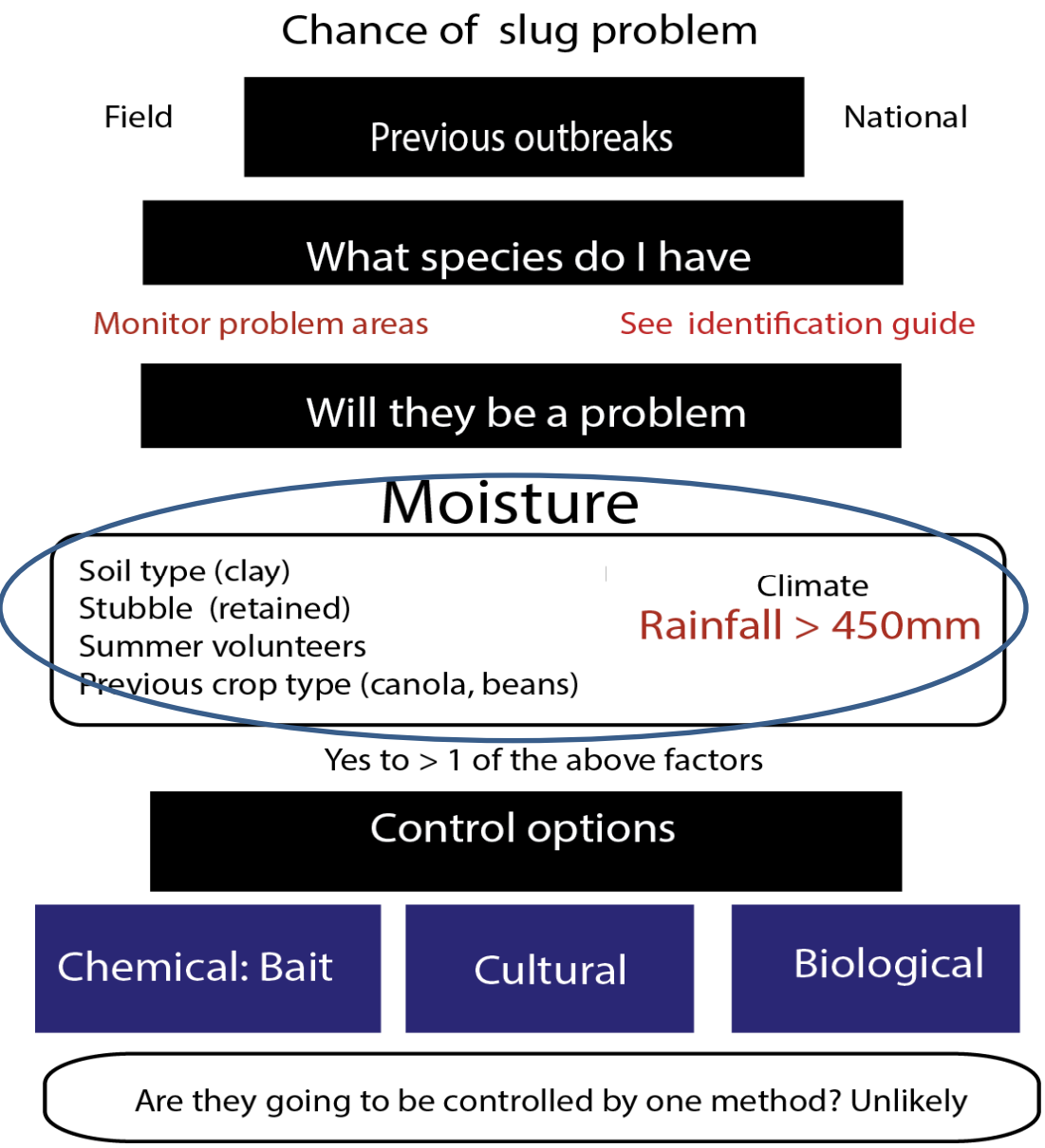

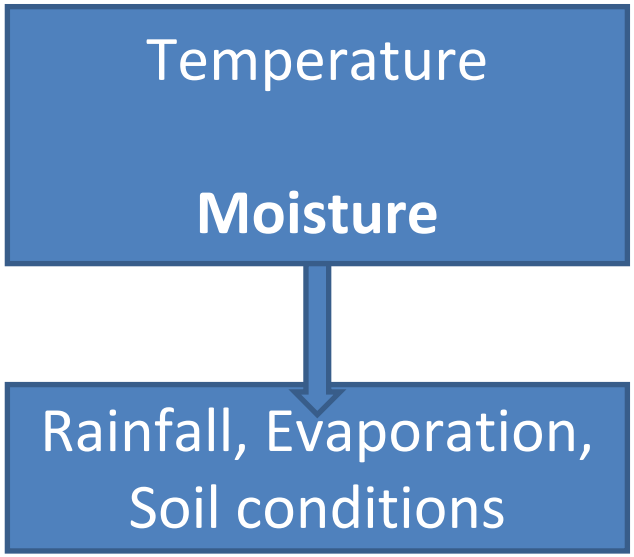

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Identifying slug risk: Paddock level

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High risk	Reduced risk	Low risk
• Irrigated and/ or > 500mm	• 500mm -450mm	• <450mm
• Above average spring to autumn rainfall	• Dry spring hot finish	• Drought
• Cold wet establishment conditions	• Warm dry conditions	
• No till, stubble retained	• Burnt only	• Tillage & burnt stubbles
• 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. ↑clay content and organic matter		• Poor moisture holding capacity; i.e. sandy & little organic matter
• Summer volunteers (green bridge for slugs and snails)		• No volunteers
• Slow crop establishment • Conventional Triazine Tolerant varieties	• Quick establishment by earlier sowing of hybrid varieties	
• Previous paddock history • Rotation: Beans/ canola	• Clean cereal crops	• No slugs • Poor Cereal crop • No weeds

Monitoring Slugs: surface refuges

Important re timing of baiting

Won't provide absolute measure of density

9 refuges placed in a 'W' shape

in each field (13 > 20ha) HGCA Topic sheet no. 85

- 32 cm x 32 cm (0.1m2)
- 50 sampling points / 40ha
- Effected by moisture: > 20% soil moisture
- Check susceptible crops regularly
- Concentrate on areas known to suffer from slug damage
- Check in the mornings when moist

Slugs can be patchy!

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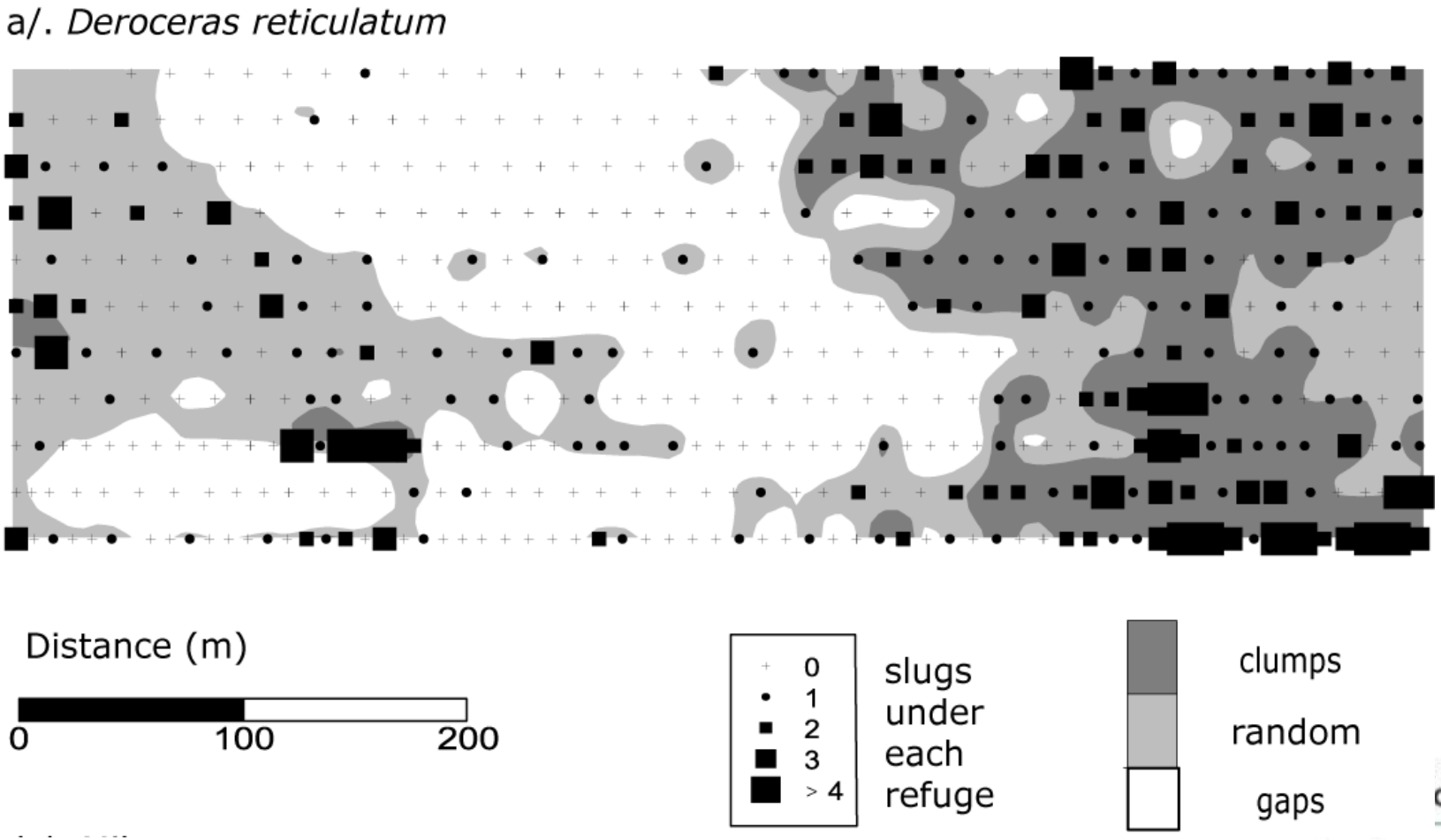
Grey field slug



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Monitoring Snails

When?

- before and (7 d) after stubble management
- before and (7 d) after burning
- before and (7 d) after baiting
- after seeding
- before harvest

How?

- use a 0.1m2 (32cm x 32cm) quadrat
- Count live snails, 2 sizes , <7mm, >7mm with sieves
- Every 10 m: along fence line; into paddock

NB snails <7mm, less likely to be controlled by bait

http://www.sardi.sa.gov.au/pestsdiseases/pests/crop_pasture_pests/snail_management/snail_control_methods/burning

Thresholds

These are a guide only and need to take into account the field, season, crop health, weather conditions and should not be relied upon

Species	Canola	Cereals	Pulses
White snails	5 /m^{2*}	20 /m^2	
Small pointed snails	20 /m^2	40 /m^2	
Grey field slug	0.5 – 1.5 /m^2	5 -15 /m^2	1-2 /m^2
Black keeled slug	< 1 /m^2	1-2 /m^2	1-2 /m^2

*a shelter trap will attract from an area approximately 1m^2. Therefore the thresholds are essentially the mean number of snails or slugs per trap.

Snails as a 'biosecurity' risk

- Snails are on the move:
  - From different properties (on machinery)
  - From different paddocks /roadside (gradual dispersal)
- Zero tolerance in clean paddocks
- Harvest infested paddocks last

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

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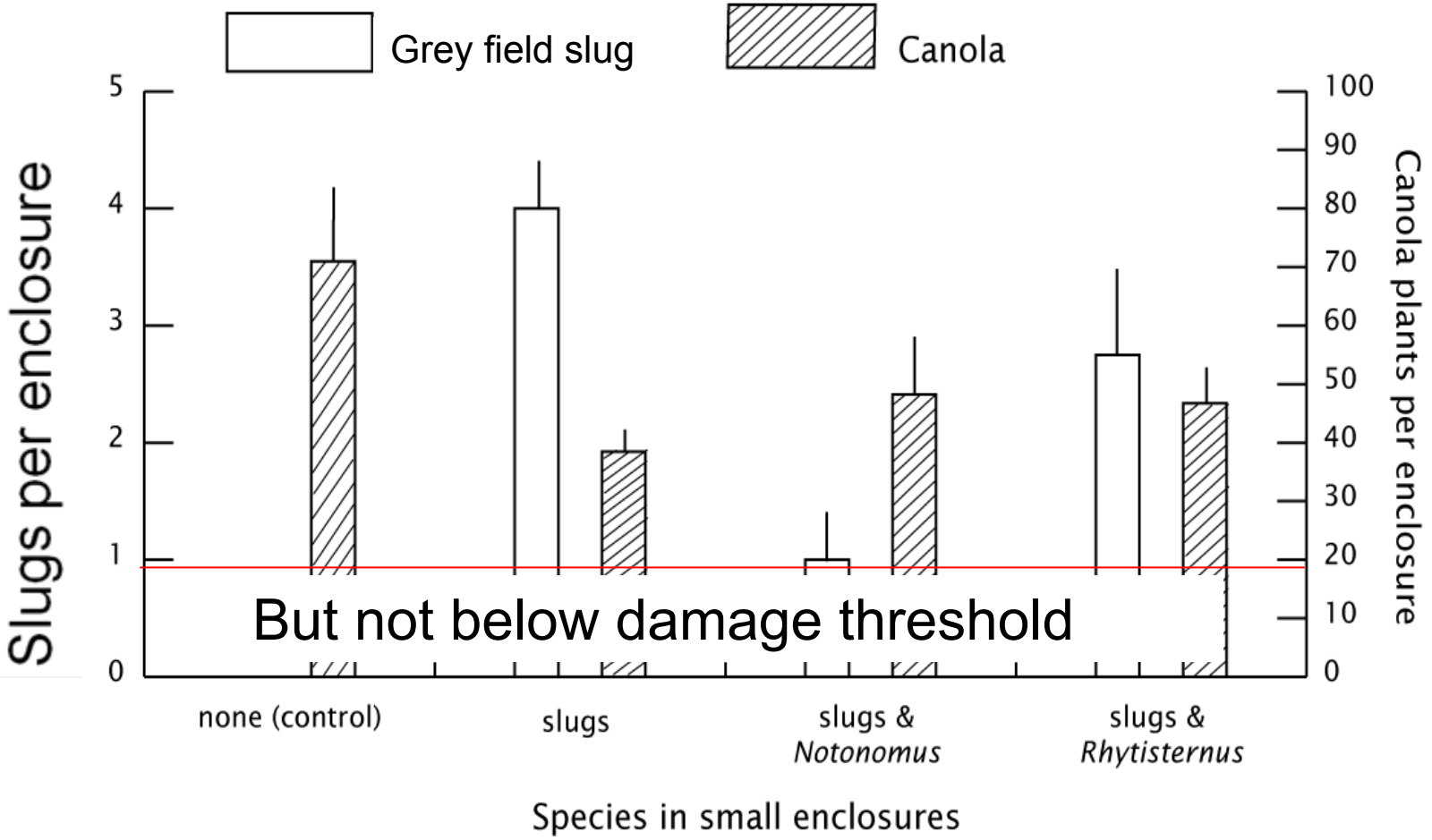
Biological control – conserving natural enemies

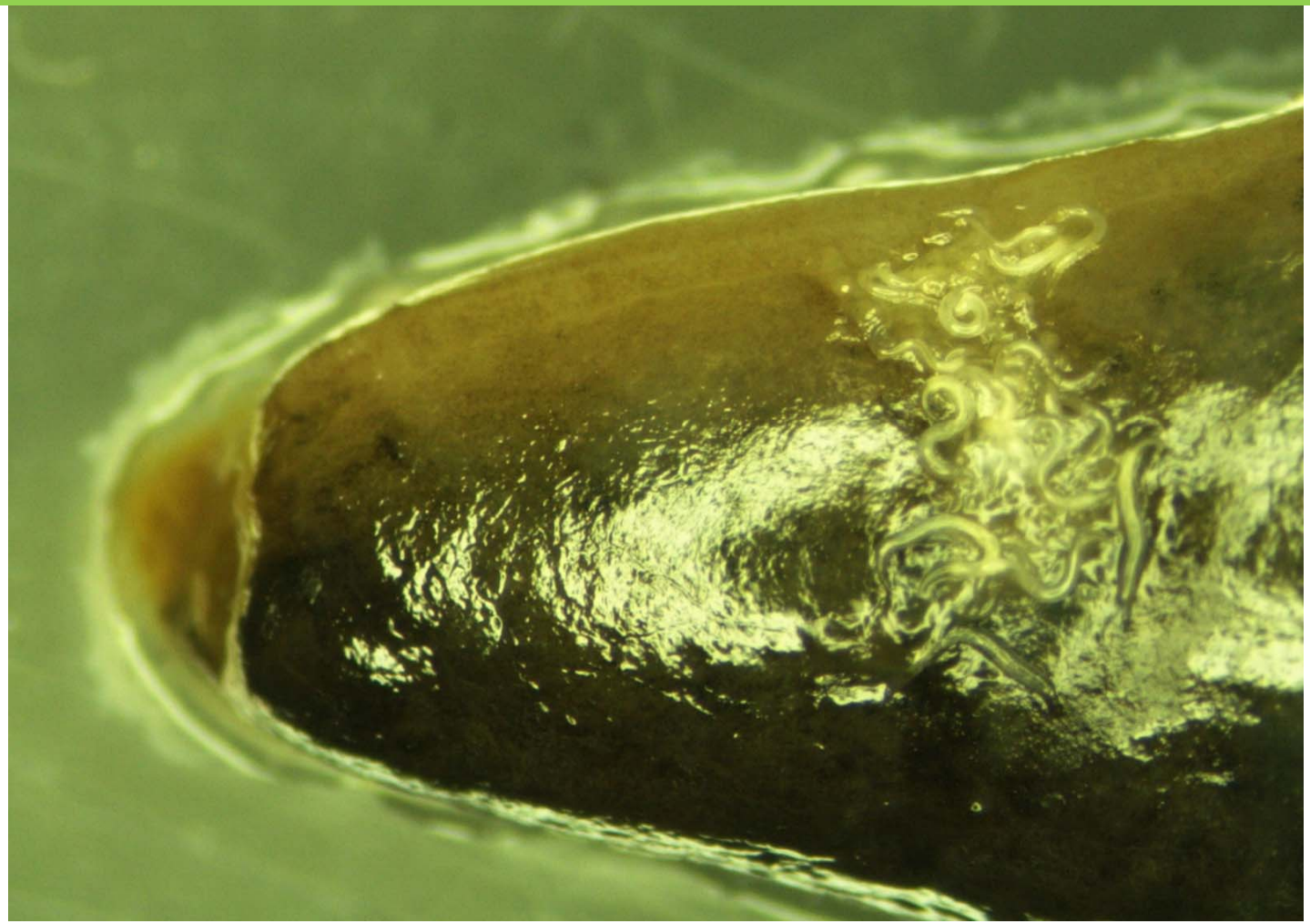
Notonomus gravis eating Deroceras reticuialtum
D Paul©

Native generalist predators limit slug populations



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

Biological control – conserving natural enemies



Cultural control

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- 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%
- Remove summer volunteers
- Rolling (broad/heavy) reduces snail and slug habitat
- Flog paddocks with Sheep

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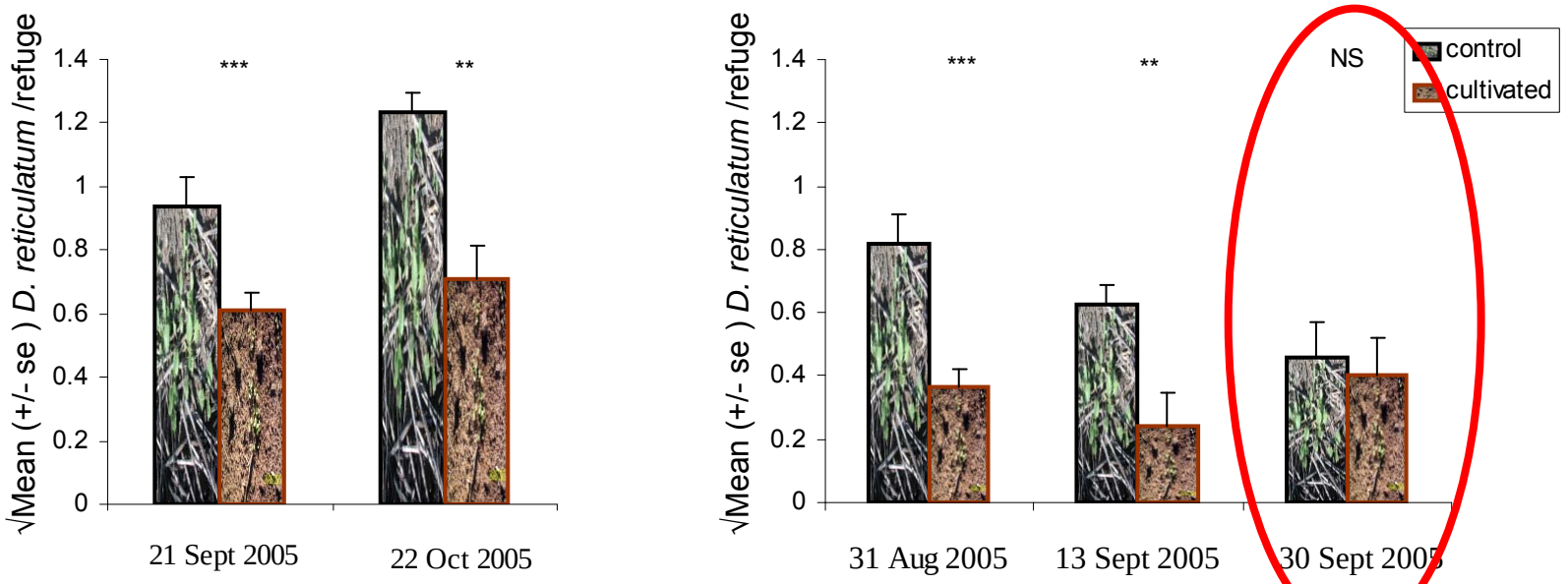
Cultivation to control grey field slugs



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

Bait Basics

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

Bran (Chook food)
Before 1980

Flour (pasta)
1990' -2000's

[metaldehyde]
cost
rain fastness
palatability

Dust & size

"showerproof" = 4mm over a 10 day period

"rainproof" = 10mm over a 10 day period

'Uniform'

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Improving chemical control

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"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 depends:

1. slug activity (weather and stage)
2. attractiveness of bait (slugs: prod & alt food)
3. number of baits per unit area (rate & uniformity)
4. complexity of habitat (snails; stubble)

Consumption of active needs:

1. Quantity of bait (bait size and kg/ha)
2. enough toxicant in the bait (formulation & degradation)
3. palatability

Comparing products @ 13 d

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Improve bait efficacy

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- How cost effective are bran based baits?
- All baits are not equal
  - Concentration of Metaldehyde better to increase from 1.5% to ≥ 3.0%
  - Increase field life of products
  - Apply bait evenly

Apply bait evenly

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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

Control Basics

Decision Making for Integrated Pest Management in Grain Crops

No one control method will work

Slugs - Bait to protect seedlings, pre-emergence, re-applying if necessary

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 (optimum 25-30/m^2)
- Enough for the number of snugs

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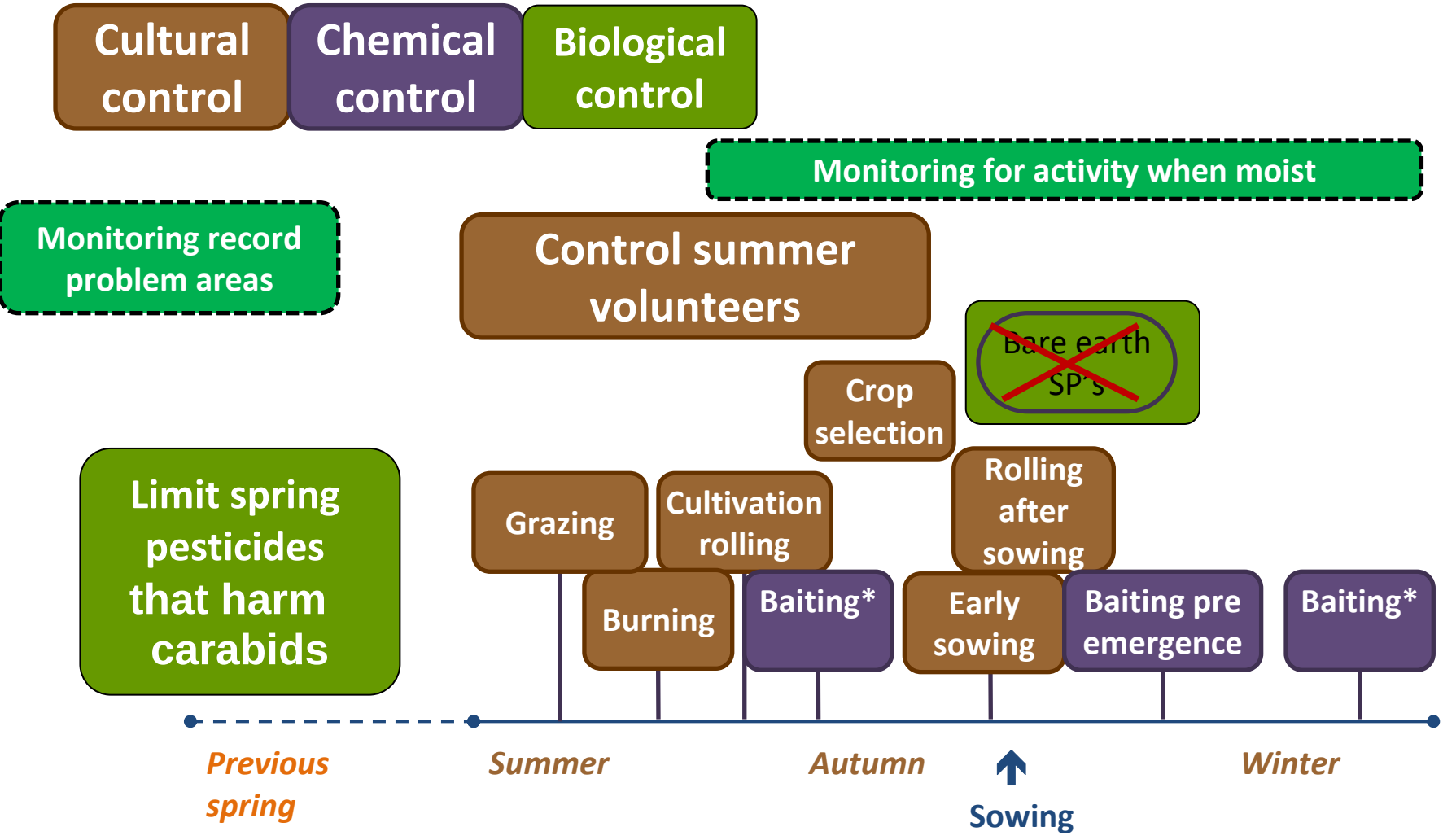
Decision timeline for slugs



** Pending monitoring results and moisture*

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Decision timeline for snails

Decision Making for Integrated Pest Management in Grain Crops

Cultural control

Chemical control

Biological control

Monitoring record problem areas

Control volunteers

Grazing

Burning

Rolling, cabling

Baiting*

Baiting pre emergence

Baiting*

Header modifications

Grain cleaning

Previous spring

Summer

Autumn

Sowing

Winter

Summe

Harvest

* *Pending monitoring results and moisture*

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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.

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.

PHOTO: DAVID LEACH

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.

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SLUG CONTROL
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

SLUG IDENTIFICATION AND MANAGEMENT

In the higher rainfall zones where zero till and stubble retention 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 increased 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 temperatures. Juveniles look like smaller versions of the adult.

The eggs of the black keeled slug, laid in a clod 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

PHOTO: DAVID LEACH

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 25 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 pasture is a frequent part of the crop rotation. A breeding pair can lay

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