SOUTHERN
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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

LENTIL

SECTION 14

ENVIRONMENTAL ISSUES

KEY POINTS | DROUGHT AND HEAT STRESS | MOISTURE STRESS | WATERLOGGING | FROST | LACK OF SUNLIGHT | SOIL EROSION

Environmental issues

Key points

- **Heat waves and moisture stress can affect lentil.**
- **Lentil is most sensitive to waterlogging, particularly at flowering.**
- **Lentil seedlings are tolerant of frost.**
- **Frost can cause flower, pod and seed abortion**

FEEDBACK

14.1 Drought and heat stress

Lentil is like other cool-season pulses in its susceptibility to extreme hot (or cold) conditions, especially at flowering. Heat waves (temperatures >35°C) and water deficiency (moisture stress) can affect lentil.

Canopy development in lentil is quite rapid, especially during early sown and warmer winter conditions. At any location, seasonal variations in temperature can bring about a significant shift in flowering times for the same time of sowing (i.e. ± 10 days is possible).

On hot days, the leaves of the lentil plant fold and the stomata close in order to reduce evapotranspiration. Plants take on a 'wilted' appearance and look more blue-grey in colour. A common coping mechanism is increased pod and leaf drop.[1]

Lentil is considered a moderately drought-tolerant crop. However, it can suffer through lack of height, and hence, harvestability in drought conditions.[2] Its inability to handle moisture stress is greatest if its rooting depth is impeded by compaction or subsoil constraints (for example boron or salt). Farming systems with lentil in low or medium rainfall areas now tend to use stubble retention and, occasionally, wider row spacing to minimise moisture loss from soil before canopy closure.

When heat stress occurs during flowering and pod-filling, significant reductions can occur in yield, seed quality and subsequent profitability to the grower.

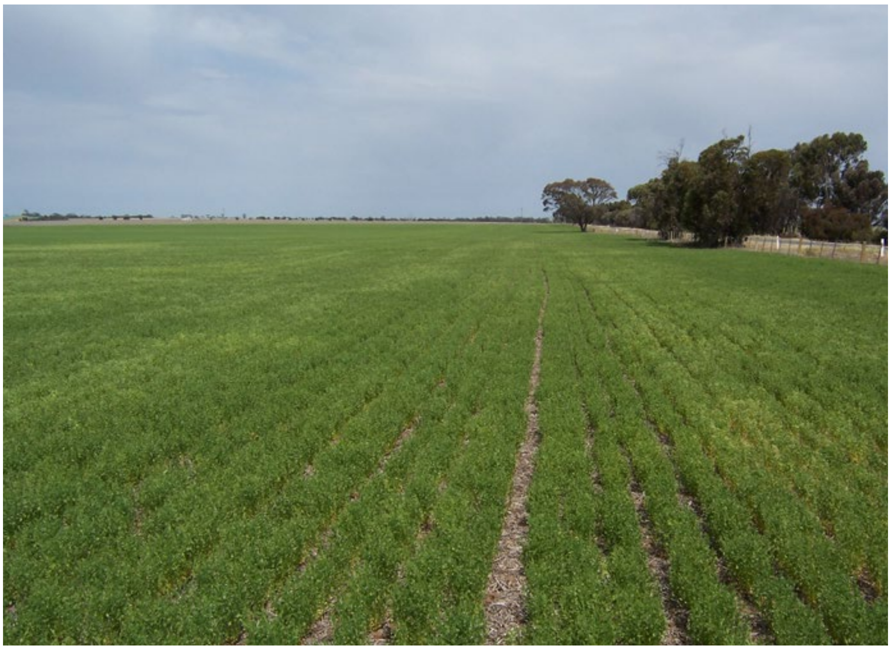

Photo 1: *Lentil showing signs of moisture stress due to competition from early weeds.*

Photo: W. Hawthorne, formerly Pulse Australia

MORE INFORMATION

GRDC Update Paper: Improving lentil tolerance to heat stress
https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/02/improving-lentil-tolerance-to-heat-stress

1 A Delahunty, J Nuttall, M Nicolas, J Brand (2015) Genotypic heat tolerance in lentil. Proceedings of the 17th ASA Conference, Hobart, http://agronomy2015.com.au/1107

2 Grains Research and Development Corporation (2016) Lentils: The Ute Guide. Grains Research and Development Corporation, https://grdc.com.au/resources-and-publications/all-publications/publications/2008/11/lentils-the-ute-guide

14.2 Moisture stress

Moisture stress in lentil influences plant height. Hence, it can affect yield and harvestability when the crop height is too short (to harvest). Timing of moisture stress relative to growth stage is important. Lentil varieties can respond individually to moisture stress depending on their general tolerance (to moisture stress), specifically at flowering.

Abortion of pods, caused by moisture stress, is usually noted on the last-formed pods in the upper parts of the plant.

Several trials have been conducted examining the effects of moisture stress on lentil, and at various stages of growth.

A stubble-management trial in South Australia showed early-maturing varieties were unable to re-flower significantly after rain.[3] Varieties with a maturity classified as anything other than 'early' were in the early-flowering stage or not flowering when the moisture deficit occurred. This meant they were less responsive to soil moisture differences related to stubble presence.

In pot experiments, water deficits reduced seed yield by up to 60% in some lentil genotypes.[4] Withholding water at flowering or podding reduced leaf area (48–55%), total dry matter (32–50%), flower production (22–55%), and number of pods and seeds (27–66%), with significantly higher flower drop and empty pods when water was withheld.

However, in some genotypes in the same trials, seed yield was increased by a temporary water deficit. This is because more flowers were produced when those genotypes were re-watered after a period of water deficit. In other genotypes, increased seed yield came as a result of podset and seedset being maintained when those lentil plants were re-watered after their period of water deficit during podding.

Photo 2: *Lentil showing signs of moisture stress.*

Photo: W. Hawthorne, formerly Pulse Australia

3 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia.

4 R Shrestha, N Turner, K Siddique, D Turner (2006) Physiological and seed yield responses to water deficits among lentil genotypes from diverse origins. Australian Journal of Agricultural Research, 57(8), 903-915 https://repository.uwa.edu.au/R/-?func=dbin-jump-full&object_id=17455&local_base=GEN01-INS01

14.3 Waterlogging

Lentil is the most sensitive of all pulse crops to waterlogging.[5] Lentil will generally not survive after periods of waterlogging, especially in cool conditions of winter. Mild waterlogging is an issue, even when foliar disease is kept under control.

Lentil is most sensitive to waterlogging at flowering. The response of lentil to waterlogging is similar to its response to low light and low temperatures; all result in flower and pod abortion and leaf senescence (drying off).[6]

This high sensitivity to waterlogging means that paddock selection with lentil is critical to minimise risks of losing the crop to 'wet feet.'

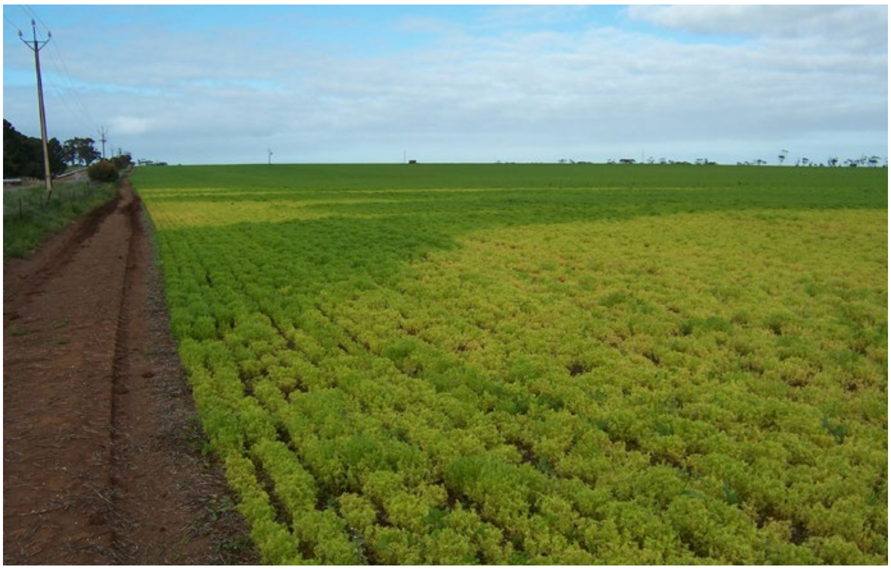

Photo 3: *Waterlogging in lentil.*

Photo: W. Hawthorne, formerly Pulse Australia

Photo 4: *Lentil dying under waterlogged conditions.*

Photo: M. Raynes, formerly Pulse Australia

5 Grains Research and Development Corporation (2016) Lentils: The Ute Guide. Grains Research and Development Corporation, https://grdc.com.au/resources-and-publications/all-publications/publications/2008/11/lentils-the-ute-guide

6 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia

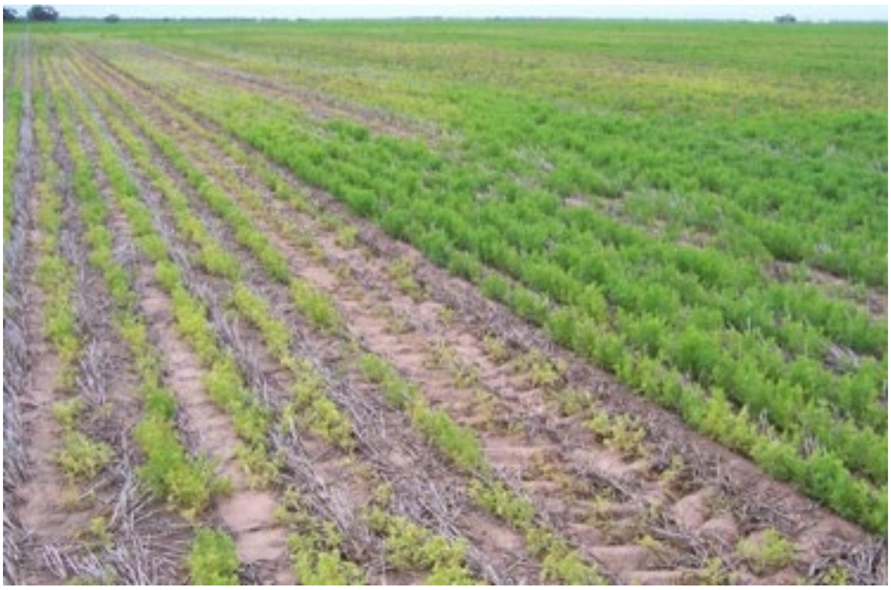

Photo 5: *Lentil growing poorly in waterlogged conditions.*

Photo: W. Hawthorne, formerly Pulse Australia

14.4 Frost

Yield losses from frost damage can be severe for a high-value crop like lentil.

Frost damage occurs when the plant is at a vulnerable stage of growth at the time of the frost. Timing is critical[7], and the level of damage depends on severity of the frost, crop sensitivity, variety maturity and sowing time. Any subsequent frosts can lead to further damage.

Frost can cause flower, pod and seed abortion. It will normally affect the smallest pods first; despite the fact they are the higher pods on the plant. Pods at a later stage of development are generally more resistant to frost than flowers and small pods. However, pods may suffer some mottled darkening of the seed coat.

Lentil has some ability to recover from frost damage by being able to regenerate new branches in severe cases. New regrowth occurs from the base of the frost-affected plants if moisture conditions are favourable.

In severe frosts, leaves are killed and the stem is wilted. If the plant is at the 1–5 node stage, there can be quick recovery from underground axillary buds. If the lentils are at the 7th node stage or beyond, plants will most likely die because axillary bud initiation will most likely not occur as the plant is moving into reproductive stages.

As well as damage to the plant and seed, frost damage can also result in an increased vulnerability to entry of pathogen (e.g. Botrytis grey mould).

Frost tolerance for lentil at flowering is –2°C to –3°C (Table 1).

Frost frequency and intensity is unpredictable. When managing frost risk, one can only work on the likelihood of a frost occurring, without knowing exactly when, or if, it will happen. On the plus side, variety specific management packages consider the probability of frost when setting out advisory planting dates.

Compared to other pulses, the lentil plant flowers later and can escape some early frosts. Lentil is a short crop and hence, can be sensitive to poor pod set or grain fill when frosts do occur. Sowing too late (to avoid frost during flowering) can lead to short crops, harvest difficulties and poor quality, if the season finishes quickly. This is

7 F Stoddard, C Balko, W Erskine, H Khan, W Link, A Sarker (2006) Screening techniques and sources of resistance to abiotic stresses in cool-season food legumes. Euphytica 147:167–186, http://www.google.com.au/

a trade-off the grower must make, between sowing early to maximise yield potential, but with a greater risk of frost affecting the flowering plant.

Frost risk is influenced by a variety of factors including:

- crop type (sensitivity, flowering date);
- crop variety (flowering date and duration);
- sowing time;
- soil type and condition;
- canopy management and row spacing;
- stubble presence;
- atmospheric and soil moisture levels;
- crop nutrition and nodulation;
- crop stress level;
- topography of land; and
- frost severity, number and timing.

Importantly, unlike chickpea, low temperatures (<2°C) are not known to cause pollen sterility in lentil.

Diagnosing frost damage

Frost damage in lentil is relatively easy to recognise and identify. Pods take on a different, 'mottled' appearance, and the grain inside becomes black and shrivelled. Damage on well-developed grains may appear 'frost burnt', leaving a stain on the sides of the grain that were exposed to the pod wall.

Severe frosts can cause a characteristic bend in the stem of the lentil plant.

Keys to success for minimising frost damage in lentil

Although it is difficult to totally minimise frost risk it is important to:

- know the period of highest probability of frost incidence;
- map the topography to show areas of greatest risk and specifically manage these areas to minimise frost damage;
- aim to reduce exposure to frost or impact at vulnerable growth stages;
- choose the appropriate variety and time of sowing;
- manage the pulse canopy. Row spacing, retained cereal stubble and small changes in temperature around the critical trigger point can assist in avoiding frost damage;
- consider planting in rows up and down a slope to increase air-flow and cool air drainage;
- understand the impact of soil type, condition and moisture status; and
- manage crop nutrition and minimise crop stress level to lessen frost damage.[8]

MORE INFORMATION

Two valuable sources of information for frost damage are:

The GRDC *Pulse & Canola – Frost Identification: the Back Pocket Guide:* https://grdc.com.au/resources-and-publications/all-publications/bookshop/2012/01/pulse-canola-frost-identification-the-back-pocket-guide-grdc046

Minimising frost damage in pulses: http://www.pulseaus.com.au/growing-pulses/publications/minimise-frost-damage

8 W Hawthorne (2007) Managing Pulses to Minimise Frost Damage. Australian Pulse Bulletin PA 2007 #01, http://www.pulseaus.com.au/storage/app/media/crops/2007_APB-Pulses-frost.pdf

Photo 6: *Lentil frosted and healthy flowers.*

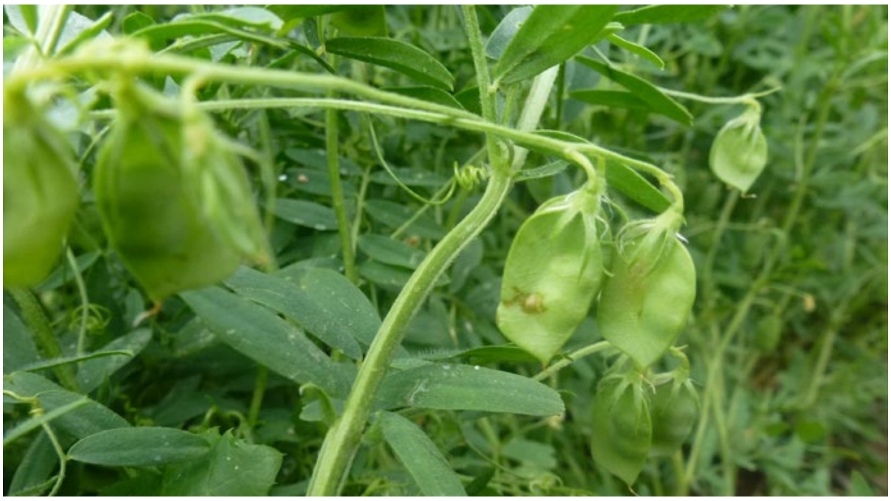

Photo 7: *Frosted spots on lentil pods.*

Photo 8: *Frosted lentil pods.*

Table 1: Range of critical damage temperatures (°C) for grain and other crops.

Crop	Germination	Flowering	Fruiting
Spring wheat	-9,–10	-1,–2	-2,–4
Oats	-8,–9	-1,–2	-2,–4
Barley	-7,–8	-1,–2	-2,–4
Lentil	-7,–8	-2,–3	-2,–4
Field pea	-7,–8	-2,–3	-3,–4
Vetchling	-7,–8	-2,–3	-2,–4
Coriander	-8,–10	-2,–3	-3,–4
Lupin	-6,–8	-3,–4	-3,–4
Spring vetch	-6,–7	-3,–4	-2,–4
Faba and Broad Bean	-5,–6	-2,–3	-3,–4
Sunflower	-5,–6	-2,–3	-2,–3
Safflower	-4,–6	-2,–3	-3,–4
Sugar beet	-6,–7	-2,–3	--
Fodder beet	-6,–7	--	--
Soybean	-3,–4	2,–3	2,–3
European yellow lupine	-4,–5	2,–3	--
Buckwheat	-1,–2	-1,–2	-0.5,–2
Rice	-0.5,–1	-0.5,–1	-0.5,–1
Tomato	0,–1	0,–1	0,–1

Source: Frost damage: Physiology and critical temperatures (undated), FAO Corporate Document Repository, http://www.fao.org/docrep/008/y7223e/y7223e0a.htm

Photo 9: *Frosted lentil pod.*

Photo 10: *Damaged lentil seed in frosted pod.*

14.5 Lack of sunlight

Lack of sunlight can be a major factor in determining the level of podset in pulses in southern Australia. A Mediterranean climate with winter rainfall dominance and a dense canopy can lead to poor podset through lack of sunlight. Total radiation, rainfall, evaporation, temperature, humidity and wind strength are all contributing factors to the level of podset.

In faba bean at least, the amount of radiation hitting the flower from when it opens and for the following 3 days is the overwhelming contributing factor to level of podset. This is regarded as likely, also, in lentil and other pulses.[9]

14.6 Soil erosion

Poor emergence is more likely with lentil on hard-setting soils and this can lead to a higher potential for soil erosion. Rolling lentil after sowing can also leave some soils prone to erosion and in these situations post-emergent rolling is preferred where possible.

Pulses make slow early growth and consequently leave the soil more susceptible to the effect of wind and water erosion than cereals. This is particularly true for lentil. Consequently, the benefits of stubble retention and limited tillage are key in growing pulses.

On light soils, pulse stubbles require careful grazing management. Stubble residues can break easily from the roots and tend to collect in heaps leaving the paddock prone to wind erosion.

On heavier soils overgrazing can create dust problems, affecting clean fleece yields.[10]

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9 F Stoddard (1993) Limits to retention of fertilized flowers in faba beans (Vicia faba L.). Journal of Agronomy and Crop Science 171 (4): 251-259, http://onlinelibrary.wiley.com/doi/10.1111/j.1439-037X.1993.tb00137.x/abstract

10 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia