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CORPORATION

# CHICKPEA

## SECTION 14

## ENVIRONMENTAL ISSUES

FROST AND TEMPERATURE ISSUES FOR CHICKPEAS | TOLERANCE TO LOW TEMPERATURE | WATERLOGGING AND FLOODING ISSUES

October 2016

SECTION 14

# Environmental issues

## 14.1 Frost and temperature issues for chickpeas

### *Effects of temperature and frost damage*

The three major factors affecting chickpeas are temperature, day length and drought. In contrast to other winter legumes, chickpeas are particularly susceptible to cold conditions, especially at flowering.

### *Frost damage to vegetative growth*

Damage is more likely to occur where the crop has rapidly grown during a period of warm weather, and is then subjected to freezing temperatures. The visible effect may occur as patches in the field, on individual plants or on branches of plants. Damage is usually more severe where stubble has been retained. Symptoms include marginal bleaching of the leaflets and a 'hockey stick' bend in branches (Figure 1). The plant could show signs of wilting and desiccation of the leaves.

Other management practices can increase the risk of frost damage, such as carry-over atrazine residues in sorghum and row orientation. Varieties can also differ markedly in their response to frost. Regrowth will generally occur where there is adequate soil moisture.

### *Frost damage to flowers and pods*

Freezing temperatures destroy flowers and young developing seed. Pods with aborted grain lose their green colour and hay-off. Pods with peas at a later stage of development are generally more resistant and may suffer only from a mottling and/or darkening of the seed coat.

### *Low-temperature flower abortion*

Low temperatures can also cause flower abortion. The most important aspect of temperature is not the maximum or minimum daily temperature but the average daily temperature. Where average mean daily temperatures are <15°C (max. temp + min. temp divided by 2), pollen viability is reduced and flowers will fail to develop into pods.

### *High-temperature flower abortion*

Temperatures >35°C cause flower abortion and may result in a lowering of yield potential due to a shorter amount of time available for seed-filling. Growers must consider planting time, and weigh up the potential yield benefits of early planting against the risk of frost and cold temperatures at flowering. [1]

**More information**

http://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/chickpeas/planting

[1] DAFF (2012) Planting chickpeas. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/chickpeas/planting

*Figure 1: Frost can cause bends like a hockey-stick in chickpea stems. (Photo: S. Loss, DAFWA)*

Late frosts also cause flower, pod and seed abortion (Figure 2). Pods at a later stage of development are generally more resistant to frost than are flowers and small pods, but may suffer some mottled darkening of the seed coat.

Frost will normally affect the earliest formed pods low on the primary and secondary branches. By contrast, pod abortion induced by moisture stress is normally noted on the last formed pods at the tips of the branches. Minimum temperatures <5°C during the reproductive stage will kill the crop, but new regrowth can occur from the base of the killed plants if moisture conditions are favourable.

*Figure 2: Frost can cause pod abortion (usually low on the stem) but the plant may set many pods late in the season if conditions are favourable. (Photo: T. Knights, NSW DPI)*

Temperatures >35°C in spring may also reduce yield in chickpea, causing flower abortion and a reduction in the time available for seed-filling. Chickpea, however, is considered more heat-tolerant than many other cool-season grain legumes.

In Australia, drought stress often accompanies high temperatures in spring, causing the abortion of flowers, immature pods and developing seeds. High levels of humidity and low light also prevent pod set. [2]

## More information

Journal article in *Crop & Pasture Science* by Devasirvatham et.al. (2012): High temperature tolerance in chickpea and its implications for plant improvement

http://www.dpi.nsw.gov.au/archive/agriculture-today-stories/ag-today-archives/may-2010/frosts-and-low-temps

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/431268/Chickpea-time-of-sowing-trial.pdf

[2] Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

See also GRDC GrowNotes (Chickpeas) Section 3: Planting and Section 4: Plant growth and physiology.

## 14.2 Tolerance to low temperature

Research overseas and within Australia has demonstrated a range of cold tolerance among chickpea varieties. In parts of the world where chickpea is grown as a spring crop because of the very cold winter, varieties have been developed that tolerate freezing conditions during vegetative growth. These varieties can be sown in autumn and survive over winter, and are ready to flower and set pods when temperatures rise in summer.

However, chickpea varieties resistant to low temperatures during flowering have not yet been found. Some genotypes from India are less sensitive than those currently grown in Australia, and these are being utilised in chickpea-breeding programs at Department of Agriculture and Food Western Australia (DAFWA) and the University of Western Australia (UWA).

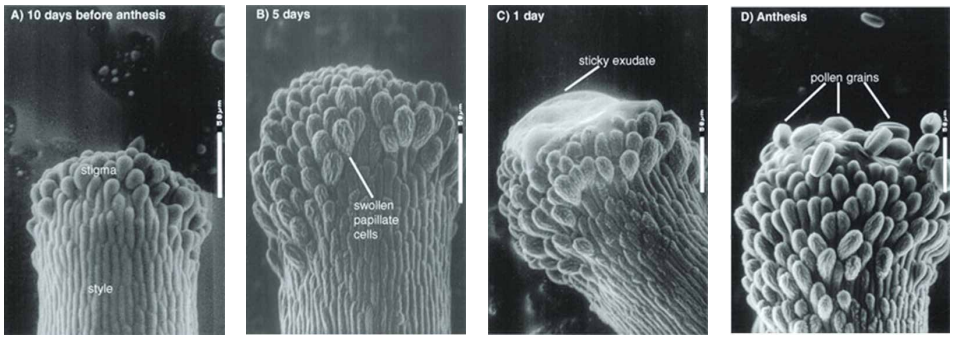


*Figure 3: Development of the style and stigma of chickpea flowers taken with an electron microscope. (Photo H. Clarke, UWA)*

Controlled environment studies at University of Western Australia have identified two stages of sensitivity to low temperature in chickpea. The first occurs during pollen development in the flower bud, resulting in infertile pollen even in open flowers. The second stage of sensitivity occurs at pollination when pollen sticks to the female style, and produces a tube that grows from the pollen down the style to the egg (Figure 3).

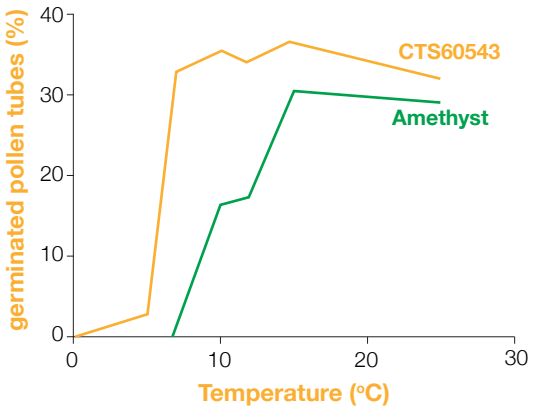


*Figure 4: Proportion of pollen germination at various temperatures in cold-sensitive (Amethyst) and cold-tolerant (CTS60543) varieties.*

At low temperatures pollen tubes grow slowly, fertilisation is less likely and the flower often aborts (Figure 4). The rate of pollen tube growth at low temperature is closely related to the cold tolerance of the whole plant (Figure 5). This trait can therefore be used to select more tolerant varieties.

Experiments have also shown that the average of day and night temperatures is more important for flowering and podset, than any specific effects of either the maximum or the minimum temperature. The critical average daily temperature for abortion of flowers in most varieties currently grown in Australia is about 15°C. New hybrids that set pods at about 13°C are being developed.

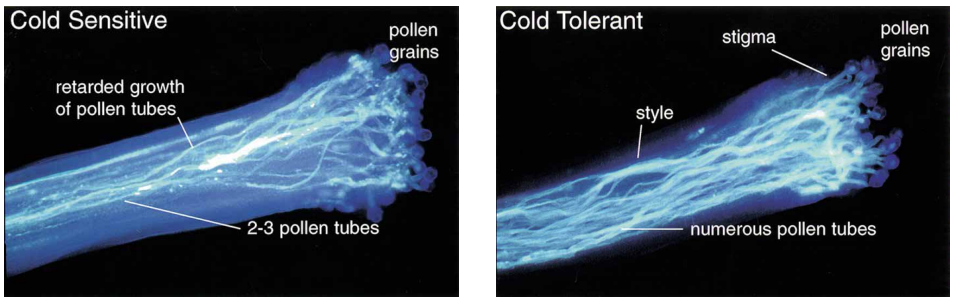


*Figure 5: Pollen tube growth (stained with a fluorescent dye) in the stigma of cold-tolerant and cold-susceptible chickpea varieties. (Photo: H. Clarke, UWA)*

In the field, cold-tolerant varieties set pods about 1–2 weeks earlier than most current varieties. As well as conventional methods for plant improvement, DNA based techniques are also being investigated. [3]

**More information**

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/11/Using-RTK-steering-data-for-soil-erosion-control-and-water-logging-prevention

## 14.3 Waterlogging and flooding issues

Chickpeas are prone to waterlogging, and as there are no in-crop control measures to deal with waterlogging, a critical management tool is avoidance of high-risk paddocks (based on previous experience and paddock history). [4]

Observations from the wet season of 2010 indicate that the natural resistance all plants have to pathogens and pests is compromised when plants are stressed (from saturated conditions). In one trial in 2010 at Tamworth, Flipper(D) had more Ascochyta blight than an adjoining plot of Yorker(D). This is not what researchers expected. In another Tamworth trial, there was more Ascochyta blight in the wettest Kyabra(D) plot than in better drained plots of Kyabra(D), despite the fact that all had been sprayed eight times with 1.0 L/ha of chlorothalonil; therefore, stress from waterlogging reduced the ability to manage Ascochyta blight with a strategy that worked in plots that were less stressed. [5]

Symptoms of waterlogging can be confused with those of Phytophthora root rot but differ as follows (Table 1):

- Plants are most susceptible to waterlogging at flowering and early pod-fill.
- Symptoms develop within 2 days of flooding, compared to at least 7 days for Phytophthora root rot.
- Roots are not rotted and are not easily pulled from the soil at first.
- Plants often die too quickly for the lower leaves to drop off.

[3] Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

[4] K Moore, M Ryley, M Sharman, J van Leur, L Jenkins, R Brill (2013) Developing a plan for chickpeas in 2013. GRDC Update Papers February 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Developing-a-plan-for-chickpeas-2013

[5] K Moore, M Ryley, T Knights, P Nash, G Chiplin, G Cumming (2011) Chickpeas—varietal selection, paddock planning and disease management in 2011—Northern Region. GRDC Update Papers April 2011

## More information

Pulse Australia (2015), Chickpea: Managing Phytophthera root rot

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Developing-a-plan-for-chickpeas-2013

http://link.springer.com/article/10.1007%2FBF02185569

http://link.springer.com/article/10.1007%2FBF02185570

*Table 1: Differences between Phytophthora root rot and waterlogging*

| Phytophthora root rot | Waterlogging |
|---|---|
| Organism kills roots | Low oxygen kills roots |
| Chickpea, medics, lucerne are hosts | No link with cropping history or weed control |
| Occurs any time of year | Usually occurs later in the year |
| Symptoms onset after a week or more | Symptom onset quite rapid |
| Lower leaves often yellow and fall off | Plants die too fast for leaves to yellow or fall |
| Roots always rotted and discoloured | Initially roots not rotted or discoloured (tips black) |
| Plants easily pulled up and out | Plants not easily pulled up initially |

Management options for waterlogging:

- Avoid poorly drained paddocks and those prone to waterlogging.
- Do not flood-irrigate after podding has commenced, especially if the crop has been stressed.

A rule of thumb is that if the crop has started podding and the soil has cracked do not irrigate. Overhead irrigation is less likely to result in waterlogging but consult your agronomist. [6]

[6] K Moore, M Ryley, M Schwinghamer, G Cumming, L Jenkins (2011) Chickpea: Phytophthora root rot management. http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot