SOUTHERN
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GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

LUPIN

SECTION 10

HARVEST

OVERVIEW | HARVEST TIMING | MINIMISING SHATTERING AND POD DROP | MAINTAINING GRAIN QUALITY | MACHINERY CONFIGURATION | MANAGING HARVEST FIRE RISKS | STUBBLE MANAGEMENT | GRAIN STORAGE

MORE INFORMATION

DPIRD 'Lupins': https://www.agric.wa.gov.au/lupins and https://www.agric.wa.gov.au/lupins/lupin-essentials-%E2%80%93-growing-successful-lupin-crop?page=0%2C4#smartpaging_toc_p4_s2_h2

Harvest

10.1 Overview

Modern lupin breeding has focused on developing lupin species and varieties that not only produce sweet and water-permeable seeds, but also have non-shattering pods to facilitate higher yields with mechanical harvest.

Shedding (or pod drop) or shattering of mature grain, plant lodging and poor plant flow into machinery have been issues for lupin crop harvesting across Australia.

Experience in the southern region indicates it is advisable to harvest lupin as soon as the crop is ripe, as delays can result in significant yield loss from these problems. Grain quality can also be affected.

The best harvesting window is typically within three weeks of crop maturity and when grain moisture content reaches 14 percent. In some seasons, this will be when plant stems are still pale green.

Lupin grain losses can be substantially reduced by harvesting when humidity is high and temperatures are not too hot.

In cooler environments, daytime temperatures are often not warm enough to cause major problems and it may be better to harvest the crop as quickly as possible, rather than switching between lupins and cereals.

Delaying harvest can lead to brittle grain that is susceptible to cracking and splitting – or incidence of staining, lodging, moulds or disease.

It is advised to take care when harvesting lupin grain to use as seed for the next year's crop. Grain harvested late for seed can be of poor quality, with a low percentage of normal seedling germination.

It is recommended to harvest as soon as the crop is mature, setting the harvester drum or rotor speed to a minimum and opening the concave relatively wide.

This tends to reduce damage to the seed embryo and helps facilitate a high germination percentage after sowing. The seed embryo is very sensitive to impact if it becomes dry and brittle.

Even seed with no visible damage may have a low germination percentage if it suffered a high impact at harvest, or during handling post-harvest when moisture content was low.

Harvest is an ideal time to employ weed seed capture and/or destruction to reduce weed burdens and help manage any herbicide resistance issues. See Chapter 5 for more information.

Tactics include creating and burning harvest windrows, towing chaff carts, using the Bale Direct system that bales chaff and straw as it exits the harvester, funneling seeds into tramlines or adopting seed destruction technology.

Storing lupin grain for next year's crop also needs close attention, with harvested grain moisture levels of about 13 percent or less ideal for storage.

Using silo aeration to keep average storage temperatures below 20°C until the next year's sowing is ideal to minimise storage insect pest activity and maintain seed quality.

FEEDBACK

MORE INFORMATION

GRDC 'Grain Legume Handbook': https://grdc.com.au/grainlegumehandbook

New South Wales Department of Primary Industries 'Windrowing Lupins': http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/lupins/windrowing-lupins

10.2 Harvest timing

Figure 1: *Lupin is best harvested as soon as the crop is ripe and within three weeks of maturity.*

(SOURCE: GRDC)

Risks of plant lodging, pod shattering, pod shedding (or pod drop), grain staining or disease can typically be minimised if lupin is harvested as soon as the crop is ripe and within three weeks of maturity.

In WA trials, yield losses of 5-40 percent have been recorded in some lupin crops due to shattering of grain when harvest is delayed.[1]

A moisture meter is useful to determine when the lupin crop is ready. Harvest is best started when grain moisture content reaches 14 percent.

In some seasons this will occur when plant stems are still pale green, although the seeds will have turned yellow inside the seed coat.

At higher moisture content, the seed may require aeration or drying for longer-term storage.

Harvesting at or below 10 percent moisture can increase the amount of bruised and cracked seed, which reduces quality and may reduce the germination percentage or normal seedling count when it is sown the next year.

A seed can be damaged even though the seed coat may appear undamaged.

Lupin grain losses can be substantially reduced by harvesting when humidity is high (at night or early morning if necessary) and temperatures are not too hot.

In cooler environments, daytime temperatures often do not become warm enough to cause major problems for harvesting.

When harvesting lupin seed for planting the following year, it is advised to carry out harvest:

- As soon as the crop is mature
- In cooler, rather than hotter conditions
- With the harvester drum or rotor speed set to a minimum
- With the concave opened quite wide.

(SOURCE: DPIRD)

1 Reithmuller (2008) Successful lupin harvesting in Western Australia – A review. Lupins. Org conference paper.

FEEDBACK

MORE INFORMATION

NSW Department of Primary Industries 'Windrowing Lupins': http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/157237/pulse-point-10.pdf

10.3 Minimising shattering and pod drop

Shattering or dropping of lupin pods on entry to the harvester can lead to significant grain losses in lupin crops as a result of:

- Vibration due to cutter bar action
- Plant on plant contact
- Reel on crop impact
- Poor removal of cut material by the auger.

Risks of shattering or pod drop resulting from splitting of mature pods can be reduced by harvesting in high humidity (at night if necessary) and when temperatures are not too hot.

Crop-topping is a tool used by some growers to help minimise pod shattering by advancing harvest timing and evening-up crop ripening.

This needs to be carried out at the correct crop maturity stage and is not recommended for crops where grain is being retained for planting seed.

Research in NSW has found swathing/windrowing lupin can be useful, when opportunities arise, to avoid pod shatter/drop.[2]

This has a positive spin-off in helping to reduce weed seed set in some years, but can lead to crop yield loss if lupin plant maturity is behind weed seed maturity.

NSW researchers advise swathing/windrowing when the top pods (the pods that are last to mature) are past physiological maturity and in the dry-down phase.

At this stage, the lowest (most mature) pods on the primary or main spike will be close to ripe with a moisture content of about 40 percent. Average grain moisture for the whole plant will be about 65 percent and cotyledons will be turning from bright green to yellow (in narrow leafed varieties).

Trials have found it is best not to windrow albus lupin varieties too early, as immature seeds can become shrivelled when dry.[3]

Swathed/windrowed lupin generally mature in a similar time to a standing crop and will be ready to harvest within about 10-30 days (depending on environment).

It is advisable to use a pick-up front to increase harvest speed and reduce grain losses.

Newer narrow leafed lupin varieties PBA Bateman$^{\Phi}$, PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$ and PBA Gunyidi$^{\Phi}$ have been bred for improved harvest shattering resistance (equal to Coromup$^{\Phi}$ and Tanjil$^{\Phi}$).

MORE INFORMATION

GRDC 'Fact Sheet Retaining Seed': https://grdc.com.au/resources-and-publications/all-publications/factsheets

10.4 Maintaining grain quality

Lupin grain quality can be optimised at harvest by matching timing to correct crop maturity and moisture levels.

Using appropriate machinery can also help maintain quality by avoiding cracked grain and/or pod shattering (pod drop).

Grain staining, fungal and disease issues can be managed with correct disease control and fungicide use at the appropriate stage of crop development. There are receival standards in place for lupin in each state that include moisture content, seed purity, seed size and colour and foreign material. Some pests and weed seeds, such as budworm, phomopsis and wild radish, can also impact on lupin deliveries to market. See Chapter 8 for more detail.

2 New South Wales Department of Primary Industries 'Windrowing lupins': http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/lupins/windrowing-lupins

3 New South Wales Department of Primary Industries 'Windrowing lupins': http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/lupins/windrowing-lupins

FEEDBACK

Seed coat and cotyledon of lupin grain can be discoloured by crop-topping or premature desiccation in parts of paddocks if ripening is uneven.

To maintain quality of lupin grain being stored for subsequent planting, it is advised to harvest at a seed moisture level of 14 percent.

Research has found it is best to store this grain at an average temperature of about 20°C. There can be significant loss of grain quality when storage temperatures are above 30°C.

A wet harvest can lead to issues of staining and weather damage that reduce lupin grain quality for sale or subsequent planting.

Rain at harvest can also result in lupin seed that produces low seedling vigour at the next planting. It is advisable to harvest seed crops early and before any rain, if possible, to minimise the risk of seed quality issues.

Weather damaged seed grain is more susceptible to poor germination, low vigour and degradation during storage and handling.

Symptoms include loose and wrinkled seed coat, staining or fully germinated seed.

10.5 Machinery configuration

To minimise losses from pods shattering or dropping on entry to the harvester and to avoid damaging lupin grain, recommendations include:

- Reducing the peripheral speed of the harvester drum or rotor to a maximum 12 metres per second (down from 20 to 30 m/s for cereal harvest)
- Using double density knife guards
- Extending knife to auger distance
- Using draper fronts and air reels.[4]

Harvesters will have a range of drum or rotor diameters, each with different speeds.

It is recommended to check the configuration so that the correct rotational speed can be used for lupin crops.

Other general rules of thumb for lupin harvester settings include incorporating:

- Slow reel speeds
- High spiral clearance
- Thresher speeds of 400-600 rpm
- Concave clearance of 10-30 mm
- High fan speed
- Top sieve of 32 mm
- Bottom sieve of 16 mm.

Using closed (comb) fronts

Most losses from closed fronts are typically caused by the plant impacting with the spiral.

To avoid the risk of this, it is advisable to ensure the height between the point of cut on the stem and the top of the crop is less than the distance between the knife and centre point of the spiral. Extended fronts – where the gap between the knife and the auger (spiral) has been extended – are recommended.

Losses may also be reduced by increasing the finger gap to 16 mm. Remove a finger as necessary.

When re-adjusting the front for wheat or barley crop harvesting, it is best to check the knife is timed so it stops behind a finger.

4 Reithmuller (2008) Successful lupin harvesting in Western Australia – A review. Lupins. Org conference paper.

FEEDBACK

Using open fronts

Open fronts have typically replaced closed fronts in rotational cropping operations to increase harvesting flexibility for a wide range of crops.

These fronts are needed for harvesting heavy, dense lupin crops and there are typically two types: conventional auger/tin fronts; and the more recent draper/belt fronts.

To reduce lupin grain losses and optimise grain quality when using conventional auger or tin fronts, recommendations include:

- Fitting double density (quad) knife guards
- Avoiding a double density knife with double density knife guards
- Using a finger or tyne reel
- Extending the table and knife forward by up to 300 mm
- Fitting Lupin Breakers® on the table auger
- Using a large capacity auger that has 1.5 pitches per rotation
- Fitting a reduced diameter auger barrel with larger flights than the conventional auger barrel
- Raising the auger to give a bigger gap between the table and the auger flighting
- Altering the retractable finger timing when fully retracted at the 2 o'clock position (viewed from driver's left-hand end)
- Replacing standard reels with air reels (on light crops) – either a manifold or full-width fan work well, depending on power available
- Use a Vibra-Mat® that oscillates with the knife.

FEEDBACK

MORE INFORMATION

GRDC 'Reducing harvester fire risk: The Back Pocket Guide': https://grdc.com.au/resources-and-publications/all-publications/publications/2013/09/grdc-bpg-reducingharvesterfirerisk

South Australian Grain Harvesting Code of Conduct and Grassland Fire Danger Index: https://www.cfs.sa.gov.au/site/prepare_for_a_fire/prepare_your_home_and_property/farm_fire_safety.jsp

10.6 Managing harvest fire risks

Harvesters are prone to catching fire, but risks can be reduced and crop and machinery losses minimised with good hygiene, inspection and maintenance.

It is estimated that, on average, about 7 percent of harvesters will start a fire in any given year in Australia.[5]

Pulses – particularly lentil, but including lupin – have the highest susceptibility to starting harvester fires. There was an increased incidence of fire events in pulse crops in parts of the southern region during the 2016-17 harvest.

This was due to higher crop biomass levels after a wetter than average growing season – creating more fire fuel load – and an increase in pulse plantings in many low rainfall areas.

The ignition temperature, which is the temperature at which a fire will start, varies between crops and from year to year. Researchers are continuing to explore the key drivers of ignition temperature across a range of crops and seasonal conditions. This means it is not always possible to predict in advance whether a certain crop is more susceptible to ignition.[6]

Guidelines for reducing harvest fire risk include:

- Be aware of and observe all relevant regulations and policies relating to harvest operations and fire – including harvest bans
- Observe the Grassland Fire Danger Index (GFDI) protocol on high fire risk days
- Recognise the main factors that contribute to fires – relative humidity, ambient temperature, wind, crop type and conditions
- Focus on harvester service, maintenance and hygiene – especially on days more hazardous for fire
- Avoid accumulation of flammable material on the manifold, turbocharger and exhaust system of the harvester
- Be aware of side and tail winds that can disrupt the radiator fan air blast that typically keep the exhaust area clean
- Be alert to areas where chaff can build-up – such as fuel lines, battery cables, wiring looms, tyres and drive belts
- Avoid overloading electrical circuits
- Periodically check bearings around the harvester front and the machine generally
- Maintain fire extinguishers on the harvester and consider adding a water-type extinguisher for residue fires
- Consider machine-mounted fire suppression systems
- If fitted, use the battery isolation switch when the harvester is parked
- Maintain two-way or mobile phone contact with base and others and establish a plan with the harvest team to respond to fires if one occurs.[7]

5 GRDC (2013), Reducing Harvester Fire Risk: The Back Pocket Guide, www.grdc.com.au/GRDC-BPG-ReducingHarvesterFireRisk

6 GRDC (2013), Reducing Harvester Fire Risk: The Back Pocket Guide, www.grdc.com.au/GRDC-BPG-ReducingHarvesterFireRisk

7 GRDC (2013), Reducing Harvester Fire Risk: The Back Pocket Guide, www.grdc.com.au/GRDC-BPG-ReducingHarvesterFireRisk

FEEDBACK

MORE INFORMATION

GRDC 'Grain Legume Handbook – Chapter 9': https://grdc.com.au/grainlegumehandbook

Soil Quality.org.au 'Fact Sheet – Benefits of Retaining Stubble – WA': http://www.soilquality.org.au/factsheets/benefits-of-retaining-stubble

10.7 Stubble management

Figure 2: *Stubble retention, such as at this site in western NSW, maintains ground cover, reduces erosion risks and helps conserve valuable soil moisture and nutrients.*

(SOURCE: GRDC)

Historically in southern Australia, the practice of removing crop stubbles by burning was widespread for ease of sowing the following year and to break cereal disease cycles.

In recent years, there has been a shift to alternative stubble management tactics, including mulching, slashing or leaving residue partially or wholly standing.

The primary agronomic purposes of stubble retention are to reduce runoff and soil loss from wind or water erosion, conserve soil moisture and nutrients for subsequent crops, protect young seedlings and lower the risks of rain splash of Brown leaf spot spores.

Retaining or partially retaining standing lupin stubble at a level of about two tonnes per hectare typically provides about 50 percent ground cover and research indicates this can significantly reduce soil losses compared to areas where stubbles have been burned.[8]

Stubble from lupin crops will also provide slow release nitrogen (N) to the soil and has an added advantage of commonly containing about 150-250 kilograms of grain per hectare after harvest.

This makes lupin stubbles an excellent grazing source for sheep and cattle during the summer months.

8 Soil Quality.org.au 'Fact Sheets – Benefits of Retaining Stubble – WA': http://www.soilquality.org.au/factsheets/benefits-of-retaining-stubble

FEEDBACK

If putting stock into stubble, it is recommended to do so shortly after harvest as this can help to avoid stem rot and fungus spread from rain.

Levels of fallen grain in lupin crop residue can often provide enough feed for one to three months of sheep grazing, depending on: stocking rate; any development of lupinosis in livestock; risk of wind erosion; and rainfall.

Lupinosis is a disease that affects livestock that eat dead lupin stems colonised by the fungus *Diaporthe toxica* (formerly known as *Phomopsis leptostromiformis*).

The fungus produces toxins, called *phomopsins*, in warm and moist conditions and when consumed by livestock these can damage the liver and can result in the animal becoming jaundiced.

Typically, lupin stubbles can be burned in autumn if required before sowing the next crop and this is most effective if a complete burn of the paddock is achieved.

10.8 Grain storage

Figure 3: *Quality control is the key focus of on-farm storage for lupin grain to be used for seed the following year.*

(SOURCE: GRDC)

Lupin grain with high germination and vigour test results can remain viable in storage for up to three years if seed moisture levels are maintained below 13 percent.

It is advised that storage life will depend on storage temperature and incidence of stored grain pests and diseases.

It is recommended to dry lupin seed at a moisture content above 14 percent before it is stored (especially in unaerated silos).

It is not advisable to delay harvest to achieve these levels of moisture as this can sometimes result in substantial yield and quality losses.

The optimal storage temperature for lupin grain is an average of 20°C and below 25°C.

It is advisable to not store lupin seed contaminated with green pods from wild radish weeds. High temperatures can volatilise toxic compounds from the radish pod that can kill the lupin seed. This process can happen in a matter of days, so temporary storage can be damaging.

MORE INFORMATION

GRDC 'Stored Grain': www.storedgrain.com.au

GRDC 'Back Pocket Guide – Stored Grain Pests Identification': http://storedgrain.com.au/stored-grain-pests-identification-the-back-pocket-guide-2011/

FEEDBACK

Other tips for optimal storage of lupin grain include:

- Using white/light silos to reflect heat
- Using silos with capacity greater than 75 tonnes that remain cooler than smaller silos
- Monitoring stored grain pest activity
- Monitoring grain quality and temperature
- Adopting precautions for any phosphine gas fumigations (only use in sealed storage)
- Consider aeration cooling systems for stored grain insect and pest control and maintaining grain quality.

Loading and out-loading of lupin grain from storage should be done with care.

Silos are designed to withstand uniform downward and outward forces and to keep these forces uniform, silos must only be loaded from the central top hatch.

Loading from the side top hatch will unbalance the lateral forces on opposite sides of the silo, which could distort the shell of the silo and place extreme pressure on the side holding the high side of the stack.

It is advised that the same principles apply when out-loading and the silo should only be emptied from the bottom central opening.

It is best to not use the 'bagging-off' chute unless the silo is designed to withstand off-centre loads.

The physical characteristics of lupin grains means higher pressures are exerted on silo walls than with some other grains.

When transferred to the lower sections of the silo wall, these forces may cause crimping or pleating of the walls (seen in elevated and flat bottom silos). For this reason, it is advised not to store lupin grain in older type silos with thin walls.