Establishment of lupin seedlings

Miles Dracup
By Miles Dracup, Lupin Physiologist
Plant Industries, South Perth

Good seedbed conditions lead to high and rapid seedling emergence and vigorous seedlings best equipped to avoid disease, weed competition and sand-blasting. Good establishment is needed for a high yielding crop.

In Western Australia, seedbed moisture and temperature are most likely to limit successful emergence of lupins, especially with the trend toward early sowing.

Research by the Department of Agriculture is helping to define seedbed temperature and moisture requirements for successful lupin establishment that will help future research for improving seedbed conditions.
Emergence is best when the soil is at field capacity. If the soil moisture content exceeds field capacity, air is displaced from remaining soil pores and aeration can restrict emergence. As moisture content falls below field capacity, water becomes less available to the seedling. Soil strength also increases as the soil dries and further restricts growth. Not surprisingly, both germination and emergence decrease as the soil becomes drier (see Figure 2).

High temperature and low moisture can cause patchy establishment, reducing crop yield. Before May, average soil temperatures often exceed 20°C, with high daily fluctuations. For example, during April at Geraldton, average soil temperatures 4 cm deep in 1991–92 were 27°C (average maximum 43°C). The soil temperature for seeds sown in early to mid-April in northern cropping areas is therefore well above the 20°C optimum for much of the time, so establishment would benefit from delaying seeding or reducing seedbed temperatures.

Temperature
Lupin seeds planted 4 cm deep in moist sand germinate and emerge best at 20°C (4.5 days) (see Figure 1). Temperatures below 10°C, and especially above 25°C, also reduce the number of seedlings that emerge (for example, only 30 per cent of the seedlings emerged from 4 cm at 30°C).

Sowing shallower than 4 cm hastens emergence if the soil remains moist (see Figure 1) but seeds may deteriorate owing to partial germination followed by desiccation if the soil surface dries (see below). Sowing deeper than 4 cm delays emergence, especially at low temperatures (see Figure 1), and also reduces the number of seedlings that emerge.

In southern areas, the soil is cooler, and during April averaged 18°C (average maximum 25°C) at Esperance and Mt Barker. With early seeding, seedbed temperatures can be reduced by sowing in furrows (see Figure 4), stubble mulching and maximising soil moisture (see below). See also “Improving sustainable production from water repellent sands” on page 160. With the cooler conditions in southern areas, establishment should be good if seeds are sown into moist soil in early to mid-April.

Moisture
Moisture availability in seedbeds can be measured by its potential. The units commonly used for moisture potential are megapascals (MPa), expressed as negative values. A value of -0.2 MPa is usually considered dry soil, whereas a value of -0.003 MPa represents moist soil at field capacity. Field capacity is the amount of water held in soil after it has been well watered and allowed to drain for two days.

Not surprisingly, both germination and emergence decrease as the soil becomes drier (see Figure 2). Emergence is best when the soil is at field capacity. If the soil moisture content exceeds field capacity, air is displaced from remaining soil pores and aeration can restrict emergence. As moisture content falls below field capacity, water becomes less available to the seedling. Soil strength also increases as the soil dries and further restricts growth.
Improving moisture supply to the seed

Emergence is also delayed in dry soil because seedlings channel more of their reserves into root growth than into shoot growth. For example, when seedlings emerged from 4 cm in soil at field capacity, the tap root was 7 cm long compared with a 23 cm long tap root in dry soil (see Figure 3). Preferential root growth helps the seedling to seek moisture but could reduce emergence if seeds are sown deeply, or if seed reserves are limited (small seeds), or metabolised rapidly (high temperature).

If the soil is very dry at seeding, seeds take up little moisture and remain hard and dormant. However, if the soil has enough moisture for the seeds to swell a little, but not enough for germination (for example, if the moisture potential is about -2 MPa, see Figure 2), seeds deteriorate. Seeds should not stay in this state for long otherwise their potential for emergence, and the vigour of seedlings that do emerge after subsequent rainfall, will be poor.

**Improving moisture supply to the seed**

Soil moisture is a major concern with early sowing because of infrequent rainfall and high evaporative loss. Furthermore, high temperatures experienced by early sown crops accentuate a seedling’s sensitivity to dry soil. In these crops it is important to minimise moisture loss and maximise channeling of moisture to the seed.

Soil moisture loss can be reduced by minimising soil disturbance (minimum tillage) and retaining stubble. Soil moisture supply to the seed can also be enhanced by using firming presswheels, harvesting water into furrows and sowing deep enough (about 4 cm) to avoid the rapid drying of surface soil.

Seeds sown in furrows benefit from higher moisture and lower temperature without the disadvantage of lots of covering soil (see Figure 4 and also “Improving sustainable production from water repellent sands” on page 160).

Soil texture and colour are also important. Coarse-textured, sandy soils hold little moisture, so dry out quickly. As the texture becomes finer, soils hold more moisture, so are less likely to dry out. However, finer textured soils also need more rainfall before germination is possible because more of the moisture is held too tightly for plant use. Evaporation is faster from moist soils that are dark-coloured than from moist, light-coloured soils.

Variation in texture, surface undulations, soil packing and sowing depth, and therefore moisture supply to seeds, probably causes much of the patchy and staggered emergence often seen in crops sown in poor seedbeds with inadequate moisture.

**Conclusions**

For best establishment of lupins the seedbed temperature should remain close to 20°C. Soil moisture should be high and the soil should be free-draining.

For early sowing, establishment will benefit from practices that lower seedbed temperatures and conserve moisture, such as furrow sowing.

Poor seedbed conditions reduce germination, emergence and seedling vigour so the crop is more susceptible to stresses, such as fungal pathogens, insects and sand-blasting, during the remaining phase of establishment. On soils susceptible to wind erosion, slow establishment will also increase the period during which wind erosion is a risk.

In crops sown ‘dry’ and early, where there may be enough moisture for some absorption by seeds but not enough for emergence, seed deterioration can be very important and greatly reduce potential emergence. Seeds may also deteriorate if sown near the soil surface where moisture conditions can fluctuate rapidly.

If the season has not broken, sowing earlier than late April is risky, particularly in northern cropping areas where temperatures are often high. In a project funded by the Grains Research and Development Corporation, Department of Agriculture research officers Doug Abrecht and Bob French are studying risks associated with early sowing.

**Acknowledgements**

The Grains Research Committee of Western Australia provided funds for the project. Christine Davies and Helen Tapscott provided technical assistance.

Further reading


Miles Dracup can be contacted on (09) 368 3785