LUPINS in South Australia & Victoria

INTRODUCTION

Lupins are Australia 's largest pulse (grain legume) crop and Australia is the world's largest exporter of lupins. The majority of production occurs in Western Australia , although lupins are widely grown in Victoria , South Australia and New South Wales . A significant feature of Narrow leafed lupins (*Lupinus angustifolius*) is that they will grow on acidic or sandy soils of low fertility where other pulses grow poorly. Very few Albus lupins (*Lupinus albus*) or yellow lupins (*Lupinus luteus*) are grown in SA and Victoria.

Lupins are one of the easier and lower cost pulse crops to grow, but they are a feed priced commodity. They tend to be grown before cereals in a rotation, sometimes after a pasture phase. On infertile sands they are grown as a cash crop preceding pasture renovation.

The lupin roots keep the stubble well anchored after harvest reducing the risk of wind erosion. While lupin stubbles have excellent grazing value, care must be taken to avoid erosion and to avoid losses of grazing stock due to lupinosis.

Narrow leafed lupin grain contains 30 to 35% protein, with a high energy and fibre content, making it a valued stock feed for sheep and cattle. Lupins are also used extensively in pig and poultry rations. Grain prices are lower than other pulses due to lower content of sulphur amino acids, which are important for feeding pigs and poultry.

GROWING REQUIREMENTS

Soil type

Narrow-leaved lupins are well adapted to districts with above 350 mm rainfall. They suit most soils provided they have low free lime (carbonate) levels and do not waterlog for extended periods. They tolerate acidic soils down to pH 4.0 (in water). Suitable soil types include sand, deep sandy loam, sand over clay, and well-structured loams. Lupins grow poorly on hard setting or shallow (<25 cm) soils.

Lupins may grow on alkaline soils (pH to 8.5) where there is no free lime (up to 4%) or calcium present in the top 20 cm. The absence of lime is more important than the actual pH. Mallee soils with free lime at the surface

will be too alkaline for lupins. Check several places and depths for the presence of free lime using drops of 10% hydrochloric acid solution. Fizzing indicates excessive free lime is present. Soil can be tested using soil testing services.

Narrow-leaved lupin types yield best and most reliably on fertile soils. They can grow satisfactory on deep and infertile sands provided enough Fertiliser is applied. Weak crops grown on unsuitable soils or with low phosphorus, potassium or sulphur are more prone to disease. The losses can be severe, particularly in the second of two successive crops grown.

They grow poorly on hard setting or shallow soils where root penetration is limited. The best yields and most reliable production occur on deep fertile soils. It is important that phosphorus Fertiliser is applied to infertile sands to achieve satisfactory growth.

Albus lupins are of value only in areas with heavy, fertile and free-draining soils. They have very low levels of phomopsis in their stubble but have not consistently out-yielded conventional narrow-leafed types in the presence of free lime in the soil. They appear resistant to cucumber mosaic virus, tolerate brown leaf spot on heavy soils but are very susceptible to anthracnose. They grow poorly on sands and are more prone to brown leaf spot on infertile soils. They are very sensitive to waterlogging.

Climate

Lupin flowers do not tolerate frost, but the extended flowering period allows lupins to compensate for lost flowers.

Temperatures above 30° C at flowering can cause substantial flower abortion. Even under normal conditions, however, only about a quarter of the flowers develop into pods. Poor pod set can occur where vegetative growth is excessive, and in seasons or areas without a vegetative check to trigger pod setting.

Paddock Selection

Choose a paddock where there is no free lime (up to 4%) or calcium present in the top 20 cm. The absence of lime is more important than the actual pH. Free lime can be detected by applying drops of 10% hydrochloric acid solution to the soil. Any fizzing shows that lime is present and is a particularly good test for small, shot sized granules of lime that are often responsible for substantial reductions in lupin growth and production.

Lupins are not susceptible to most cereal diseases. Rhizoctonia root rot is an exception; it can infect all crop species. Lupins complement rotations with cereals. Soil residues of sulfonylurea herbicides may render a paddock unsuitable for lupins for one or more seasons. Plant back periods on the labels of these herbicides should be strictly adhered to in order to avoid damage from residues.

PLACE IN ROTATION

Lupins grow and yield better after cereals than after pasture. Cereal yields are higher after lupins than after pasture. On infertile soils or after high yielding lupin crops, cereals grown after lupins will still need nitrogen Fertiliser applications.

Pasture production is also better after lupins than after cereals, particularly on infertile sands.

Growing successive lupin crops is not recommended because of the risk of disease, particularly *Pleiochaeta.* Where close cropping of lupins is intended, remove as much lupin stubble as possible to ensure less disease is carried through, treat the seed with a fungicide, leave cereal stubble to cover the ground and direct drill.

Lupins grown in rotation with cereals have the advantage of:

- providing cash income - although the price of the grain is often lower compared with other pulses, the value to the growth of subsequent crops is often greater,
- maintaining or improving available soil nitrogen - as lupins gain much of their nitrogen needs from fixation rather than from the soil,
- often dramatically increasing yields of cereals following lupins, in particular on sandy soils,
- decreasing cereal disease - they assist control of cereal root diseases, provided grassy weeds are controlled,
- allowing the use of herbicides like simazine which control Silver Grass,
- can be crop topped to prevent herbicide resistant weeds setting seed.
- being the only pulse crop suited to acidic sandy soils
- offering a cheap, less erosion prone alternative legume to peas where soils are suitable.

Be aware of herbicide residues and plant-back requirements in the rotation.

For more detailed information on 'Herbicide residues and rotation planning' click here for herbicide residual brochure or GRDC 2007 brochure after the drought (including herbicide residues)

VARIETIES

Types

There are many species of lupin, four of which have been used in broad-area production in Australia:

• Narrow leaf lupin (*L. angustifolius*) - accounts for the majority of production.

• Broad leaf or albus lupin (*L. albus*) - has large seeds but a limited production area, mainly in NSW

• Sand plain or blue lupin (*L. cosentinii*) - has bitter seed and is used for grazing in WA.

• Yellow lupin (*L. luteus*) - commercial production is even less than for albus lupins and is confined to the eastern wheatbelt in WA and a few crops in NSW.

Following the detection of the fungal disease lupin anthracnose in WA, there have been restrictions placed on the transport of lupin grain and seed into the eastern states. Anthracnose infection in SA has been confined to the southern Eyre Peninsula in narrow leafed lupins, and the Lower South-East in bitter albus lupins.

Annual inspections of lupin crops confirm that Victoria remains free of anthracnose.

Narrow leaf lupin

Varieties are available for production in most cropping zones of southern Australia with an average annual rainfall of at least 300mm. They are well adapted to lower fertility sandy soils and the stubble is well anchored to resist wind erosion after harvest. Narrow leaf lupins are tolerant of acid soils with high levels of exchangeable aluminium and manganese. They are not suitable for highly alkaline or calcareous soils, where free lime exceeds 4% or where the surface soil pH is greater than 8.5 (water). Narrow leaf lupins prefer well-drained soils that are not prone to waterlogging.

A wide range of varieties is available to growers. See the variety sowing guides for each state for full variety details. Choose varieties for their grain yield, area of adaptation, and resistance to diseases and pests.

The new variety Mandelup is rapidly gaining popularity and is expected to be rapidly adopted in both states to replace many of the current favourites. Wonga, Jindalee and the long time favourite Merrit have been the most

widely grown lupin varieties in SA, with some Quilinock and Moonah grown. Moonah has been widely grown variety in Victoria , with less Jindalee.

Varieties have varying flowering dates, maturities and ability to pod under lush vegetative conditions. They also have varying levels of resistance and susceptibility to anthracnose, an important issue in managing the risk in SA. Varieties also have varying levels of resistance to phomopsis infection on the stems, which can differ from resistant to infection on the pods and seeds at maturity. With phomopsis resistance, lupinosis is not eliminated, but the potential for stubble toxicity is reduced.

Albus lupin

Albus lupins are of value only in areas with heavy, fertile and free-draining soils. The larger seed with higher protein content may attract premiums for limited niche markets. Albus lupins generally yield less than narrow leaf lupins in low rainfall regions but can have a yield advantage under higher rainfall conditions of at least 450mm. They are sensitive to waterlogging but will tolerate soils with a slightly greater alkalinity than narrow leaf lupins.

Current commercially grown varieties are very susceptible to lupin anthracnose, although the new variety Andromeda released in WA has some resistance. They have very low levels of phomopsis in their stubble. Their susceptibility to the presence of free lime in the soil is similar to the narrow-leafed types. They appear resistant to cucumber mosaic virus and tolerate to brown leaf spot on heavy soils. They grow poorly on sands and are more prone to brown leaf spot on infertile soils. They are very sensitive to waterlogging.

Kiev Mutant has been the commonly grown albus lupin variety. Luxor and Rosetta are likely to replace it with time, seed of these new varieties being available in 2008. The seed of albus lupins should be tested for bitter contaminants.

For information on testing broadleaf albus lupins for bitterness click here

Yellow lupin

It was released as an option for acid soils.

Wodjil is the first variety of Yellow lupins (*L. luteus*) released in WA with early flowering for Australian conditions. It was released for the acidic sands of WA where aluminium toxicity was likely . It does not yield as well as narrow leafed lupins on most other soils. Yellow lupins have higher seed protein content than all other lupins, and also have higher sulphur amino acids and lysine. Wodjil is highly resistant to brown spot and Pleiochaeta root rot, and is immune to cucumber mosaic virus. It is tolerant of Mn deficiency, and highly efficient at extracting P from soil. Wodjil is tolerant of mild water logging on sands. It is very susceptible to Aphids and anthracnose.

For the SARDI lupin variety sowing guide click here

For descriptions on lupins for sowing in Victoria click DPI sowing guide 2007 update for 2006 lupin sowing guide

For the ‘Variety management package for Mandelup narrow leaf lupin' click here

For the ‘Variety management package for Luxor albus lupin' click here

For the ‘Variety management package for Rossetta albus lupin' click here

For more detailed PBR information click here

SOWING

Seed Quality

Lupin seed should have high germination, purity and be free from disease. A "clean" result from seed tests for Cucumber Mosaic Virus (CMV) and lupin anthracnose does not guarantee that the seed bulk is 100% free of those diseases but it is highly recommended when new seed is purchased. An annual CMV test will detect a build up in infection levels of seed produced on the farm. A germination of above 75% is preferable.

Harvest farm seed from fertile areas that are disease free and weed free. Seed from low fertility areas may have low seed phosphorus and potassium which reduces seedling vigour and causes poorer establishment in colder conditions. Grading removes weed and other crop seed contamination.

Inoculation

The rhizobia strain to effectively nodulate lupins and fix nitrogen does not occur naturally in Australian soils. Apply type G inoculum on the seed of the first lupin crop sown in a paddock. The inoculum may persist in for 10 years or more after a successful lupin crop. Re-inoculation may be needed for each lupin crop in some rotations.

Double recommended rates and commercial stickers are suggested when first sowing a paddock to lupins, particularly in cold conditions or with late sowing. Store inoculum in a cool, shaded place or the crisper of a fridge. Inoculated seed should also be kept cool and ideally used within 24 hours. Rhizobia die quickly between inoculation and sowing. After 3 days there will be so few rhizobia surviving (even under ideal storage conditions) that the seed must be re-inoculated before sowing. New granular and other forms of inoculum becoming available may assist in rhizobial survival, particularly when the lupins are sown dry. Do not mix inoculants and seed dressing together unless the inoculant's label specifies compatibility.

For information on assessing nodulation click here

Seed dressings

Treating seed with fungicides protect seedlings against brown leaf spot and the more devastating form of the disease, known as Pleiochaeta root rot. Iprodione (for example Rovral ® liquid seed dressing fungicide) and procymidone (for example Sumitomo Sumisclex ® broadacre fungicide) seed dressings reduce the incidence of seed-borne infection. Both are effective on brown leaf spot, but cannot fully control pleiochaeta root rot, especially under severe conditions. Seed dressing is desirable in close lupin rotations. If seed is to be inoculated, apply the inoculum to fungicide treated seed just before sowing.

Seed treatment with thiram fungicide will reduce spread of anthracnose by seed. This fungicide gives poor control of brown leaf spot and should be used in conjunction with the above products.

For information on ‘Pulse seed treatment and foliar fungicides' click here

Paddock preparation

Ensure early paddock preparation to enable timely sowing. Lupins can suit a wide range of sowing conditions. And can be successfully direct drilled so long as correct seed depth is maintained. Maintaining trash on the soil surface is beneficial in reducing raindrop splash transmission of fungal spores from the soil to lupin seedlings.

Cultivated seed beds may result in better seed-soil contact, can be less demanding on seeders, and enable pre-emergent herbicides to be incorporated. However erosion risks are higher if trash is not present

Control measures for large populations of problem weeds should start well before sowing. The practical way to suppress Skeleton Weed is to apply an appropriate herbicide in the previous cereal crop.

Sowing

Sowing time, variety choice, stubble cover and row spacing can help influence the risk of frost damage.

Click here for ways to minimise frost damage in pulses

Although early lupin sowing is desirable, it should not be at the expense of good management to ensure effective establishment, weed control and nodulation. Lupin crops should ideally be sown into a moist seedbed to ensure good even establishment and nodulation. On non-wetting sands, sowing during or just before rain will give the best nodulation and establishment.

Non-wetting sands

The claying of non-wetting (oily) sands has dramatically improved the potential for lupin production on these soils, provided the clay applied is not too sodic or calcareous.

On non-wetting sands, dry ploughing at normal depth is not recommended. Deep ploughing (200 to 300 mm) reduces the non-wetting problem but is expensive and can cause drifting.

Disturbing the non-wetting sand by ploughing, cultivation or harrowing during rain reduces the non-wetting character and achieves uniform wetting. Harrowing or cultivating during and after rain mixes the soil and is effective in improving its wetting ability.

To direct drill lupins into non-wetting sands, adjust the sowing rows (15 to 45 cm) to sow shallow in the bottom of deeply cut furrows. Compact the soil in the furrow, using either press wheels, step-pack rollers or heavy chains dragging behind each tyne. This allows the ridges to remain dry and channels the moisture into the furrow near the seed. Sow across contours to prevent run off. Often a split application of herbicide is used. If the herbicide is applied post-sowing, it can be washed into the furrows causing crop damage in the furrows and poor weed control on the ridges. Applying the simazine pre-seeding is preferable, but poor weed control in the furrows can then sometimes occur.

Heavy soils or clayed sands

Crusting of hard setting clays and red brown earth soils can cause lupin establishment problems. Avoid deep sowing and surface compaction after sowing. Stubble retention will assist in establishment by preventing compaction by rain before emergence.

Deep ripping can benefit lupins in soils with hard pans and subsoil structure problems.

Bracken areas

In bracken fern areas, herbicides such as glyphosate or Brushoff® should have been applied in the previous spring to kill the bracken. Cultivation on bracken areas should start in January or February by blade ploughing or disc ploughing.

This early preparation allows the bracken trash to become brittle for easier breakdown with later workings and will help conserve moisture for early sowing. The sand will be very dry and fluffy however, and will need rolling after rains.

Herbicides, early ploughing combined with early lupin sowing reduces the subsequent bracken density.

Reduced or no tillage

Lupins can be successfully direct-drilled where the soil is sufficiently friable to give good seed to soil contact.

Controls need be in place for weeds and red-legged earth-mite control.

The increased risk of rhizoctonia with direct drilling can be reduced by a three-week weed free period before sowing, and by using cultivating tynes at seeding that cultivate deeper than the sowing depth. At least one working or soil disturbance before seeding could be desirable on sandy soils where rhizoctonia is a frequent problem.

Carefully check soil moisture is adequate for direct drilling or reduced tillage, especially on non-wetting soils.

Dry sowing

Dry sowing lupins can be successful on paddocks that have grown a well nodulated lupin crop within the last four years, provided it is not a non-wetting sand. Some herbicides may need to be applied before seeding, others after the germinating rains. Nodulation could be severely reduced if lupins are dry sown into a paddock that has not grown lupins before. Granular inoculums now available may enable lupins to be dry sown in paddocks that require rhizobia inoculation.

For further information on 'Dry sowing of pulses' click here.

Sowing depth

Avoid sowing lupins too deep. The actual depth will vary, needing to be shallower on the harder setting heavier soils. Sow at from 10 to 30 mm, and never deeper than 50 mm. Broadcast sowing on sands can be an effective, quick low-cost method of crop establishment, provided Pleiochaeta root rot is not a potential problem. The soil must be loose and moist to broadcast seed, and on heavier soils prickle chaining, harrowing or rolling may be necessary to cover the seed.

Sowing slightly deeper than normal may reduce infection by brown leaf spot spores near the soil surface but do not sow deeper than 5 cm in an attempt to reach moisture. Deep sowing should also be avoided on heavy,

crusting soils. Retaining stubbles reduces soil compaction by rain. Late sowing into cold, wet soils and poor vigour seed can reduce crop establishment and may lead to crop failure.

To minimise the risk of rhizoctonia, use tynes that cultivate deeper than the sowing depth, ideally placing phosphorus Fertiliser at this greater depth as well. Perhaps work the soil once prior to sowing on sandy soils where rhizoctonia is more likely.

Seeding rates/ plant densities

Densities of 45 plants/m ^{2} or greater are suggested for narrow leaf varieties. This equates to a sowing rate of 75 to 100 kg a hectare of 75% germinable seed. Use higher densities if sowing is delayed or if the crop is weakened by low fertility or weed competition. On heavier soils in low rainfall areas and in long-season areas plant densities should not exceed 45 plants/m ^{2} . Suggested plant densities remain the same for row spacings from 150-350 mm.

The seeding rate required to achieve these plant densities is calculated by knowing seed size, germination percentage and mortality after germination. A seeding rate of at least 100 kg/ha of seed with at least 75% germination is a guide for narrow leaf lupin.

Albus lupin does not require quite as high a plant density. However, albus varieties have larger seeds, and a sowing rate of 160 kg/ha is suggested.

Use the formula:
Seeding rate (kg/ha) = Plant density (plants/m ^{2}) x 100 seed wt (g) x 10 ÷ Germination percentage

Sowing time

Lupins must be sown early to take advantage of warmer May temperatures for quicker seedling establishment, growth and nodulation. Sowing too early can result in excessive growth, lodging, and poor pod set, particularly on fertile soils. Late-sown lupins are shorter and yield considerably less. Frosts affect flowering and pod set but the extended flowering period enables later flowers to compensate.

Sowing after mid June is only worthwhile in particular areas with an extended growing season, *eg* on shallow sands over clay in coastal areas of the Upper and Mid South-East of SA.

Early sowing increases the risk of cucumber mosaic virus where infected seed is sown, especially with an early break to the season.

If the seasonal break is late, sow the lupins dry if the paddock has had lupins before, otherwise sow just ahead of the break or as soon after the break as possible.

For information on sowing dates in Victoria, click DPI sowing guide 2007 update or for 2006 click lupin sowing guide

Rolling

Rolling is usually carried out post sowing and best before crop emergence. Press wheels serve the same purpose of ensuring good seed to soil contact, to prevent the soil surface from drying, but do not level the soil for easier harvest. Prickle chaining can achieve all of these. Rolling is usually done with a steel or rubber tyred roller, when soil is moist but not too wet or dry. Its purpose is to flatten any ridges caused by sowing and press any rocks into the soil leaving a flat bed to allow the header comb to pick up the short crop at harvest. This reduces harvest losses, harvester wear and contamination in the seed sample.

NUTRITION

Phosphorus

Lupins have vigorous tap roots to access nutrients, however root development may be impeded by sub-soil constraints. They are highly responsive to Phosphorus (P). Rates of 15 kg/ha (160 kg/ha of superphosphate or the equivalent in high analysis Fertiliser) are justified in most environments. Higher analysis phosphate Fertilisers generally contain little sulphur so should be avoided on soils where sulphur levels are critically low, or supplementary sulphur applied, eg. with gypsum. A 1 t/ha lupin crop needs 4.5 kg/ha P. although the rate of P applied as Fertiliser will need to be greater than this on soils where P is less available to the crop eg. high pH Mallee soils.

Sowing high rates of P with lupins can reduce nodulation and crop establishment on acid soils when sowing with narrow points. Deep banding of the Fertiliser will avoid this. It is not recommended for deep acid sands where P can leach below the root zone.

Nitrogen

Applying 5 kg/ha of "starter" nitrogen (N) at sowing can assist lupin establishment. At these rates nodulation is not inhibited.

Potassium

Clay soils have adequate amounts of potassium (K) for plant growth. However, sandy soils can be deficient in K. Fertiliser K is only required when there is lower than 50-70 ppm of K in the soil.

Sulphur

Deficiency can occur in wet seasons on deep sands, or where Fertilisers low in sulphur (S) have been used for years. Sulphur is usually adequate on soils where gypsum has been applied in recent years.

Zinc

Zinc (Zn) is deficient in most Mallee and Wimmera soils and zinc is applied every few years as a matter of course. As pulses are more responsive to zinc than cereals the addition of 2 kg/ha Zn in Fertiliser in the lupin year makes a sensible routine. Use a Zn coated granular Fertiliser to achieve uniform distribution in the soil.

Manganese

Severe deficiencies are usually restricted to some areas of SA, even after a seeding application of Manganese (Mn). Split seeds are a symptom of a mild deficiency. Severe deficiency results in shrivelled seeds, delayed maturity and crop failure. A tissue test value of less than 20 mg/kg in the top 10 cm of stem taken just before the first flower bud opens indicates 1.0 kg/ha of Mn should be applied as a foliar spray when the primary (first) flowering stems have small pods.

Crop with Confidence, Rural Solutions SA http://www.ruralsolutions.sa.gov.au

WEED MANAGEMENT

The need to sow lupins early, their slow early growth coupled with the use of no till or reduced tillage techniques increases the dependence on herbicides for weed control.

Weeds can be controlled by:

- Spray-topping in pasture years to lessen weed seed set.
- Effective weed control in preceding cereal crops.
- Cultivation and knockdown herbicides.
- Early sowing of the lupins for better weed competition.

Weeds should be controlled pre-seeding, using crop rotations including cereals to minimise weed build up, spray-topping in pasture years to lessen weed seed set, planting vigorous high density early crops for better weed competition and using cultivation and knockdown herbicides.

Pre-emergent weed control options include trifluralin, simazine and diflufenican. Post -emergent herbicide options for broadleaf weeds include metosulam, diflufenican, picolinefen and simazine.

Simazine is widely used, pre-sowing, often mixed with trifluralin, or applied post-sowing pre-emergence. It is a broad-spectrum residual herbicide that controls a wide range of broadleaf weeds and grasses for a four to eight week period.

A range of post-emergent grass herbicides is available to control most grasses, including Silver Grass and sand fescue.

Overuse of particular groups of herbicides can lead to herbicide resistance, especially in grass weeds. To avoid herbicide resistance, weed management through the rotation should minimise the need for herbicides. Avoid overuse of any one chemical group, use the least selective herbicide, and avoid the need to spray high weed populations. Effective grass control in the lupin crop has the benefit of reducing the need for selective grass herbicides in the following cereal year.

For South Australia, Refer to latest *Pulse weed spraying chart*. Rural Solutions SA Roseworthy Information Centre are: Freecall: 1800 356 446 www.ruralsolutions.sa.gov.au.

DISEASE

Management prior to sowing is important for minimising losses from disease.

Key strategies are:

- Make every effort to use seed which is free from lupin anthracnose and CMV.
- Avoid sowing deeper than 5 cm.
- Allow at least three years between lupin crops, preferably four years.
- Retain stubble or other ground cover to prevent rain splash.

• Be wary of sowing this season's lupin crop adjacent to last season's lupin paddock

Viruses

For information on how to minimize viruses in pulses and control of their transmission by aphids and other vectors, click here.

For more information on specific viruses in pulses and lupins: Cucumber Mosaic Virus (CMV) in lupins, click here or for CMV in pulses, click here. To see about Alfalfa Mosaic Virus (AMV), click here . For Bean Yellow Mosaic Virus (BYMV), click here. For Bean Leaf Roll Virus (BLRV), click here for more information.

Lupin disease guide summary

Disease	Organism	Symptoms	Occurrence	Inoculum source	Control
FUNGAL DISEASES					
Brown leaf spot WA information	*Pleiochaeta setosa*	Dark spots on leaves and pods, leaves drop off, lesions may girdle stem.	Very common but losses usually minor in dry areas, yield loss can be significant in cool damp areas.	Spores survive in soil and lupin trash. Infection through rain splash of spores.	Fungicide seed dressings, crop rotation, variety selection, early sowing.
Pleiochaeta root rot WA information	*Pleiochaeta setosa*	Browning and rotting of tap and lateral roots, seedling plant death.	Serious reduction in lupin plant density and vigour.	Spores in soil infect roots usually at seedling stage and later spread by rain splash onto foliage.	Rotation minimum 4 years between lupins, fungicide seed dressings.
Phytopthora root rot	*Phytophthora spp.*	Rapid wilting and death of healthy looking plants during flowering and pod fill. Dry root rot, brown woody tap root	Appears after waterlogging during winter, especially were hardpans are present. Disease appears as temperatures rise in spring	Unknown at this stage	Avoid sowing lupins into paddocks with hardpan layers, duplex or poorly drained soils.
Rhizoctonia root rot	*Rhizoctonia spp.*	Bare circular patches in crop, spear tipped root ends, hypocotyl rot and stain.	Can be severe in isolated patches, reduces stand density, favoured by minimum tillage, wet soils and mild conditions.	Soil borne infection on wide host range, survives as fungal fragments in soil and plant debris.	Tillage prior and during sowing, rotation has no effect, increased seeding rate.

Disease	Organism	Symptoms	Occurrence	Inoculum source	Control
Phomopsis stem blight	*Diaporthe toxica*	Generally few symptoms on live plants. Black fungal fruiting bodies are embedded in infected lupin trash after harvest. Infected seed is discoloured. Toxins produced in infected lupin trash can poison stock (lupinosis)	Plants can become infected any time during growth. Cool, moist conditions favour infection.	Infected seed can spread the disease and carryover the disease between seasons. The fungus also survives on infected trash. Spores are spread by rain splash.	Resistant varieties are available. Be wary of stock grazing lupin stubbles over summer and especially following rains over summer.
Anthracnose more information	*Colletotrichum gloeosporioides*	Stems crook over, pods and leaves above crook twist and deform, dark lesions with pale centres on leaves, stems and pods.	Severe infections can result in complete crop failure.	Fungus survives on infected seed and lupin trash. Disease is spread within the crop by rainsplash of spores, also movement of machinery and animals.	Clean seed and machinery, 4 year break between lupins, resistant varieties, fungicide seed dressings.
VIRUS DISEASES					
CMV click here WA information CMV) and aphids	Cucumber mosaic virus	All growth after infection is dwarfed, leaflets are yellowed and bunched. Plants stunted. Persistent green plants at harvest.	Early wide spread infection severely reduces yield, minor infections prevent use of harvested grain as seed.	Seed borne infection in narrow leaf lupin, Aphids transmit the disease within a crop. Survives in many legume and weed species	Sow clean seed, use a seed test, high sowing rates and cereal barriers around crops reduce aphid transmission.
BYMV click here	Bean yellow mosaic virus	Brown streaks on stem, shepherd crook, pods blackened and flat, plants wilt and die.	Can be severe in higher rainfall areas, usually transmitted from pasture.	Seed borne in albus, aphid spread in crop,. Survives in many legume and weed species	High plant density, cereal barrier, control weed and volunteer lupins.

To access anthracnose information for South Australian growers and marketers, click here. For anthracnose Management for Victorian Grown Lupins: Five management strategies for reducing risk in Victorian crops, click here for PDF file.

For information on ‘Pulse seed treatment and foliar fungicides' click here.

For South Australia, refer to latest *Field crops disease spraying chart*. Available for purchase from Rural Solutions SA Roseworthy Information Centre are: Freecall: 1800 356 446 www.ruralsolutions.sa.gov.au .

For the latest information on permits and registrations in pulses visit the Pulse Australia site at http://www.pulseaus.com.au or

http://services.apvma.gov.au/PubcrisWebClient (registrations)

http://www.apvma.gov.au/permits/permits.shtml (permits)

PESTS

Establishment pests: **Redlegged Earth Mite (*Halotydeus destructor*) and Blue Oat Mite (*Penthaleus major*).**

Problems are likely to be worse in crops following pasture. Severe infestations can kill seedlings. Watch crops closely at emergence. Redlegged Earth Mite and Blue Oat Mite feed on the sap of leaves which mottle, then turn white or silvery.

Use of a registered, bare earth insecticide post sowing, will protect germinating seedlings when most vulnerable. Seed treatments work best when mites are active during germination yet numbers are not too high.

Monitor young crops weekly. Inspect plants in 0.5 m of crop row at 10 different sites within the crop. Weather conditions affect mite activity. If weather is fine, estimate the numbers per leaf, if cold and cloudy estimate the numbers per 100 cm ^{2} (10 cm x 10 cm) around the base of the plants. Repeat this at 10 sites within the crop. Mite damage is typically greater around the edge of paddocks, where there is higher pressure from mites invading from outside the paddock. An average of 50 mites per area warrants spraying.

Lucerne Flea (*Penthaleus major*)

Lucerne Flea remove the upper surface of the leaf leaving transparent windows. Leaves may wilt and shrivel. Protect crops by treating seed with insecticide the day before sowing or by spraying infected crops. Border spraying can protect new crop from mites migrating from surrounding pastures.

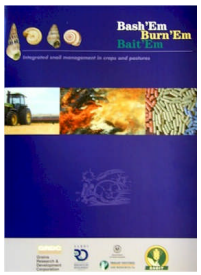
Native Budworm (*Helicoverpa punctigera*)

The caterpillars burrow into pods, reduce yield and downgrade seed. Moths lay eggs from August to November on flower buds, flowers, young pods and leaves. Hatching occurs in 3-5 days in warmer conditions and 6-16 days in cooler weather. Check for caterpillars using a sweep-net twice a week during flowering and podding. Spray when more than 10 caterpillars per 10 sweeps (10/m ^{2} by plant sampling) are caught. For more information click here.

For information on lesser budworm (*Heliothis punctifera)*, click here

Snails

"*Bash 'Em, Burn 'Em, Bait 'Em: Integrated snail management in crops and pastures*". This colour manual produced by SARDI contains information about snail lifecycle and habits as well as practical guidelines on preventing grain contamination, harvester modifications and cleaning options. It includes a section on the fly biocontrol agent being released in S.A.



Available from the Roseworthy information centre on 1800 356 446 and costs $20 (GST inclusive) plus $5 postage and handling.
See also more information

For South ausytalia, refer to latest *Insect spraying chart field crops and pastures* Available for purchase from Rural Solutions SA Roseworthy Information Centre are: Freecall: 1800 356 446 www.ruralsolutions.sa.gov.au

For WA information about aphids on lupins, click here.

HARVESTING

Timing

Harvest as soon as the crop is mature and moisture is 14%. Lupins can be harvested with conventional headers, but care and timing are important. Most harvesting losses are caused by shattering, pod loss or whole plants passing under the comb. Open front machines handle heavy crops, but allow some pod loss in light crops. Closed front machines can have feeding problems in heavy crops, even when the fingers are spaced.

Harvest can begin as soon as the last seeds have turned yellow inside the seed coat (cotyledon). At this stage the pods are brown but the stems may still be green. Set a low thresher speed (500 to 600 rpm) and an open concave (15 to 18 mm).

Grain to be kept for seed should be harvested first to ensure good germination. Germination rates are better if the seed has a moisture level above 11.5% at harvest. Do not store seed harvested at above 13.5% moisture in a steel silo. The Marconi moisture meter, set on the wheat scale, gives a reading about one percentage point higher than the actual lupin moisture content for readings of 9 to 13%.

If harvest is delayed, the plants dry quickly and only harvesting in cool conditions when the plants are less brittle can reduce physical losses.

Windrowing

Windrowing will reduce shattering losses when it is known that harvest will be considerably delayed. Losses will still be greater than when harvesting straight after maturity. Windrowing is effective in short or weedy crops. Commence windrowing when the cotyledon colour of the seeds in the primary pods is turning from green to yellow.

Grain losses at harvest from either the header front or over the back of the header can be calculated by averaging a number of seed counts from with one square metre using the following formula:

Seed loss (kg/ha) = No. seeds per sq. m X seed wt (g per 100 seeds) ÷ 10

'Windrowing and desication of pulses' GRDC Hi-Grain update 2003, click here..

Grain storage

Rats and mice can be a problem in grain stored on the farm in bags or hessian silos. Weevils are not usually a problem during short-term storage, but can damage grain that is cracked, has split seeds or has been damaged by seed borers.

MARKETING

Prices for lupins have been relatively high in recent years, based on the domestic demand over the last few years. The majority of the eastern states lupin crop is sold into the local domestic market, principally for feeding ruminants. There has often tended to be a price advantage from storing lupins on farm or in a wharehouse facility to market them after harvest.

Lupin grain entering Victoria from South Australia must have either:

- PIRSA documentation proving it is free of anthracnose, or
- be marketed to specific DPI approved end-users, and be transported by accredited agencies under strict protocols and specific transport routes.

For an update on the conditions of lupin movement between SA and Victoria, click here

For an up to date list of Lupin traders and their contact details visit the Pulse Australia website http://www.pulseaus.com.au/crops/lupins

Receival standards

Narrow leafed, farmer dressed Lupin receival standard

	Maximum moisture content (%)	Minimum purity (%)	Maximum defective plus poor colour (%)	Screen size for defective (mm)	Poor colour maximum (%)	Foreign material maximum in total (%)
Narrow leafed lupin receival standard	14	97	7	-	See footnote	3
Albus lupin receival standard	14	97	5	6.75 round	1, plus see footnote	3
	Unmillable material maximum	**Snail maximum**	**Insect maximum**	**Nominated weed seed maximums (maximums for each type)**		
Narrow leafed lupin receival standard	0.5 (0.3% soil)	1 per 200g	15 per 200g	See footnote for weeds and amounts allowable 2% max wild radish		
Albus lupin receival standard	0.5 (0.3% soil)	2 per 400g	30 per 400g	See footnote for weeds and amounts allowable 2% max wild radish		

Definitions:

Defective grain: includes cotyledons that are broken, grain that is heat damaged, hail damaged, insect damaged, shrivelled, split, chipped, sprouted, affected by mould (field or storage). Includes pods that contain lupins, whether broken or unbroken and loose seed coat. No screen size applies now. Phomopsis infected grain maximum 17 per 200g and bitter types 2 per 200g maximum.

Foreign material: includes unmillable material and all foreign vegetable matter (includes cereals, Wild Oats, oilseeds, other legumes and weed seeds not otherwise specified). Wild Radish maximum is 2%.

Unmillable material: includes soil, stones, metal and non-vegetable matter.

Nominated foreign weed examples:

Type 1 (4 per 200g): three *-cornered* jack

Type *2:* (nil per 200g): wild garlic, coriander and any other tainting agents.

Type 3a (1 per 200g in total): Bathurst burr, caltrop.

Type 3b (2 per 200g total): vetches (tares).

Type 3c (4 per 200g total): heliotrope.

Type 4a (10 per 200g total): cut leaf mignonette, melilotus (if no taint *)* nightshades, skeleton weed, variegated thistle,.

Type 5 (20 per 200g in total): knapweed, salvation jane

Type 6 (5 seeds/5 pods total per 200g) medic pods, marshmallow pods, saffron thistle, wild radish pods

Type 7a (10 seeds per 200g total): other pulses.

Type 7b (10 seeds per 200g total): cereals, turnip weed, bindweed.

Type 7c (1 seed in total per 200g): safflower, sunflower.

Type 8 (100 seeds per 200g): bellvine.

Small foreign seeds (0.6% by weight): amsinkia, canola, charlock, marshmallow seeds, hedge mustard, etc.

See pulse receival and export standards at www.pulseaus.com.au/standards/

Grazing stubbles

Graze stubbles as soon as possible after harvest. The risk of lupinosis after harvest is in proportion to the amount of phomopsis infection on the stem. Resistant varieties become increasingly likely to cause lupinosis towards autumn. Lupinosis risk increases following autumn rains or if only stubble remains because all the grain has been consumed. Lupinosis risk is also higher in successive lupin crops in the rotation, especially if the lupin crops are consecutive or if lupins are close in the rotation with minimal break between.

FURTHER INFORMATION

Grain Legume Handbook and its 2006 updates. (The Grain Legume Handbook Committee)

The dedicated lupin web site, http://www.lupins.org for information extensive national and international information on all aspects of lupins.

Topcrop lupin paddock recording card click here

Checklist for a successful Lupin crop click here

To identify early growth stages in lupins, click here

Guide to the key pests of Pulses click here.

Pulse & Canola - Frost Identification: The back pocket guide (Bulletin 4401) (TOPCROP Australia, Grains Research and Development Corporation) Free from some local DPI offices and Ground Cover Direct Free phone 1800110044 fax 1800009988.

Wurst M. et al (2002) *Winter Pulse Disorders: The ute guide* (Primary Industries and Resources SA) For sale through some local DPI offices and Ground Cover Direct Free phone 1800110044 fax 1800009988.

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