WESTERN
JUNE 2018

GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

LUPIN

SECTION 9

DESICCATION, CROP-TOPPING AND GREEN/ BROWN MANURING

OVERVIEW | WINDROWING/SWATHING | DECISION-MAKING FOR DESICCATION | DECISION-MAKING FOR CROP-TOPPING | PRODUCTS AND TIMING FOR CROP-TOPPING AND DESICCATION | GREEN MANURING OF LUPIN | BROWN MANURING OF LUPIN

MORE INFORMATION

GRDC Fact Sheet 'Pre-harvest herbicide use': www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

GRDC Fact Sheet 'Late season herbicide use': https://grdc.com.au/uploads/documents/GRDC_LateSeasonHerbicideUse_FS.pdf

DAFWA Fact Sheet 'Weed control in mature crops and desiccation': https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C5#smartpaging_toc_p5_s4_h3

DPIRD 'Crop weeds' hub: https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C3#smartpaging_toc_p3_s1_h3

Pulse Australia, Australian Pulse Bulletin 'Desiccation and croptopping in pulses': http://www.pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping

Desiccation, crop-topping and green/brown manuring

9.1 Overview

Desiccation and crop-topping involve strategic application of a registered herbicide close to the final maturity of the lupin crop.

These tactics can be used alone or in combination to meet different objectives on individual properties.

Desiccation (typically coupled with windrowing/swathing) terminates crop growth, regardless of the development stage of weeds. The aim is to encourage even ripening of crops and minimal infestations of green weeds for ease of harvest.

It is well suited to Western Australia's southern grainbelt areas prone to late season rainfall and helps to manage risks of weather damage at harvest.

Crop-topping is the application of a non-selective knockdown herbicide near crop maturity and is aimed at preventing seed set in weeds (mainly grasses), controlling in-crop weed escapees and lowering paddock weed seedbanks.

This approach broadens weed management options and strengthens the role of lupin and other pulses in crop rotations for WA farming systems.

For crop-topping, timing is critical and for best results it must be matched to weed seed development – irrespective of the development stage of the crop.

Lupin crops in WA have been found to suffer substantial yield losses if the crop has not reached physiological maturity at or before the timing of crop-topping.

Breeding and variety development by Pulse Breeding Australia (PBA) has produced earlier maturing narrow leafed varieties, such as PBA Leeman$^{\Phi}$, PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$ and PBA Gunyidi$^{\Phi}$ – and the albus line Amira$^{\Phi}$ – that are much better suited to this system than older varieties.

Pulse Australia says, typically, albus lupin tends to mature too late for crop-topping to be effective and desiccation is rarely needed to even-up ripening of these varieties.[1]

As with all herbicide use, the Grains Research and Development Corporation (GRDC) advises strict adherence to product label registrations, rates and withholding periods when undertaking desiccation and/or crop-topping in the lupin crop.

Harvest can start as soon as the harvest withholding period has been observed.

Late season herbicide issue increases the risks of detectable herbicide residues in harvested grain and it is important to know the maximum residue limits (MRLs) for lupin.

It is recommended to harvest crop-topped lupin as soon as possible (mindful of any withholding periods) if weed seed capture is an objective.

Crop-topping increases the speed at which weeds die-off and drop their seeds on the ground, making capture in chaff carts, bales of straw, windrows or the seed destruction technology important.

1 Pulse Australia (2016) Australian Pulse Bulletin – Desiccation and croptopping in pulses, http://www.pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping

FEEDBACK

It is advised not to use lupin seed from crop-topped paddocks for planting the following year, as there is a risk of lower vigour.

Using lupin crops for green or brown manuring can be another strategy for reducing weed burdens in WA cropping systems, with the added benefits of improving soil fertility and soil organic matter, but there are significant risks of wind and water erosion from green manuring that would require consideration.

9.2 Windrowing/swathing

Figure 1: *Pictures show the pod and seed development of narrow leafed lupin, and embryos from those pods, at various stages in their development. The coloured bars show changes in the colours of the pod, seed and embryo.*

(SOURCE: DAFWA)

Windrowing, or swathing, of lupin involves cutting the crop and laying it in a windrow. It is carried out when the seed is close to physiological maturity, before desiccation, to help manage risks of grain shattering and spoilage.

This tactic is suitable for narrow leafed and albus types and also provides benefits of: avoiding grain contamination with green material (such as late germinating weeds); reducing potential grain storage problems (due to high moisture levels in weed seeds); helping to manage crops that are ripening unevenly; and reducing weed seed set as part of a harvest weed seed control program.

Timing the windrowing operation is vital to its success and is based on an assessment of seed maturity in the order of pods (primary to final). This involves checking the cotyledon (kernel) colour, which will often be green for seeds found in pods on the lateral branches and yellow for those found on the main stem.

Typically, windrowing of lupin crops can start when the average moisture content of all seed is 65 percent. This tends to occur at the start of leaf drop, when the stems and leaves of the plant are light green-yellow.

It is recommended to avoid windrowing if seed moisture content falls below 50 percent, as the risk of yield loss through pod drop during the operation and while the crop is in the windrow increases. It is advised to cut the crop 10-20 cm above the ground.

Windrows will typically be ready to harvest about 10-30 days after cutting. Harvester settings are important to minimise potential yield loss from pod drop or shattering.

For albus lupin varieties, it is important to avoid windrowing too early, as immature seeds can shrivel when dry and lead to lower grain quality. For narrow leafed

varieties, it is advised to avoid cutting crops if there are prolonged dry conditions at harvest, as this can cause higher levels of pod drop. See Chapter 10 for more information about harvesting lupin.

Figure 2: *Pod wall, seed coat and cotyledon colour of narrow leafed lupin at the correct stage of maturity to windrow.*

(SOURCE: NSWAg Pulse Point)

Figure 3: *Seed coat and cotyledon colour of albus lupin at the earliest stage at which they should be windrowed.*

(SOURCE: NSWAg Pulse Point)

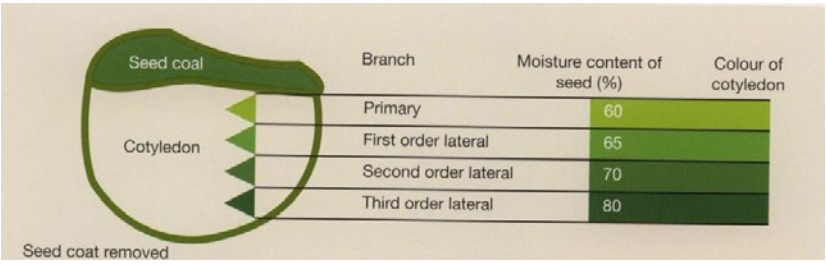

Figure 4: *Summary of lupin growth stage and when to undertake windrowing.*

(SOURCE: DAFWA)

FEEDBACK

9.3 Decision-making for desiccation (with windrowing/swathing)

Crop desiccation and windrowing/swathing are predominantly harvest aids. But these practices can provide significant weed management benefits in some conditions and seasons, especially by lowering the weed seedbank.[2]

The main reasons for using desiccation, with windrowing/swathing, in WA lupin crops include:

- Accelerate or even-up crop ripening for ease of harvesting
- Improve harvest speed and efficiency
- Minimise grain loss from shattering or lodging in prone areas
- Improve grain quality
- Reduce risks of weather damage
- Conserve soil moisture for the next crops
- Stop seed set in late season weeds
- Prevent seed set of annual ryegrass (*Lolium rigidum*)
- Help to manage any herbicide resistance issues.[3]

9.4 Decision-making for crop-topping

Crop-topping can be a valuable strategy to reduce the weed seedbank to enable early dry sowing in a low-weed-burden paddock the following year, rather than waiting for sufficient rain to germinate weeds for a knockdown herbicide application.

Crop-topping in lupin helps to manage weeds, especially grasses, that are often difficult to control in cereal and canola crops and is a useful part of a longer-term herbicide resistance management plan.

Key reasons for crop-topping WA lupin crops include to:

- Minimise production of viable weed seeds (especially annual ryegrass and other grasses)
- Optimise grain yields
- Even-up crop maturity
- Help manage any herbicide resistance issues.[4]

2 DPIRD (2016) Crop Weeds: Stop weed seed set – In-crop weed management for seed set control, https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C5#smartpaging_toc_p5_s4_h3

3 DPIRD (2016) Crop Weeds: Stop weed seed set – In-crop weed management for seed set control, https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C5#smartpaging_toc_p5_s4_h3

4 DPIRD (2016) Crop Topping Pulse Crops, https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops

FEEDBACK

MORE INFORMATION

GRDC's Fact Sheet 'Pre-harvest herbicide use': www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

DPIRD 'Crop-topping pulse crops': https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops

Pulse Australia Fact Sheet 'Desiccation and crop-topping in pulses': http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjBssbUmMfOAhWDFpQKHW7JDpAQFggbMAA&url=http%3A%2F%2Fcanfa.com.au%2FLiteratureRetrieve.aspx%3FID%3D104717&usg=AFQjCNExNMc9-H_d1GHCCrAfsjCv2pfLfQ

'Maximum residue limits for late-season herbicides': www.pestgenie.com.au and www.apvma.gov.au

Nufarm SprayWise: www.spraywisedecisions.com.au

9.5 Products and timing for desiccation and crop-topping

Desiccating lupin with the Group L herbicide active diquat or crop-topping lupin with the Group L herbicide active paraquat (registered for annual ryegrass only) can be effective to help control some grass weeds in conducive seasons in WA.

It is recommended these tactics are carried out as part of an integrated weed management (IWM) program that might also include cutting crops for hay, green or brown manuring and/or using harvest weed seed control (HWSC) measures.

Desiccation and/or crop-topping is best carried out when lupin plants have lost 80-90 percent of leaves (including all brown leaves still attached to the plant) and grass weed species are at the 'flowering' to 'soft dough' stage.[5]

Early maturing narrow leafed varieties, including PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$, PBA Gunyidi$^{\Phi}$ and Mandelup$^{\Phi}$, tend reach this stage up to 10 days before later maturing, older lines, such as Tanjil$^{\Phi}$.

In WA, desiccation and crop-topping success relies on seasonal conditions, especially in high rainfall areas.

If there is a prolonged wet spring, this can extend lupin flowering and podding and annual ryegrass can often develop too quickly (past the ideal stage), before the crop is ready to treat with herbicides.

In the State's northern agricultural region, some growers are successfully crop-topping lupin to help manage annual ryegrass seed set in preparation for dry sowing wheat crops the following year.

The guide to assessing annual ryegrass development stage for desiccation and crop-topping includes:

- Pull seed off from the middle of the seed head
- Squeeze the seed between your fingers
- If there is just sappy liquid – the seed is 'watery ripe'
- If there is milky, white liquid – this is the 'milk stage'
- Sap thickness denotes early, middle and late milk stages
- If there is sap that is sludgy but still soft and like dough – this is the 'dough stage'
- When there is very limited moisture – this is the 'firm or hard dough stage'
- If the seed hardly compresses and is a yellow/brown color – this is near 'ripening'
- After this, it will be too late to get good control.[6]

Research trials in WA have found paraquat can achieve 64-97 percent annual ryegrass control when used for crop-topping at label rates at the annual ryegrass flowering to soft dough stage.[7]

Research has also shown the yields of lupin, and other pulse crops, are typically not reduced if crop-topping is delayed until seeds in the top pods of lupin are 75 percent or more of full size.[8]

But there may need to be a balance between optimal timing for effective annual ryegrass control (which is often earlier) and potential lupin grain yield loss.

5 DPIRD (2016) Crop Topping Pulse Crops, https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops

6 DPIRD (2016) Crop Topping Pulse Crops, https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops

7 GRDC Fact Sheet (2015) Pre-harvest Herbicide Use, www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

8 GRDC Fact Sheet (2015) Pre-harvest Herbicide Use, www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

FEEDBACK

It is best not to desiccate or crop-top lupin that will have seed retained for subsequent planting, as this has potential to adversely affect seed quality due to uneven ripening.[9]

9.5.1 Paraquat use

WA research and experience has demonstrated that paraquat can be effective for crop-topping when applied later in the season – up to when grass weed seeds have reached soft dough stage.[10]

For annual ryegrass, the last seed heads at the bottom of the plant can be emerged and most heads should be at – or just past – flowering and not yet haying-off.

In most grainbelt areas of WA, this is typically in late September and early October.

Guidelines for using paraquat (at 250 grams per litre) on WA lupin crops for crop-topping include:

- Rates of 400—800 mL/ha
- Use highest registered herbicide rate
- Ground application only
- Minimum spray volume of 30 L water/ha
- Aim for medium droplets
- Annual ryegrass should be at or just past flowering
- Harvest withholding period is seven days after application.[11]

9.5.2 Diquat use

Diquat is particularly useful for desiccation of lupin and it is recommended to apply as soon as the crop has reached full maturity.

It can accelerate crop drying and reduce seed moisture levels, which reduces grain drying costs, risks of harvesting delays and weather risks at this time of year.

Guidelines for using diquat (at 200 g/L) on WA lupin crops for desiccation include:

- 2-3 L/ha
- Application by boomspray or aeroplane
- Minimum spray volume of 100 L/ha recommended for ground application
- Spray volume of 30—60 L/ha recommended for aerial application
- Aim for fine to medium spray quality
- Flat fan nozzle is preferred on ground
- Aim to minimise drift from any aerial application
- Apply when crop has reached full maturity
- No specified withholding period in WA.[12]

9 DPIRD (2016) Crop Topping Pulse Crops, https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops

10 GRDC Fact Sheet (2015) Pre-harvest Herbicide Use, www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

11 Pulse Australia (2016) Australian Pulse Bulletin – Desiccation and croptopping in pulses, http://www.pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping

12 Pulse Australia (2016) Australian Pulse Bulletin – Desiccation and croptopping in pulses, http://www.pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping

FEEDBACK

MORE INFORMATION

DPIRD 'Green manuring': https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C3#smartpaging_toc_p3_s1_h3

DPIRD Carbon Farming Fact Sheet 'Green and brown manuring': https://www.agric.wa.gov.au/carbon-farming/carbon-farming-fact-sheet-green-and-brown-manuring

MORE INFORMATION

GRDC Fact Sheet 'Manuring of pulse crops': https://grdc.com.au/Resources/Factsheets/2013/09/Manuring-of-Pulse-Crops

GRDC Over the Fence video 'Incorporating a brown manure crop': www.grdc.com.au/OTF-BrownManure

DPIRD 'Brown manuring': https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C3#smartpaging_toc_p3_s1_h3

9.6 Green manuring lupin

This tactic involves growing a crop for the specific purpose of turning it into the soil when green in spring, using cultivation, with the aim of boosting soil organic matter content and reducing weed burdens.

But there is a significant risk of wind and water erosion on green manured paddocks that needs careful consideration.

Green manuring is typically carried out using an offset disc plough. The cultivation aim is to kill weeds and control seed set.

The green manuring process requires good management and timing of cultivation and depends on seasonal conditions. The optimum time to green manure WA lupin crops (in a typical rainfall year) is when they reach early podding stage.[13]

9.7 Brown manuring lupin

In WA, brown manuring is a 'no-till' version of green manuring that uses a non-selective herbicide to desiccate the crop (and weeds) at flowering.

It can be used to help manage weeds and herbicide resistance issues, boost levels of soil nitrogen (N) and organic matter, conserve moisture for subsequent crops, break cereal disease cycles and retain ground cover during summer.

Brown manuring leaves plant residues standing, which can be a preferred option to green manuring on lighter soils that are prone to erosion.

Some of the benefits of adopting brown manuring of lupin crops (especially compared to using a long fallow) may include:

- Increased crop competition with weeds
- Prevention of seed set in weeds
- Less use of knockdown herbicides during the growing season
- Ability to rotate herbicide modes of action
- Accumulation of soil N
- Potential for less fertiliser N use in the next crop
- Maintenance of ground cover in the growing season and over summer
- Less soil surface evaporation
- Water conservation
- Less risk of wind erosion
- Better environment for germinating and controlling weeds in summer.[14]

Research in the southern region in 2012 found a crop production system that included brown manuring of legumes in the rotation could be as profitable as continuous cropping.[15]

This project showed that, even if this system was slightly less profitable, it had considerably fewer production and financial risks due to lower input and operating costs. This is because, typically, crops grown for brown manuring receive minimal fertiliser and fungicides and there is no need for cultivation to turn-in the crop.[16]

A long-term trial in WA's central grainbelt, set up in 2003, is investigating the use of brown manuring in the lupin phase of the rotation as part of improved farming systems.

13 DPIRD (2016) Crop Weeds: Stop weed seed set – In-crop weed management for seed set control, https://www.agric.wa.gov.au/grains/crop-weeds-stop-weed-seed-set?page=0%2C5#smartpaging_toc_p5_s4_h3

14 Patterson, R.A (2014) GRDC Grains Research Update Paper 'Brown manure as a farm risk strategy', https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Brown-manure-as-a-farm-risk-strategy-a-whole-farm-perspective

15 Patterson, R.A (2014) GRDC Grains Research Update Paper 'Brown manure as a farm risk strategy', https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Brown-manure-as-a-farm-risk-strategy-a-whole-farm-perspective

16 Patterson, R.A (2014) GRDC Grains Research Update Paper 'Brown manure as a farm risk strategy', https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Brown-manure-as-a-farm-risk-strategy-a-whole-farm-perspective

FEEDBACK

Preliminary findings from this trial indicate management practices to improve soil fertility (including brown manuring and adding organic matter) are having a positive impact on soil organic carbon levels and potentially soil N. This research is continuing.[17]

Researchers nationally have shown brown manuring lupin and other pulses can maximise N fixation by delaying the crop knockdown until it is close to maturity, or as it is reaching maximum dry matter production. This requires effective weed control.

When brown manuring lupin (and other pulse crops), desiccation with registered herbicides should be carried out at – or before – weed seed milky dough stage. This is usually at or before the 80-90 percent pod stage for the lupin crop.

At this stage, the crop is growing at maximum rate – of about 80-100 kilograms of dry matter per day.

If the main aim is to maximise N fixation, the recommendation is to brown manure close to this maximum dry matter production (which will be mostly determined by season and soil type).[18]

Other tips and tactics for optimising the value of brown manuring in WA lupin crops include:

- Close analysis of two-year economic benefits in the rotation, especially for sandy soils
- Use tactically in drought years for weed/crop failure risk management
- Avoid or minimise fertiliser application at sowing
- Add phosphorus (P) if soil reserves are low
- Spray crops with a registered knockdown herbicide before viable weed seed set
- Use a double-knock
- Time desiccation on growth stage of weeds, not crops
- Spray before the initiation of lupin pod development.[19]

17 Liebe Group (2007) Liebe Group Soil Biology Trial, Online Farm Trials, www.farmtrials.com.au/trial/10461

18 Patterson, R.A (2014) GRDC Grains Research Update Paper 'Brown manure as a farm risk strategy', https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Brown-manure-as-a-farm-risk-strategy-a-whole-farm-perspective

19 Patterson, R.A (2014) GRDC Grains Research Update Paper 'Brown manure as a farm risk strategy', https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Brown-manure-as-a-farm-risk-strategy-a-whole-farm-perspective