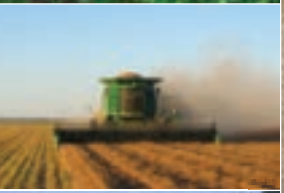


LENTILS

the Ute Guide

PBA
PULSE BREEDING AUSTRALIA

GRDC
Grains
Research &
Development
Corporation

Developed by Rural Solutions SA for the Grains Research and Development Corporation.

Published by Primary Industries and Resources South Australia.

Designed by PIRSA Publishing

ISBN 978-1-921399-23-7

PBA PULSE BREEDING AUSTRALIA

GRDC Grains Research & Development Corporation

Government of South Australia

SARDI RESEARCH AND DEVELOPMENT

PULSE AUSTRALIA

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Department of Agriculture and Food

State Government Victoria Department of Primary Industries

Supported by Rural Solutions SA

Cover Images:
W Hawthorne, Pulse Australia;
R Ruwoldt;
T Yeatman, Rural Solutions SA

PP_080291

Authors

Tom Yeatman, Rural Solutions SA

Wayne Hawthorne, Pulse Australia

Larn McMurray, South Australian Research and Development Institute

Michael Materne, Victorian Department of Primary Industries

Kurt Lindbeck, New South Wales Department of Primary industries

Jason Brand, Victorian Department of Primary Industries

Jenny Davidson, South Australian Research and Development Institute

Ian Pritchard, Department of Agriculture and Food Western Australia

Mark Seymour, Department of Agriculture and Food Western Australia

Ken Henry, South Australian Research and Development Institute

Judy Bellati, South Australian Research and Development Institute

Acknowledgements

The authors thank individuals and organisations who have contributed to the production of this publication.

This publication was initiated and funded by the Grains Research and Development Corporation (GRDC)

Text and images for this ute guide have been adapted from the following publications and the contributions of those involved in those publications is gratefully acknowledged.

Winter Pulse Disorders: The Ute Guide (GRDC)

Crop Insects The Ute Guide, Southern Grain Belt Edition (GRDC)

Field Crop Herbicide Injury The Ute Guide (GRDC)

Grain Quality Winter Grain Crops The Ute Guide (GRDC)

Grain Legume Handbook 2008 edition

Lentil Variety Sowing Guide 2009 (SARDI)

Lentils in SA and Victoria Fact Sheet (Pulse Australia)

AUTHORS and ACKNOWLEDGEMENTS

CONTENTS

CONTENTS

ABBREVIATIONS

CESAR Centre for Environmental Stress and Adaptation Research

DAFWA Department of Agriculture and Fisheries Western Australia

GRDC Grains Research and Development Corporation

PaDIL Pest and Disease Image Library, Museum Victoria

SARDI South Australian Research and Development Institute

QDPI&F Department of Primary Industries and Fisheries, Queensland

VDPI Victorian Department of Primary Industries

This guide is designed to assist in the recognition of symptoms including those of disease, insect attack and poor nutrition in lentil crops, as well as identifying critical issues of best practice in growing and marketing the crop.

Abnormal symptoms that are identified in the crop can indicate a physical, nutritional, chemical or disease caused disorder, which can be initially identified using the Symptom Sorter on *Pages 24 and 25* of this guide. The appropriate section of the guide to seek further clarification and direction as to best practice to manage or avoid the disorder in the future is indicated.

It should be noted that varieties and products mentioned in this guide are those available and registered at November 2008 and may change over time.

Images: W Hawthorne, Pulse Australia

A healthy and productive crop without a physical, nutritional, chemical or disease disorder.

LENTIL TYPES and SELECTION

Major lentil types *(Lens culinaris)* are based on the size and kernel (cotyledon) colour of seeds.

Red lentils (also known small or Persian lentils) are more widely grown and are usually split for cooking (Masur dhal) or increasingly retained whole as 'footballs' depending on grain size and market. Larger lentils are usually split. Cotyledons are red, hence the name, and seed coat varies from light grey, through brown, to black, and may be speckled. Seed size is 2–6 mm diameter.

Green lentils (also large or Chilean lentils), are used whole for cooking. Seed coat is green to brown and cotyledons are yellow. Seed size is 4.5–8 mm diameter.

Images: T Yeatman, Rural Solutions SA

Paddock selection

Lentils are best suited to areas receiving between 350 and 600 mm of annual rainfall. In drier or colder areas, they may grow too short to be harvested efficiently. Spring sowing is an option in some higher rainfall areas.

Lentils are suited to well drained, level, sandy loam to clay loam soils of good fertility. They prefer deeper soils with higher water holding capacity. Lentils perform poorly on sandy acidic soils. They are very susceptible to waterlogging, salinity, low pH and soils high in boron. Consider applying lime where soils are below a pH of 6.0 in water.

Lentil plants are poor weed competitors with limited in-crop herbicide options. Reduce the weed seed soil bank in preceding years, particularly of problem weeds. Do not sow into former vetch paddocks to avoid seed contamination at harvest. Other pulses are easily cleaned from lentil seed. Avoid cereal grain contamination by removing self-sown cereals in crop with a grass herbicide.

Lentils not of the specified variety are restricted to 1% at delivery. This is of particular concern when growing varieties with different seed coat colours. Be aware of the potential for contamination from hard seed and volunteer lentils in paddocks when changing to new varieties with different seed coat colours ie Northfield to Nipper(1).

Check list for lentil paddock selection:

Rainfall needs to be greater than 350 mm/year, and with good sub-soil moisture retention

- If rainfall is greater than 550 mm, then assess if Spring sowing possible
- Soil should be of a texture and deep enough to hold sufficient water to finish the crop
- Ensure that soil type is friable and does not set excessively hard on surface
- Avoid low pH and soils high in boron
- Soils must be free draining with no waterlogging

- Soil surface needs to be flat and free of undulations, so rolling may be needed for harvest to be free of sticks, clods and stones
- Paddocks must be relatively free of problem weeds like herbicide resistant ryegrass, medics, bifora, bedstraw, wild radish, vetch, tares or self-sown pulses like peas, chickpeas or beans
- Maximum plant-back periods after herbicides must have been satisfied, e.g. sulphonylureas, Lontrel®, triazines and imidazolinones
- Stubble clumps from sowing must be minimised or flattened to enable efficient harvest and safe application of post sowing pre emergent herbicides.

Place in rotation

Weed free lentil crops provide a cereal disease break and are generally sown after a cereal crop. A crop sequence should consider disease, weed control, herbicide residues and tillage practices which might affect ease of harvest. Nodulated lentils fix nitrogen, providing additional available nitrogen for the next crop, but generally do not contribute as much soil nitrogen to the next crop as faba bean, field pea or lupin.

Lentils are particularly sensitive to clopyralid, sulfonylurea and several imidazolinone herbicide residues in the soil. Not all labels include lentils in plant back details, so extra caution and advice from the manufacturer is recommended after using these and some knockdown herbicides.

Good seedling establishment, a flat soil surface, no stubble clumps, or herbicide residues.

Image: R Ruwoldt

Lentils bring the following benefits to cereal rotations:

- An alternative pulse, increasing the yields of following cereal crops and allowing an extended phase of cropping.
- Decrease many cereal diseases–grass free lentil crops help control root diseases CCN and Take-all.
- Control weeds–grass selective herbicides can be used on lentils to control self-sown cereals and competitive grass weeds difficult to control in cereal crops, e.g. Brome grass and Barley grass.
- Can be crop topped to prevent herbicide resistant weeds from setting seed.
- Available soil nitrogen is maintained or improved.
- Spread management due to their divergent growth and development allow sowing, spraying and harvest windows to be widened.
- Well adapted to no till, standing stubble systems aimed at improving soil sustainability.

Depressed cereal growth following cereal the previous year.

Good cereal growth following a pulse the previous year.

Images: W Hawthorne, Pulse Australia

Variety

Consider markets, yield, disease reaction, abiotic stress tolerance and maturity, along with lodging and shattering resistance.

Be aware of the necessity to segregate and market on a variety basis. Price premiums (e.g. for *Northfield, Aldinga*) and discounts (e.g. *Aldinga*) have sometimes applied to specific varieties based on supply and demand.

The most widely grown red lentil variety is *Nugget*, but *Digger, Aldinga* and *Northfield* are also grown for market or adaptation reasons. *Nipper*(Φ), a new red lentil variety with ascochyta blight and botrytis grey mould resistance has now become available.

Matilda, a green lentil, was not widely grown, and is now superseded by the new variety *Boomer*(Φ) with improved adaptation, seed size and disease resistance. *Tiara*, a long season green lentil with very large seed size will become available for Spring sowings in high rainfall areas.

Variety	Type	Maturity	Seed coat colour	Seed size g/1000	Height	Lodging resistance	Shattering	Ascochyta blight		Botrytis grey mould	Boron	Salt
								Foliage	Seed			
CIPAL411	red	e-mid	green	40-50	med	MR	MR	MR	MR	S	MI	MI
CIPAL415	red	mid	grey	30-40	med	MS	MR	MR	MR	MS	I	MI
Nipper(Φ)	red	mid	grey	30-40	med/ short	MR	MR	R	R	R	I	MT
Nugget	red	mid-late	grey	35-45	med	MS-MR	MS	MR-R	MS-MR	MR	I	I
Northfield	red	mid	tan	30-40	med/ short	MS	MS	R	R	S	I	I
Aldinga	red	mid	green	45-60	med	S	MR	MR	MS	MS	I	I
Digger	red	mid-late	grey	35-45	med	MS	MS	MR	MS	MR	I	I
Boomer(Φ)	green	late	green	55-80	tall	MS	S	MR-R	MS	MR	I	I
Tiara	green	v late	green	65-85	tall	MS	MS	S	S	–	–	–
Matilda	green	mid	green	50-60	med	MR	MS	MR	S	MS	I	I

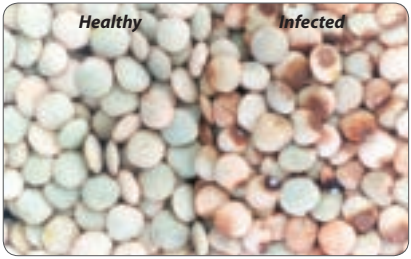
R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible
T = tolerant; MT = moderately tolerant; MI = moderately intolerant; I = intolerant

Seed quality

Sow high quality seed. Grading helps ensure seed is free from weed and crop seed contamination. Check germination percentage and purity. Do not keep seed from severely diseased crops. Have seed tested for its disease status. Avoid using seed with greater than 2 % infection of ascochyta blight (*Ascochyta lentis*) and botrytis grey mould (*Botrytis* spp.). Use seed which has been tested for seed-borne viruses, including Cucumber mosaic virus (CMV) and Alfalfa mosaic virus (AMV).

A sample of good quality seed.

Ensure seed sown is free of weeds hard to control in lentils such as vetch.



Ascochyta blight – healthy and infected seed comparison.

Images: T Yeatman, Rural Solutions SA; W Hawthorne, Pulse Australia

CROP ESTABLISHMENT

Lentils are well suited to no-till, reduced tillage and stubble retention systems. Sow at the correct depth (5–10 cm) to ensure seed-to-soil contact for good emergence and improved safety to post-sow pre-emergent herbicides. Lentils sown between rows of standing cereal stubble often remain erect at harvest. Lentils can be successfully dry sown, providing problem weeds such as medic are not going to be an issue and a level seed surface can be safely achieved before herbicide application.

Sow lentil seed into a friable soil ensuring good seed-to-soil contact. Retention of adequate plant residue on the surface is important to protect the soil from erosion both during growth and after harvest and reduces soil water evaporation in early growth stages. Retention of cereal stubble does not affect lentil germination or growth, and can improve establishment on hard setting, surface crusting soils. Stubble clumps cause seed placement and harvesting difficulties.

Sufficient moisture and a level soil surface must be present at application for some soil active broadleaf herbicides to be fully effective and to avoid crop damage. Leave the soil surface flat to minimise herbicide damage and assist harvest by ensuring that clods or stones don't enter the harvester.

Image: W Hawthorne, Pulse Australia

Good even crop establishment.

Sowing depth

Sow at a depth between 5 and 10 cm. Sowing at this depth helps to avoid herbicide damage from pre-emergent herbicides. Lentils emerge faster than other pulses, but growth is slow in Winter. If germination coincides with soil temperatures below 5 °C, complete emergence may take 30 days.

Ensure even sowing depth at 5–10 cm with good seed to soil contact.

Sowing rate and plant density

Use densities of approximately 100–120 plants/m^2.

The sowing rate required for a variety will depend on the germination percentage of the seed and its seed weight. The number of seeds that emerge is often less than the seeds sown due to non viable seed, seedlings with poor vigour, disease, herbicide damage or poor soil structure. This may necessitate an increase in sowing rate.

Use the formula:
Seeding rate (kg/ha) = Plant density (plants/m^2) x 1000 seed wt (g) ÷ Emergence percentage*.

** Includes the germination percentage of the seed as well as the proportion of seedlings that successfully emerge.*

Sowing rate x time of sowing trial.

Images: R Rainbow, formerly SARDI; J Brand, VDPI

Time of sowing

Time of sowing of lentils is often a compromise. Early sowing increases the risk of disease development as a result of excessive vegetative growth and lodging. Risk of frost damage may also be increased. Sowing later than normal runs the risk of low plant growth compromising harvest and high temperatures and dry conditions during flowering and pod fill.

Lentils can be sown dry to ensure timely sowing, but factors like disease and frost risk must also be considered. Growers tend to have more confidence in early sowing where new systems of inter-row sowing into standing stubble using wider row spacing are used to ensure that canopy closure is delayed and the lentils remain more erect at harvest.

Optimum sowing times for southern Australia

Region (annual rainfall)	Month	May				June				July			
	Week	1	2	3	4	1	2	3	4	1	2	3	4
350–375 mm													
375–400 mm													
400–450 mm													
450–500 mm													
500–600 mm[a]													

Marginal areas or low disease risk areas *Preferred planting time* *For high disease risk areas*[b]

[a] preferred sowing time for Spring-sown lentils is August-September [b] Sow later If a more susceptible variety (e.g. Northfield), or in districts with milder Winter temperatures where botrytis grey mould (BGM) is a regular problem (e.g. Yorke Peninsula, Lower Eyre Peninsula, Upper SE of SA), to reduce the disease risk.

Inoculation

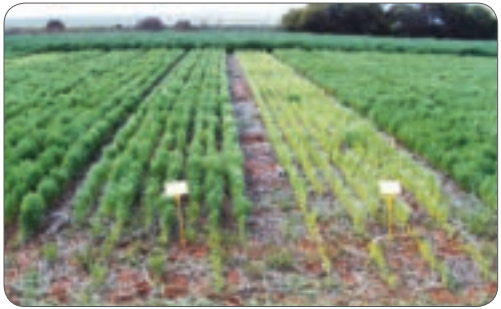
Lentils require inoculation with Group F rhizobium which can provide increases in growth, yield and soil nitrogen balance if soil rhizobia levels are low. Group F inoculant will ensure maximum nodulation and nitrogen fixation.

Inoculation of the seed with Group F rhizobium for each lentil crop may be necessary on waterlogged, saline or acidic soils, particularly poorly structured red clays or red brown earths where conditions for survival of rhizobia are poor.

New granular and other forms of inoculum becoming available may assist in rhizobial survival, particularly in acid soils or when the pulse is sown dry.

In assessing the effectiveness of nodulation, the more nodules and the earlier the nodulation occurs (i.e. on the tap and crown roots) the better. Nodules need to be pink to be effective.

Image: Professor J Howieson, Centre for Rhizobium Studies & National Rhizobium Program, GRDC; M Denton, VDPI



Inoculated (left) with WSM1455 (an excellent Group F inoculant strain for lentils) versus a non-effective strain (right).

Inoculum can be applied in one of several formulations.

Fungicide seed treatment

A fungicidal seed dressing can give some control of damping off diseases and improve seedling emergence in wet soil conditions.

If using both inoculum and seed dressing, apply the seed dressing first and then inoculate immediately before seeding. Do not mix inoculants and seed dressing together unless the inoculant's label specifies compatibility.

Fungicidal seed dressings are the first component of an overall disease management program aimed to provide unblemished grain. Use of a seed dressing to control ascochyta blight and botrytis grey mould during the 8–10 weeks after sowing can give a 5–15% yield improvement.

See page 29 Fungicide guide for seed treatments.

Yellow leaves in poorly nodulated plant.

Adding inoculum to lentils through an auger.

Images: J Brand, VDPI; M Witney, Dodgshun Medlin

Row spacing

Row spacing can be varied (15 to 45 cm), but the wider rows are only used if sowing is into standing cereal stubble to avoid lodging at harvest and inter-row weed control is available. Some growers use medium-wide row spacings (25 to 36 cm) to suit trash clearance, intra-row weed control or to delay canopy closure to allow greater air movement between the rows and decrease the risk of botrytis grey mould disease.

The height of bottom pods may be increased with wider row spacings or with higher seeding rates. Weed control can be more difficult with wider row spacing unless shielded sprayers are used.

Wide row 24" spacing left compared with 12" spacing right.

Image: J Brand, VDPI

Avoiding herbicide damage

Under adverse conditions, most post sowing, pre emergent (PSPE) herbicides are capable of causing damage in lentils. Post emergent applications can also cause crop damage or delay flowering and pod formation in some circumstances. In most cases damage can be attributed to the products solubility and:

- Sowing too shallow.
- Applying the herbicides to dry soils followed by heavy rainfall.
- Rate too high for the soil type.
- Uneven soil surface.
- Accumulation of herbicide into press wheel furrows.
- Differences in susceptibility of varieties.

To reduce the risks of herbicide damage when using metribuzin or other products PSPE on lentils:

- Sow at 5 cm or deeper.
- Apply the herbicides to a level soil surface (e.g. prickle chaining, rolling).
- Appreciate that rolling after press wheels may not do enough to level out the furrow.
- Avoid applying these herbicides post sowing to dry soils and in front of heavy rainfall events.
- Choose the right rate for your soil type (lighter soils require lower rates).
- Consider applying herbicide incorporated by seeding (IBS).
- Have knowledge of varietal herbicide sensitivity.

Example of herbicide damage on lentils.

Image: L McMurray, SARDI

Lentil *(Lens culinaris) plant parts*

** Source "Weeds in Winter Pulses" (2004), CRC for Australian Weed Management. Lentil herbicide labels refer to the number of nodes for the timing of herbicide applications. Nodes are counted from the point at which the first true leaves are attached to the stem.*

Lentil growth stages

Development phase	Growth stage (GS)	Description
G Germination	GS G0 Dry seed	
	GS G1 Imbibed seed	
	GS G2 Radicle apparent	
	GS G3 Plumule and radicle apparent	
	GS G4 Emergence	
V Vegetative	GS V1 First node	First leaf fully unfolded with one pair leaflets
	GS V(x) x First node	X leaf fully unfolded with more than one pair of leaflets, complex tendril
	GS V(n) n, last recorded node	n – any number of nodes on the main stem with fully unfolded leaves according to the cultivar
R Reproductive	GS R1 First bloom	One open flower at any node
	GS R2 Full bloom	Flower open or has opened on nodes 10 to 13 of the basal primary branch
	GS R3 Early pod	Pods on nodes 10 to 15 of the basal primary branch visible
	GS R4 Flat pod	Pods on nodes 10 to 15 of the basal primary branch has reached its full length and is largely flat. Seeds fill less than half of the pod area but can be felt as a bump between the fingers
	GS R5 Full seed	Seed on any single pod on nodes 1 to 13 of the basal primary branch are swollen and completely fill the pod cavity
	GS R6 Full pod cavities	At all the normal pods on nodes 10 to 13 of the basal primary branch are swollen and completely fill the pod cavity
	GS R7 Physiological maturity	The leaves start yellowing and 50% of the pods have turned yellow
	GS R8 Full maturity	90% of the pods on the plant are golden brown

** Source E. Erskine, F Muehlbauer, R.W. Short*

Rolling

Surface rolling flattens clods and ridges caused by sowing or press wheels. It also presses rocks and sticks into the soil leaving a flat surface to allow easier harvest. This reduces harvest losses, harvester wear and contamination in the seed sample. Sowing with modern disc machines may eliminate the need to roll lentils. Beneficial trellising effects of standing cereal stubble may be lost or reduced by rolling lentils.

Rolling is usually done post sowing, but can be from pre-emergence to the 4–5 leaf stage. Avoid rolling lentils when plants are just emerging as the young shoots can be damaged. A rubber tyre roller is best, used when soil is moist but not too wet or dry.

Rolling may have to be delayed until the crop has emerged if the soil is prone to hard setting or crusting, or if prone to erosion on sandy or sloping country. The safest time to roll lentils post emergence is at the 3–5 leaf stage. Roll in warmer conditions when the plants are limp, and not brittle from cold or frosty conditions. Choose an afternoon or a warmer day to minimise any crop damage. Avoid rolling two weeks before or after applying a post-emergent herbicide.

Rolling flattens clods, ridges and rocks to assist harvest.

Clods need to have been rolled.

Image: I McNeil; W Hawthorne, Pulse Australia

Crop affect	Distribution	Plant symptoms	Disorder	Page
Poor emergence	Patches	Seed rotted	Damping off	–
			Botrytis seedling blight	38
		Plants chewed	Mice	–
			Snails	106
	General	Plants distorted	Trifluralin damage	54
		Plants stunted	Seed sown too deep	15
		Ungerminated seed	Poor storage	13
			Insect damage	–
Wilting	Scattered plants	Reduced growth – yellow	Fusarium wilt	40
		Yellow/red	Virus	44
		Premature death	Root rots	28
	Patches	Stunted	Herbicide damage	49
		Premature death	Fusarium wilt	40
			Botrytis grey mould	38
			Water logging	74
			Virus	44
			Salinity	110
	General	Plants limp	Herbicide damage	49
Stunted/distorted	Scattered	Reduced growth	Orobanche (Broom Rape)	–
		Leaves/stem distorted	Stem nematode	46
			Virus	44
			Mites	91
	Patches	Yellow – death of young leaves	Iron deficiency	68
			Manganese deficiency	69
			Sulfonyl urea damage	50
			Broadstrike® damage	50
		Yellow/red	Damping off (pythium root rot)	28
			Virus	44
			Nodulation failure	70
		General	Herbicide damage (e.g. Hormone)	58

Crop affect	Distribution	Plant symptoms	Disorder	Page
Leaf and stem spotting/ discolouration	Scattered plants	Brown lesion with pepper spots	Ascochyta blight	36
		Yellow leaves, grey mould growth on lower stems	Botrytis grey mould	38
		Yellow/red	Diflufenican damage	56
		Tip death	Triazine damage	52
		Tip death	Zinc deficiency	66
		Shrunken – purplish-brown	Ascochyta blight	36
Pods discoloured	General	Mainly within canopy, may have small black sclerotes	Botrytis grey mould	38
		Tan spots on pods with small, dark fruiting bodies within spots	Ascochyta blight	36
White fungal growth	Stems and leaves	May be with a soft slimy rot, may have larger black sclerotes	Sclerotinia blight	42
		Plants chewed	Mouse damage	–
Physical damage	Patches	Plants chewed	Snail damage	106
		Pods chewed	Native budworm	82
		Pods chewed	Lucerne seed web moth	80
		Stem, leaves and pods damaged	Mouse damage	–
	General	Stem, leaves and pods damaged	Hail damage	74
		Stem bent and twisted	Frost	71

DISEASE MANAGEMENT

Effective disease management relies on the combination of variety selection with the best profile of disease resistance, the most suitable paddock, clean seed, canopy management and agronomic practices, as well as the strategic use of foliar fungicides.

Physical damage to the crop from machinery travelling over the paddock can be a major cause of disease or poor grain quality. Consider, 'tram lining' and controlled traffic.

Factor	Best practice
Paddock history	A minimum of 2 years break between lentil crops. (*see page 28 for other Pulse Disease hosts*).
Paddock hygiene	Select paddocks at least 500 m from last year's crop stubble if infected with disease
Variety	Select a variety with suitable level of disease resistance for your district
Seed source	Use seed from crops that are disease free, especially at podding, or with known freedom from disease infection – laboratory seed tests can confirm disease levels
Sowing time	Minimise the risk of foliar disease development due to excessive vegetative growth. Do not sow too early – early emergence leads to early canopy closure, which increases the susceptibility to foliar disease
Sowing rate	Higher seeding rates and plant populations greater than 120 plants per square metre result in the increased risk of disease due to denser crop canopy growth
Row spacing	Wider rows delay canopy closure, reducing the risk of botrytis grey mould. But an increased risk of lodging may increase the chance of botrytis grey mould
Fungicide application	**Seed:** Treatment with a thiram + thiabendazole product will reduce disease transmission by seed and help control ascochyta, botrytis and seedling root rots **Foliar:** Most effective on disease susceptible varieties when applied before or at first signs of disease. Protection lasts for 10–12 days, but new growth is unprotected. Ongoing protection requires additional sprays applied prior to rain
Aphid control	Early detection and control can reduce spread of virus, but spread often occurs as control too late. Cultural practices like Summer weed control, crop density, stubble and minimising bare soil become important in reducing the presence of aphids
Harvest management	Early harvest will reduce disease infection on the seed

Carry over as an infection source of key diseases

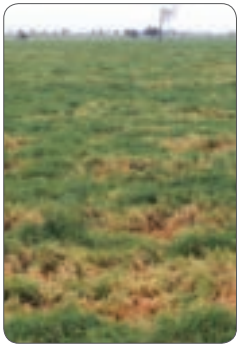
Disease	Stubble	Seed	Soil	Aphids
Ascochyta blight	***	***	*	-
Botrytis grey mould	***	***	*	-
Seed borne viruses	-	**	-	***
Non-seed borne viruses *Luteo viruses*	-	-	-	***

Relative importance

- \- Nil
- * Minor
- ** Moderate
- *** Major

Ref: Grain Legume Handbook

Ascochyta leaf lesions.



Botrytis grey mould.

Virus infected crop.

Images: M Materne, VDPI; M Ramsey formerly SARDI

Diseases and potential for cross infection from other pulses

Disease	Lentils	Peas	Faba beans	Vetch	Chickpeas	Lupins
Botrytis grey mould *Botrytis cinerea*	**	*	**	**	**	*
Botrytis fabae	**		**	**		
Sclerotinia *Sclerotinia sclerotiorium*	**	**	*	*	**	**
Bacterial blight *Pseudomonas syringae* pv. *syrinae*	**	**				
Ascochyta blight *Ascochyta lentis*	**					
Phoma blight *Phoma medicaginis* var *pinodella*	*	**	**	*	**	*
Grey leaf spot *Stemphylium botryosum*	**				*	**
Virus **Cucumber mosaic virus**	**		*			**
Lueteo virus complex (e.g. BLRV and BWYV)	*	**	**	**	**	
Alfalfa mosaic virus	**		*	*	**	
Root rots *Fusarium* **ssp.**	*	*	*	*	*	*
Pythium **ssp.**	*	*	*	*	*	*
Rhizoctonia **ssp.**	**	**	**	**	*	**
Botrytis seedling blight	**	*	**	*	**	*

* This disease occurs on this crop but has not caused major damage

** This disease has caused major damage on this crop

Not a host

Ref: Grain Legume Handbook

Fungicide guide

	Fungicide				
Chemical	**Thiram + thiabendazole**	**Mancozeb**	**Chlorothalonil**	**Carbendazim**	**Procymidone**
Products (Nov 2008)	P-Pickel T® Fairgro® Reaper®TT	Dithane Rainshield® Penncozeb®750 DF Manzate®750 WG Mancozeb®	Barrack® Unite® Bravo®	Howzat® Carbend® Spinflo® Bavistin® Boomer® Goldazim®	Sumisclex® Fortress®
WHP Grazing	Not required	14 days	No grazing	4 weeks	21 days
Harvest	Not required	28 days	No grazing	4 weeks	21 days

Disease	**Seed**	**Foliar**			
Ascochyta blight	✓	✓	✓	-	-
Botrytis grey mould	-	✓	✓	✓	✓
Seedling root rot	✓	-	-	-	-

✓ Disease controlled or suppressed
- No control
✓ Permit for use expired 9/1/2009 check for current permit or registration
Withholding period after application until grazing or harvest

®registered for this use on this crop

Reference: Pulse Seed Treatments and Foliar Fungicides - fifth edition 2008

Controlling viruses

Manage viruses by preventing their introduction. Virus develops from either infected seed or via aphids.

Seed-borne viruses of concern are Cucumber Mosaic Virus (CMV) and Alfalfa Mosaic Virus (AMV). Viruses brought in by aphids include Beet Western Yellows Virus (BWYV).

- Minimise the virus source (seed, Summer weeds or pasture).
- Sow virus free seed, <0.1% seed infection in high risk areas, <0.5% seed infection in low risk areas.
- Manage the crop to minimise aphid landing sites. Avoid bare soil – aphids land in crops where there is a clearly defined contrast in colour between bare soil and green foliage.
  - Ensure good establishment
  - Retain standing cereal stubble
  - Produce a dense canopy
- Minimise herbicide "stress" as stressed plants that are more "attractive" to aphids.
- Control in-crop weeds early.
- Choose an aphicide that is "soft" on beneficials.
- Monitor for aphid activity and early control to minimise possible virus spread.
- Control any Summer legume and weed "green bridge" and any aphid build-up on them.

Cucumber Mosaic Virus (CMV).

Beet Western Yellows Virus (BWYV).

Images: W Hawthorne, Pulse Australia

Fungicide spraying program

There are three critical periods for fungicide spraying lentil crops for disease.

Start monitoring for disease 6–8 weeks after emergence (WAE).

Critical period	Crop stage	
1	10–14 WAE	Just prior to canopy closure to ensure maximum protection through the canopy from botrytis grey mould.
2	14–16 WAE	Early flowering to early pod fill if botrytis grey mould or ascochyta blight is present or conditions are conducive to disease. A mixture of fungicides may be required to control both diseases.
3	16–18 WAE	End of flowering to mid pod fill to prevent ascochyta blight infection during pod formation and filling in susceptible varieties resulting in yield loss and stained seed.

Apply fungicide before rain at the critical periods in high rainfall areas, in a wet year, or where the crop is at high risk e.g. if a susceptible variety, crop rotation is tight, or where adjacent to a lentil stubble.

Under high disease pressure, all varieties could require fungicide protection to control epidemics.

Spray just prior to canopy closure.

Image: W Hawthorne, Pulse Australia

Fungicide application guide[a]

by variety, disease[b], risk, critical period[c] and rainfall (>400mm and <400mm)

Critical period[c]	Nipper(ф)	Digger, Nugget, Boomer (ф)	Tiara, Aldinga, Matilda, Cobber	Northfield
First (10-14 WAE)	**> 400 mm only** • If BGM risk high 1, 2, 3, 4[a]	**> 400 mm only** • If BGM risk med/high 1, 2, 3, 4[a]	All rainfalls • If BGM risk med/high 1, 2, 3, 4[a]	All rainfalls • BGM risk is med/high 1, 2, 3, 4[a]
Second (14-16 WAE)	**> 400 mm only** • If BGM risk is very high 1, 2, 3, 4	**> 400 mm** • If AB present + BGM risk low 3, 4 • If AB present + BGM risk high 5, 6, 7, 8,3, 4 • If AB absent and risk is low + BGM risk high 1, 2 **< 400 mm** • If AB risk 1, 2	**> 400 mm** • If AB present + BGM risk low 3, 4 • If AB present + BGM risk med/ high 5, 6, 7, 8, 3, 4 • If AB absent and risk low + BGM risk med/high 1, 2, 3, 4 **< 400 mm** • If AB risk 1, 2	**> 400 mm** • If BGM risk med 1, 2, 3, 4 • If BGM risk high 1, 2 • Monitor, as more than one fungicide application may be required for BGM prior to the end of flowering (critical period 3) **< 400 mm** • If BGM risk med/high 1, 2, 3, 4
Third (16-18 WAE)	-	**> 400 mm only** • If AB present and risk high 3, 4	**> 400 mm only** • If AB present and risk high 3, 4	**> 400 mm only** • If BGM present 1, 2, 3, 4

[a] *Fungicides: 1= carbendazim; 2 = procymidone; 3 = chlorothalonil; 4 = mancozeb; 5 = 1+3, 6 = 1+4, 7 = 2+3, 8 = 2+4 (see page 33 for efficacies)*
[b] *AB = Ascochyta blight and BGM = Botrytis grey mould*
[c] *See page 31 for critical periods; WAE = weeks after emergence*

Fungicide efficacy and use

Fungicide	Botrytis grey mould (BGM)		Ascochyta blight (AB)		Critical use periods[c]
	Efficacy	Use if BGM risk	Efficacy	Use if AB risk	When to use
(1) Carbendazim	***	Med-high	-	Nil	First to third
(2) Procymidone	***	Med-high	-	Nil	First to third
(3) Chlorothalonil	**	Low-med	***	Low-high	First to third
(4) Mancozeb	*	Low-med	**	Low-high	First to third
(5) Carbendazim + chlorothalonil	***	Med-high	***	Med-high	Second and third
(6) Carbendazim + mancozeb	***	Med-high	**	Low-med	Second and third
(7) Procymidone + chlorothalonil	***	Med-high	***	Med-high	Second and third
(8) Procymidone + mancozeb	***	Med-high	**	Low-med	Second and third

*** High efficacy ** Medium efficacy * Low efficacy - No efficacy

Anthracnose (*Colletotrichum truncatum*) in lentils

Description: Occurs in cool moist conditions and spreads rapidly in high humidity and warm temperatures (25–30° C). Disease spreads rapidly towards the end of the season with a large number of lesions developing.

Irregular shaped, light brown sunken lesions develop on the base of the stem, progressing up the plant to the leaves and pods. Only a few circular lesions develop on leaves and pods. The centre of lesions contain small, black micro-sclerotia survival bodies.

Affected plants lodge.

Could be confused with ascochyta blight.

Management:
This disease is not present in Australia.

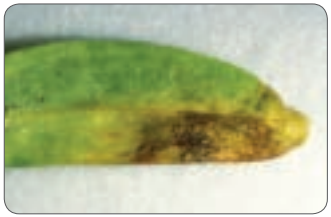
Reported in a number of countries, but only economically important in Canada.

Sow disease free seed.

Submit samples to your local Department of Agriculture or Primary Industries for confirmation.

Anthracnose in lentil crop.

Image: M Materne, VDPI



Anthracnose leaf.

Affected leaf drop.

Affected crop.

Microsclerotia survival bodies.

Anthracnose on stems.

Images: M Materne, VDPI and K Lindbeck, formerly VDPI

Ascochyta blight (*Ascochyta lentis*)

Description: The major disease of lentils in southern Australia.

Occurs in prolonged cool, moist conditions. Leaves, stems and pods develop circular or oblong shaped tan spots. Centres of spots fade to a light tan colour with scattered small black dots (fruiting bodies).

Young leaf spots are usually surrounded by light yellow halo; whole leaf may yellow and heavily infected leaflets wither and fall.

Severely infected seeds are shrivelled and have a purplish-brown stain on the seed coat.

Heavy rainfall late in season promotes pod and seed infection.

Herbicide damage can produce similar symptoms without the black spots (fruiting bodies) present.

Ascochyta affected canopy.

Early leaf infection.

Ascochyta infected seed.

Stem infection.

Images: Grain Legume Handbook M Materne, VDPI; M Ramsey, formerly SARDI

Management: Use resistant varieties (*Nipper*[◊] and *Northfield* have resistance to seed and foliar infection).

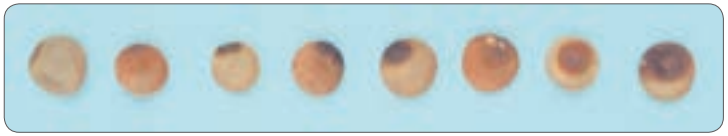
Avoid early sowing and high plant densities.

Sow seed free of infection and avoid sowing adjacent to infected stubble.

Apply fungicide to seed to reduce seed transmission.

All current Australian varieties have at least moderate foliar resistance – apply a foliar fungicide to prevent infection at early podding and/or mid-pod fill in varieties that are susceptible to pod infection (critical periods 2 and 3).

Ascochyta blight on leaves of mature plant.



A range of ascochyta infected seed. Seed infection is the major source of infection in crops. Infection levels below 2% are unlikely to cause disease losses in most seasons.

Ascochyta blight affected plant.

Images: Grain Legume Handbook, M Materne, VDPI; Clive Palmer

Botrytis grey mould (*Botrytis cinerea* and *B. fabae*)

Description: Occurs in wet, humid conditions at any stage of growth, especially after canopy closure.

Spots on leaves are initially pale cream coloured; upper leaves and pods may be affected turning brown-yellow. Base of stems become light brown and develop a soft rot. Botrytis grey mould develops rapidly once canopy closure has occurred, masses of spores are released when disturbed; affected areas become covered with fluffy grey mould.

Few branches or the entire plant may wither and die; plants may ripen prematurely. Large areas of the crop may collapse, wither and die.

Infects flowers reducing pod set; affected pods may produce discoloured and shrivelled seed.

Infected seed does not always show clear symptoms.

Small black sclerotes may form on infected tissue.

Can spread between lentils, vetch and faba beans.

Botrytis grey mould in a mature crop.

Seed pod affected by *Botrytis cinerea*.

Images:
K Lindbeck, formerly VDPI

Management: Use varieties with reduced suscepibility (*Northfield* is very susceptible).

Avoid growing lentils in paddocks recently infected by botrytis grey mould in chickpeas or lentils or chocolate spot in faba beans.

Avoid excessive vegetative growth through early sowing, high seeding rates or high soil fertility.

Avoid sowing infected seed or sowing into infected stubble.

Apply foliar fungicide just prior to canopy closure in susceptible varieties.

Apply fungicidal seed dressing to reduce seed transmission.

Apply carbendazim or procymidone when disease pressure high and re-apply 10–14 days later if conditions persist.

Do not grow in close rotation with, or close to, faba bean, chickpea, lathyrus or vetch.

Botrytis grey mould.

Botrytis grey mould.

Botrytis grey mould on stem.

Images: M Materne, VDPI; J Davidson, SARDI

Fusarium wilt (*Fusarium oxysporum* f. sp. lentis)

Fusarium wilt is considered the most important disease of lentils world wide. This disease can cause complete crop failure under favourable conditions.

It is exotic to Australia and breeding lines have been tested internationally as part of a pre-emptive breeding strategy for this disease. *F. oxysporum* is a common root rot pathogen in Australia, but the lentil specific strain has not been detected in Australian commercial lentil crops.

Disease development is favoured by warm dry conditions, and mild temperatures (22–25° C) during late Winter/early Spring.

Description: Symptoms generally appear during flowering to pod filling stages of crop growth. Plants appear in patches within a crop. Sudden wilting of top leaves, stunting of plants, shrinking and curling of leaves without defoliation. Root symptoms include reduced growth with a marked brown discolouration, tap root tips that are damaged, and sometimes a proliferation of secondary roots. Discolouration of the vascular tissue and lower stem may not always be present.

Management: ***This disease is not present in Australia.***

Submit samples to your local Department of Agriculture or Primary Industries for confirmation.

Infected plant on left.

Image: L McMurray, SARDI

Lentil rust (*Uromyces viciae-fabae*)

Lentil rust is a major constraint to lentil production in countries such as India, Pakistan, Turkey, Ethiopia, Morocco, Canada, Argentina, Chile and Brazil. Complete crop failures can occur due to this disease.

Despite the causal fungus being present in Australia, (on faba bean and vetch crops), the disease has never been detected in Australian commercial lentil crops suggesting the lentil attacking pathotype is not present. The Australian breeding program uses lines that are resistant to this disease in its crossing program and has screened advanced lines in international lentil rust nurseries as part of a pre-emptive breeding strategy for this disease.

High humidity, with mild temperatures (20–25° C) around flowering/early podding favours disease development.

Description: Initial infection appears as yellowish-white spore masses on leaves.

Orange–brown rust pustules (circular and up to 1 mm in diameter) later form on leaflets, stems and pods. Rust pustules darken with age to become dark brown to black. Severe infection causes premature defoliation and death of plants producing little or no seed.

Management:
This disease is not present in Australia.
Submit samples to your local Department of Agriculture or Primary Industries for confirmation.

Lentil rust in canopy.

Lentil rust on leaves.

Images: K Lindbeck, formerly VDPI

Sclerotinia blight (*Sclerotinia sclerotiorum*)

Description: Often occurs in wetter seasons under conditions that often favour botrytis grey mould.

Appears mainly on older plants.

Water soaked patches on stems and lower leaves develop a soft, slimy rot which exudes droplets of a brown liquid.

When dry, a fine white fungal growth including sclerotes develops.

Affected plants wilt and rapidly die.

Infected weeds are smaller and discoloured.

Management: Use disease free seed.

Do not grow in close rotation with canola, pulses and broadleaved weeds such as capeweed.

Avoid sowing adjacent to infected stubble.

Eliminate infected stubbles.

Sclerotinia blight.

Image: K Lindbeck, formerly VDPI

Luteovirus – Bean leaf roll virus (BLRV), Subterranean clover red leaf virus (SCRLV) and Beet western yellows virus (BWYV)

Description: Plants are stunted with distinct yellow patches along rows.

Leaves are small with mild yellowing between the veins; eventually the whole leaf becomes yellow.

Early infection severely stunts plants with no or few pods produced.

They infect the aphid leading to greater spread (persistent transmission).

More damaging than viruses that are only transmitted by infected seed.

Management: Spray to control aphids and prevent them transmitting the viruses from nearby infected subterranean clover pastures.

Prevent the build up of aphid numbers.

A distinct patch of yellow stunted plants.

Image: W Hawthorne, Pulse Australia

Viruses: Alfalfa mosaic virus (AMV), Cucumber mosaic virus (CMV), Bean yellow mosaic virus (BYMV) and Clover yellow vein virus (CYVV)

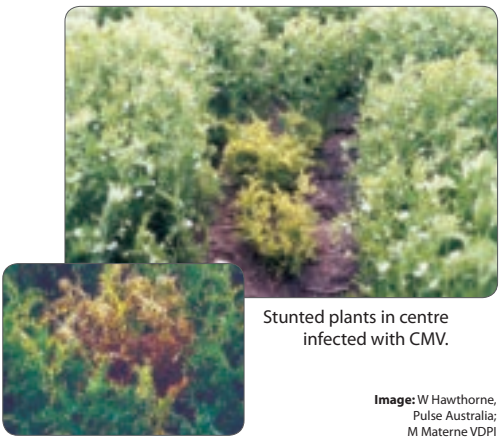
Description: Plants are yellow, stunted and may die prematurely; occurs in distinct yellow patches along rows; centres of patches show most severe symptoms.

Young leaves are pale green, small twisted and distorted; faint mosaic may develop; leaves sometimes develop brown/red edges.

BYMV produces most severe symptoms with AMV least severe; patches resemble root disease or herbicide residue damage.

Management: Use disease free seed.

Spray to control aphids that transmit the virus from seed infected plants and nearby host crops e.g. narrow leaf lupins.



Stunted plants in centre infected with CMV.

Image: W Hawthorne, Pulse Australia; M Materne VDPI

Rhizoctonia root rot (*Rhizoctonia solani*)

Description: Foliage turns yellow and plants die in patches.

Affects both seedling and adult plants.

Favoured by warm soil and conditions susceptible to poor root growth such as marginal moisture.

Worse with reduced tillage, poor fertility (especially zinc), build-up on weed roots prior to sowing.

With late infection, plants survive for some time with only yellowing of leaves.

Leaves become yellow progressively from the bottom of the plant.

Roots become reddish brown with a distinct constriction at or below the collar; the main root below the constriction initially remains healthy.

Roots are reddish-brown.

Image: M Ramsey, formerly SARDI

Management: Eliminate green growth at least four weeks prior to sowing.

Provide adequate nutrition and conditions for rapid root growth.

Disturb soil several centimetres below the seed to reduce infection in the soil.

Stem nematode damage (*Ditylenchus dipsaci*)

Description: Large patches of delayed/poor emergence.

Patches of malformed and stunted seedlings.

Plants recover in most seasons (unless extremely cold and wet).

Additional stems may shoot from base.

Affected stem, malformed, stunted and yellow.

Can be confused with herbicide damage.

Only found in parts of South Australia.

Favoured by wet conditions.

Management: Use nematode free seed.

Do not introduce in infected straw or hay.

Avoid rotation of crops that increase nematode populations e.g. oats, field peas, faba beans and susceptible weeds (bedstraw, wild oats).

Healthy plant (left); Malformed and stunted seedling (right) with additional stems shooting from base.

Image: S Taylor, formerly SARDI

Weed control is essential. Lentils grow slowly during Winter and are poor competitors with weeds. Avoid sowing lentils in paddocks with a history of severe broad-leafed weed problems. Vetches, tares, medics, clovers, wild radish, bedstraw, bifora and self-sown pulses are particularly hard to control. Prevent seed set of broad-leafed weeds in the year prior to growing lentils.

It is essential to plan your weed control strategy before sowing. Delayed sowing is an option in most areas except lower rainfall areas. This can enable several weed kills before sowing. Application of pre-emergent herbicides is also a useful strategy. Most grass weeds can be controlled either pre or post-emergence. Diflufenican and flumetsulam products are currently registered for post emergent broadleafed weed control in lentils.

Lentils provide a valuable rotational opportunity to use alternative weed control practices to those used in the cereal and oilseed phases. The opportunity to use grass herbicides, alternative herbicides and herbicide groups, as well as crop topping and wick wipers in lentils assist in reducing seed bank levels and hard to control weeds. Crop topping and wick wipers importantly reduce weed numbers with minimal or no movement of the population towards resistance.

Weed infestation.

Grassy weed growth.

The impact of early grassy weeds.

Image: M Materne, VDPI; W Hawthorne, Pulse Australia

Effective weed control

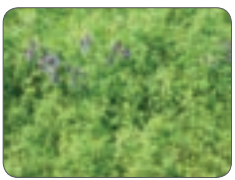
If weeds are not controlled early options for effective weed control are very limited. Ensure a low seed bank of weeds exists before electing to sow lentils. Sprays need to be applied while canopies still allow adequate spray coverage of the weed.

The use of wick wipers and crop topping has greatly helped control ryegrass to make lentils a more robust part of a rotation. Control of musk weed, vetch and medic in lentil crops still relies on pre-season seed bank management.

- Control weeds as early as possible.
- Control when weeds and the crop are at the correct growth stage.
- Do not spray when weeds or the crop are under stress.
- Check the 'rainfast' period prior to rain.
- Do not spray in windy conditions over 15 km/hr.
- Use the right nozzle output and droplet size to ensure adequate coverage.
- Ensure the sprayrig is properly cleansed of damaging residual chemicals.
- Check the withholding period for grazing and harvest.

Lentils with broadleaf weeds that need controlling.

Lentils contaminated with prickly lettuce.



Avoid vetch contamination to minimise marketability problems.

Images: W Hawthorne, Pulse Australia

Herbicide injury

Causes of herbicide injury:

- Incorrect rate or timing of application.
- Cultivar susceptibility.
- Adverse weather conditions.
- Soil ridged which allows herbicide wash.
- Shallow seeding depth.
- Herbicide drift.

Effects of herbicide injury may vary, depending on the dose received and crop susceptibility. Herbicide damage may be very obvious such as with scorched leaves, or may be more subtle, such as with poor establishment, poor root growth or delayed maturity. Symptoms can vary from slight stunting or leaf discolouration to crop death, depending on the type of herbicide, the crop and seasonal conditions.

Herbicide crop injury symptoms can easily be confused with symptoms produced by other causes, such as from frost, disease, nutrient deficiencies or toxicities. Correctly diagnosing causes of a specific set of symptoms can therefore be difficult.

Symptoms of crop damage from herbicides do not always mean there will be a loss in grain yield.

Broadstrike herbicide bare patch.

Crop affected by broadstrike herbicide.

Images:
M Materne, VDPI;
W Hawthorne, Pulse Australia

Group B
Inhibitors of the Enzyme ALS

Sulfonylureas (SU's)		Sulfonamides		Imidazolinones (IMI's)	
Trade name*	**Chemical name**	**Trade name**	**Chemical name**	**Trade name**	**Chemical name**
Ally®	metsulfuron	Broadstrike®	flumetsulam	Arsenal®	imazapyr
Glean®	chlorsulfuron	Eclipse®	metosulam	Flame®	imazameth
Hussar®	iodosulfuron	Torpedo®	florasulam	Midas®	imazapic +
imazapyr					
Logran®	trisulfuron			OnDuty® Intervix®	
Monza®	sulfosulfuron			Spinnaker®	imazethapyr
Atlantis®	mesosulfuron + mefenpyr			Raptor®	imazamox

Description: Visual symptoms appear 5 to 8 days after spray application or where there are residues in the soil. Lentils are very sensitive to residues of these herbicides.

Seedlings may emerge and grow for several weeks before plants become stunted with shortened internodes. New foliage has a yellow to red to purplish colouration which progresses throughout the plant. Leaf curl may be apparent.

Growth of lateral roots may be reduced.

Management: Follow plant-back periods as indicated on label where high pH calcareous soils (> pH 7.5 $CaCl_2$).

Cold, wet conditions and compacted soil (e.g. wheel tracks) can be contributing factors, as is zinc deficiency, and conditions that stress and prevent the plant recovering.

Grass herbicides can strip residues from the spray boom and tank.

A Group B herbicide can result in more significant crop damage when applied where Group B residues exist.

Reddening of some whole plants.

Growing point and young leaves pale green to yellow.

Glean® residue affect on right.

Plants severely stunted.

Mottled reddening of leaves.

Images: VDPI

Group C
Inhibitors of Photosynthesis (photosystem II)

Triazine		Triazinone		Urea	
Trade name	**Chemical name**	**Trade name**	**Chemical name**	**Trade name**	**Chemical name**
Gesaprim®	atrazine	Lexone®/Sencor®	metribuzin	Karmex® Krovar®	diuron
Gesatop®	simazine	**Nitrile**		**Phenyl-pyridazine**	
Igran®	terbutryn	Buctril® Jaguar®	bromoxynil	Tough®	pyridate

Description: Visual symptoms appear as the weeds emerge (for soil applied Group C herbicides) or 4 to 6 days after spray application on emerged weeds.

Lentils are more sensitive to triazine herbicides than most pulses.

Symptoms develop rapidly but require light. Rapid yellowing and necrosis beginning at the edge of leaves occurs leading to desiccation and burned appearance of leaves. Interveinal chlorosis or veinal chlorosis can occur.

Tolerant plants (crops) often recover.

Metribuzin damage.

Images: W Hawthorne, Pulse Australia

Management: Follow plant-back periods as indicated on label where there are alkaline calcareous soils and leachable soils with low organic matter, or of lighter texture. Duplex soils with shallow sand over heavy clay also present a risk of damage.

Damage is most likely from herbicide leaching into seed furrows after heavy rainfall in ridged soils and where there is shallow sowing.

Metribuzin affected seedlings.

Lentils – metribuzin symptoms, yellowing and stunting.

Images: L McMurray, SARDI

Group D
Inhibitors of Cell Division (by inhibiting tubulin formation)

Dinitro-anilines		Benzamides	
Trade name	**Chemical name**	**Trade name**	**Chemical name**
Stomp®	pendimethalin	Kerb®	propyzamide
Trifluralin®/Treflan®	trifluralin		
Yield®	trifluralin + oryzalin		

Description: Visual symptoms appear as the crop emerges with intermittent emergence along drill rows as a result of the shortening and thickening of the hypocotyl.

Lentils are the most sensitive pulse crop to Group D herbicides. Seeds germinate, but shoots are unable to emerge. Emerging leaves in affected plants are twisted and distorted.

Roots can be shortened and thickened.

Lentils – trifluralin symptoms, stunted seedling.

Images: M Materne, VDPI

Management: Avoid sowing seed into the layer of herbicide treated soil. This often occurs from the seeder set-up resulting in variable depth of sowing, or from sowing too fast throwing herbicide treated soil onto adjacent furrows.

Symptoms are often worse when wet cold conditions slow germination and emergence.

Lentils – Treflan® symptoms, damaged roots.

Lentils – Trifluralin symptoms. Untreated plant (left)l shortened hypocotyl and roots (right).

Images: I Koch, J & D Southwoods

Group F
Inhibitors of Carotenoid Biosynthesis

Nicotinanalides		Picolinamide	
Trade name	Chemical name	Trade name	Chemical name
Brodal®	diflufenican	Sniper®	picolinofen

Description: White/yellow spots/bands may develop within three to four days after application (two days in bright sunny weather).

Lentil plants turn light green and whole leaves turn yellow to cream colour.

Effects disappear as new growth develops with no long term effects.

Management: Affects are worse when applied to crops suffering stress such as frost, cold wet conditions, or high temperatures soon after spraying. Some lentil varieties are more sensitive than others. Do not apply to *Northfield* variety. Preliminary results show *Boomer*ϕ may be more sensitive than *Nugget* to label application rates.

Bleached leaves on seedling plants.

Lentil – Brodal® symptoms.

Bleached leaves from Brodal®.

Images: A Mayfield, Allan Mayfield Consulting

Group G
Inhibitors of Protoporphyrinogen

Diphenyl Ethers		Aryl triazolinone		Pyrimidindione	
Trade name	**Chemical name**	**Trade name**	**Chemical name**	**Trade name**	**Chemical name**
Goal®/Spark® /Striker®	oxyfluorfen	Affinity® Hammer®	carfentrazone	Butafenacil part of Touchdown® B-Power and Logran® B-Power	butafenacil
N-diphenylphthalamides					
Pledge®	flumioxazin				

Description: Numerous white spots on the leaves from the droplets of herbicide contact within one or two days of application.

May lead to desiccation and death in lentils although grasses and cereals generally recover.

Management: Ensure that herbicide drift does not occur onto lentil crops, especially where fine droplets are targeted for the use of products as indicated by the label.

Peas showing Goal® damage.

Images: VDPI

Group I
Disruptors of Plant Cell Growth (Auxinic herbicides)

Phenoxy acids		Benzoic acids		Pyridines	
Trade name	Chemical name	Trade name	Chemical name	Trade name	Chemical name
Many	2,4D amine	Banvel®/Cadence®	dicamba	Lontrel®	clopyralid
Many	2,4D ester			Garlon®	triclopyr
Many	MCPA amine			Starane®	fluroxypyr
Many	MCPA ester				
MCPB®	MCPB				
Trifolamine®	2,4DB				

Description: Visual symptoms appear within 3 to 4 days of application. Plants start to twist and appear misshapen with epinastic bending and twisting of stems and petioles, stem swelling – especially at nodes, elongation, leaf cupping and curling.

This is followed by yellowing at the growing point, reduced growth, wilting and necrosis.

Leaves may be mottled. Leaf spotting without the 'hormonal' distortion can occur with MCPB.

Death occurs slowly over 3–5 weeks

Management: Do not seed if there might be residues from pre-sowing application.

Ensure that herbicide drift does not occur onto lentil crops.

Stem elongation due to low rate of Group I 2,4-D.

Curling and distortion of seedling plants due to Group I.

Image: M Materne, VDPI

Group J
Inhibitors of fat synthesis

Thiocarbamates	
Trade name	**Chemical name**
Avadex®	tri-allate

Description: Visual symptoms appear underground or as the crop emerges with reduced or poor seedling emergence.

Shoots, if emerged, are often swollen and bright green.

Roots are often pruned, leaving stubby root knobs.

Management: Ensure seed is not sown into the band of herbicide in the soil. Affects are worse when wet cold conditions slows germination and emergence.

Group K

Inhibitors of cell division and very long chain fatty acids

Amides	
Trade name	**Chemical name**
Dual®	metolachlor

Description: Visual symptoms appear as the crop emerges with reduced or poor seedling emergence. In most cases weeds do not appear. Seedlings are malformed and twisted, with transitory crop yellowing.

Management: Ensure seed is not sown into the band of herbicide in the soil.

Affects are more severe in light textured soils with low organic matter and also in waterlogged conditions, where crops are stressed from lack of moisture or lack of nutrients, and when frost occurs within 10 days of application.

Images: C Preston, University of Adelaide

Reduced root growth in affected plant left.

Twisted leaves of affected plant right.

Group L

Inhibitors of Photosynthesis (photosystem I)

Bipyridyls	
Trade name	**Chemical name**
Gramoxone®	paraquat
Reglone®	diquat
Spray.Seed®	diquat + paraquat

Description: Visual symptoms appear within hours of application with spots of dead tissue on otherwise healthy leaves. There may also be wilting and inter-veinal yellowing followed by browning and blackening of the leaf edges.

Plants shrivel up within four days of application if damage is severe.

Signs are often worse on one side of the plant or stem.

Effects disappear as new growth develops.

Management: Ensure that herbicide drift does not occur onto lentil crops.

Chickpea–Group L symptoms. Water-soaked spots on leaves.

Peanut-paraquat symptoms. Small white spots with brown-red borders on leaves.

Images: QDPI&F

Group M
Inhibitors of EPSP Synthase (inhibits amino acid synthesis)

Glycines	
Trade name	**Chemical name**
Many including: Credit® Glyphostae® Roundup® Touchdown®	glyphosate

Description: Symptoms are most obvious at growing points within five to seven days of application.

Plants are stunted (growth stopped until recovery or death) with leaves turning yellow to red, followed by browning.

There may be some twisting of plants.

Plant looks flaccid and tend to lie on the soil surface.

Management: Ensure that herbicide drift does not occur on lentil crops.

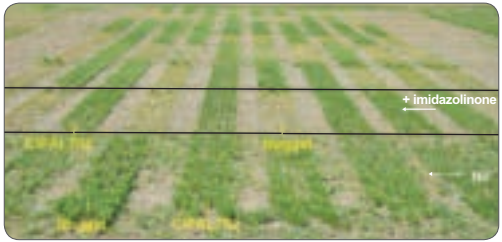
Affected lentil showing twisted, small, yellowing and dying leaves.

Image: C Preston, University of Adelaide

Herbicide (imidazolinone) tolerant line

The Pulse Breeding Australia (PBA) Lentil Program is developing lines with tolerance to imidazolinone Group B herbicides which will expand the range of broadleaf weeds that can be controlled in-crop.

It is expected that improved tolerance to Group B herbicides will improve weed control options in the rotation by reducing damage from sulfonyl urea Group B herbicides when used in preceding crops.



New tolerant line showing tolerance in imidazolinone treated plots compared to other non tolerant lines.

Agronomic work is currently underway to validate the potential of this technology.

CIPAL702 (pictured) is one of a number of Imidazolinone lines being multiplied for potential release to growers in 2011.

Tolerant CIPAL702, left, and intolerant variety, right, both with imidazolinone applied.

Images: M Materne, VDPI

Avoiding and managing herbicide resistance

Key points on resistance

1. Weed numbers – the higher the numbers the greater the risk of resistant weeds being present.
2. Each herbicide application will increase the proportion of resistant individuals in the population.
3. Resistance is generally not reversible (particularly for Group A and B herbicides).
4. The proportion of resistance in subsequent populations is not increased after the use of a herbicide if seed set is prevented.
5. Resistance occurs quickest where there is repeated use of only a limited number of weed control methods.

Management tactics

Tactic	Management	Practical issues
Deplete weed seed bank in the soil	Burn residues	Increase erosion risk on some soils
	Invert seedbank by ploughing	Only practical in deep soils
	Autumn tickle	Useful to increase weed germination
	Delay sowing	Only practical in years with an early break
	No till seeding	Keeps seed on surface from germinating
Control seedling weeds in the target area	Fallow and cultivate pre-sowing	Can increase germination of dormant weed seeds
	Herbicides	
	Knockdown herbicides	Glyphosate or paraquat plus spike for difficult to control weeds
	Double knockdown	Glyphosate followed by paraquat three to four days later
	Pre-emergent herbicides	Trifluralin (Group D) + Dual® Gold (Group K) or Avadex® (Group E) mix

Tactic	Management	Practical issues
	Selective post-emergent herbicides	Group A herbicides applied when weeds small and actively growing Clearfield™ system Atrazine and simazine application to triazine tolerant varieties
	Non-selective post-emergent herbicides	Glyphosate application to Roundup Ready® varieties Glufosinate application to InVigour® varieties
	Crop competition	Sow early using narrow row spacing Ensure correct sowing depth and good seed soil contact for rapid and even emergence
Stop weed seed set	**In crop weed management**	
	Cut for hay	This may be the best longer term option where there are high numbers of resistant weeds
	Windrowing	Will reduce seed set
	Spraying with non-selective herbicides	Apply glyphosate during the windrowing operation to kill surviving plants/stop seed set
Prevent viable weed seeds being added to seed bank	Weed seed collection at harvest	May be impractical; slowing harvest, demand on header power, disposal of weed seeds
	Weed seed destruction at harvest	Not yet available; greater power requirement; degree of effectiveness
	Narrow header rows	Enables header rows to be burnt
Prevent introduction of viable weed seed	Sow weed-free seed	
	Clean farm machinery and vehicles	
	Prevent introduction in hay and grain	

Lentils should be self sufficient for nitrogen if well nodulated. Rates of 10–20 kg/ha of starter nitrogen may be useful on lighter and slightly acid soils.

Phosphorus removal is about 4 kg/tonne of grain. A replacement application of 6 kg/tonne of grain is needed to maintain available P levels. More is required on soils such as calcareous soils with a higher buffering index.

The grain legume type fertilisers are formulated to supply sulphur needs of pulse crops. Paddocks with a history of single super or gypsum applications may have adequate sulphur.

Use tissue testing kits to monitor availability of trace elements. Zinc is required for lentils on alkaline soils. It should be applied to the soil every 2–7 years depending on soil type. Manganese is sometimes required for lentils on highly alkaline soils or under fluffy soil conditions. Foliar applications of iron are sometimes required for lentils grown on highly alkaline soils, wet soils. Lentils may respond to molybdenum in soils that are deficient.

Healthy crop.

Image: W Hawthorne, Pulse Australia

As for other crops, lentils need an adequate supply of both the major and minor nutrients for growth and to maximise yield. When grain is harvested from the paddock, nutrients are removed in the grain in the following amounts.

The main deficiencies encountered in lentils are of:

Nitrogen	When nodulation is poor or ineffective (e.g. in acid soils)
Phosphorus	On high production or calcareous ground with inadequate history of phosphorus input
Zinc	On many southern Australian cropping soils
Manganese	On soils with high lime content

Toxicity

Lentils are affected by salinity and boron levels encountered in sub-soils in many areas in the southern cropping zone in Australia. Lentils are very sensitive to boron and salinity toxicity, exhibiting symptoms at lower soil levels than seen in cereal crops. They are also very sensitive to aluminium and manganese toxicity which affects acidic soils generally unsuitable for lentils.

Guide to nutrient removal in one tonne of lentil grain

Major nutrients (kg)			Minor nutrients (g)		
Nitrogen	N	40	Copper	Cu	7
Phosphorus	P	3.9	Zinc	Zn	28
Potassium	K	8	Manganese	Mn	14
Sulphur	S	1.8			
Calcium	Ca	0.7			
Magnesium	Mg	0.9			

Affect of boron toxicity on lentil leaves in PBA screening trial.

Image:
M Materne, VDPI

Iron deficiency

Description: Often appears in young plants related to soil type where there is a high lime content in cold wet conditions. Plants often recover as conditions warm.

Deficiency shows up as chlorotic leaves and poor growth. New leaves and young growth become yellow, causing smaller and unfolded leaves. Deficiency then spreads to older leaves, and young growth stops. Stems become slender and shortened.

Management: Iron deficiency can be transient, and foliar iron applications may not necessarily be absorbed into the leaf if symptoms are severe. Avoid high pH calcareous soils.

Iron deficiency.

Image: W Hawthorne, Pulse Australia

Manganese deficiency

Description: Is common on highly alkaline, calcareous soils. Is worse on fluffy soils, and wheel tracks are not as badly affected.

Is often worse on fluffy soils.

Deficiency late in the season may lead to discolouration, splitting and deformity of seeds.

Management: Apply manganese at seeding in fertiliser, on the seed or as foliar application.

Image: N Wilhelm, SARDI

Yellowing between the veins of young leaves.

Nodulation failure

Description: Signs of nodulation failure are plants that become yellow or pale green with restricted growth, especially during cold wet periods through the seedling stages. Oldest leaves are worst affected.

There are none or few nodules on roots, or nodules lack red pigmentation inside.

Plants can appear normal until flowering on soils with moderate to high nitrogen levels, but then become pale green, with older leaves being affected most and first.

Management: Apply nitrogen needs of affected crops with N fertiliser if economic. Ensure future crops are adequately covered with viable Group F inoculum.

Nodule score	Distribution and number of effective nodules	
	Crown/ Tap root	Laterals
0	0	0
0.5	0	1–4
1	0	5–9
1.5	0	10 or more
2	Few	0
2.5	Few	Few
3	Many	0
4	Many	Few
5	Many	Many

Healthy nodulation showing active signs of nitrogen fixation (pink colouring).

Image: Professor J Howieson, Centre for Rhizobium Studies & National Rhizobium Program, GRDC

Frost

Description: Frost during flowering and podding can cause significant yield loss and damage to the grain. During flowering plants will drop flowers and abort setting pods after a frost. During pod filling frost can damage the seed coat and the kernel. Seed coats are generally finely wrinkled, may closely adhere to the kernel and show discolouration. Seed coats vary in colour depending on the extent of damage, but are usually darker in colour. Frost on immature grain causes small and thin grains with poor colour, while frost on well developed grains does not affect grain size, but causes poor colour. Frosted grain might also be classified as wrinkled or shrivelled grain.

Management: Sowing later or using later maturing varieties will help reduce the risk of frost. Rolling or claying sandy surface soils will reduce the severity of frost. Sowing in a north-south direction might reduce frost risk, as would sowing down hill to channel cold air. Avoid sowing in areas particularly prone to severe frost damage.

Normal (top) and frost damaged seed.

Image: M Materne, VDPI

Wrinkled seed

Wrinkled seed arises from stress during the maturation phase that causes visible damage to the seed coat. The seed coats must be significantly indented into the kernel and appear as coarse waves rather than soft waves. Seed coats may thus loosely adhere to the kernel (loose seed coat). Seed coats with a slight degree of indentations are not classified as wrinkled. A distinct ridge on the seed coat must be present to be classified as wrinkled.

Heavy rain at maturity can cause wrinkled, bleached and brittle grains with loose seed coats.


Examples of wrinkled seed.

Loose seed coat

Loose seed coat damage is caused by weather conditions prior to harvest, such as rain near harvest. It may also be due to poor handling or harvesting techniques. It results in breakage or cracking of the seed coat. The seed coat might be separated from the kernel or about to separate. It is the next stage to a split seed coat or skin damage.



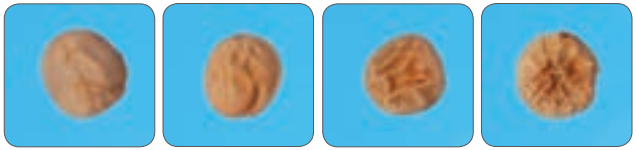
Examples of damaged seed coat.

Images: M Schilling, Northern Yorke Processors; G McMullen, Pulse Australia

Shrivelled seed

Shrivelled seed arises from some form of stress during the maturation phase. Seed coats may be wrinkled and significantly indented into the kernel. Seed coats might thus tightly adhere to the kernel.

Seed coats vary in colour depending on the extent of the damage. Grains are often smaller than the majority of the sample. Seed coats with only a slight degree of indentations are not considered shrivelled. A distinct ridge on the seed coat must be present to be classified as shrivelled.



Normal seed, (first and second from left), and shrivelled seed (two on right).

Images: G McMullen, Pulse Australia; T Yeatman, Rural Solutions SA

Drought

Lack of growing season rainfall can lead to poor growth and very short crops resulting in difficulties harvesting. A dry Spring after adequate rains in Winter can lead to poor yields with poor grain fill and smaller grain. Warm windy weather with dry conditions in Spring can reduce flower set and yield.

Well grown crop hayed off prematurely due to moisture stress.

Hail

Description: During the vegetative stage hail can shred leaves and slow crop development. Stems may be severely bruised or cut off completely. Later, it can remove flowers and pods or flatten crops making them hard to harvest and pods can shatter in mature pods reducing yields severely.

Hail usually damages a swath through the crop.

Waterlogging in shallow soil.

Waterlogging

Lentils are one of the most sensitive crops to waterlogging.

Description: Lentils are very susceptible to even short periods of waterlogging. Damage is most severe later in the season (early flowering).

Occurs in prolonged wet weather, poorly drained soils, on shallow duplex soils and hardpans.

Plants are stunted and turn yellow to red; wither and eventually die.

Root and collar portion rot.

Waterlogged plants are stunted, turn yellow with some reddening.

Images:
W Hawthorne, Pulse Australia

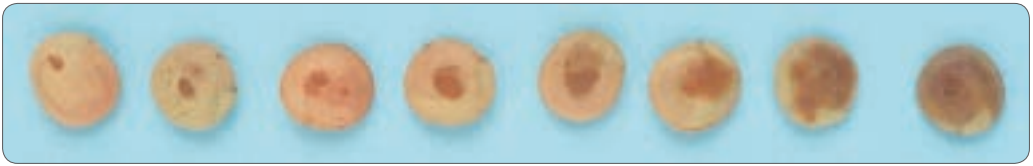
Weather damaged seed

Description: Prolonged wet weather at grain maturity can cause weather and disease staining of grain.

Weather damage is a general term to describe visible damage to the seed coat or kernel that has occurred during the maturation phase due to some form of weather event prior to harvest. Seed coats and kernels may be discoloured or altered in size or shape. Weather damage may lead to poor colour, loose seed coat, wrinkled or other defects.

Management: Harvest lentils as soon as possible.

Various weather damage in seeds.



Range of weather stained grain from slight on left to severe on right.

Images: G McMullen, Pulse Australia; Clive Palmer

Brown Pasture Looper (*Ciampa arietaria*)

Description: Larvae are up to 25 mm long, are dark brown to grey with a yellow line along the back either side of a conspicuous dark band. They have a red colouration surrounding the spiracles (breathing holes) on the sides of their body. Larvae move with a looping action except when mature. Moths are 20 mm long and are pale dusty-brown with grey and brown streaking on the forewings. Wings are held over the body at rest. One generation per year.

Larvae feed on leaves and are present from July to October. Older larvae can move in large numbers into crops from adjoining pastures, resulting in severe defoliation.

Management: Check crops after establishment particularly around the perimeter of the crop. High numbers can be found on broad leaf weeds, particularly capeweed.

Biocontrol: Glossy shield bug, spined predatory shield bug and caterpillar egg parasites.

Larva.

Adult.

Images: SARDI; DAFWA

Cutworms (Common cutworm or Bogong moth, Black cutworm, Brown or Pink cutworm and Herringbone cutworm) *Agrotis infusa*, *Agrotis ipsilon*, *Agrotis munda* and other *Agrotis* species

Description: Larvae are hairless with a greasy appearance, have dark heads and usually darkish coloured bodies, often with longitudinal lines and/or dark spots. Larvae are up to 50 mm long, curl up and remain still if picked up. Larvae live and pupate in the soil and emerge at night to feed.

A. infusa (common or bogong) larvae are black, green-brown or grey. Moths vary in colour from dull dark brown to black and have a wingspan of 30–50 mm. Moths of the Winter generation emerge in late Spring or early Summer and are often observed entering houses and buildings for shelter over Summer.

Black cutworm, *A. ipsilon*.

Brown cutworm, *A. munda*.

Bogong moth, *A. infusa*.

Images: SARDI; DAFWA

A. munda (brown or pink cutworms) larvae are greyish-green to brown without distinct markings and become darker as they mature. Moths are light to dark brown in colour with a wingspan of 30–40 mm and have one or two generations per year. Forewings have a grey-brown pattern and hindwings are whitish. Moths of other *Agrotis* spp. are usually a dull brown-black in colour. Herringbone cutworm larvae have diagonal markings.

Larvae feed at or near ground level on the leaves or stem, with large larvae often cutting through the stems of young seedlings, hence the name "cutworms". Bogong moth larvae are sporadic pests that cause damage to wheat, barley and oats in late Winter and early Spring.

Management: Check crops from emergence through to establishment. Damage is often patchy. Larvae are usually just beneath the soil surface during the day and emerge to feed at night. Check the base of healthy or recently damaged plants adjoining damaged, bare or thin areas.

Biocontrols: Orange caterpillar parasite, two-toned caterpillar parasite, orchid dupe, caterpillar fungal diseases, spiders and Bt.

Brown cutworm larvae.

Black cutworm larva and chewing damage.

Images: SARDI; DAFWA

Looper Caterpillar (*Chrysodeixis* sp.)

Description: Larvae have a predominantly green body that tapers towards the head. Newly hatched larvae have dark heads. Older larvae have white lines running the length of the body and are up to 35 mm long. Larvae move with a distinctive looping action and have two pairs of abdominal prolegs. Moths are up to 40 mm long, mottled grey or brown with distinct silvery and irregular shaped markings on the forewings. Several generations occur from Autumn to Spring.

Larvae feed on leaves leaving large holes.

Management: Larvae may be noticed when checking for other pests but do not require special attention.

Biocontrol: Glossy shield bug, spined predatory shield bug, tachinid flies, orange caterpillar parasite, two-toned caterpillar parasite, orchid dupe, Bt and NPV.

Larva.

Adult.

Images: DAFWA; P Reid, QDPI&F

Lucerne Seed Web Moth (*Etiella behrii*)

Description: Newly hatched larvae are approximately 1 mm in length and are light orange. As larvae develop, their body colour changes to a pale green, sometimes cream, with distinctive pink stripes. Mature larvae are up to 10–12 mm long and pinkish red in colour. Adults are grey, 10–15 mm long with a protruding beak.

The forewing has a distinctive white stripe running along its full length. At rest, the wings are folded over the body making the moth appear long and slender. Up to three generations occur per year from Spring to Autumn.

Larva.

Adult.

Eggs are commonly laid in the calyx of developing pods. Larvae bore into pods within a short time of hatching and begin feeding on developing seeds. This results in yield loss and a reduction in quality. Larvae have the ability to web several pods together to continue feeding.

Management: Regular monitoring for adults using a sweep net should occur from the onset of pod formation. Management should be based on timing insecticide application to target the presence of adult moths within the crop prior to egg lay.

The degree-day model can be used to identify the onset of significant Etiella flight activity within crops. The model requires daily maximum and minimum temperatures to be entered from June 21. From these the model identifies the date to commence spraying, when 351 degree-day units have been received.

Biocontrols: Glossy shield bug and spined predatory shield bug.

Egg on pod.

Larva in seed.

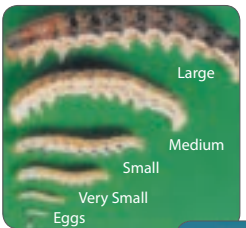
Damage to lentil grains.

Images: SARDI

Native Budworm and Corn Earworm or Cotton Bollworm (*Helicoverpa punctigera* and *Helicoverpa armigera*)

Description: Larvae of both species are up to 40 mm long with considerable colour variation (usually shades of brown, green and orange) and have lines and bands running along the length of the body. The body is sparsely covered with small bumps and bristles and long stiff black hairs. Newly hatched larvae are light in colour with tiny dark spots and dark heads. As larvae develop they become darker in colour and the darker spots become more obvious. Both species of *Helicoverpa* have four pairs of abdominal prolegs in addition to a pair of anal prolegs.

It is possible to distinguish between *Helicoverpa* species for medium and large larvae, pupae and adults. *H. armigera* have white hairs around the head, medium larvae have a saddle of darker pigment on the fourth abdominal segment (see photo) and dark coloured legs.

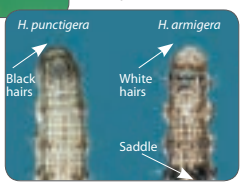


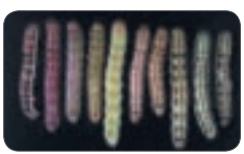
Size categories

Large (23 mm plus)
Medium (7-23 mm)
Small (3-7 mm)
Very small (1.5-3 mm)

Eggs

Note: false legs, size and colour variation in caterpillars.





Range of colours.

Male (top) and female (bottom).

H.punctigera have black hairs around the head (see photo), medium larvae have no saddle and light coloured legs.

Moths with a wing span of 30 mm, forewings are buff olive to red brown with dark spots and blotches near the edge. *H. punctigera* are pale with a uniform dark band along the lower edge of the hindwing, while *H. armigera* have a small light or pale patch in the dark band.

The eggs are 0.5 mm in diameter and change colours from white when laid, to brown and then to a black before hatching. *H. punctigera* is more common in the southern region than *H. armigera*.

Damage: Larvae are typically seen feeding high up on plants with their heads buried in buds, flowers, fruiting parts and seeds. Less serious damage occurs when larvae chew on leaves. Larvae of all sizes damage seed pods.

Management: Eggs are most commonly laid on the top third of the plant and growing points. Crops need to be monitored closely for larvae from budding and flowering through to maturity. A sweep net should be used from early flowering and throughout podding.

Biocontrol: On larvae – glossy shield bug, spined predatory shield bug, damsel bug, assassin bug, tachinid flies, orange caterpillar parasite, two-toned caterpillar parasite, orchid dupe, Bt, NPV, caterpillar fungal diseases, lacewings and spiders. On eggs – damsel bug, caterpillar egg parasites, ladybird beetles, lacewings and spiders.

Image: SARDI; L Turon & M Cahill, QDPI&F; DAFWA

Seeds damaged by caterpillars feeding within the pod.

Mandalotus Weevil (*Mandalotus* spp.)

Description: Adults are 3–5 mm long, round and dull brown in appearance resembling small clods of dirt. Occurs mainly on rubbly, lighter or calcareous soil types. Commonly found in the mallee districts of southern Australia, but can be found in other regions. Little is known about their life cycle. One generation a year.

Adults actively feed at night on leaves of young seedlings resulting in scallop shaped notches. In severe cases seedlings often ring-barked at ground level causing them to drop. During the day they hide under clods of dirt and trash.

Management: Major damage occurs after emergence and crops should be regularly inspected. Monitoring and control should be conducted at night when adults are most active.

Adult.

Damage.

Images: CESAR; C Bell, Rural Solutions SA

Bluegreen Aphid (*Acyrthosiphon kondoi*)

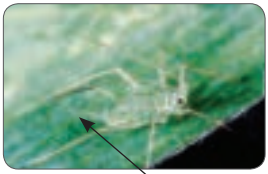
Description: Adults are 3 mm long, may have wings, vary from grey-green to blue-green and have two long siphuncles that extend beyond the base of the abdomen. They are normally found on the upper part of the plant, particularly on growing points. Nymphs are similar but smaller in size.

They can vector plant virus diseases. Adults and nymphs suck sap causing misshapen leaves, yellowing and stunting. Honeydew and black sooty mould can occur with high numbers.

Management: This pest is more common in cooler months but check all stages of crop.

Biocontrols: Aphid diseases, aphid parasites, ladybird beetles, hoverflies and lacewings.

Winged adult.



Non-winged adult. Note the two long siphuncles.

Infestation, note white skin casts.

Images: SARDI; DAFWA

Cowpea Aphid (*Aphis craccivora*)

Description: Adults are up to 2 mm long, may have wings, and are shiny black. Nymphs are dull grey, but all stages have white and black legs. They form dense colonies on the growing points of a single plant before moving on to other surrounding plants.

Heavy infestations deform leaves, growing points and stunt plants. Very dense colonies may cause visible wilting and severe yield loss. Honeydew and black sooty mould can occur with high numbers. This aphid can vector many plant virus diseases.

Management: Check through all crop stages especially during flowering.

Biocontrols: Aphid diseases, aphid parasites, ladybird beetles, hoverflies and lacewings.

Non-winged adults, nymphs and cast skins.

Winged adult.

Images: SARDI

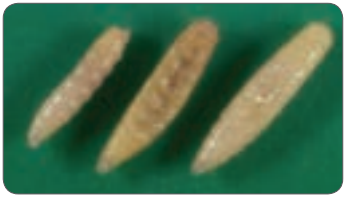
Onion Maggot (*Delia platura*)

Description: Maggots are typical fly larvae up to 7 mm long cream with a thickened tail, and tapering front with a modified head region and visible dark mouth hook.

Larvae tunnel in the stem and root, often causing death of the plant in association with rotting organisms.

Management: Check crops at emergence and early growth. Crops sown into paddocks with large quantities of plant stubble and debris will be more at risk. More severe damage may be seen on previous years stubble rows.

Adult.



Maggots.

Images: PaDIL; SARDI

European Earwig and Native Earwig (*Forficulina auricularia* and *Labidura truncata* plus other spp.)

European Earwig

Description: Adults are up to 20 mm long, with a smooth flattened body and a pair of pincers at the end of the body. They are shiny brown with distinctive yellowish legs, pincers and shoulder margins. Pincers are long and straight for females and curved for males. Nymphs resemble adults but are paler and wingless.

Earwigs are largely nocturnal and feed on leaves and stems, sometimes down to ground level. Mainly on heavy soil types. Typical earwig damage is irregular shaped holes in leaves. They can also chew pods, reducing seed development and can contaminate windrows at harvest.

European earwigs, male (left), female (right).

Native earwig, *L. truncata.*

Native Earwig

Description: Are similar to European earwigs but are reddish-brown with darker abdomens and pincers. Native earwigs are polyphagous; they generally do not damage plants but can potentially be pests. *L.truncata*, the common brown earwig prefers soft-bodied insects and is a predator of caterpillars and may also attack redlegged earth mite and lucerne flea. It can be distinguished by the presence of an orange triangle behind the head on the wing case (elytra).

Images: CESAR; DAFWA

Onion Thrips, Plague Thrips and Western Flower Thrips (*Thrips tabaci, Thrips imaginis* and *Frankliniella occidentalis*)

Description: Adults are 2 mm long, cigar-shaped and range in colour from yellow-orange to dark grey. They have tiny, narrow wings carried over the back. Nymphs are similar in shape, pale yellow to orange-yellow, wingless and smaller in size. Species differentiation is extremely difficult in the field.

Adults and nymphs pierce plant tissue and suck sap. Their impact on crops is minimal, even with occasionally high numbers.

Management: Check seedling and flowering crops. Shake flowers over a white surface or container to dislodge thrips.

Typical thrips body shape.

Thrips on weeds.

Images: DAFWA

Lucerne Flea (*Sminthurus viridis*)

Description: Adults and nymphs are yellow-green, wingless and globular in shape. They can have dark markings. Adults are up to 3 mm in length. They spring off vegetation when disturbed using a special organ under the body. Mostly found on loam/clay soils.

The pests work up the plants from ground level and leave distinctive damage of transparent "windows" on the leaves. In a severe infestation all green material may be removed. They are present from Autumn to Spring, with numbers tending to peak in late Spring.

The lucerne flea is a more serious pest of young crops but can also be damaging to older crops. It is important to check for insects and damage in paddocks with high humidity and moisture.

Management: Regularly check for damage from Autumn to Spring. Control is generally achieved with organophosphate insecticide but they are more tolerant to a range of synthetic pyrethroids. When mites are also present, use a product to control both pests A border spray will stop invasion from neighbouring paddocks.

Treat the infested area approximately three weeks after lucerne flea is first observed from regular monitoring on the crop to allow for over-Summering eggs to hatch but before they lay Winter eggs. Control lucerne flea in the season prior to growing lentils.

Biocontrols: The pasture snout mite and the spiny snout mite prevent outbreaks of this pest when sufficient numbers are present.

Adult.

Distinctive leaf damage.

Images: CESAR

Balaustium Mite (*Balaustium medicagoense*)

Description: Adults grow up to 2 mm long and are variable in colour, but mainly dark red-brown with characteristic short stout hairs covering the body. They have eight red coloured legs. Newly hatched nymphs have six legs and are bright orange in colour.

Mites feed on the leaves of plants by probing into the surface cells with their mouth parts, and sucking out sap. Leaves may become bleached with high mite numbers, but plants are usually able to outgrow the damage. In severe cases plants will be retarded or die.

Crops sown into paddocks, with high levels of broad leaf weeds, especially capeweed, will be most at risk from mite damage.

Management: Check crops from March to early December, particularly in paddocks with a history of chemical treatments for redlegged earth mites. They have been shown to be more tolerant than RLEM to a range of synthetic pyrethroids and organophosphates.

Image: DAFWA

Adult.

Blue Oat Mite (*Penthaleus* spp.)

Description: Adults are 1 mm long and have eight red-orange legs. They can be identified by their dark blue-black bodies with a distinct oval red/orange spot on the back. They generally feed singularly. This pest is active from Autumn to late Spring and is widely distributed across southern Australia.

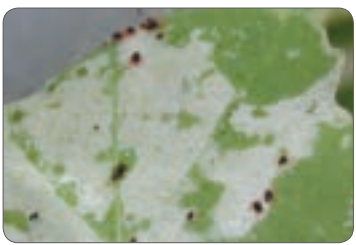
Feeding causes a silver or white discolouration of leaves and distortion or shrivelling if severe. Mites are most damaging to emerging crops, greatly reducing seedling survival and development.

Management: Check paddocks prior to sowing in Autumn and throughout Winter. Examine plants for damage and search for mites on leaves and on the ground, especially in late sown crops.

Biocontrols: The French Anystis mite is an effective predator but is limited in distribution. Snout mites will also prey upon this pest and help keep populations in check.

Some are more tolerant than RLEM to a range of synthetic pyrethroids and organophosphates insecticides.

Adult.



Feeding damage.

Images: CESAR

Clover Mite or Bryobia Mite (*Bryobia* spp.)

Description: Adults are about 0.75 mm in length, have an oval shaped and flattened body. They have a brown to fawn-orange coloured body and eight pale orange legs. The front legs are 1.5 times the length of their body. They are most active in warm conditions in Autumn, Spring and early Summer. These mites are generally found in low numbers over the Winter period. Summer rains followed by warm mild Autumns give *Bryobia* mites the best conditions for survival and increase.

Mites feed on the upper surfaces of the leaf by piercing cells and sucking out the contents. They cause distinct whitish grey feeding trails on cotyledons and leaves. Attack on newly emerged leaves can result in discoloured leaves, which fail to grow.

Management: Mites are difficult to find when conditions are wet. Check during the warmer part of the day when mites are most active. Look for damage and the presence of mites on clovers and *Brassica* weeds before sowing and examine crops at emergence. Early control of Summer weeds in paddocks that are to be cropped will prevent the build up of mite populations.

If in large numbers, the incorporation of insecticide with herbicide immediately prior to sowing is a more effective control strategy than spraying when the crop is emerging and has very little cover of green material.

Organophosphate–based chemicals reportedly give better control over *Bryobia* than synthetic pyrethroids. Rates of insecticides commonly used to control RLEM are generally not effective against *Bryobia* mites.

Adult. **Image:** CESAR

Redlegged Earth Mite (*Halotydeus destructor*)

Description: Adults are 1 mm long and have eight red-orange legs. Adults and nymphs have a velvety black body. Newly hatched mites are pinkish-orange with six legs and are only 0.2 mm long. Redlegged earth mites generally feed in large groups of up to 30 individuals. Mites are active from Autumn to late Spring and are found in southern Australia, but not in northern NSW.

They also feed on a range of weed species including Paterson's curse, ox-tongue and capeweed. Feeding causes a silver or white discolouration of leaves and distortion or shrivelling in severe infestations. Affected seedlings can die at emergence with high mite populations.

Management: It is especially important to inspect crops regularly in the first three to five weeks after sowing. When disturbed during feeding they will drop to the ground and seek shelter. They will crawl into cracks in the ground to avoid heat and cold. Mites are best detected feeding on the leaves in the morning or on overcast days. In the warmer part of the day redlegged earth mites tend to gather at the base of plants, sheltering in leaf sheaths and under debris. Foliage sprays are applied once the crop has emerged and are generally an effective method of control.

Feeding aggregation.

Adult.

Biocontrols: At least 19 predators and one pathogen are known to attack earth mites in eastern Australia. The chemical impact on predator species can be minimised by choosing a spray that has least impact and by reducing the number of chemical applications. The French Anystis mite is the most effective predator but is limited in its distribution. Snout mites will also prey upon this pest and help keep populations in check.

Using cultural control methods can decrease the need for chemical control. Rotating crops or pastures with non-host crops or cultivation can reduce pest colonisation.

Feeding damage to canola seedlings.

Images: CESAR

GRDC PESTLINKS

GRDC
Grains
Research &
Development
Corporation


BLUE OAT MITE


LUCERNE FLEA

PHOTO: CESAR CONSULTANTS

DID YOU KNOW

- IT IS ESTIMATED THAT INTRODUCED INVERTEBRATE PESTS COST AUSTRALIAN AGRICULTURE MORE THAN $4.7 BILLION IN LOST PRODUCTION ANNUALLY and
- A FURTHER $750 MILLION IS SPENT ON CONTROL COSTS.

DO YOU KNOW WHAT PEST IS DAMAGING YOUR CROP OR HOW TO MANAGE IT?

FOR OPTIONS ON MANAGING PESTS IN YOUR GRAIN CROPS GO TO:

www.grdc.com.au/pestlinks

BENEFICIAL ORGANISMS

All pest populations are regulated to some degree by the direct effect of other living organisms. A wide range of beneficial organisms can be grouped into three categories:

- **Parasites** – organisms that feed on or in the body of another, the host. Most eventually kill their host and are free-living as an adult (parasitoids) e.g. aphid wasp parasites.
- **Predators** – mainly free-living insects that consume a large number of prey during their lifetime e.g. shield bugs, lacewings, hover flies, spiders, predatory mites and predatory beetles.
- **Insect diseases** – include bacterial, fungal and viral infections of insects.

Integrated pest management (IPM) in its simplest form, is a control strategy in which a variety of biological, chemical and cultural control practices are combined to provide stable long-term pest control.

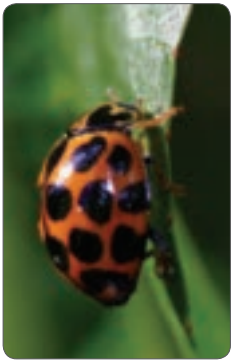
A key component of any IPM program is to maximise the number of beneficial invertebrates and incorporate management strategies other than pesticides that will help to keep pest insect numbers below an economic threshold.

Correct identification and regular monitoring is the cornerstone of IPM. When monitoring crops for insects, it is important to also check for the presence and record the build-up or decline in the numbers of these beneficials to make the best insect control decisions.

The proper use of insecticides only where necessary, together with the integration of other pest management practices to maximise the number of beneficial organisms, will result in the better control of insect pest populations and a reduced reliance on the use of insecticide.

Beetles

Adult, carabid beetle.



Common spotted ladybird.

Transverse ladybird.

Bugs

Adult, damsel bug.

Adult, glossy shield bug.

Nymph, damsel bug.

Nymph, glossy shield bug.

Nymph, assassin bug.

Nymph, spined predatory shield bug.

Images: SARDI; CESAR; J. Wessels, QDPI&F; DAFWA

Flies

Hover fly.

Tachinid fly.

Lacewings

Adult, green lacewing.

Stalked egg, green lacewing.

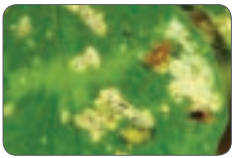
Hoverfly larva feeding on aphids.

Adult, brown lacewing.

Brown lacewing larva feeding on an aphid.

Images: SARDI; DAFWA; CEASAR

Mites



Snout mite next to redlegged earth mite and lucerne flea.

Anystis mite fungal diseased aphid redlegged earth mites.

Caterpillar wasps

Helicoverpa larva being parasitised by an orange caterpillar parasite wasp.

Wasp larva on noctuid caterpillar.

Telenomus wasp parasitising *Helicoverpa* eggs.

Trichogramma wasp.

Two-toned caterpillar wasp parasite.

Banded caterpillar wasp parasite.

Orchid dupe.

Braconid wasp (*Microplitis demolitor*) parasitising a caterpillar larva.

Images: D Ironside, QDPI&F; VDPI; P. Reid and C. Mares, QDPI&F; NSW Agriculture

Aphid wasps

Aphidius ervi on bluegreen aphid.

Trioxys complanatus wasp.

Parasitised aphid (mummy on the left).

Aphid mummy with parasite exit hole.

Spiders

Wolf spider.

Jumping spider.

Images: SARDI; DAFWA; D Paul, University of Melbourne; CESAR

Insect diseases – viral and fungal

Bacillus thuringiensis (Bt) infected *Helicoverpa* larva

Noctuid larva showing typical v-shaped infection from *Nuclear polyhedrosis* virus (NPV).

Diseased aphids with parasitised aphid mummy (right).

Fungal diseased aphid.

Images: R Teakie, QDPI&F; DAFWA

Reticulated or grey field slug and black keeled slug

Description: The reticulated slug, or grey field slug, *Deroceras reticulatum* is variable in colour, often a light grey to fawn with dark brown markings. Slugs can grow to 50 mm long. A distinctive feature of this slug is that it secretes milky-white mucus when disturbed. The reticulated slug will reproduce at any time of the year if conditions, especially moisture, are suitable. Soils that retain moisture are most likely to harbour slugs. This species is mainly surface active.

The black keeled slug *Milax gagates* is usually black with a sharp ridge or keel down the back. This is most obvious when the slug is disturbed and its body contracts. Slugs grow between 40–60 mm in length. This species is of relatively greater importance in drier areas, such as South Australia and western Victoria. The black keeled slug tends to burrow and feeds both on the soil surface and below the ground on germinating seed embryos.

Adult reticulated or grey field slug.

Plants may fail to emerge, be eaten to ground level or irregular areas may be removed from leaves.

Management: Consider checking paddocks before seeding or crop emergence, especially those with heavy soils or previous slug problems. Slug numbers can be monitored by placing refuges that retain moisture, such as tiles, on the soil surface at a number of sites across the paddock. Counting the number under refuges should occur on mornings after moist conditions. To assess direct activity, crops should be checked on moist nights as they are emerging.

Biocontrol: Carabid beetles can play an important role in suppressing slug populations.

Adult black keeled slug.

Images: CESAR; DAFWA

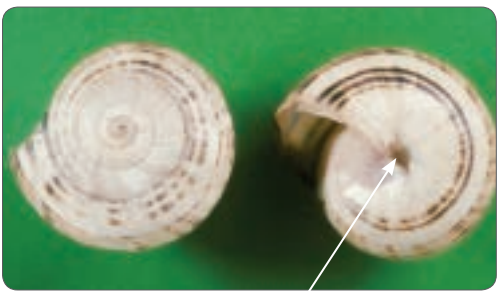
Round or white snails

Description: White Italian snail *Theba pisana* has white coiled shells up to 30 mm in diameter, mostly with broken brown bands in the line of the spiral, although some are all white. Umbilicus is semi-circular or partly closed.

Vineyard or common white snail *Cernuella virgata* has white coiled shells up to 20 mm in diameter, mostly with continuous brown bands in the line of the spiral, although some are all white. Open circular umbilicus.

Feed on green plant material and dead organic material. Leaves are shredded by rasping mouthpart of *T. pisana* and emerging crops may be defoliated. Over Summer they can be found above ground on stubble, posts, etc and especially on green weeds and can become a major contaminant of grain.

Snail	Snails over 7 mm/sq metre	Bait required kg/ha
Round or white snails	Less than 80/metre square	5 kg/ha
Conical snails	No threshold established	5 kg/ha



Theba pisana, partly closed umbilicus.

Management: Concentrate monitoring between January and April. Control tactics include stubble management (January and February), burning when fire restrictions permit and baiting in early April. Continue monitoring through growing season to detect any snail movements, particularly from the edges of paddocks.

Rasping damage.

Cernuella vergata, note open circular umbilicus and continuous brown markings.

Images: SARDI

Pointed or conical snails

Description: Pointed or conical snail *Cochlicella acuta* has fawn, grey or brown conical shells up to 18 mm long. The ratio of the shell length to its base diameter is always greater than two.

Small pointed or small conical snail *Cochlicella barbara* has fawn, grey or brown conical shells up to 10 mm long. The ratio of the shell length to its base diameter is always two or less. Most abundant in high rainfall areas.

They both feed on dead organic material. Seedlings may be eaten by *C. barbara* to ground level when in high numbers and the very small shells can be a grain contaminant. Often over-Summer in leaf litter at the soil surface or just below surface and under stones and stumps, but can be found on posts and vegetation. Build up in numbers in the pasture phase of cropping rotations.

Adult, *Cochlicella acuta*.

Adult, *Cochlicella barbara*.

Management: Concentrate monitoring between January and April. Control tactics for *C. acuta* include stubble management (January and February), burning when fire restrictions permit and baiting in early April.

Continue monitoring through growing season to detect any snail movement, particularly from the edges of paddocks.

Biocontrol: Sarcophagid parasitic fly *Sarcophaga penicillata*.

Conical snail infestation.

Images: SARDI

Salinity

Description: Lentils are highly sensitive to salinity.

Plants are stunted with yellowish discolouration followed by bright red pigmentation. Nodulation is poor or not present. Where severe, seedlings fail to emerge.

Where the water table rises after establishment, the crop stops growing, leaves drop and plants die.

Management: Avoid sowing on areas at risk or irrigated with saline water.

Often occurs in patches with most severe symptoms in the centre.

Stunted plants with yellowish discolouration.

Images: M Materne, VDPI

Lodging

Description: Lentils can lodge when grown excessively tall. Lentils which lodge prior to flowering have an increased foliar disease risk. Juvenile lodging can also cause shading of flowers leading to flower abortion and reduced seed set. Lodging can also occur near maturity. Lodged lentils are slower and more difficult to harvest, and lead to greater grain losses. Harvest direction may have to be adjusted to pick up the crop. Lodged lentils may lead to less pod shattering or pod drop than erect lentils from strong wind at maturity.

Management: Use a more erect or shorter variety. Manage crop canopy to reduce overall crop height and bulk by delaying sowing. Avoid excessively high or low plant populations and highly fertile paddocks.

Sow into standing cereal stubble, preferably inter row, to trellis the lentils. Avoid sowing lentils in wide rows (e.g. >30 cm) unless there is standing stubble trellis present.

Lodged lentils.

Crop with dense canopy not lodged.

Images: W Hawthorne, Pulse Australia

Markets require both consistent quality and quantity of lentils.

Grain quality requirements

	Quality characteristics	Comments
Red lentils	Seed size, absence of seed coat blemishes or poor colour of splits, seed coat colour.	Seed size is important for markets (small, medium and large). Seed coat colour is less important, but it must be virtually free of blemishes and be uniform in size and colour. A grey-brown to red seed coat is most common, with dark (red-orange) coloured splits preferable to a lighter (yellow-red) colour. Poor seed coat colour may be caused by disease, weather staining, delayed harvest or frost, which may also affect quality. Green cotyledon discolouration is caused by premature ripening.
	Use	Red lentils are mainly consumed as splits or dehulled (footballs). Rounder shaped grain is preferred for improved splitting efficiency. Cereal, vetch or lentil seed from another variety are major contaminants of lentils. Insect attack at podding downgrades grain quality.
Green lentils	Seed size, absence of seed coat blemishes, seed coat colour.	Green lentils are mainly used for whole consumption so grain must be blemish free and of a consistent colour and size. Market preference for certain varieties is based on seed colour (paleness of green) and seed size.
	Optimal seed size will depend on variety.	Larger sized green lentils tend to be preferred as they are more competitive with overseas varieties on export markets. Grain that is not blemished, split, chipped or damaged by insects is important for quality.

Helicoverpa damage (top); *Etiella* damage (bottom).

Image: C Palmer

Commercial buying and selling arrangements

Variety	Commercial Partner/Licensee	Market restrictions
Aldinga	AFCA	None
Boomer(◊)	AWB Seeds	Under contract, multiple buyers
Cobber	None	None
Digger	None	None
Matilda	None	None
Nipper(◊)	AWB Seeds	Under contract, multiple buyers
Northfield	AFCA	None
Nugget	PlantTech Pty Ltd	Under contract, multiple buyers
Tiara	AWB Seeds	Under contract, multiple buyers

*(current as of September 2008)

As with all pulses, quality and appearance is of prime importance.

Lentil varieties may not necessarily be covered by PBR, but many have a number of different types of seed purchase agreements and royalty/marketing or levy arrangements that impact on marketing and sale of seed for sowing. Check any royalty/marketing arrangements and restrictions for that variety with the seed agent before purchase.

Images: L McMurray, SARDI

Receival standards

The national receival standards for lentils are set by the pulse industry for Pulse Australia. Number 1 grade reflects market requirements for a quality food product. Varieties are segregated with only 1% off-type varieties allowed. Delivery requires minimal discolouration or staining of seed coat (1% maximum) and lentil kernel (maximum 1% poor colour), as well as minimal insect damage or breakage (defectives 3% maximum) and minimal foreign material or impurities (3% maximum). Sizing through round and slotted screens may also occur. Failure to achieve lentils that meet these receival standards may mean price discounts, re-cleaning or even market rejection if severe. A number 2 grade standard has recently been set to assist delivery and marketing of product that just misses number 1 grade quality.

	Maximum moisture content (%)	Minimum purity (%)	Maximum defective plus poor colour (%)	Screen size for defective (mm)	Poor colour maximum (%)	Foreign material maximum in total (%)
Red lentil receival standard	14	97	4	2.00 or 2.2 slotted	1 seed coat 1 kernel	3
Green lentil receival standard	14	97	4	2.00 slotted	1 seed coat 1 kernel	3

	Unmillable material maximum	Snail maximum	Insect maximum	Nominated weed seed maximums (maximums for each type)
Red lentil receival standard	0.5 (0.3% soil)	1 per 200 g	15 per 200 g	See footnote for pulse standards
Green lentil receival standard	0.5 (0.3% soil)	2 per 400 g	30 per 400 g	See footnote for pulse standards

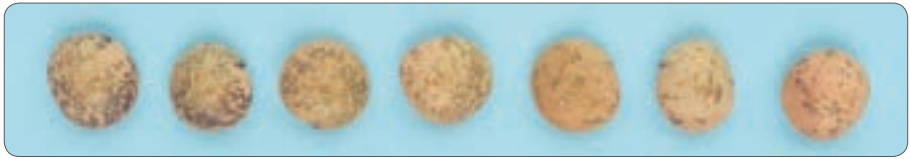
See pulse receival and export standards at <www.pulseaus.com.au/standards>

Poor colour

A poor colour seed coat or cotyledon is distinctly off colour from the characteristic colour of the variety. Both are important, and may be caused by delayed harvest, rain at harvest, disease (ascochyta and botrytis grey mould), frosting, a dry finish, premature ripening or poor storage.

Seed coat flecking is not considered poor colour.

Range of discolouration.



Flecking is not poor colour but a genetic attribute.

Images: G McMullen, Pulse Australia; Clive Palmer

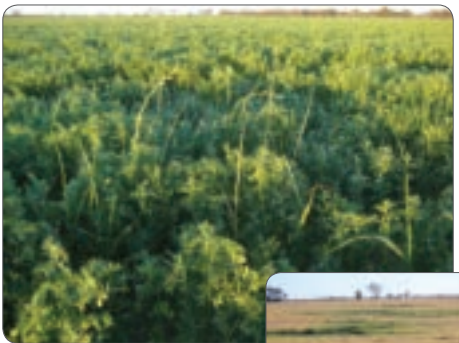
Desiccation and crop topping

Desiccation ensures even ripening of the crop for earlier and easier harvest, or to 'brown off' late weed infestations to improve the ease of harvest. Apply when greater than 80% of pods have turned from yellow to brown on the majority of plants to minimise loss of yield and quality.

Crop top to control seed set of weeds, normally rye grass. Timing is determined by the growth stage of the grass and the herbicide to be used. Crop top as late as practical to minimise reduction in yield and quality. The crop should be starting to turn yellow/brown and ideally finished flowering with well formed seeds in the pods. Crop topping too early can affect grain quality, causing green kernels or seed coat blemishes from premature ripening of late developing pods. Earlier maturing varieties are more easily crop topped. Green lentils can be safely sprayed before red types.

Coloured foam markers can stain lentil seed through the pods.

Observe all withholding periods to avoid grain residues.



Crop topping will prevent ryegrass setting seed.

Uneven ripening.

Images: T Yeatman, Rural Solutions SA; W Hawthorne, Pulse Australia

Weed wiping

Weed wiping is used successfully in lentils to prevent weed seed set of herbicide resistant ryegrass and other tall weeds that stand above the crop. Crop height needs to be considered in choosing a variety.

Weed wiping.

Lentils can be harvested in windrows.

Windrow can be ruined by wind.

Images: Lentil Growers Guide, VDPI; W Hawthorne, Pulse Australia

Windrowing

Lentil windrows often lack bulk, have no short stubble to sit on, are difficult to pick up from the bare ground, and tend to be blown around in strong winds when left to dry. Some growers place wide swathes into a bulkier windrow and use a 'cotton wheel roller' to compact the windrow. Windrowing directly in front of the harvester has been used as an aid to harvesting short crops or to reduce snail contamination in the sample. It needs to be in cool, dewy conditions to prevent pod loss or shattering. Windrowing too early can affect grain quality, causing green kernels or seed coat blemishes from premature ripening of late developing pods. The taller and larger variety Boomer(ᵇ may be more suited to windrowing than other varieties but care is still required.

Timing of harvest

Lentils can be delivered at up to 14% moisture content where aeration is possible, aiding early harvest.

Early harvesting maximises quality. Crops harvested even a few days later when conditions are very dry, have a far greater proportion of split and broken grain (defectives) and increased levels of ascochyta blight and weather damage. Lodging also occurs and seed becomes brittle, discoloured, prone to mould, and germination is reduced. Harvest efficiency is also dramatically reduced.

Often the difference between a crop that is easy to reap and one that is more difficult is 2 to 5 days. Uniformity of ripening and earlier harvest date can be influenced by desiccation, crop topping or windrowing lentils at the correct growth stage.

Harvesting lentils.

Image: R Ruwoldt

Lentils ripen quickly, but unevenly. Seed that develops from first flowers (lowest pods) mature before seed from the later flowers (top pods). Some foliage or stem may still be green when the crop is ready to harvest. Harvest when the lower pods have turned a pale brown colour and their seeds rattle in the pods. Seed moisture content of 15% is satisfactory, although seed needs to be at 12 or 13% for safe storage.

Crops that remain upright at maturity are more prone to pod drop during windy conditions, so early harvest is essential. Standing stubble may give some wind protection.

Boomer ® markets prefer a large sized seed with bright green colour free of environmental blemish and staining. Delayed harvest can result in poorer seed colour and blemished seed. It is more prone to shattering than other varieties and delayed harvest can result in seed loss and reduced grain yield.

Air system to assist harvest.

Draper front.

Short lentil lifters and air assist.

Images: W Hawthorne, Pulse Australia

Harvesting

Harvest at ground level to get the lentil crop into the comb. It can be challenging with lodging or a relatively low crop height varying from 15 to 50 cm. All except very short crops will show some lodging at or after maturity. Some varieties are more erect than others. Lentils sown inter-row into standing cereal stubbles tend to stand taller and remain more erect at harvest.

Tips for harvesting

- Harvest as soon as possible, delays can be costly.
- Harvest early in the day or in the evening; humidity reduces seed shatter.
- Flex or pick-up fronts give best results under a range of conditions.
- Blowers or a vortex reel enable harvesting lower to the ground ensuring good crop feed.
- Air assist, short crop lifters and double fingers improve harvest efficiency.
- Open fronts can harvest lentils successfully if an even paddock surface and the crop canopy is dense and free of weeds. Crop lifters are required.
- An extended cutter bar table and air assistance will reduce harvest losses.
- Harvest lodged crops into or across the direction in which the crop lies.
- Thinner, shorter or lodged crops are more challenging; harvest direction may have to be one-way.
- Harvest speed should not be excessive to minimise the likelihood of splitting and damaging the grain.
- Use a desiccant if Summer weeds prevent early harvest.

Harvest performance poor in wheel tracks.

Image: W Hawthorne, Pulse Australia

Harvesting for quality

Visual appearance of the final product is critical for lentils. Human food markets demand a quality sample without chipping, cracking, de-hulling, staining or insect damage. Early harvest is important for quality.

Larger green lentil types or dry grain are more prone to splitting during harvest and handling than smaller red lentils or those at desirable moisture (12–13%). Set up harvesters to minimise cracking.

The larger seed of green lentils make them prone to mechanical damage. Harvest early morning with a low drum speed and a wide concave clearance.

Axial or rotary harvest drums cause much less seed damage. Use minimum drum speed, a concave setting fully open at the front, and half closed at the back. Lentil seed is heavy compared with stem and leaf trash, so it is safe to use draft to remove trash.

Image: W Hawthorne, Pulse Australia

Harvesting for seed

To ensure maximum germination and minimal disease carryover choose an area of a paddock where there has been minimal disease, pest and weed infestation. Ensure that headers, bins, augers and other equipment are free of cereal contamination as these grains are hard to remove during cleaning.

Harvesting settings critical to maintain quality grain.

Lentil seeds are more prone to mechanical damage than most other pulses. Belt shifters are preferred. Minimise handling. When using screw augers run the auger full and slower than for cereals.

Stored seed should be no more than 13% moisture. If higher, aeration in storage will prevent spoilage. Moving moist grain on a warm, dry day between two silos will reduce the moisture content by 1–2%. Dry them, cool them, store them in the dark, and sell them as quickly as possible.

Damage to silo side walls and even collapse can occur when emptying silos of stored lentils. Store lentils in field bin type silos only (those with low walls) or only partially fill taller silos. Unload lentils slowly and in smaller amounts than other crops.

Grain hygiene is important. Contaminants such as insects, weeds or other grains are undesirable. Animal excreta, rodent carcasses and mouldy grain are unacceptable.

Sound sheds, bunkers and silos are suitable storages for lentils. Silo bags should only be considered as short term storage because discolouration of the lentil grain can occur, moisture may be difficult to handle, and the plastic can be holed by birds, vermin or pests.

Check regularly for insects or mould or other problems in stored grain.

Belt shifter to safely move and elevate lentils.

Image: W Hawthorne, Pulse Australia

Bold type indicates an image

PBA
PULSE BREEDING AUSTRALIA

PULSE BREEDING AUSTRALIA

To deliver superior pulse varieties faster, **Pulse Breeding Australia** (PBA) focuses on:

- excellent leadership and communications;
- accessing reliable market signals;
- accessing elite germplasm and enabling technologies;
- a proficient and cost effective breeding process; and
- ensuring rapid adoption of newly released varieties.

The establishment of **Pulse Breeding Australia** provides a single world-class breeding and germplasm enhancement program for chickpeas, field peas, faba beans and lentils in Australia.

By sharing germplasm, technologies and intellectual property across all states, **PBA** delivers to Australian growers new pulse varieties that have better disease resistance, are higher-yielding and are adapted to Australian conditions.

Better pulse varieties faster

Pulse Breeding Australia
c/o GRDC
PO Box 5367,
Kingston ACT 2604

grdc@grdc.com.au
02 6166 4500

FOR MORE INFORMATION

Lentils

Dr Michael Materne
DPI Victoria
03 5362 2312
michael.materne@dpi.vic.gov.au