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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 14

ENVIRONMENTAL ISSUES

TEMPERATURE | FROST | WATERLOGGING AND FLOODING | DROUGHT

Environmental issues

Key messages

- Frost damage is not always obvious and crops should be checked 5–7 days after a suspected frost.
- Faba beans have a medium tolerance to frost due to their thick pod walls.
- Faba beans are the pulse most tolerant to waterlogging.
- Disease resistance is especially important in drought-prone areas.

14.1 Temperature

Temperature, daylight, day length, and drought are the major factors affecting flowering in faba beans. Temperature is generally more important than day length. Flowering is invariably delayed under low temperatures but more branching occurs.

Progress towards flowering is rapid during long days. With short days, flowering is delayed but never prevented. However, some faba bean varieties are less sensitive to day length than others. This has enabled breeders to identify varieties that flower early in the short-day winter growing season in southern Australia. [1]

High temperatures

Separating the effects of very high temperature from those of water stress is difficult, because in rain-fed agriculture, they nearly always occur together.

There is, however, no doubt that high temperature is damaging: in all pulses, high temperature will cause premature cessation of flowering, and shedding of flowers and young pods. Planting early maturing faba beans, field peas, and lentils is an effective strategy to escape high temperature. [2]

Temperature and sowing time

The timing of sowing largely determines the timing of the crop's finish and the temperature environment in which it will finish.

Plants sown before the recommended sowing window tend to be more vegetative and suffer from:

- poor early podset because of low light or low temperatures (10°C) at flowering commencement
- higher risk of chocolate spot at flowering and through podding
- crops being more pre-disposed to lodging
- increased frost risk at flowering and early podding
- high water use prior to effective flowering and the earlier onset of moisture stress during flowering and podding

Late-planted crops are more likely to suffer from:

- high temperatures and moisture stress during flowering and podding
- greater pressure from native budworms
- fewer branching and flowering sites, unless plant population is increased
- shorter plants and lower podset, which makes plants more difficult to harvest [3]

1 Pulse Breeding Australia (2013) Southern/Western Faba & Broad Bean–Best Management Practices Training Course. Module 3–Varieties

2 DAWA (2005) Producing pulses in the northern agricultural region. Bulletin 4656. Department of Agriculture, Western Australia.

3 Pulse Breeding Australia (2013) Southern/Western Faba & Broad Bean–Best Management Practices Training Course. Module 3–Varieties.

14.2 Frost

Frost is a complex and erratic constraint to Western Australian (WA) cropping systems, and can have dramatic consequences to a grower's business. Research that investigated trends since the 1960s has shown that:

- WA's frost window has widened, and on average frosts start three weeks earlier and finish 2 weeks later in the year.
- Consecutive frost events have increased by an average of up to three days at a time and mostly occur in August and September in the frost-prone regions.
- The frosts are getting colder, with minimum temperatures dropping. [4]

The sequence of weather events that typically generate damaging frosts is composed of the passage of a weak cold front, followed by cold southerly winds and the establishment of a ridge of high pressure. This results in cool daytime temperatures, light winds and clear skies overnight. [5]

Faba beans have a medium tolerance to frost due to their thick pod walls, which provide insulation to the developing seeds, but they are still quite susceptible to flower, yield and quality losses when frost intensity or duration is severe. Symptoms include:

- Growing points are sometimes distorted (bent) during early vegetative and flowering stages. This weakens the cells of the stem, allowing disease such as chocolate spot to invade easily.
- Flowers are killed by frost, leaving only a flower stalk.
- White or green mottling, and blistering of pods.
- Seeds developing in the pod are shrivelled or absent.
- Affected pods feel spongy and the seeds inside turn black. [6]

Tolerance to low temperature

Sub-zero temperatures in winter can damage the leaves and stems of the plant. Severe frosts can cause a characteristic 'hockey-stick' bend in the stem (Photo 1). However, faba beans have some ability to recover from this damage by being able to regenerate new branches. New growth occurs from the base of the frost-affected plants if moisture conditions are favourable.

Photo 1: *Severe vegetative frost can cause bends like a hockey stick in faba bean stems and branches in northern Australia.*

Photos: G Cumming, Pulse Australia

Frosts can also cause flower, pod and seed abortion. Pods at a later stage of development are generally more resistant to frost than flowers and small pods (Photo 2), but may suffer some mottled darkening of the seed coat (Photo 3).

4 GRDC (2016) Pre-seeding planning to manage frost risk in WA. GRDC Media Centre, https://grdc.com.au/Media-Centre/Hot-Topics/Preseeding-planning-to-manage-frost-risk-in-WA

5 DAFWA (2016) The science of frost. Department of Agriculture and Food, Western Australia, https://www.agric.wa.gov.au/frost/science-frost

6 DAFWA (2016) Frost: diagnosing the problem. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/66

Frost will normally affect the smallest pods first, even though they are the higher pods on the plant. Similarly, pod abortion induced by moisture stress is normally also noted on the last formed pods in the upper parts of the plant. Visual symptoms of frost and moisture stress damage to pods are, however, quite different.

In Western Australia, frost or low minimum temperatures (<5°C) during the reproductive stage will not physically damage the crop. There may be a slight leaf tipping on upper leaves to indicate a frost has occurred.

Frost during early flowering that affects early podset can be compensated for later by subsequent pods that set higher up the plant, provided the seasonal conditions are favourable to fill them. [7]

Photo 2: *Frost can cause flower or pod abortion (usually smaller pods). Damage to the seed depends on the size of the pod or seed and the severity of the frost.*

Photo: W. Hawthorne, Pulse Australia

7 Pulse Breeding Australia (2013) Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 2–Plant Physiology.

Photo 3: *Frost can cause seed staining from 'burning' the seed coat next to the pod wall.*

Photo: W. Hawthorne, Pulse Australia

Tolerance to frost at either vegetative or reproductive stages is not a breeding priority in southern Australia. However, improved early podset under conditions of low temperatures and low light is a breeding priority. [8]

14.2.1 Managing frost damage

Although it is difficult to totally manage frost risk in pulses, it is important to know the period of highest probability of frost incidence. Aim to reduce exposure to frost or impact at vulnerable growth stages. Frost-zone management tactics include the following.

Use of the frost zone

Map the topography to show areas of greatest risk, and specifically manage these areas. The use of identified frost zones should be carefully considered. Avoid large-scale exposure to frost of highly susceptible crops.

Modify soil heat bank

The soil-heat bank is important for reducing the risk of frost. Farming practices that manipulate the storage and release of heat from the soil-heat bank into the crop canopy at night are important considerations to reduce the impact of a frost. These include:

8 Pulse Breeding Australia (2013) Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 2–Plant Physiology.

- Practices that alleviate non-wetting sands, such as clay delving, mouldboard ploughing or spading.
- Rolling sandy soil and loamy clay soil after seeding.
- Reducing the amount of stubble.

Manipulate flowering times

Sowing time remains a major driver of yield in all crops, with the primary objective being to achieve a balance between crops flowering after the risk of frost has passed, but before the onset of heat stress. The loss of yield from sowing late to avoid frost risk is often outweighed by the gains from sowing on time to reduce heat and moisture stress in spring. [9]

14.3 Waterlogging and flooding

Pulses are generally not well suited to waterlogged soils. Faba beans are the pulse most tolerant to waterlogging and they exhibit some adaptation in new roots when the soil has been saturated for >2 weeks. Faba beans are able to produce good yields under waterlogged conditions that can cause failure of chickpea or lentil crops.

Importantly, the growth of faba beans will still be reduced when they are subjected to extended periods of waterlogging (>2 weeks), and chocolate spot disease is likely to be more severe. [10]

14.4 Drought

Drought tolerance through osmotic adjustment has not yet been demonstrated in faba beans, although it is found in many other legumes including chickpeas and field peas. Deeper root growth, leading to uptake of otherwise unavailable water, helps the plant to avoid drought by delaying dehydration, but genetic variation and heritability of the trait are essentially unknown for faba beans. [11]

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9 GRDC (2016) Tips and Tactics. Managing frost risk: northern southern and western regions, https://grdc.com.au/Resources/Factsheets/2016/02/Managing-frost-risk-Northern-Southern-and-Western-Regions

10 DAWA (2005) Producing pulses in the northern agricultural region. Bulletin 4656. Department of Agriculture, Western Australia.

11 H R Khan, J G Paull, K H M Siddique and F L Stoddard (2010) Faba bean breeding for drought-affected environments: A physiological and agronomic perspective. Field Crop Research. 115 (3) 279–286, http://www.sciencedirect.com/science/article/pii/S037842900900238X