WESTERN
JUNE 2018

GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

LUPIN

SECTION 6

PESTS AND INSECTS

OVERVIEW | INTEGRATED MANAGEMENT | ECONOMICS OF INSECT AND PEST CONTROL | PEST IDENTIFICATION AND MANAGEMENT — SEEDLING STAGE | PEST IDENTIFICATION AND MANAGEMENT – FLOWERING STAGE | PEST IDENTIFICATION AND MANAGEMENT – POD FILL STAGE | PEST IDENTIFICATION AND MANAGEMENT – SPRING, HARVEST AND SUMMER

MORE INFORMATION

Integrated Pest Management Guidelines for Grains – Lupins: http://ipmguidelinesforgrains.com.au/crops/winter-pulses/lupins/

DPIRD 'Pulse crops – insect threshold levels': https://www.agric.wa.gov.au/mycrop/pulse-crops-insect-threshold-levels

DPIRD 'Managing insects, weeds and disease on albus lupin variety Andromeda': https://www.agric.wa.gov.au/search?search_api_views_fulltext=lupin%20insects

cesar 'PestFacts map': http://www.cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern/pestfacts-map/

Control of pests and insects

6.1 Overview

Lupin crops tend to be more prone to insect and allied pest damage than cereal crops in Western Australia and need to be checked and monitored at critical stages of development.

Major insects and pests for narrow leafed and/or albus varieties in this State are:

Break of season to three-weeks after crop emergence

- Redlegged earth mite (RLEM, *Halotydeus destructor*)
- Cutworms (*Agrotis sp.*)
- Brown pasture looper (*Ciampa arietaria*)
- Lucerne flea (*Sminthurus viridis*)
- Bryobia mite (*Bryobia praetiosa*)
- Blue oat mite (*Penthaleus sp.*)
- Slugs
- Snails
- Balaustium mite (*Balaustium medicagoense*) – mainly in the southern region

Flowering

- Aphids (*Aphididae*)
- Thrips (*Thysanoptera*)

Pod fill

- Native budworms (*Helicoverpa punctigera*)
- Lucerne seed web moth (*Etiella behrii*) – rarely

Harvest and summer

- Snails as a grain contaminant.

Strategies to control these insects and pests will depend on presence and levels in the crop at that time.

An appropriate registered insecticide, often applied with a knockdown herbicide, can be effective for pre-seeding control if insects and pests are found on weeds before sowing.

If RLEM are not present on weeds before sowing, a bare-earth application just prior to crop emergence can be effective.

Monitoring for aphids should be carried out from crop budding through to early podding. A general rule-of-thumb is to apply an insecticide if more than 30 percent of crop plants have clusters of aphids visible and some leaves are beginning to curl from feeding damage. [1]

1 DPIRD-GRDC (2016) MyCrop Lupin diagnostic tool, Diagnosing aphids in narrow leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-aphids-narrow-leafed-lupins

FEEDBACK

Native budworm can be highly damaging to WA lupin crops during podding, especially for albus varieties, and a sweep net is particularly effective for monitoring numbers. The general rule-of-thumb is to use an insecticide if there is more than one budworm per 10 sweeps of a sweep net.[2] It is advised to sweep the crop in several locations across the paddock.

The timing of insecticide sprays in spring is critical for protecting lupin crop yields and, for native budworm, it is important not to wait for caterpillars to grow.

Snails and slugs can also be pests of lupin crops in WA, causing crop damage early in the season and grain contamination at harvest. Baits are available for control.

Guidelines for insecticide use thresholds on WA pulse crops (including lupin) are outlined in Table 1.

2 DPIRD website (2016) Managing insects, weeds and disease in albus lupin variety Andromeda, https://www.agric.wa.gov.au/lupins/managing-insects-weeds-and-disease-albus-lupin-variety-andromeda

FEEDBACK

Table 1: Insect threshold levels in pulse crops

Pest	Control thresholds	Sampling recommendation	Additional notes
Caterpillars			
Caterpillars: Brown pasture looper	10–12 loopers per m^2	Examine plants, old litter and soil surface in 0.5 m of row. Repeat at five to 10 sites	Larvae may migrate into crop edges from nearby capeweed.
Caterpillars: Cutworms	2–3 cutworm per m^2	Examine plants, old litter and soil surface in 0.5 m of row. Repeat at five to 10 sites	Apply as soon as pest is noticed at threshold levels.
Fleas			
Lucerne flea	Consider control measures if holes are increasingly being found on leaves	Inspect 0.5m of crop row. Look for characteristic holes in leaves. Repeat at five to 10 sites	Commonly found on soils with loam or clay texture.
Mites			
Balaustium mites	Look for silvering on extensive areas of cotyledons and leaves and stress caused to plants	Cotyledons and first true leaves appear silvered and 'leathery', sometimes may shrivel and seedling may die. Damage occurs post emergence.	Found on weeds, soil and seedlings.
Clover mite	Look for silvering on extensive areas of cotyledons and leaves and stress caused to plants	Same damage as Redlegged earth mite. White lines often seen on top of cotyledons. Seedling may shrivel and die.	Found on weeds, soil and seedlings.
Redlegged earth mite & Blue oat mite	Look for silvering on extensive areas of cotyledons and leaves and stress caused to plants	Cotyledons appear 'leathery', silver, twisted shrivelled and seedlings may die. Damage may occur before seedling emergence	Found on weeds, soil and seedlings.
Slugs:			
Black keeled slug			
Reticulated slug	10 or more slugs per m^2	They are found on plants at night or hidden under clods, trash or other objects during the day	Chewed leaves or whole plants. Sometimes feed on lupin seeds at seeding. Slime trails may sometime be seen.
Snails:			
White Italian snails Vineyard snail	Five or more snails per m^2	Found on leaves, stems or other nearby objects.	Look for chewed leaves, slime trails may sometimes be seen.
Small pointed snail	Three or more snails per m^2		

(SOURCE: https://www.agric.wa.gov.au/mycrop/pulse-crops-insect-threshold-levels)

FEEDBACK

MORE INFORMATION

CropLife Australia 'Resistance Management': http://www.croplife.org.au/industry-stewardship/resistance-management/

GRDC Ground Cover Supplement 'Pest resistance drives need for IPM': https://grdc.com.au/Media-Centre/Ground-Cover-Supplements/Ground-Cover-issue-94-SepOct-2011-Crop-Protection-Supplement/Pest-resistance-drives-need-for-IPM

6.2 Integrated management

An Integrated Pest Management (IPM) plan is recommended for sustainable cropping systems in WA, taking into account:

- Crop rotations – some rotations can support pest presence (long-term pasture paddocks are more susceptible to pests)
- Soil preparation – summer and autumn cultivation or herbicide use can eliminate pest food sources
- Sowing time – schedule planting windows when there is less likelihood of pest presence during critical crop development phases
- Crop establishment – uniform crop establishment can help crops withstand pest attack, as can appropriately treated seeds
- Crop choice and variety – varieties with inherited disease and pest resistance are preferable, particularly those with good seedling vigour and physiological features (such as hard seed coats) to deter pests
- Weed management – insects use weeds as host plants and weed control should be considered for adjacent paddocks, fence lines and road sides (as well as in-crop control)
- Disease management – insects can be disease transmitters and damage exposes crops to infestations. Diseased plants tend to be unable to compete with insect attack
- Hygiene and sanitation – machinery, vehicles and people can carry insects and potential to move pests around should be minimised
- Insecticide use – consider exposure of surrounding wildlife and insects
- Environmental conditions – some weather, such as heavy rain, can affect the presence of insects on plants and may reduce the need for insecticide use.
- Beneficial insect preservation – tolerate non-economic, early season damage and encourage beneficial insects into crops.

Incorporating cultural control measures with strategic insecticide use in the lupin phase of the crop rotation is important in reducing pest resistance risks as part of an IPM plan.

Research is finding an over-reliance on broad-spectrum insecticides and pesticides, such as synthetic pyrethroids (SPs), is resulting in development of resistance in pests such as Green peach aphid (*Myzus persicae*) and RLEM.

Researchers advise that more strategic pest management is required to control resistant populations and minimise the risks of resistance developing further.

Research is being carried out to map pesticide resistance in crop pest insects around Australia, along with further development and promotion of IPM practices.

The key IPM strategy for legumes, including lupin, is to avoid non-selective insecticides for as long as possible to foster a build-up of predators and parasites (with a national industry message to: 'go soft early').

This helps to keep early pests, such as aphids, in check, as predators can stop populations from building up.

However, intervention may be required during podding, especially against native budworm and aphid populations, which can peak during late pod fill.

FEEDBACK

MORE INFORMATION

DPIRD 'MyEconomic Tool': https://www.agric.wa.gov.au/wheat/myeconomic-tool

GRDC 'The current and potential costs of invertebrate pests in grain crops': www.grdc.com.au/Resources/Bookshop/2013/02/The-current-and-potential-costs-of-invertebrate-pests-in-grain-crops

6.3 Economics of insect and pest control

Economic damage from insects and allied pests can occur in lupin during all crop growth stages.

The lupin plant can compensate for moderate damage that occurs early in development by setting new buds and pods to replace those lost.

But excessive early damage can reduce yield and potentially delay harvest.

A useful decision support calculator called MyEconomic Tool has been developed that can help assess the risks and costs of a range of insect treatment options for use in lupin (and other broadacre crops).

It takes into account expected treatment costs, potential crop yield, commodity prices and input costs to analyse a range of scenarios.

A 2013 GRDC-funded report, 'The current and potential costs of invertebrate pests in grain crops', studied the costs of control measures for major insect pests across Australia.

In the western region, potential economic loss to the State's grain growers from major insect and allied pests (when cultural and chemical practices are not used) was estimated at:

- RLEM – $21.62 per hectare, or $11.6 million
- Cutworm – $1.08/ha or $0.6m
- Lucerne flea – $3.24/ha or $1.7m
- Bryobia/balaustium mite – $1.62/ha or $0.9m
- Aphids – $9.73/ha or $5.2m
- Budworms – $14.59/ha or $7.9m
- Snails – $0.95/hectare or $0.5 million
- Total costs from invertebrate pests: $58.51/ha or $31.5 million.

(SOURCE: GRDC report 'The current and potential costs of invertebrate pests in grain crops', 2013)[3]

The 2013 GRDC report found the average cost of treating all insects and pests in WA lupin crops was $15.20/ha, or $8.2m annually.[4]

It outlined that action thresholds drive treatment for most pests, but very few of these have been derived from empirical (observation and experience) analysis.

The report recommended the economic benefits of controlling pests should be weighed-up carefully by growers and advisers as part of an IPM plan, as chemical costs per pest can be high. This is illustrated in Table 2.

3 Murray, Dave, Clarke, Michael, Ronning, David (2013) The current and potential costs of invertebrate pests in grain crops', https://grdc.com.au/Resources/Bookshop/2013/02/The-current-and-potential-costs-of-invertebrate-pests-in-grain-crops

4 Murray, Dave, Clarke, Michael, Ronning, David (2013) The current and potential costs of invertebrate pests in grain crops', https://grdc.com.au/Resources/Bookshop/2013/02/The-current-and-potential-costs-of-invertebrate-pests-in-grain-crops

FEEDBACK

Table 2: Representative pesticide treatment used and cost – lupin

Invertebrate pest	Representative pesticide control	Active ingredient	Chemical cost per ha
Snails			
Snails (various)	baits	metaldehyde	$12.00
Mites			
Redlegged earth mite	PSPE	bifenthrin	$1.60
Blue oat mite	PSPE	bifenthrin	$1.60
Bryobia (various) / Balaustium mite	presowing and knockdown	omethoate	$1.90
Springtails			
Lucerne flea	PSPE	omethoate	$1.90
Aphids			
Aphids (various)	dimethoate	dimethoate	$6.25
Caterpillars			
Etiella moth	SP	alpha-cypermethrin	$2.55
Budworms	SP	alpha-cypermethrin	$2.55
Cutworms (various)	SP	alpha-cypermethrin	$0.64
Weed web moth	SP	alpha-cypermethrin	$2.55
Beetles			
Weevils (various)	SP	alpha-cypermethrin	$0.85
Earwigs			
European earwigs	no treatment*		
Additional Pests (N/A)			

PSPE: post sowing pre-emergent, SP: Synthetic pyrethroid * Controls may be permitted under relevant State Pesticide Regulations

FEEDBACK

MORE INFORMATION

CSIRO 'Insect identification resources online': http://www.csiro.au/en/Research/Collections/ANIC/ID-Resources

GRDC 'Ute Guide – Insects': https://grdc.com.au/Resources/Ute-Guides/Insects

DPIRD-GRDC MyCrop: https://www.agric.wa.gov.au/mycrop

TimeRite®: www.timerite.com.au

GRDC 'Back Pocket Guide – Crop Mites': www.grdc.com.au/BPG-CropMites

cesar 'Redlegged earth mite': http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

DPIRD 'Diagnosing Redlegged earth mite': https://www.agric.wa.gov.au/mycrop/diagnosing-redlegged-earth-mite

GRDC Fact Sheet 'RLEM Resistance Management Strategy – Western': https://grdc.com.au/FS-RLEM-Resistance-strategy-West

6.4 Pest identification and management — seedling stage

6.4.1 Redlegged earth mites, RLEM (*Halotydeus destructor*)

Figure 1: *Redlegged earth mites are a serious pest of lupin crops.*

(SOURCE: © Western Australian Agriculture Authority (Department of Agriculture and Food, WA))

Redlegged earth mites (RLEM) are about the size of a pin head (up to 1 mm), with a velvety black body and eight red-orange legs.

These mites spend about 90 percent of their time on the soil surface, rather than on plant foliage, but will feed on crop foliage for short periods before moving around to settle at the next feeding site.

In WA, RLEM are most active between April and November and can have up to three generations in a year.

At the end of spring, the mites lay thick-walled, over-summering eggs that can resist dry summer conditions and carry the mite population into the next season.

Mites hatch from the over-summering eggs after adequate exposure to moisture and low temperatures.

Lupin crops are most susceptible to RLEM damage as young seedlings and when there are high numbers of mites. The mites cluster, rupture cells and suck the juices out of the leaves, giving them a leathery and silvery appearance.

But lupin has large, robust cotyledons and can be relatively tolerant of RLEM, often growing away from any damage caused.

Severe symptoms of RLEM damage in lupin crops include white bleached leaves and slow growth. A heavy infestation of RLEM may reduce plant density, retard the development of the crop or even kill seedlings.

Monitoring

Recommendations for monitoring RLEM in lupin crops include:

- Inspect crops in the first three to five weeks after sowing
- Inspect crops from autumn to spring for mite presence and damage
- Look for mites early in the morning or on overcast days
- Consider control if plants are not outgrowing damage.

FEEDBACK

Control

It is advised that RLEM control in WA lupin crops is best started in the spring of the year prior to sowing.

The aim is to reduce mite numbers and the number of over-summering eggs produced to depress populations hatching the following autumn.

Strategies to achieve this include:

- In-crop weed control to reduce mite food sources
- Grazing pastures in spring to less than 2 tonnes per hectare of feed on offer (dry weight)
- Spray insecticide before summer eggs are laid using the TimeRite® package (if in a pasture phase).

Early sown lupin crops have the best chance of establishing before populations of RLEM increase to damaging levels.

Lupin seed can be treated with systemic insecticides to protect seedlings, especially when there are low-moderate mite numbers.

Compatible insecticides can be applied with a knockdown herbicide or as a bare earth spray prior to crop emergence.

Typically in WA, it is only necessary to use a foliar insecticide for RLEM if lupin crops are not growing away from damage.

Researchers have detected RLEM with resistance to SPs in WA and tolerance to the organophosphates (OPs) chlorpyrifos and omethoate (the only state in Australia with this problem to date) and this is a risk growers need to manage.[5]

GRDC released a new Fact Sheet in mid-2016 that contains an overview of the latest advice about IPM tactics to deal with RLEM resistance issues. It can be found at this link https://grdc.com.au/FS-RLEM-Resistance-strategy-West

It is advised to rotate chemical groups in and between seasons, avoid prophylactic sprays and apply insecticides only if control is warranted.

Insecticides used at, or after, sowing should be applied within three weeks of the first appearance of mites, before adults start laying eggs. Insecticides do not kill mite eggs. Treating paddock fence lines and borders can be an effective way to control mites and pre and post-sowing weed management, particularly of broadleaf weeds, is vital when growing lupin. Non-chemical control options for RLEM include grazing during summer with livestock or sowing non-susceptible crops, such as barley, in the rotation.[6]

Approved insecticide actives for the control of RLEM in lupin crops in the western region include:

- Lambda-cyhalothrin
- Gamma-cyhalothrin
- Alpha-cypermethrin
- Chlorpyrifos
- Methidathion
- Bifenthrin.

5 DPIRD website (2016) Prevent redlegged earth mite resistance, https://www.agric.wa.gov.au/mites-spiders/prevent-redlegged-earth-mite-resistance

6 DPIRD website (2016) Diagnosing redlegged earth mite, https://www.agric.wa.gov.au/mycrop/diagnosing-redlegged-earth-mite

FEEDBACK

MORE INFORMATION

DPIRD 'Cutworm: pests of crops and pastures': https://www.agric.wa.gov.au/pest-insects/cutworm-pests-crops-and-pastures

DPIRD 'Diagnosing cutworm in canola and pulses': https://www.agric.wa.gov.au/mycrop/diagnosing-cutworm-canola-and-pulses

IPM Guidelines 'Cutworms': http://ipmguidelinesforgrains.com.au/pests/soil-insects/cutworms/

cesar Australia 'Cutworms': http://www.cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern/past-issues/2014/pestfacts-issue-no-4-5th-june-2014/cutworms/

PIRSA 'Cutworm alert': http://www.pir.sa.gov.au/research/services/reports_and_newsletters/pestfacts_newsletter/pestfacts_issue_3_2016/cutworm_alert_for_the_sa_mallee

6.4.2 Cutworms (*Agrotis* spp.)

Figure 2: *Larvae of cutworms can feed on young plants and stems at or below the soil surface and often cut off entire plants.*

(SOURCE: SARDI)

Cutworms are plump, smooth-bodied caterpillars of several moth species that grow to about 50 mm in length and are pinkish-brown to black in colour.

Heads are slightly darker and these pests have dark lines or spots along their body and curl up and remain still if disturbed.

Cutworms hide under the soil or litter in the day and feed at night, causing damage to emerging and seedling lupin at or below the soil surface.

When young, cutworms feed on the surface tissue of foliage and, when older, earn their name by eating plants off at the stem.

These pests are most damaging in autumn, when large caterpillars (more than 20 mm in length) transfer from summer and autumn weeds to newly emerged crop seedlings.

Control

Control measures for cutworms in WA lupin crops include:

- Remove any green bridge of weeds or crop volunteers two weeks before planting lupin
- Monitor closely early in the season, as these pests can be hard to find and numbers easily under-estimated
- If necessary, apply registered insecticides
- Label rates of SPs are effective
- Spot-spraying affected areas often provides adequate control.

Approved insecticide actives for use on cutworm in lupin crops in the western region include:

- Zeta-cypermethrin
- Esfenvalerate
- Deltamethrin
- Cypermethrin
- Beta-cypermethrin
- Alpha-cypermethrin.

DPIRD's MyEconomic Tool can help calculate the economic risks and financial costs of various treatments for cutworm. See: https://www.agric.wa.gov.au/wheat/myeconomic-tool?type=Cutworm

FEEDBACK

It advises any management plan for this pest should take into account:

- Potential yield losses associated with cutworm feeding damage
- Costs and benefits of taking preventative action
- Costs and benefits of controlling summer weeds (green bridge)
- Costs, benefits and risks of in-crop management, versus doing nothing or delaying treatment
- Assessing the impact of a range of grain price and seasonal conditions on net income
- Costs and benefits of an IPM system, including resistance management.

(SOURCE: DAFWA)

MORE INFORMATION

DPIRD-GRDC MyCrop 'Brown pasture looper': https://www.agric.wa.gov.au/mycrop/diagnosing-brown-pasture-looper

6.4.3 Brown pasture looper (*Ciampa arietaria*)

The brown pasture looper is a grey or dark-brown caterpillar, with yellow lines along its back on either side of a dark band, and chews seedling lupin crops.

Young caterpillars move with a characteristic looping motion, which stops when at full size (about 35 mm in length).

Eggs are laid in early to mid-autumn and hatched caterpillars grow to full size in about two months, after which they pupate and remain in the pupal stage during spring and summer to later emerge as moths in the following season. Brown pasture loopers are most damaging as large (more than 20 mm in length) caterpillars in autumn.

Often this pest is found around crop edges, having moved in from adjacent pasture or rock heaps.

Affected lupin crops will have leaves chewed from the edges.

Control

Control measures for brown pasture loopers in WA lupin crops include close paddock inspection, especially in weedy areas, and – if necessary – use of insecticides.

Registered products for control in WA lupin crops include:

- Bifenthrin
- Esfenvalerate
- Gamma-cyhalothrin
- Lambda-cyhalothrin.

FEEDBACK

MORE INFORMATION

DPIRD 'Diagnosing Lucerne flea': https://www.agric.wa.gov.au/mycrop/diagnosing-lucerne-flea

IPM Guidelines 'Lucerne flea': http://ipmguidelinesforgrains.com.au/pests/lucerne-flea-in-winter-seedling-crops/

GRDC Hot Topic 'Beating the Lucerne flea': https://grdc.com.au/Media-Centre/Hot-Topics/Beating-the-lucerne-flea

cesar Australia 'Lucerne flea': http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-flea

6.4.4 Lucerne flea (*Sminthurus viridis*)

Figure 3: *Lucerne flea typically moves up the lupin plant from ground level, eating tissue from the underside of foliage.*

(SOURCE: Andrew Weeks, **cesar**)

Lucerne fleas are small jumping insects that appear early in the season, commonly on WA's loam-clay soils, and chew on young leaves of lupin crops, other broadleaf crops and legume pastures.

Adults grow to about 3 mm and are yellow-green in colour, wingless and have a furcula underneath the abdomen – allowing them to spring off vegetation when disturbed. This trait gives the insect its common name of 'spring tails'.

In WA, lucerne fleas are often distributed in patches in paddocks and across a region, but favour heavy soil types and are rare on sandy soils with low clay contents. In cool moist conditions, this pest can produce up to five generations each year.

Lucerne fleas hatch from over-summering eggs after the first soaking rains in autumn.

They move up plants from ground level, eating tissue from the underside of foliage and leaving behind a thin clear layer of membrane that appears as transparent windows through the leaf.

In severe infestations, this damage can skeletonise the leaf and stunt or kill plant seedlings.

Lupin crops are most susceptible at the time of emergence and early signs of damage include chewed leaflet spots and edges.

Control

Management options for lucerne flea in WA lupin crops include:

- Effective weed control in spring to reduce the green bridge
- Grazing management of pastures in spring to suppress populations
- Border sprays or spot-spraying if required
- If required, use of the approved insecticide methidathion.

It is advised to calculate the economic value of controlling lucerne flea in lupin crops, taking into account potential yield losses from feeding damage, costs of preventative action, risks of doing nothing and costs of summer weed control.

The MyEconomic Tool decision-support calculator on the DPIRD website can help with this process.

FEEDBACK

MORE INFORMATION

DPIRD-GRDC MyCrop 'Bryobia mite': https://www.agric.wa.gov.au/mycrop/diagnosing-bryobia-mite

6.4.5 Bryobia mite or clover mite (*Bryobia praetiosa*)

Bryobia mite, also known as clover mite, is reddish-grey and grows to 1 mm in size, with red legs and two long forelegs. These pests can be confused with RLEM.

Over-wintering eggs of bryobia mite are typically laid in early to mid-winter and hatch as conditions warm up in spring.

As pastures deteriorate in late spring or summer, over-summering eggs are produced and these hatch as soon as there is sufficient moisture for plants to germinate at the break of the next season.

Adult bryobia mites are most active in warm conditions, especially in autumn, late spring and summer, and tend not to survive cold winters or very dry summers.

In areas protected from these extremes, all life stages of the mites may be present in the lupin crop if there is sufficient green plant material available.

Bryobia mites create long trails of whitish grey spots on the top of cotyledons and the leaf surface. This differs from RLEM, which cause silvering on leaves.

Damage is more severe when seedlings are stressed, such as an autumn or winter drought.

The mites can become a serious pest of lupin crops in years when there are early autumn rains that facilitate weed growth and early establishment of mite populations.

Bryobia mite is difficult to control, especially if insecticides are targeted to stop damage to crops at emergence.

A more effective option is killing all weeds well before seeding and/or applying a miticide to weeds with knockdown herbicides if the crop is not out-growing pest damage.

The registered active for control in WA lupin crops is bifenthrin.

MORE INFORMATION

DPIRD-GRDC MyCrop 'Balaustium mite': https://www.agric.wa.gov.au/mycrop/diagnosing-balaustium-mite

HerbiGuide 'Balaustium mite': http://www.herbiguide.com.au/Descriptions/hg_Balaustium_Mite.htm

6.4.6 Balaustium mites (*Balaustium medicagoense*)

Figure 4: *The balaustium mite adult reaches about 2 mm in length, with a rounded dark red-brown body and red legs with distinct short hairs on the body.*

(SOURCE: SARDI)

This mite grows to about 2 mm in length as an adult, about twice the size of RLEM and bryobia mite.

It has a rounded dark red-brown body with distinct short hairs and red legs and is more common in southern agricultural regions.

Balaustium mites survive throughout the year if there is green plant material and typically produce two generations.

Over-summering eggs are laid in late spring or summer, as pastures deteriorate, and hatch the next year when there is sufficient moisture for plants to germinate.

FEEDBACK

Unlike the eggs of RLEM, the eggs of balaustium mites do not require cold temperatures to stimulate hatching.

Balaustium mites typically attack leaf edges and leaf tips of plants and, in lupin crops, damage is seen as irregular white spotting on cotyledons and leaves – giving a 'leathery' and silver appearance.

If mites are present in high numbers, leaves and cotyledons may be bleached. Lupin crops are usually able to grow away from balaustium mite damage.

Early control of summer and autumn weeds, especially capeweed (*Arctotheca calendula*) and grasses, can suppress mite populations.

There are no registered pesticide actives to control balaustium mites in WA lupin crops.

MORE INFORMATION

DPIRD-GRDC MyCrop 'Diagnosing blue oat mite': https://www.agric.wa.gov.au/mycrop/diagnosing-blue-oat-mite

http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/274090/Blue_oat_mite.pdf

6.4.7 Blue oat mite (*Penthaleus major*)

Figure 5: *Blue oat mite are dark purple or blue with a red spot and can cause discoloration of crop leaves.*

(SOURCE: Andrew Weeks, **cesar**)

WA lupin crops are vulnerable to blue oat mites, particularly at the seedling stage. But crops can typically grow away from any damage caused by the mite when seasonal conditions are good.

Blue oat mites often co-exist with RLEM and can be confused with this pest, as they are a similar size of about 1 mm in length and have eight orange legs. But the blue oat mite is a dark purple/blue colour with a distinctive red spot on the back.

This mite is active in autumn, winter and spring and has a similar life cycle to RLEM, but can produce up to four generations each year that last for eight to 10 weeks.

Over-summering eggs hatch in autumn, stimulated by cold temperatures and adequate moisture.

Mite damage is common in early sown crops in years with summer rain and a green bridge.

Signs of damage in lupin crops includes cotyledons with a leathery and silvery appearance, bleached leaves and sometimes death of seedlings when numbers are high.

Insecticide and cultural controls are available for blue oat mite, but this mite has a higher natural tolerance to some actives.

To prevent population build up, insecticides are best applied at full registered rates within three weeks of the first appearance of mites before adults start laying eggs.

The currently registered insecticide for blue oat mite – chlorpyrifos – is only effective on active stages of mites.

FEEDBACK

For low-moderate mite populations, insecticide seed dressings can be an effective method of control.

It is recommended to avoid prophylactic sprays; apply insecticide only if control is warranted and mite identity is positive.

When monitoring for blue oat mites, consider these insects are active in winter and spring, hatching in autumn from summer-laid eggs.

Mites are most easily seen in the late afternoon when they begin feeding on leaves. Check from planting to early vegetative stage, particularly in dry seasons.

6.5 Pest identification and management – flowering stage

6.5.1 Aphids (*Aphididae*)

Figure 6: *Aphids are a pest of lupin crops at the flowering stage.*

(SOURCE: © Western Australian Agriculture Authority (Department of Agriculture and Food, WA))

The three types of aphids responsible for the bulk of infestations in WA lupin crops are Cowpea aphids (*Aphis craccivora*), Blue green aphids (*Acyrthosiphon kondoi*) and Green peach aphids (*Myzus persicae*).

Less common are Leafcurl plum aphid (*Brachycaudus helychrisi*) and Potato aphid (*Macrosiphum euphorbiae*).

Cowpea aphids are charcoal grey to shiny black and tend to colonise single plants or groups in 'hot spots'.

Blue green aphids are about the same colour as lupin leaves and typically distribute more evenly through the crop, but can congregate on some plants in larger population sizes.

Green peach aphids are pale green, similar to the colour of the lupin stem, and are usually found on the underside of older lupin plant leaves. These usually cause less feeding damage to lupin than other aphid species.

Lupin crops are rarely attacked by other species of aphids, but the WA grains industry is closely monitoring the incidence of Russian wheat aphid (RWA, *Diuraphis noxia*) in other states. This pest is potentially a severe crop threat – especially for susceptible cereal crops.

MORE INFORMATION

GRDC 'Ute Guide – Crop insects': https://grdc.com.au/Resources/Ute-Guides/Insects

GRDC 'Tips and Tactics – Reducing aphid and virus risk': https://grdc.com.au/Resources/Factsheets/2015/02/Reducing-aphid-and-virus-risk

GRDC 'Back Pocket Guide – Crop Aphids': https://grdc.com.au/Resources/Bookshop/2015/02/Crop-Aphids-Back-Pocket-Guide

DPIRD 'Management of aphids in Western Australian lupin crops': https://www.agric.wa.gov.au/grains-research-development/management-aphids-western-australian-lupin-crops

DPIRD 'Russian wheat aphid': agric.wa.gov.au/rwa2016

IPM Guidelines 'Aphids in pulses': http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-pulses/

FEEDBACK

Monitoring

Aphids grow to about 3 mm in length, can be winged or wingless and are most likely to colonise the edges of crops first.

For this reason, it is recommended growers monitor a 20-metre border of paddocks for the first signs of aphids or crop damage from this insect.

When checking crops, it is best to get a close look by getting on hands and knees and inspecting the leaves down to the crown of the plant, where aphids may be hiding.

WA growers can use the GRDC-DPIRD MyPestGuide Crops application (smart technology app) to identify aphid species, size and crop damage symptoms.[7]

Control

It is advisable to treat crops according to aphid thresholds to avoid unnecessary or prophylactic sprays.

The threshold for aphid control with insecticide to produce a yield response in WA lupin crops is when 30 percent of flowering buds have more than 30 aphids.[8]

These estimates are based on assessing plants in numerous parts of the lupin crop paddock and inspecting flowering heads at random, looking for insect clusters and symptoms of leaf curling.

It is advisable when deciding to treat crops to consider other beneficial insects, such as hover flies (*Syrphidae*), ladybirds (*Coccinellidae*), lacewings (*Chrysopidae*) and parasitic wasps (*Braconidae*) that attack aphids and keep populations low. Using sprays that target aphids only can leave beneficial insects unharmed.

Aphids cause the bulk of damage to lupin crops before plant symptoms are obvious. By the time symptoms are visible, yield loss that cannot be recovered by insecticide control may have occurred.

Crop yields are affected by direct aphid feeding damage causing flower and pod abortion during budding and flowering.

Aphids are also vectors of the damaging Cucumber mosaic virus (CMV) and Bean yellow mosaic virus (BYMV) in WA lupin crops.

Winged aphids fly into lupin crops from surrounding vegetation and pastures.

Spring population sizes will depend on autumn and winter conditions.

Long autumn growing periods allow early build-up and spread of aphids.

Mild (not cold) winters allow further development and spread of winged aphids, which can establish many small colonies of wingless aphids in a crop.

Some lupin varieties are more susceptible to aphid feeding damage than others, as shown in Table 3.

Without control, research indicates aphid damage in susceptible varieties can be as high as 90 percent and damage to varieties with intermediate resistance can be up to 30 percent.[9]

7 DPIRD website (2016) The MyPestGuide Suite, https://www.agric.wa.gov.au/biosecurity/mypestguide-suite

8 DPIRD-GRDC (2016) MyCrop Lupin diagnostic tool, Diagnosing aphids in narrow leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-aphids-narrow-leafed-lupins

9 DPIRD-GRDC (2016) MyCrop Lupin diagnostic tool, Diagnosing aphids in narrow leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-aphids-narrow-leafed-lupins

FEEDBACK

Table 3: Susceptibility of narrow leafed lupin varieties grown in Western Australia to aphid colonisation and aphid borne viruses: Cucumber mosaic virus (CMV; seed-borne) and Bean yellow mosaic virus (BYMV).

Variety	Aphids	CMV (seed borne)	BYMV
Belara	S	MS	S
Coromup$^{\Phi}$	R	MR	MS
Jenabillup$^{\Phi}$	R	MRMS	MR
Mandelup$^{\Phi}$	R	MRMS	S
PBA Barlock$^{\Phi}$	R	MR	MS
PBA Gunyidi$^{\Phi}$	R	MRMS	MS
PBA Jurien$^{\Phi}$	R	MRMS	MR
Quilinock$^{\Phi}$	MS	MR	MR

Key: VS=very susceptible, S=susceptible, MS= moderately susceptible, MR=moderately resistant, R=resistant, VR=very resistant.
(SOURCE: Pulse Breeding Australia.)

Management strategies for controlling aphids in WA lupin crops include:

- Sowing healthy seed
- Using high seeding rates to generate dense stands
- Putting cereal barriers around the crop
- Heavy grazing of adjoining pasture paddocks to reduce aphid numbers
- Strategic aphicide sprays
- Delaying spraying if a cold front is expected
- Using 'soft' products, such as pirimicarb, that are aphid-specific
- Considering short-term residual sprays
- Considering a barrier spray only (crop edges)
- Considering stubble retention (repels aphids from landing)
- Ensuring good weed control to avoid a green bridge between seasons
- Encouraging aphid predators and parasites.

Some WA Green peach aphid (GPA) populations are resistant to pyrethroids (Group 3A), OPs (Group 1B) and carbamates (Group 1A). But the level of resistance to OPs appears to have plateaued in WA, according to researchers.[10]

Testing of populations of GPA across southern Australia in 2016 found resistance to neonicotinoid insecticides (commonly used in seed treatments) for the first time.

To assist growers with GPA management strategies, the GRDC has collaborated with **cesar**, the South Australian Research and Development Institute (SARDI – a division of Primary Industries and Regions South Australia, or PIRSA), the New South Wales Department of Primary Industries (NSW DPI) and the Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR) to produce a 'Tips and Tactics' publication focused on 'Reducing aphid and virus risk'. It can be found at: https://grdc.com.au/Resources/Factsheets/2015/02/Reducing-aphid-and-virus-risk

The industry 'Resistance management strategy for GPA in Australian grains' can be viewed at: http://ipmguidelinesforgrains.com.au/ipm-information/resistance-management-strategies/

10 GRDC (2015) Tips and Tactics 'Reducing aphid and virus risk', https://grdc.com.au/Resources/Factsheets/2015/02/Reducing-aphid-and-virus-risk

Approved insecticides for control of aphids in WA lupin crops include:

Cowpea aphid

- Methidathion
- Dimethoate.

Blue green aphid

- Dimethoate.

Green peach aphid

- Pirimicarb
- Petroleum oil
- Paraffinic oil (suppression only)
- Omethoate (suppression only)
- Dimethoate.

6.5.2 Thrips

Adult onion thrips (*Thrips tabaci*) and plague thrips (*Thrips imagines*) are 2 mm long, cigar-shaped insects that affect WA lupin crops.

These pests range in colour from yellowish-orange to dark grey and it is difficult to differentiate between the two species in the field.

Thrips breed all year round on green plant material, especially flowering plants, piercing plant tissue and sucking sap.

This leads to distorted leaves and, in extreme cases, high numbers at the flowering stage of the lupin crop may cause flower abortion.

But, in WA, this pest rarely causes damage that is sufficient to warrant control measures.

6.6 Pest identification and management – pod fill stage

6.6.1 Native budworm (*Helicoverpa punctigera*)

Figure 7: *The larvae of native budworm are shades of orange, brown and green with dark stripes on the body.*

(SOURCE: SARDI)

Native budworm (*H. punctigera*) is a major insect pest in WA lupin crops, especially in the South West region. The caterpillar can cause serious yield loss as pods mature in late winter and spring.

These caterpillars grow to about 40 mm in length in seven weeks from egg hatching and are shades of orange, brown and green – typically with dark stripes on the body.

MORE INFORMATION

GRDC 'Ute Guide – Insects': https://grdc.com.au/Resources/Ute-Guides/Insects/Thrips/South/Onion-Thrips-Plague-Thrips-and-Western-Flower-Thrips

DPIRD-GRDC MyCrop 'Thrips': https://www.agric.wa.gov.au/mycrop/diagnosing-thrips-lupins

MORE INFORMATION

DPIRD 'Diagnosing native budworm in narrow-leafed lupins': https://www.agric.wa.gov.au/mycrop/diagnosing-native-budworm-narrow-leafed-lupins

DPIRD 'Management and economic thresholds for native budworm': https://www.agric.wa.gov.au/grains/management-and-economic-thresholds-native-budworm ?page=0%2C4#smartpaging _toc_p4_s1_h3

DPIRD 'Albus lupins': https://www.agric.wa.gov.au/lupins/amira-anthracnose-resistant-albus-lupin-western-australia?page=0%2C2

IPM Guidelines 'Native budworm in winter pulses': http://ipmguidelinesforgrains.com.au/pests/helicoverpa/native-budworm-in-winter-pulses/

FEEDBACK

Adult moths are about 15-18 mm in length and a buff, light brown to red-brown colour, with numerous dark spots and blotches.

The hind wings of the adult moth are pale with a dark band along the lower edge and span 30-35 mm. Migratory flights of these moths are unpredictable and they can be carried by air currents for hundreds of kilometres.

Native budworm caterpillars feed on lupin plant leaves and stems until the crop nears maturity, at which time they are attracted to the pods.

When about 15 mm in length, the caterpillars can drill through the pod wall and eat the seeds.

At the final two growths stages (fifth and sixth instar), the caterpillars tend to eat more than 90 percent of their total grain consumption.

New moth flights and egg laying will result in caterpillars of varying sizes in a crop at any one time.

Crop losses occur from direct seed weight loss (through being partly or wholly eaten after sowing) and/or downgraded grain quality from unacceptable levels of chewed grain or fungal infections from caterpillar entry to the pod.

Damage to narrow leafed lupin typically occurs when plants are close to maturity and the pods are losing their green colour. Signs of infestation include chewed leaves, flowers and pods.

Native budworm is potentially the most serious seed insect pest of Amira□ and Andromeda□ albus lupin, affecting the podding of these varieties.

DPIRD monitors the numbers of native budworm moths through pheromone (female sex scent) traps spread across the WA grainbelt and results are published regularly through its PestFax service.

It advises that on-farm monitoring for native budworm numbers is best carried out by sweeping with an insect net.

Recommendations for effective sweeping include:

- Use a standard insect net that is 380 mm in diameter
- Taking 2-m wide, long sweeping arc sweeps
- Taking multiples of 10 sweeps in several parts of the lupin crop
- Checking short and thin areas for highest efficiency of sweeping
- Keeping the lower leading edge of the sweep net slightly forward of the opening.

Monitor

Monitoring to gauge the size and age of caterpillars should start well before damage to pods is expected.

Large caterpillars will damage the lupin as it drops its leaves and caterpillars begin to feed on the pods.

If the population is made up of large, ageing caterpillars when the lupin plant still has leaves, treating with insecticide may not be necessary – as the caterpillars may pupate before pod damage occurs.

But if large numbers of small caterpillars are present before leaf drop, spraying may be required – as these caterpillars will mature just as the lupin plant drops its leaves and pod damage may occur.

An alternative to sweeping for crop monitoring, especially in dense crops or where plants are too stiff and pods too spikey, is to cut plants from the base in several parts of the crop paddock and, at each sample point, shake these into a bin to count caterpillar numbers. About 40 plants is equivalent to one square metre of crop.

FEEDBACK

This is considered the easiest method for assessing damage levels for the entire crop.

Control

Threshold levels for economic control of native budworm in narrow leafed lupin varieties at prices of about $300 per tonne and insecticide costs of about $8 per hectare (for product and application) are about six grubs of 15 mm or longer per 10 sweeps.[11]

If the price of grain increases, or the cost of application decreases, the economic threshold levels decrease.

At times, losses from native budworm can be less than predicted, if, for example, the season is shortened by a lack of moisture.

Spray thresholds have not yet been developed for Amira□ or Andromeda□ albus varieties in WA, but the rule-of-thumb is to spray insecticide if there is more than 1 budworm per 10 sweeps.[12]

The timing of insecticide sprays is critical for protecting albus lupin yields and it is recommended not to wait for caterpillars to grow.

For both narrow leafed and albus lupin, a decision to spray an insecticide on a lupin crop for native budworm control should not be made until damage is about to occur and pods are beginning to mature.

Effective control requires understanding when the crop is at risk and the economic threshold for when to spray.

Natural mortality of budworm populations is sometimes sufficient to prevent economic damage and monitoring should continue around crop maturity and podding. Registered insecticides for controlling native budworm in WA lupin crops include:

- Zeta-cypermethrin
- Spinetoram
- Nuclear polyhedrosis virus of helicoverpa armigera
- Methomyl
- Lambda-cyhalothrin
- Esfenvalerate
- Deltamethrin
- Cypermethrin
- Beta-cypermethrin
- Bacillus thuringiensis subsp kurstaki strain HD-1
- Alpha-cypermethrin.

11 DPIRD website (2016) MyCrop diagnosing native budworm, https://www.agric.wa.gov.au/mycrop/diagnosing-native-budworm-narrow-leafed-lupins

12 DPIRD website (2016) Managing insects, weeds and disease in albus lupin variety Andromeda, https://www.agric.wa.gov.au/lupins/managing-insects-weeds-and-disease-albus-lupin-variety-andromeda

FEEDBACK

MORE INFORMATION

IPM guidelines 'Etiella': http://ipmguidelinesforgrains.com.au/pests/etiella/

cesar Australia 'Lucerne seed web moth or Etiella': http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-seed-web-moth-or-Etiella

Pest Web 'Etiella moth': http://agspsrv34.agric.wa.gov.au/ento/pestweb/Query1_1.idc?ID=1701059111

6.6.2 Lucerne seed web moth (*Etiella behrii*)

Figure 8: *The lucerne seed web moth is grey-brown, up to 12 mm long with a protruding 'beak' and is a sporadic pest of lupin crops. Pictured is its larvae.*

(SOURCE: SARDI)

Lucerne seed web moths grow to about 20 mm, are grey-brown with a stripe on each forewing and have an orange band across the wing base.

In WA, this pest is rare and sporadic and removing early season volunteer legume plants near lupin crops may provide sufficient control.

Lucerne seed web moths produce three to four generations each year in spring, summer and autumn and newly hatched larvae feed on the seed in lupin crop pods.

Damaged seeds have jagged edges, similar to native budworm damage, but are distinguished by the presence of webbing in the pod.

In most seasons, this pest causes only minor damage to seed. It is only in years when numbers are high that significant yield losses have been reported.

Monitoring for lucerne seed web moth in lupin crops should focus on detecting the presence of webbing in flowers and in the growing points of the plant.

Early detection is important, but lucerne seed web moths do not usually cause economic damage in WA lupin crops – unless there are crops growing over summer (for example, lucerne) that host the pest and allow numbers to build-up.

FEEDBACK

MORE INFORMATION

GRDC 'Fact Sheet – Snail management': https://grdc.com.au/Resources/Factsheets/2012/09/Snail-Management

GRDC 'Hot Topic – New insights to give snails and slugs the slip': https://grdc.com.au/Media-Centre/Hot-Topics/New-insights-to-give-snails-and-slugs-the-slip

GRDC 'Ute Guide —Insects: slugs and snails': https://grdc.com.au/Resources/Ute-Guides/Insects/Slugs-snails

GRDC 'Ground Cover TV snail and slug playlists': http://www.grdc.com.au/GCTV17-SnailPlaylist; http://www.grdc.com.au/GCTV-Slugs

GRDC 'Back Paddock Guide – Snail identification and control': www.grdc.com.au/Resources/Publications/2011/03/Snail-Identification-and-Control-The-Back-Pocket-Guide

DPIRD 'Identification and control of pest slugs and snails for broadacre crops in WA': www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

IPM guidelines 'Slugs and snails': http://ipmguidelinesforgrains.com.au/pests/slugs-and-snails/

SARDI 'Bash'em, Burn'em, Bait'em': https://grdc.com.au/uploads/documents/Snails%20BBB.pdf

6.7 Pest identification and management – spring, harvest and summer

6.7.1 Snails

The three main species of snails that attack WA lupin crops as seedlings and potentially contaminate grain at harvest are:

» Conical or small pointed snail (*Cochlicella barbara*).

» White Italian snail (*Theba pisana*)

FEEDBACK

» Vineyard or common white snail (*Cernuella virgata*)

The small pointed snail is light brown with a conical shell and grows up to 10 mm in length, chewing lupin plant leaves and leaving slime trails.

It is most common in WA's high rainfall areas and control is recommended where numbers reach any more than five per square metre.[13]

The white Italian snail has a white shell, sometimes with broken brown bands in the line of the spiral, and grows up to 24 mm in width.

The vineyard snail has a shell that is up to 20 mm wide with a continuous brown band. Both the white Italian and vineyard snail species feed on crop leaves and control is recommended when numbers exceed five per square metre.

In summer, as conditions begin to dry and temperatures increase, white Italian and vineyard snails move up plant vegetation to avoid water loss.

The small pointed snail may move up vegetation or harbour underneath stubble to retain moisture. Summer rains can trigger short periods of snail activity, but are unlikely to trigger breeding

High levels of snail activity tend to start with the onset of cool, moist conditions in autumn and require only 1 mm of rain to get these pests moving.

13 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

FEEDBACK

Monitoring

When monitoring lupin crops for snail presence, it is advised to check for irregular pieces chewed off leaves, shredded leaf edges or total defoliation.

Snails tend not to eat seedlings down to ground level, unless the seedling has just emerged.

But lupin plants can not compensate for the damage or loss of cotyledons due to snail damage.

The rule-of-thumb is to monitor numbers on a regular basis and implement control prior to seeding.

Monitoring snail presence and activity in lupin involves:

- January-February – assess stubble management
- March-April – assess numbers for burning and/or baiting
- May to August – assess numbers for baiting, especially along fence lines
- Three to four weeks before harvest – assess numbers for risk of grain contamination.

(SOURCE: DAFWA) [14]

Control

Pre-seeding management can assist with controlling snails and tactics include:

- An even burn of stubbles (can lead to an 80-100 percent kill)
- Grazing during summer (reduces ground cover)
- Summer weed control (reduces refuge areas)
- Using wide points or full-cut discs to 5 cm (can reduce numbers by 60 percent).[15]

Baiting is the only option for snail control after the lupin crop has been sown and germination has started.

Multiple bait applications may be required and there are no registered foliar-applied products for snail control in-crop.

Baits are only suitable for snails bigger than seven millimetres in diameter and there is an associated kill rate of around 50 percent when these are applied at 5 kg/ha in areas of the paddock where the pests are active.[16]

Spreading baits early can reduce snail numbers, but it may be difficult to obtain good control because snails feed on green plant material as well as decomposing organic matter.

GRDC-funded research has found regular bait re-application is necessary due to field degradation or pest populations not actively feeding, or both. [17]

Under testing, commonly used bran-based bait products lasted less than two weeks.

The research showed rainfall not only physically breaks down the bran pellets, it reduces the number of white Italian snails killed, as these were less likely to consume a lethal dose. The project found that mould on products did not influence bait consumption or efficacy.

Researchers found temperature, not UV light, reduces the efficacy of metaldehyde baits. Growers who use metaldehyde products during summer should not expect these to last more than two weeks.

14 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

15 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

16 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

17 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

FEEDBACK

At harvest, if snails remain above control threshold levels of 5 per square metre in lupin crops, it is likely they will contaminate harvested grain.

This can occur if snail management practices were not applied early in the season, or management of the snails was ineffective.

As the harvest progresses, snails migrate up the crop to escape the hot ground and it is ideal in susceptible areas if harvest can coincide with cooler conditions.

Round snails (white Italian and vineyard species) are more likely to be dislodged off crops during harvest. But small pointed snails are often found in sheltered locations, such as between the leaf and stem, are difficult to dislodge and are more likely to be intact in the harvested grain.

Harvester modifications are more effective on round, rather than conical, snails.

Cleaning grain after harvest may remove small pointed snails from the grain. For more information refer to SARDI's 'Bash'em, Burn'em, Bait'em – Integrated snail management in crops and pastures' publication. It can be found here: https://grdc.com.au/uploads/documents/Snails%20BBB.pdf

Windrowing, summer weed spraying and fence line weed control can assist in snail management, as can introducing certain beetle species as a biological control measure.

Windrow burning for snail control was found to be effective in 2015 trials in a high rainfall zone, initiated by the GRDC's Albany port zone Regional Cropping Solutions Networks (RCSN) group.[18]

This project showed that snails attracted to fallen stubble in the inter-rows could pose an issue for the next crop and burning the windrow could significantly reduce populations.

It is advised that economic and financial implications need to be considered when choosing a management option for snails in WA lupin crops. These include:

- Understanding the risk of snails being present
- Gauging potential yield losses associated with snail feeding damage
- Assessing the costs and benefits of taking preventative action, such as removing a green bridge or destroying stubble
- Comparing costs, benefits and risks of each management option against doing nothing
- Considering risk and associated costs or savings of no treatment or delaying treatment
- Ignoring all previous treatment costs in assessing current management options
- Undertaking scenario analysis to see what impact changing the variables (such as grain price and seasonal conditions) will have on the economic outcome.

(SOURCE: DAFWA)

A new research project has been initiated by GRDC across the western and southern regions to provide growers with specific localised information for effective timing of snail control.

The focus is on the ecology, behaviours and biology of the most threatening snail and slug species in each region.

In WA, this involves DPIRD researchers monitoring – including with cameras – the small pointed snail at four sites in Albany and Esperance.

They are tracking soil moisture, temperature and humidity data and undertaking laboratory-based snail and slug biology studies.

18 GRDC Albany port zone Regional Cropping Solutions Networks (RCSN) group project (2015) Hot Topic New Insights to give snails and slugs the slip, https://grdc.com.au/Media-Centre/Hot-Topics/New-insights-to-give-snails-and-slugs-the-slip/Details

FEEDBACK

The goal is to identify the environmental triggers for slug and snail activity and the pest response.

This should lead to better predictions of outbreaks and pave the way for timely and economic control tactics by growers in high risk situations.

At each trial site, there are also investigations into the relationships between the snails/slugs and climate/abiotic factors, such as soil type, amelioration practices and crop rotations.

This is aimed at improving decision-making about the timing and location of on-farm baiting.

6.7.2 Slugs

Lupin can be damaged by the common species of slugs affecting WA broadacre crops. These are the black keeled slug (*Milax gagates*) and the reticulated slug (*Derocerus reticulatum*).

Black keeled slugs are black-brown with a ridge down the back. Reticulated slugs have dark brown mottling and range in colour from light grey to fawn.

Both of these slug species grow to about 25 mm in length and are hermaphrodites, with each of the mating pair able to lay eggs.

Mating usually takes place when favourably moist conditions occur after summer.

Eggs are laid into moist soils in mid-autumn to mid-winter and hatch within two to four weeks. Eggs cannot survive a hot dry summer or lie dormant in the soil. Young slugs become sexually mature at one-year-old.

Slugs tend to inhabit heavier-textured soils and wet areas in WA's high rainfall zones and can be particularly problematic in paddocks where stubbles have been retained or there are rock piles.

They take refuge in soil cracks or under large clods during the day and are active at night, especially when conditions are moist, warm and still.

Damage to lupin crops from slugs includes destruction of seeds at sowing or chewed leaves, shredded leaf edges or eating of whole seedlings to ground level.

Monitoring

Slug activity can be detected by fresh trails of white and clear slime in the morning.

Numbers of about 10 large slugs/square metre may destroy an emerging lupin crop and it is advised that the threshold for control is one or two slugs per square metre.[19]

It can be difficult to accurately estimate the population of slugs in a paddock, especially in cracking soils.

A useful method of detection before seeding or crop emergence is to lay lines of slug baits with a rabbit baiter.

In infested areas, slugs are attracted to the freshly turned soil and bait pellets placed in the furrow and soon big numbers will be found dead or dying.

An alternative method to monitor numbers is to place carpet squares or tiles on the soil surface, with pellets underneath. After a few days, count the number of slugs under and around each square.

After sowing and during germination, it is best to examine crops at night for slug activity.

MORE INFORMATION

GRDC 'Ground Cover TV snail and slug playlists': http://www.grdc.com.au/GCTV17-SnailPlaylist; http://www.grdc.com.au/GCTV-Slugs

GRDC 'Hot Topic – New insights to give snails and slugs the slip': www.grdc.com.au/Media-Centre/Hot-Topics/New-insights-to-give-snails-and-slugs-the-slip

DPIRD 'Identification and control of pest slugs and snails for broadacre crops in WA': www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

19 DPIRD website (2016) Identification and control of pest slugs and snails for broadacre crops in Western Australia, www.agric.wa.gov.au/grains/identification-and-control-pest-slugs-and-snails-broadacre-crops-western-australia

FEEDBACK

Control

Tips for controlling slugs in WA lupin crops include:

- Application of baits
- Baits work best when there is no green material (weeds, crops)
- Spread when slugs are active after rain
- Use registered label rates of bait (such as metaldehyde 50g/kg at 5 kg/ha)
- Use baits in areas where slugs are active
- Try to avoid late baiting
- Re-application of baits may be needed (effectiveness is lost after a few days)
- Burning and tillage can be effective for reticulated slugs (not black keeled slugs).

DPIRD's MyEconomic Tool can help to assess the economics of baiting for slugs and can be found at: https://www.agric.wa.gov.au/wheat/myeconomic-tool