NORTHERN

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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

CANOLA

SECTION 14

ENVIRONMENTAL ISSUES

FROST | WATERLOGGING AND FLOODING

Environmental issues

Frost, moisture stress and heat stress can all have an impact on grain yield, oil content and oil quality. Frost can occur at any time during the growth of the canola plant, but the most damaging frosts occur when pods are small. Pods affected at this time have a green to yellowish discoloration, then shrivel and eventually drop off. Pods affected later may appear blistered on the outside of the pod and usually have missing seeds.

Moisture stress and heat stress are linked; the plant will suffer heat stress at a lower temperature if it is also under moisture stress. Flower abortion, shorter flowering period, fewer pods, fewer seeds per pod and lower seed weight are the main effects, occurring either independently or in combination. [1]

MORE INFORMATION

Phenology of canola cultivars in the northern region and implications for frost risk

DAFWA: Frost and cropping

GRDC Update papers: What's going on with frost?

The GRDC National Frost Initiative

Burnt stubble pre-empts frost risk

14.1 Frost

Once established, canola is relatively frost-tolerant, but damage can occur during the cotyledon stage and the seedlings can die if frosted. Plants become more frost-tolerant as they develop.

Seedling growth and vigour are reduced at temperatures <7°C, and occasionally seedlings will die.

Soluble carbohydrates accumulate when there is a rapid reduction in leaf temperature. This accumulation suppresses photosynthesis, and therefore seedling growth rates, during the cooler winter months. [2]

Canola is least tolerant to frost damage from flowering to the clear watery stage (~60% moisture).

MORE INFORMATION

Frost-damaged crops—where to from here?

Symptoms include:

- yellow-green discoloration of pods (Figure 1)
- scarring of external pod surfaces
- abortion of flowers (Figure 2)
- shrivelling of pods
- pods eventually dropping off (Figure 3)
- shrivelling and absence of seeds (Figure 4).

1 T Potter (2009) The canola plant and how it grows. Ch. 3. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

2 J Edwards, K Hertel (2011) Canola growth and development. New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

Figure 1: *Yellow-green discoloration of pods, compared with healthy green pods.*

Figure 2: *Canola plant showing various stages of pod loss and flower abortion.*

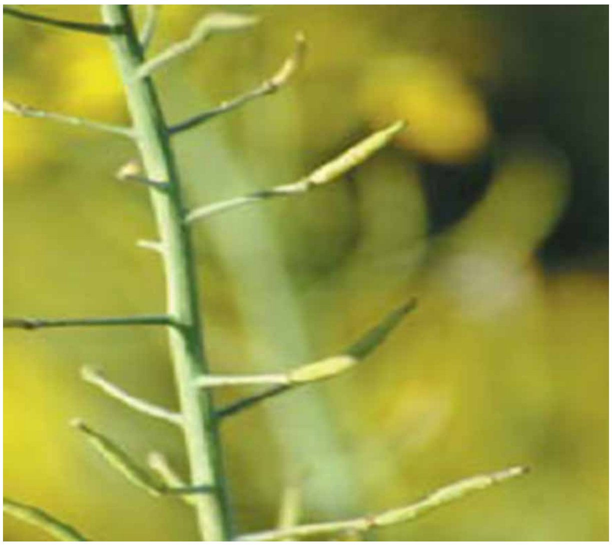


Figure 3: *Stunted pods that have dropped off.*

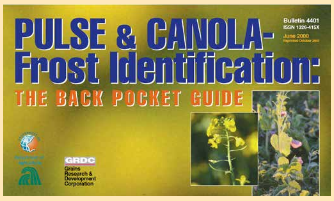
Figure 4: *Missing and shrivelled seeds.*

Canola flowers for a 30–40-day period, allowing podset to continue after a frost. Open flowers are most susceptible to frost damage, whereas pods and unopened buds usually escape. If seed moisture content is <40% when frost occurs, oil quality will not be affected. [3]

MORE INFORMATION

Diagnosing frost damage in canola

Pulse and canola—frost identification



14.1.1 Risk management for frost

The variability in the incidence and severity of frost means that growers need to adopt a number of strategies as part of their farm management plan. These include pre-season, in-season, and post-frost strategies. [4]

See GRDC Tips and Tactics Managing frost risk for general principles of establishing a frost management plan.

Growers need to consider carefully whether earlier sowing is justified in seasons where warmer temperatures are predicted. Warmer temperatures may reduce the

3 C White (2000) Pulse and canola—frost identification. The Back Pocket Guide. Reprinted 2003. Department of Agriculture, Western Australia/GRDC, https://www.grdc.com.au/Resources/Bookshop/2012/01/Pulse-Canola-Frost-Identification-The-Back-Pocket-Guide-GRDC046

4 GRDC (2016) Managing frost risk. Northern, Southern and Western Regions. GRDC Tips and Tactics, http://www.grdc.com.au/ManagingFrostRisk

frequency of frost events but also increase the rate of crop development bringing crops to the susceptible, post heading stages earlier. [5]

14.1.2 The changing nature of frost in Australia

The length of the frost season has increased across much of the Australian grainbelt by between 10 and 55 days between 1960 and 2011. In some parts of eastern Australia, the number of frost events has increased.

CSIRO analysis of climate data over this period suggests the increasing frost incidence is due to the southerly displacement and intensification of high pressure systems (subtropical ridges) and to heightened dry atmospheric conditions associated with more frequent El Niño conditions during this period.

The southern shifting highs bring air masses from further south than in the past. This air is very cold and contributes to frost conditions.

In the eastern Australian grainbelt the window of frost occurrence has broadened, so frosts are occurring both earlier and much later in the season. In the Western Australian grainbelt there are fewer earlier frosts and a shift to frosts later into the season.

The frost window has lengthened by three weeks in the Victorian grainbelt and by two weeks in the NSW grainbelt. The frost window in Western Australia and Queensland has remained the same length, while sites in eastern South Australia are similar to Victoria and sites in western South Australia are more like Western Australia. Northern Victoria seems to be the epicentre of the change in frost occurrence, with some locations experiencing a broadening of the frost season by 53 days. [6]

14.1.3 Issues that can be confused with frost damage

Many other problems can be confused with frost damage. The main ones are those causing distortion of the plant, absence of the seeds or unusual colour (see examples in Figures 5–7). Management and recent environmental conditions should be taken into account when identifying any crop disorder.

Figure 5: *Aphids on canola flower stem.*

5 J Christopher, B Zheng, S Chapman, A Borrell, T Frederiks, K Chenu (2016) An analysis of frost impact plus guidelines to reduce frost risk and assess frost damage. GRDC Update Papers 20 July 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/07/An-analysis-of-frost-impact-plus-guidelines-to-reduce-frost-risk-and-assess-frost-damage

6 GRDC (2016) Managing frost risk. Northern, Southern and Western Regions. GRDC Tips and Tactics, http://www.grdc.com.au/ManagingFrostRisk

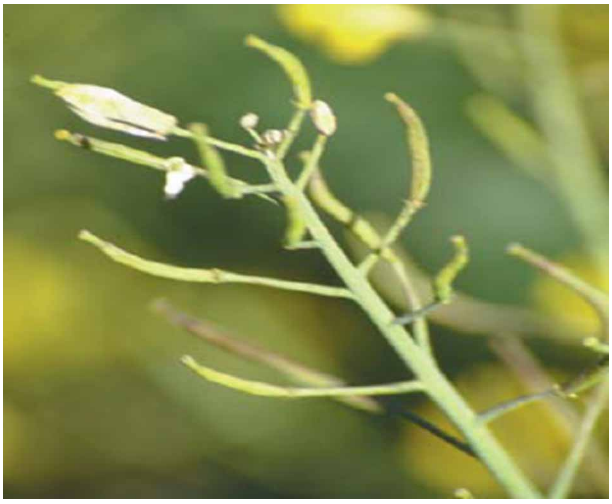


Figure 6: *Sulfur deficiency and aphids. Flower petals retained; pods stunted with yellowing-reddening.*

Figure 7: *Herbicide damage in lupins.*

It is important to remember that frost damage is random and sporadic, and not all plants (or parts of plants) will be affected, whereas most disease, nutrient and moisture-related symptoms will follow soil type. [7]

The optimum temperature range for leaf development of canola is 13°–22°C. At higher temperatures, growth is faster, and the period of leaf development is therefore shorter. Lower temperatures do not reduce yield in early growth, except when heavy frosts occur, but they do slow the rate of development. As temperatures increase to >20°C in July and August, yields are reduced.

7 C White (2000) Pulse and canola—frost identification. The Back Pocket Guide. Reprinted 2003. Department of Agriculture, Western Australia/GRDC, https://www.grdc.com.au/Resources/Bookshop/2012/01/Pulse-Canola-Frost-Identification-The-Back-Pocket-Guide-GRDC046

For frost injury, ice must form between or inside the cells. Water surrounding the plant cells will freeze at 0°C, but water inside the cells needs to be a few degrees cooler to freeze. The length of exposure of the plant to cold is another important factor. Plants can be cold-hardened by repeated exposure over several days. They can survive –8°C to –12°C in Canada, but exposure to warm weather will reverse this hardening, making the plants susceptible to temperatures of –3°C to –4°C. [8]

Crops that have been treated with herbicides before or immediately after frosts will often show greater effect. Growers should delay herbicide applications until the crop is actively growing.

14.2 Waterlogging and flooding

14.2.1 Symptoms of waterlogging

Paddock symptoms:

- Poor germination or purple-yellow plants can occur in areas that collect water.
- Bare wet soil and/or water-loving weeds are present.
- Plant lodging and early death occur in waterlogging-prone areas.
- Saline areas are more affected.

Plant symptoms:

- Waterlogged seedlings can die before emergence or show symptoms similar to nitrogen deficiency.
- Lower leaves turn purple-red to yellow, then die.
- Prolonged waterlogging causes root death and eventually death of the whole plant; plants are more susceptible to root disease.
- Waterlogging of adult plants causes yellowing of lower leaves.
- Salinity magnifies waterlogging effects, with more marked stunting and oldest leaf marginal necrosis and death. [9]

14.2.2 Effect on yield

Canola roots need a good mix of water and air in the soil. When the amount of water exceeds the soil's water-holding capacity, waterlogging may occur. Canola is susceptible to waterlogging and shows a yield reduction after only 3 days.

The severity of yield loss depends on the growth stage at the time of waterlogging, the duration of waterlogging, and the temperature (Figure 8).

8 J Edwards, K Hertel (2011) Canola growth and development. New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

9 DAFWA. Diagnosing waterlogging in canola. MyCrop. Department of Agriculture and Food Western Australia, https://www.agric.wa.gov.au/mycrop/diagnosing-waterlogging-canola

MORE INFORMATION

Should waterlogged crops be topdressed with N fertiliser?

Over the bar with better canola agronomy

Diagnosing waterlogging in canola.

Alleviation of waterlogging damage by foliar application of nitrogen compounds and tricyclazole in canola.

Growing canola on raised beds in south-west Victoria.

Nitrogen and sulfur for wheat and canola—protein and oil.

APSIM Canola.

Waterlogging and canola.

Waterlogging in Australian agricultural landscapes: a review of plant responses and crop models.

Crop production potential and constraints in the high rainfall zone of southwestern Australia: Yield and yield components.

Improving canola establishment to reduce wind erosion.

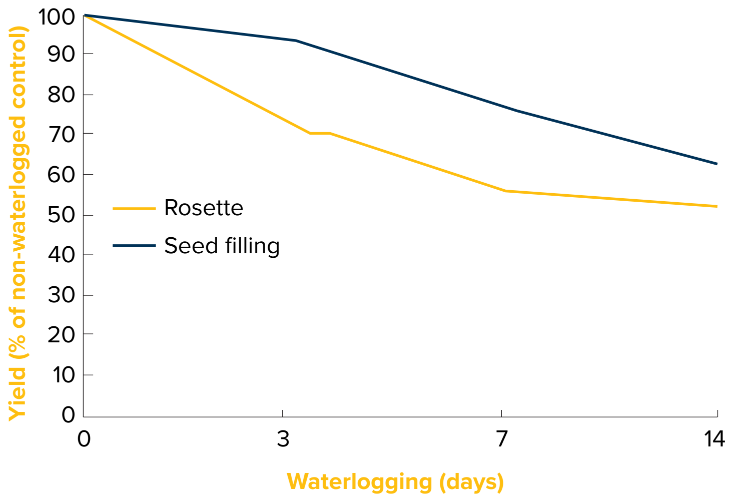


Figure 8: *Effect of waterlogging on yield.*

Source: Canola Council of Canada 2003

Wet soils will slow or prevent gas exchange between the soil and atmosphere, causing oxygen deficiency. High temperatures cause high respiration rates in roots and soil microorganisms, so soil oxygen is consumed more quickly.

Soil texture also affects the time at which critical levels of soil oxygen are reached. This is due to the oxygen-carrying capacity of soils. Coarser textured soils can hold more oxygen, increasing the amount of time before oxygen levels are reduced to a critical point.

The other effects of waterlogging are reductions in root growth, plant growth, plant height, dry matter production and nutrient uptake. [10]

14.2.3 Germination

Canola is sensitive to waterlogging during germination. When soils become waterlogged, the oxygen supply in the soil solution rapidly decreases. Oxygen is essential for seed germination. Without oxygen, seeds cannot continue their metabolic processes, and germination ceases. Prolonged waterlogging can kill canola seeds and seedlings. [11]

14.2.4 Seedfill

During seed-filling, waterlogging for >7 days decreases individual seed weight and oil content. High temperatures exacerbate the effects of waterlogging on canola yield.

The impact of waterlogging is greater if it occurs at the rosette stage. The longer the period of waterlogging, the greater the impact. [12]

10 J Edwards, K Hertel (2011) Canola growth and development. New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

11 J Edwards, K Hertel (2011) Canola growth and development. New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

12 J Edwards, K Hertel (2011) Canola growth and development. New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf