Optimising sorghum production in variable climates

Introduction

Australia's climate has warmed by about 1.4 °C since 1910, leading to an increase in the frequency and intensity of extreme heat and water stress. As such, there is a need to explore innovative approaches to reduce the risks to summer crop options for growers.

Grain sorghum is a major summer crop of northern New South Wales (NSW), southern Queensland (Qld) and the central highlands of Qld, allowing growers to include a summer crop in some areas that have predominantly winter-based rotations.

Sorghum crops enable:

- the use of alternative herbicides with different modes of action
- the ability to spread labour and machinery use and split logistics
- increased cash flow
- a disease break as sorghum is not a host of crown rot and is resistant to the root lesion nematode *Pratylenchus thorneii*
- the possibility of double cropping (with early sorghum planting) a winter pulse or cereal.

The stubble produced from sorghum also provides ground cover for following crops, increasing both water infiltration and nitrogen (N) mineralisation.

One of the main challenges of growing a profitable sorghum crop is the limited planting opportunities and the likelihood of periods of extreme heat and moisture stress during and after flowering. These extreme conditions are becoming more common with climate change and increased climate variability. Heat stresses can also be expected to be more frequent and intense during El Niño and neutral years. Such risks have led to reduced grower confidence, particularly in the drier and hotter environments of north-western NSW and southern Qld.

Since 2018, the Grains Research Development Corporation (GRDC), University of Queensland (UQ), NSW Department of Primary Industries (DPI) and Department of Agriculture and Fisheries, Queensland (DAF) have partnered in a research program to test the boundaries of the sorghum (Figure 1) planting window. This has involved sowing earlier than usual, and measuring the effects on plant establishment, crop development, grain yield and quality in the GRDC Optimising Sorghum Agronomy project (UOQ 1808-001RTX).

Under this project, the research team focused on answering the following questions:

- Can farmers avoid heat stresses around flowering by planting sorghum earlier e.g. in late winter?
- How do cold soils affect crop establishment?
- Are there differences in cold tolerance between hybrids?
- Does planting sorghum into cold soils affect root growth, soil water use and water use efficiency (WUE)?
- What are the effects on grain yield and quality?
- What are the implications of early sowing at the cropping system level?

Figure 1. Sorghum experiments at Breeza. Photo: Mark Hellyer, NSW DPI.

Benefits of planting sorghum early

- In sites and seasons affected by heat stress, early planted sorghum yielded up to 2,000 kg/ha more than those sown in traditional planting times. This represents a ~$400/ha increase in farmers' gross margins (GM).
- Moving the flowering window earlier reduces the risk of flowering in extreme heat and the intensity of terminal drought stresses.
- There is an increased chance of double cropping back into a winter pulse crop (e.g. chickpea) and increased profitability by up to ~$250/ha.
- There is the potential for improved grain quality; primarily through reduced screenings.
- There is increased ground cover and the number of crop days, i.e. days in the year with a crop in the field.
- Earlier planting and harvesting will help split on-farm logistics to avoid the overlap between winter planting and summer harvest.
- Early planting provides additional planting opportunities for summer crops, especially in the more marginal environments of north-western NSW and south-western Qld.
- Transfer of water use from vegetative to reproductive stages makes more water available for grain fill.
- The potential to increase the WUE.

Risks of planting sorghum early

- Frost damage, which can range from mild (e.g. leaf burn) to complete plant death, when planting earlier than traditionally recommended (if the frosts occur after the crop has 7 leaves). Significant plant death has not been seen during the experiments conducted under this project, but could still be a possibility in extreme seasons.
- Planting sorghum into colder soils will delay crop emergence by 2–3 weeks and result in slower early crop growth as the plants are growing in cooler conditions than usual.
- Slower emergence means there is more time for seed to be possibly affected by soil insects or pathogens.
- Establishment can be affected i.e. less than the desired 80% emergence. Increasing the planting rate can help compensate for this. However, seed losses can result in poor plant uniformity, which negatively affects weed suppression and resource capture, such as moisture.

Early sorghum should target soil temperature of at least 13 °C and rising for a period of 7 days. Measure soil temperature at the intended planting depth and at the same time of the day e.g. 8 am EST

Why plant sorghum earlier?

Experiments conducted as part of UOQ 1808-001RTX have shown that planting sorghum early provides benefits that far outweigh the risks.

Traditionally sorghum planting starts when soil temperature reaches 16–18 °C (at 8 am EST at the planting depth). Results from these experiments have shown that sorghum could be planted earlier when soil temperatures of 13 °C and increasing have been reached.

Tips to getting early planting right

Seed quality

Source high quality seed with known germination rate and quality.

Successful establishment starts with seed that has both good germination and vigour. Seed quality testing in trials has shown variability in seed germination percentages between hybrids and seed lots. Cold soil temperatures are an additional stress on seedlings, so use only the best quality seed available. Poor vigour can lead to reduced and prolonged emergence, particularly when seed is planted into cool soils (Figure 2).

Setting yourself up

The project team developed a tool that uses historical soil temperature to predict seasonal soil temperatures. Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/) gives farmers guidance on when to expect soil temperatures above 13 °C.

Figure 2. Sorghum planting date experiment at Breeza on the Liverpool Plains in 2021.

Seeding rate

Increase seeding rate to compensate for reduced emergence and establishment.

Planting rates are typically calculated on establishment percentages of ~80%. NSW DPI experiments have shown that early planting can result in lower establishment percentages. This could be due to several factors including:

- colder soil temperatures
- a longer time for seed to germinate and emerge
- disease/pests
- inadequate soil moisture around the seed.

Early planted crops might have reduced establishment, so more seeds per hectare might need to be planted to achieve the target plant population. Where soil temperatures are at 13 °C in combination with marginal seedbed moisture, seed losses of 30–40% can occur. Seeding rate needs to be adjusted accordingly. Target a specific plant population in plants/m², regardless of your row spacing (Table 1).

Table 1. Recommended sorghum plant population under different growing conditions.

Growing conditions	Target population (plants/m²)
Dryland	
Favourable environments	4–6
Marginal environments	3–5
Irrigation	
Supplementary	5–10
Full	10–15

Soil temperature

It is important to check the 2-week weather forecast, as approaching cold fronts could reduce soil temperatures, delaying emergence and affecting plant stands.

Soil temperatures fluctuate widely during late winter and early spring. This is greater at shallower soil depths, where there is less insulation against changing day/night temperatures. The presence and amount of stubble cover also influence the soil temperature and its fluctuation. A large amount of stubble cover acts as an insulation layer, keeping soils cooler and at more stable temperatures. Other factors include paddock aspect and soil type. Monitor soil temperatures in your paddock, as there is no replacement for measuring local conditions.

Growers who want to plant early sorghum should target soil temperatures of at least 13 °C and rising for a period of 7 days. Soil temperature needs to be measured at the intended planting depth and at the same time of the day, e.g. 8 am EST (which is close to the soil's daily minimum temperature).

The ideal soil temperature for rapid crop emergence is 16 °C and increasing. Planting sorghum into cold soils will extend the time to crop emergence by up to 14–21 days after sowing. After this point, there should be an even establishment.

Tips for success

The level of success in establishing a uniform plant stand from early planting depends on:

- using high quality (germination) seed
- adjusting seeding rate to compensate for reduced seed emergence and establishment
- monitoring soil temperature at sowing depth
- sowing into adequate moisture in the seedbed.

Soil moisture

Planting sorghum early into cooler soils means the seed takes longer to emerge compared with normal planting dates. To ensure the seed does not dry out and stop the germination process, ensure there is adequate moisture around the seed at planting. For normal planting times, plants emerge in 5–7 days and in as little as 3 days when planting in the heat of summer. Early planted sorghum can take 14–21 days to emerge, or longer if cold conditions prevail.

Crop uniformity will be affected if the seedbed dries out or if the seeds are affected by soil insects or pathogens. This is more likely if there is heavy rain after planting and the seeds are sitting in waterlogged conditions.

For some parts of QLD and north-western NSW, the crop might need to be sown and established on residual moisture from summer rainfall, as the likelihood of winter rain could be low. In this situation, checking seedbed moisture is even more important.

Sorghum should always be planted into a soil profile that is at least 80% full with sufficient seedbed moisture for an extended seed germination and crop emergence period. Paddocks should be free from spring grass weeds that are difficult to control.

Hybrid

Differences in cold tolerance between hybrids

The research found some differences in response to soil temperature by current commercial hybrids (Figure 3). Some hybrids (85G33) showed some cold tolerance and small seed losses (~95% establishment) at 13 °C or higher. Other hybrids showed small seed losses, though only when sown at about 15 °C or higher (MR Buster and HGS114). Cracka showed some cold tolerance and some seed losses (85% establishment). Some hybrids (Agitator) only had high establishment rates (>85%) when soil temperature was above 16 °C.

Most companies test their hybrids for cold tolerance. As new hybrids and fresh seed lots are launched into the market each year, it is important that growers contact their preferred seed company to obtain specific information on seed and hybrid availability.

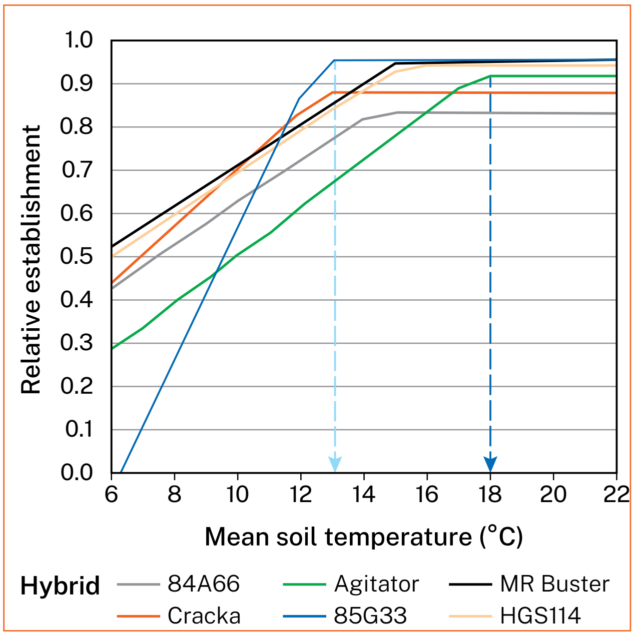

Figure 3. Relative establishment (crop establishment relative to the target plant population) as a function of soil temperature at 8 am over 7 days from the planting date for 6 commercial hybrids.

Changes in the growth pattern

Early planted sorghum has a slower germination and emergence due to colder soil temperatures. Early vegetative growth rates are also slower as cooler day and night temperatures in late winter–early spring result in a longer time to accumulate day degrees, which drives plant growth.

Sorghum plants tend to produce more tillers when planted earlier and have a longer period of vegetative and panicle growth. As a result, it takes more days to reach 50% flowering compared with a normal planting date, but the flowering period is earlier. Planting date had the largest effect on days to flowering in this research. The earlier the planting date, the more days required to reach flowering.

Planting date influenced maturity differences between hybrids. In these experiments, the effect of different plant populations on flowering time was very small.

Earlier flowering reduces the risk of heat stress and reduced pollen viability from high temperatures. Temperatures above 36 °C can reduce pollen viability, resulting in less seed set. The effect of high temperatures is not just at flowering, but also during pollen formation before flowering, meaning there is around a 10-day period of possible susceptibility.

Figure 4. Sorghum experiment at Gatton, Queensland. Photo: Daniel Rodriguez, UQ.

Yield x plant density x environment

Are there yield differences in response to plant density and environments between hybrids?

There was a range of different plant densities and hybrid combinations that were tested and taken through to yield (Figure 5). The different sites yielded between a few hundred kilograms to more than 8,000 g/ha (dry basis).

The environment yield is an indicator of the achievable yield of that site/season. The environment yield is the average yield of all the treatments at an individual site/season (Figure 5). Plant densities of 3–12 plants/m^2 were tested in all experiments. The response of varying plant density in very poor to very high yielding environments (Figure 5a). The optimum plant density in all environments was 6 plants/m^2. This was where yield was optimised and seed costs minimised. Similar yields were obtained from 9 plants/m^2 and 12 plants/m^2, but with higher seed costs. The lowest plant population only performed as well as the higher plant populations in environments where yields were below 4,000 kg/ha. At the high yielding sites (>8,000 kg/ha), the difference between 3 plants/m^2 and 6 plants/m^2 was ~1,000 kg/ha.

The hybrids tested in this series of experiments performed differently in the low and high yielding environments (Figure 5b). Hybrids HGS-114 and MR Taurus performed well in the high yielding environments (>5,000 kg/ha). A66 and Agitator had relatively low yields in the higher rainfall seasons compared with the better yielding hybrids, but performed well with more stable yields in the drier environments.

The challenge for growers and advisors is to match the hybrid and quality seed availability with the potential yields in each season.

Yield and quality

What is the effect of early planting on grain quality and yield?

Early planted sorghum produced grain yields that were equal to or better than those resulting from normal planting times at most sites and seasons (Figure 6). Over 3 seasons of on-farm experiments, late winter and spring plantings produced similar median yields, though slightly higher than the yields from the summer sown trials (Figure 6a).

Grain quality can be improved by earlier planting as screenings at harvest might be lower, as the intensity of terminal drought stresses are potentially reduced. Typically, there has also been less lodging associated with early sowing resulting in less grain losses.

> Early planted sorghum produced grain yields that have been better than or equal to those resulting from normal planting times.

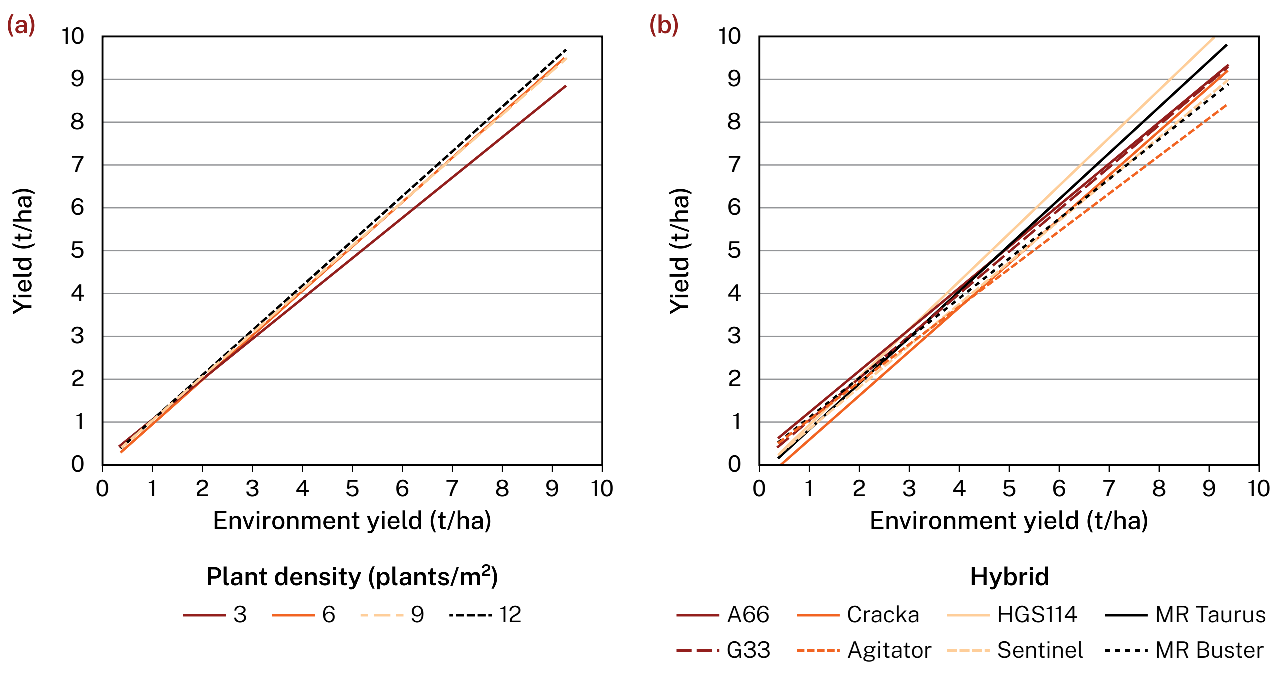

Figure 5. Relationship between yield and density (a) or hybrid (b) across sites and seasons (environment yields).

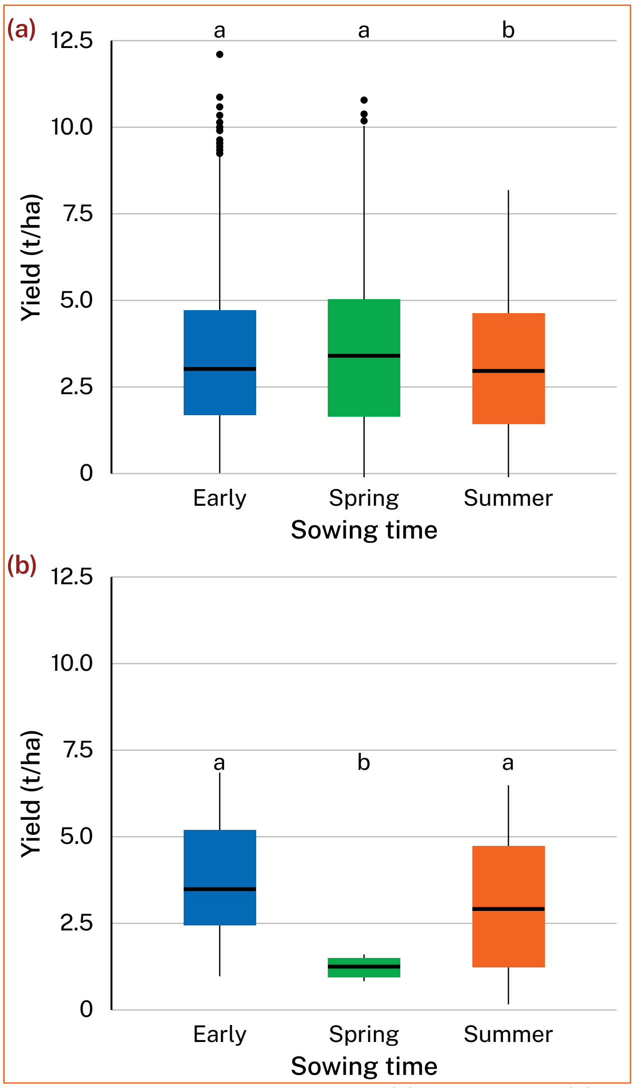

Figure 6. Yield from 2019–2021 for (a) all sites, and (b) selected sites and seasons where spring and summer sown crops were affected by heat stress around flowering.

Heat stress on seed set

Filtering the data to look at only sites that were affected by heat stress, large yield differences were identified (Figure 6). Compared with crops affected by heat stress from traditional planting times, early sown sorghum can yield up to 2,000 kg/ha more. This represents a ~$400/ha increase in farmers' GM (2023 prices).

In Figure 7, the per cent seed set for all sites and seasons (2019–2021) was based on flowering times and maximum air temperatures around flowering. Early planted crops were less exposed to extreme heat than those planted in spring and summer.

Experiments with early planted sorghum showed potential increases in WUE

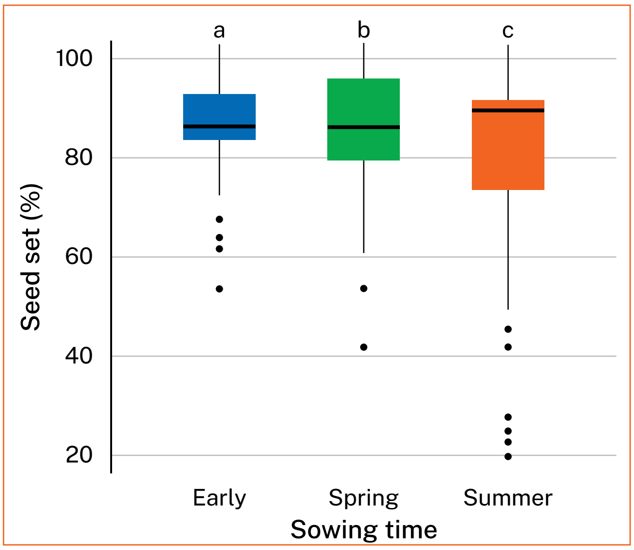

Figure 7. Calculated seed set (%) based on flowering times and maximum air temperatures around flowering for all sites and seasons (2019–2021).

Water use and water use efficiency

One of the major factors affecting a crop's yield potential in northern NSW and Qld is water. Using tools to help manipulate soil water use to produce the highest WUE (kg grain/ha/mm water used) are key profit drivers for growers.

Experiments with early planted sorghum showed potential increases in WUE. Early planted crops had lower water use in 2 growth periods:

1. vegetative (leaf producing) stage between emergence and 7 leaves
2. reproductive (head producing) stage between 7 leaves and flowering.

Early planted crops benefited from reduced water use at the growth stages before flowering, so there was more water available for use between flowering and maturity. The result was a higher WUE for the earlier sown crop compared with the spring–summer sown crops (Figure 8).

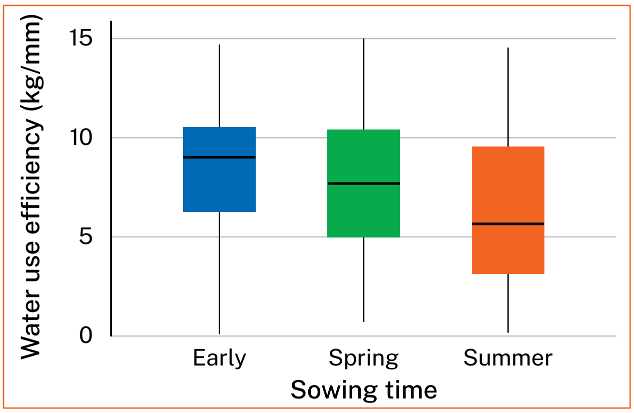

Figure 8. WUE from 3 years of early, spring–summer sown sorghum on-farm experiments between the Liverpool Plains, NSW and Emerald, Qld.

Gross margin (GM)

UOQ 1808-001RTX investigated the influence on GMs of adding an early sown sorghum crop into the farm rotation. The notion that 'yield is king' in sorghum can be misleading as it fails to acknowledge the key parameters of farm profit and risk, and the effects that changes in crop rotation can have on other facets of the farm business.

The project used APSIM (Agricultural Production Systems sIMulator) modelling to assess the profits and risks of 2 contrasting crop rotations:

1. Based on current practice.
2. Including an early sown sorghum.

Growers interviewed were interested in the comparative benefits of a sorghum-based cropping system that uses early planting, in contrast to planting the crop in spring–summer.

Two contrasting rotations were tested, both starting with a barley crop (Figure 9, top). In rotation 1 (without early sorghum), the crop cycle started with a long fallow into a spring–summer sorghum crop, depending on planting opportunities. The sorghum crop was then followed by a short fallow into a double crop chickpea or long fallow, if there was no planting opportunity. The planting opportunity for a spring–summer sorghum planting was defined as having at least an 80% full soil profile and rainfall of at least 30 mm accumulated over 3 days. For rotation 2 (with early sown sorghum), the trigger was when there was at least an 80% full soil profile, soil temperature at sowing depth was higher than 13 °C and the seed bed was moist.

Optimising sorghum production in the regions

The region covered by these experiments spans over 1,000 km from the Liverpool Plains in NSW to Emerald in Qld. Temperature and rainfall vary considerably over this geographic spread. This section aims to provide more regionally specific information.

Firstly, within each region, SILO data (1950–present) have been used to estimate soil temperatures. The graph for each location includes a black line (e.g. Figure 9), which is the median soil temperature at planting depth, and a red line to assist in identifying when soil temperature is likely to reach 13 °C, or the earliest planting date.

Once the earliest potential planting date, based on soil temperature, has been established, it is then important to consider when the crop will be flowering and the risk of frost and/or heat stress.

APSIM was used to predict the flowering dates and risk of heat stress for a sorghum crop at selected sowing dates at key locations included in the project:

1. Breeza, Moree and Mungindi in NSW between 15 July and 15 January
2. Dalby and Warra in Qld between 15 July and 15 January
3. Emerald in Qld, between 1 June and 15 January.

The box plots in each graph show the predicted flowering period, while the red line indicates the risk of heat stress (days >36 °C) at flowering for each planting date.

The suggested planting window in each region has been indicated by the blue/green boxes. These suggested planting windows are based on the region reaching the minimum soil temperature of 13 °C and a low risk of a frost damaging the crop at 7-leaf stage, and trying to minimise the probability of exposing the crop to heat stress at flowering.

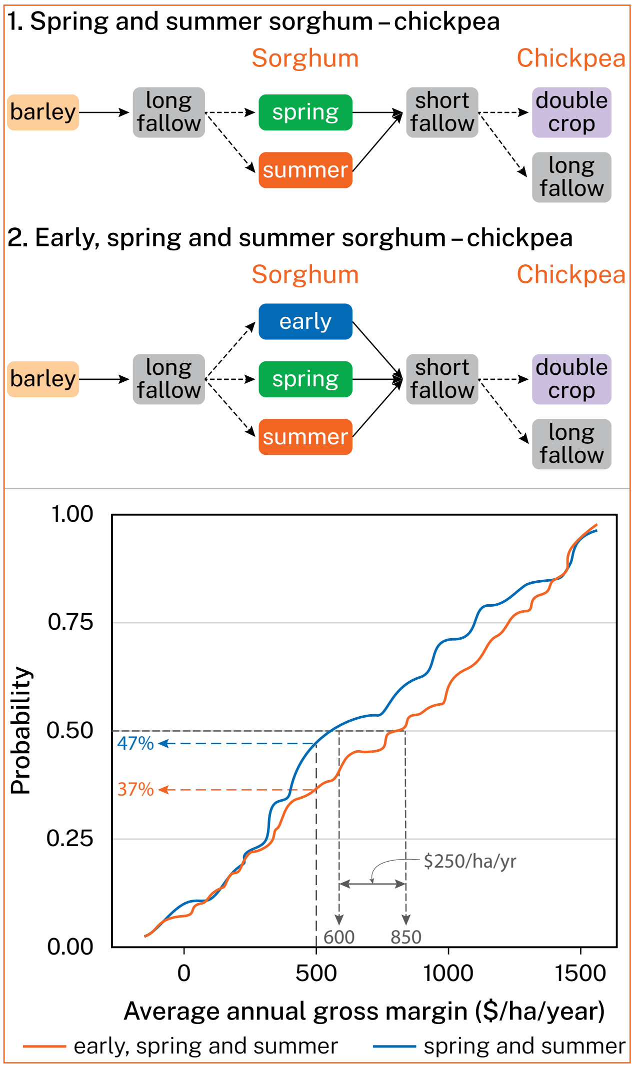

Figure 9. Two APSIM simulated rotations (top), and the average annual GMs (bottom) for a sorghum–chickpea rotation including spring/summer planted sorghum (blue line) or including an early planted sorghum crop (red line).

Breeza, Liverpool Plains, New South Wales

Breeza SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperature during each spring (Figure 10). The graph shows the earliest planting date for sorghum would be ~19 September. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line). The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture, and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below 13 °C for the range of planting dates (Figure 11). These should be used as a reference with actual soil temperature in each intended paddock measured before planting.

At Breeza, on the Liverpool Plains of NSW, the risk of heat stress around flowering increases significantly for planting dates after early September (>60% chance) and decreases sharply for planting times after late December (Figure 10).

Late plantings are more likely to be affected by frost at flowering (~25% of the years with planting in mid-January), as these crops would not reach flowering until the end of March.

The Liverpool Plains suggested planting windows are:

1. mid-September to mid-October
2. late planting: early November to 1 January.

Locally relevant trial work

Optimising sorghum production, Breeza 2020–21 Northern NSW Research Results 2022, NSW DPI (https://www.dpi.nsw.gov.au/?a=1431841).

The changing face of sorghum planting windows – Breeza dryland 2018/19 Northern NSW Research Results 2019, NSW DPI (https://www.dpi.nsw.gov.au/?a=1214351).

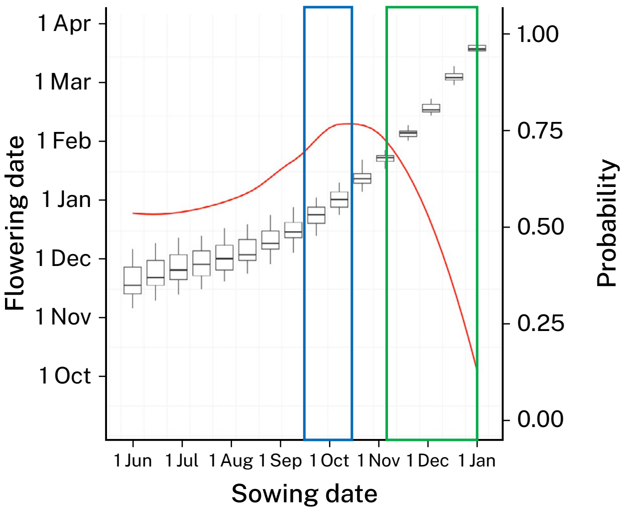

Figure 10. Predicted flowering dates (APSIM simulations) for sorghum sown from 1 June to 15 January at Breeza, NSW. The red line indicates the risk of heat stress at flowering, and the blue/green boxes are the suggested sowing windows.

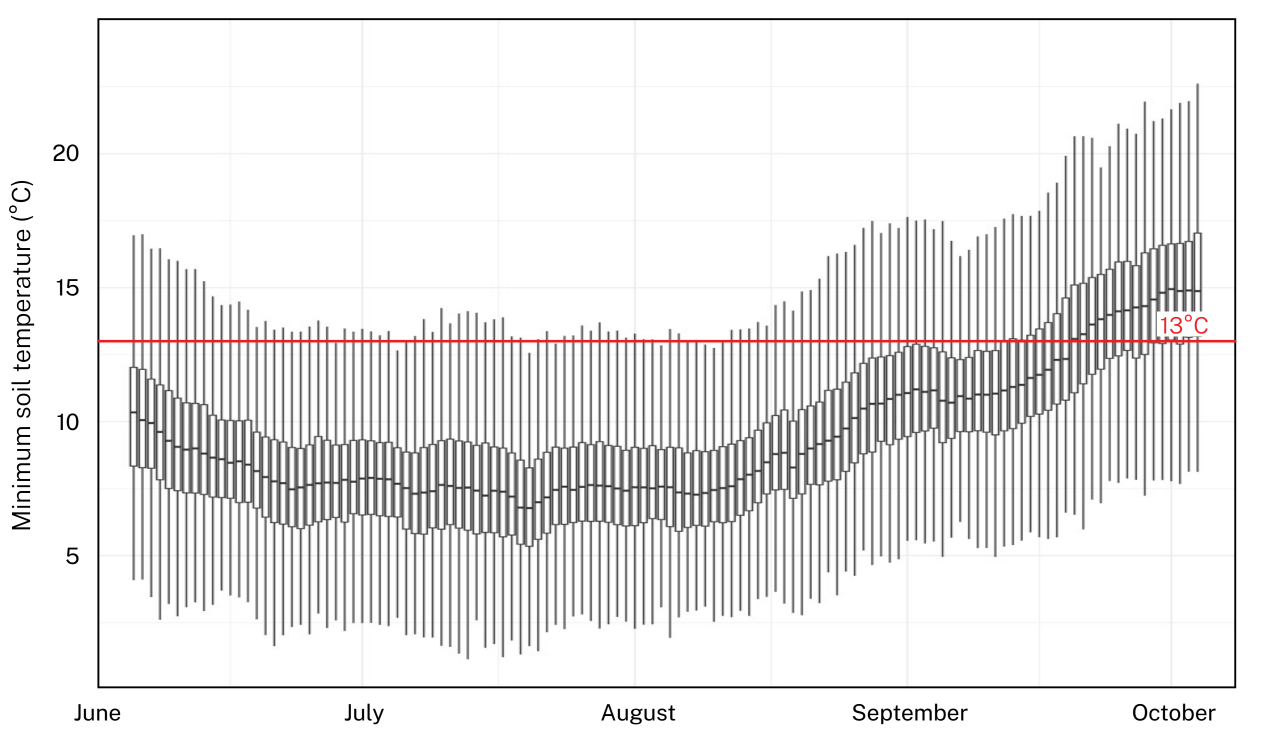

Figure 11. APSIM simulations of soil temperature at Breeza, NSW using data from SILO.

Moree, north western Plains, New South Wales

Moree SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperature during each spring (Figure 12). The graph shows that the earliest planting window for sorghum would be mid-September. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line). The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below the 13 °C for the range of planting dates (Figure 13). The figures should be used as a reference with soil temperatures in each intended paddock measured before planting.

At Moree, on the north-western plains of NSW, the risk of heat stress around flowering increases significantly for planting dates after early September (>70% chance) and decreases sharply for planting times after mid-December (Figure 12).

Late plantings are more likely to be affected by frost at flowering (~25% of the years with planting in mid-January), as these crops would not reach flowering until early March.

The Moree region suggested planting windows are:

1. early September to mid-October
2. late planting: mid-November to early January.

Locally relevant trial work

Optimising sorghum production at Moree in 2020–2021 Northern Research Results 2021, NSW DPI (https://www.dpi.nsw.gov.au/?a=1387156).

The changing face of sorghum planting windows – Ponjola, Moree, dryland 2018/19 Northern NSW Research Results 2019, NSW DPI (https://www.dpi.nsw.gov.au/?a=1214352).

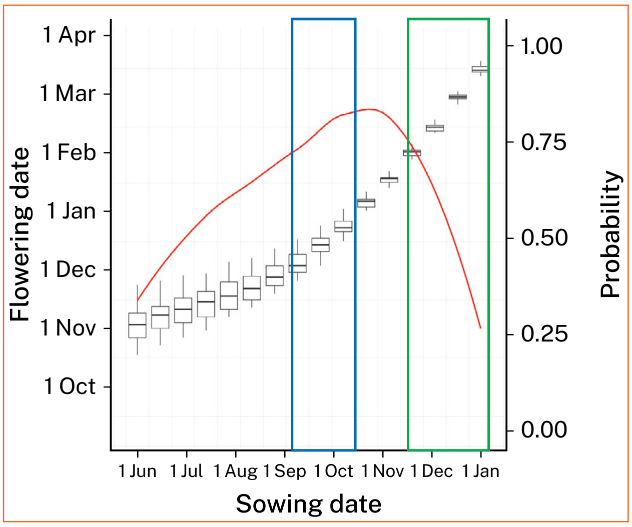

Figure 12. Predicted flowering dates (APSIM simulations) for sorghum sown from 1 June to 15 January at Moree, NSW. The red line indicates the risk of heat stress at flowering for each sowing time, and the blue/green boxes are the suggested sowing windows.

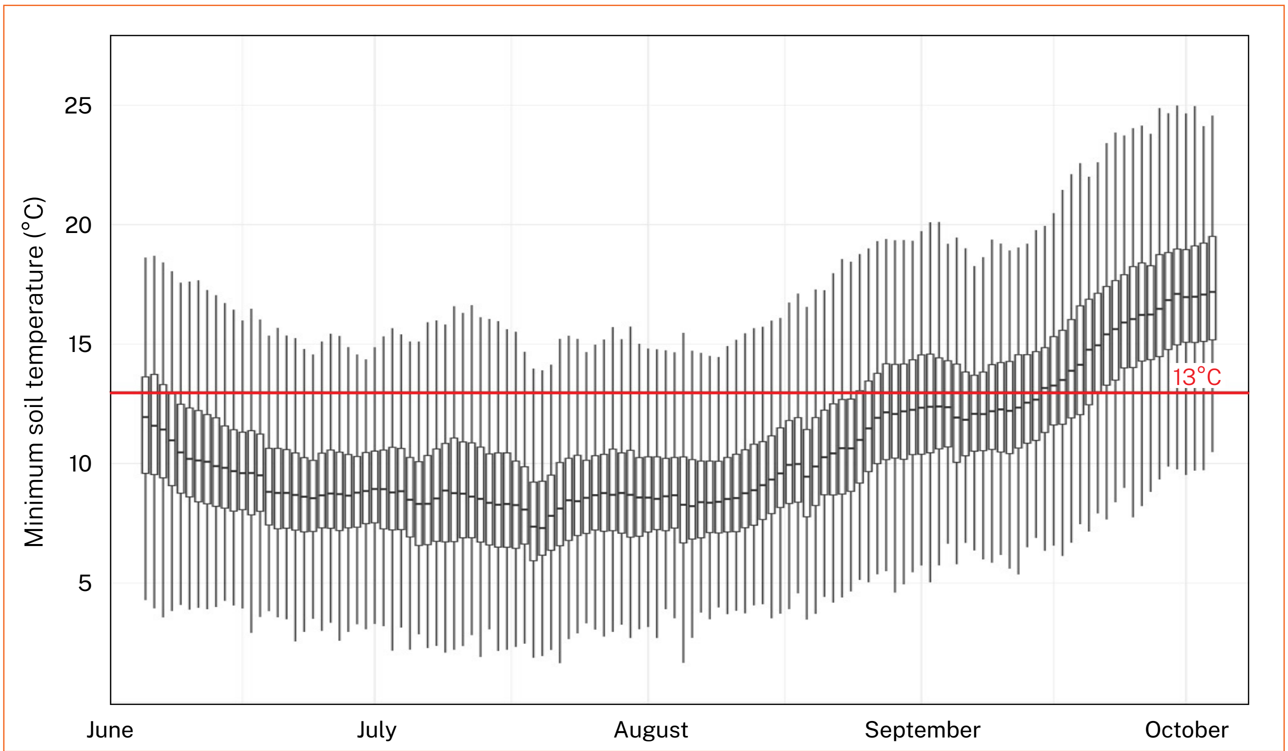

Figure 13. APSIM simulations of soil temperature at Moree, NSW using data from SILO.

Mungindi, New South Wales

Mungindi SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperatures during each spring (Figure 14). The graph shows the earliest planting window for sorghum would start around the 25 August. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line).

The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture, and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below the 13 °C for the range of planting dates (Figure 15). The figures should be used as a reference with soil temperatures in each intended paddock measured before planting.

At Mungindi, in the north-western plains on the border of NSW and Qld, the risk of heat stress at flowering is greater than 75% for planting dates after 1 August when minimum soil temperatures are marginal for reaching 13 °C (Figure 14). The high risk of heat stress does not decline until planting after mid-December. This creates the need to plant as early as possible on rising soil temperatures.

Late plantings are less likely to be exposed to heat at flowering but will need to be established in hot soil conditions. The late planted crops will not mature until the cooler months so harvesting might be delayed until the winter months.

Mungindi region suggested planting windows are:

1. mid–late August to late September
2. late planting: December to early January.

Locally relevant trial work

Can winter planted sorghum be successfully established at Mungindi? Northern NSW Research Results 2019, NSW DPI (https://www.dpi.nsw.gov.au/?a=1246099).

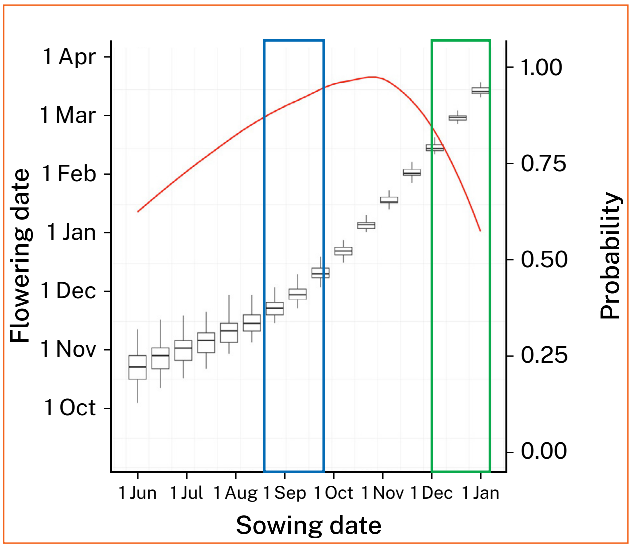

Figure 14. Predicted flowering dates (APSIM simulations)for sorghum sown from 1 June to 15 January at Mungindi, NSW. The red line indicates the risk of heat stress at flowering for each sowing time, and the blue/green boxes are the suggested sowing windows.

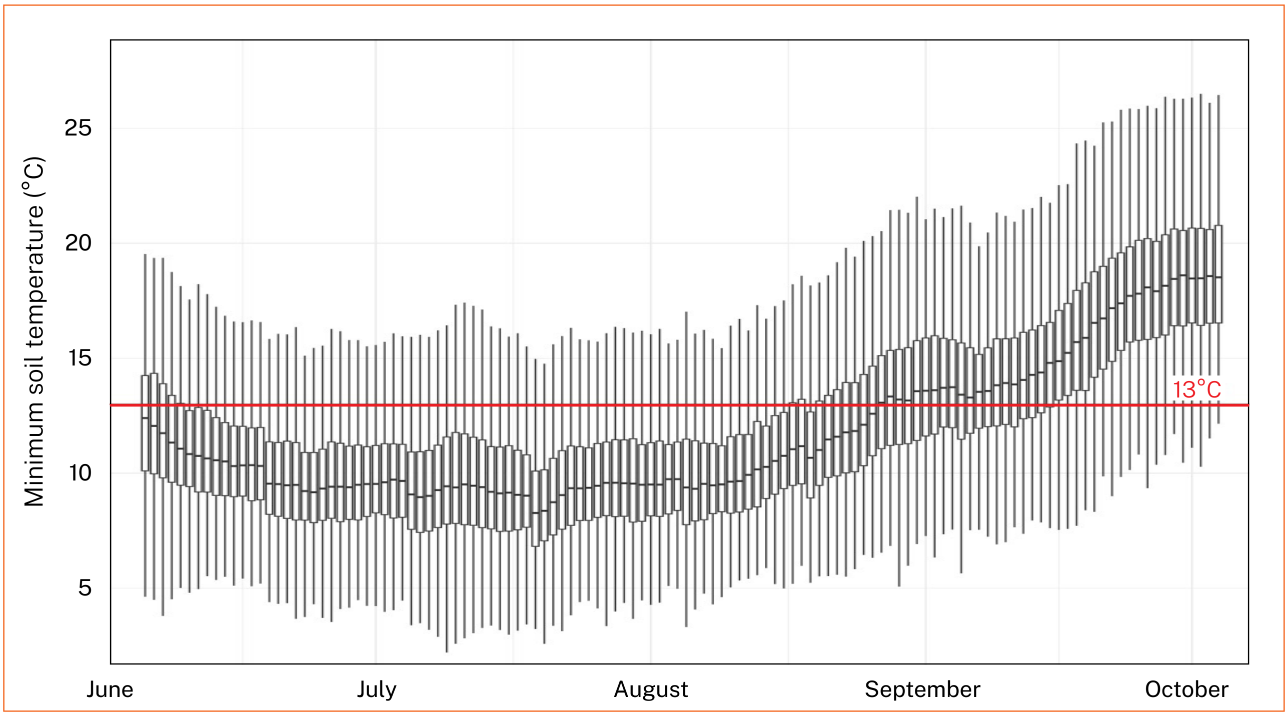

Figure 15. APSIM simulations of soil temperature at Mungindi, NSW using data from SILO.

Dalby, Darling Downs, Queensland

Dalby, on the Darling Downs, SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperature during each spring (Figure 16). The graph shows the earliest planting window for sorghum would open by late August or early September. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line).

The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below the 13 °C for the range of planting dates (Figure 17). The figures should be used as a reference with soil temperatures in each intended paddock measured before planting.

On the Darling Downs, the risk of frost damage is higher (25%) for plantings in early June than later in the year. By late July–early August, the risk of frost damage to the crop is nearly nil, which corresponds to about 50% chance of the crop being affected by heat stress (compared with nearly 70% for October plantings) (Figure 16).

The Darling Downs region suggested planting windows are:

1. mid-late August to October
2. late planting: late November to January.

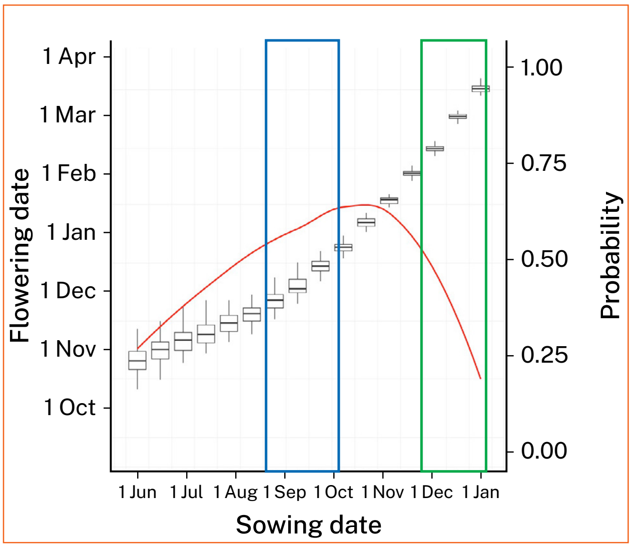

Figure 16. Boxplots of APSIM simulations showing Predicted flowering dates (APSIM simulations)for sorghum sown from 1 June to 15 January at Dalby, Qld. The red line indicates the risk of heat stress at flowering for each sowing time, and the blue boxes are the suggested sowing window.

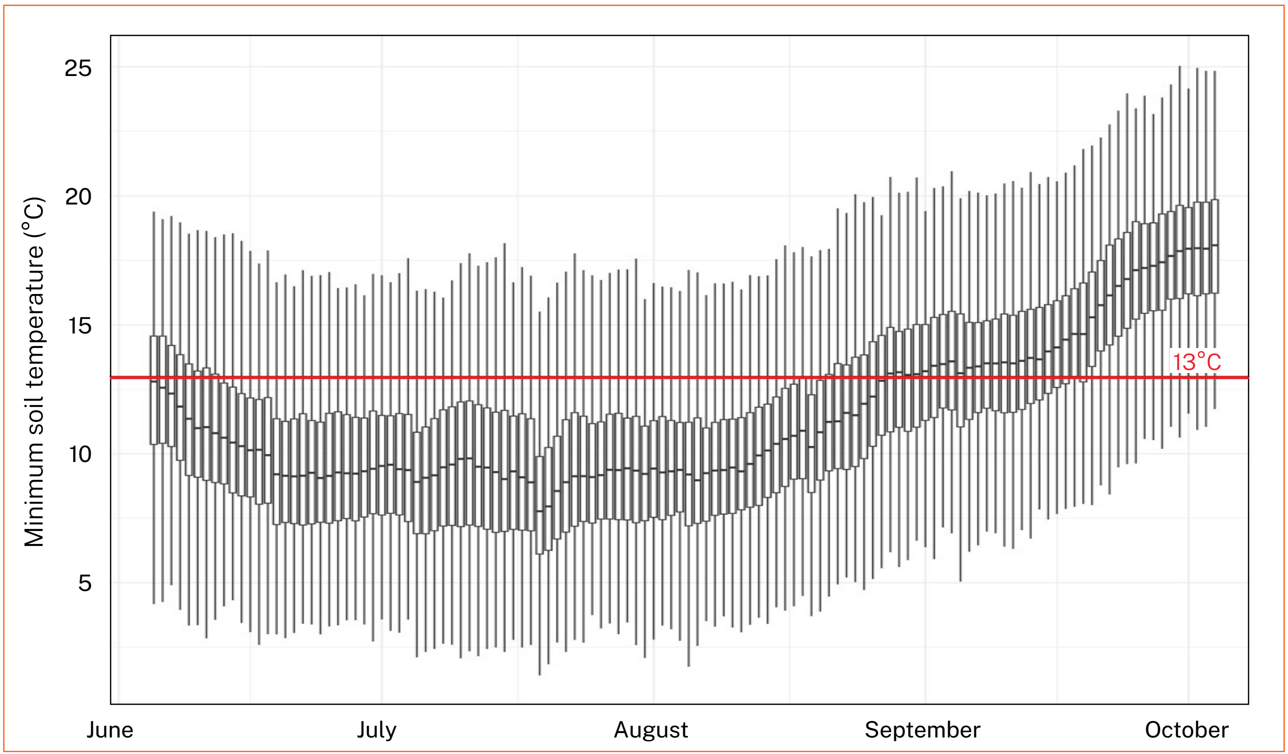

Figure 17. APSIM simulations of soil temperature for Dalby, Qld using data from SILO.

Warra, Western Downs, Queensland

Warra, on the Western Downs, SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperature during each spring (Figure 18). The graph shows the earliest planting window for sorghum would be around the end of August. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line).

The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below the 13 °C for the range of planting dates (Figure 19). The figures should be used as a reference with soil temperatures in each intended paddock measured before planting.

On the Western Downs the risk of frost damage is higher (25%) for plantings in early June than later in the year. Though, by late July–early August the risk of crop damage by frosts is nearly nil, which corresponds to about 50% chance of the crop being affected by heat stress (compared with nearly 70% for October plantings) (Figure 18).

The Western Downs region suggested planting windows are:

1. late August to October
2. late planting: late November to January.

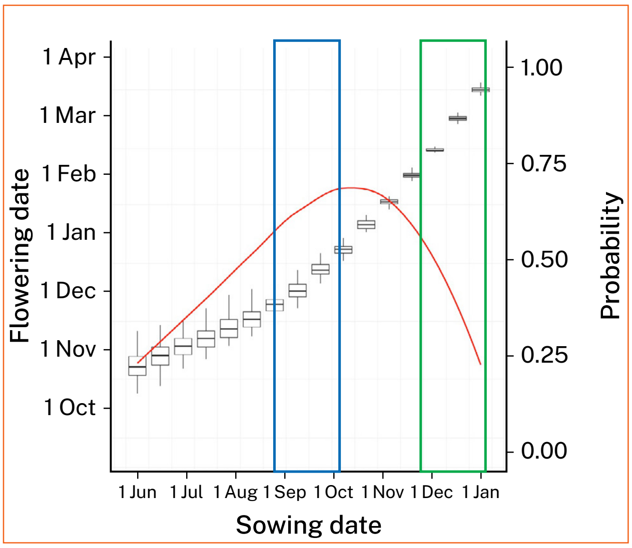

Figure 18. Predicted flowering dates (APSIM simulations)for sorghum sown from 1 June to 15 January at Warra, Qld. The red line indicates the risk of heat stress at flowering for each sowing time, and the blue/green boxes are the suggested sowing windows.

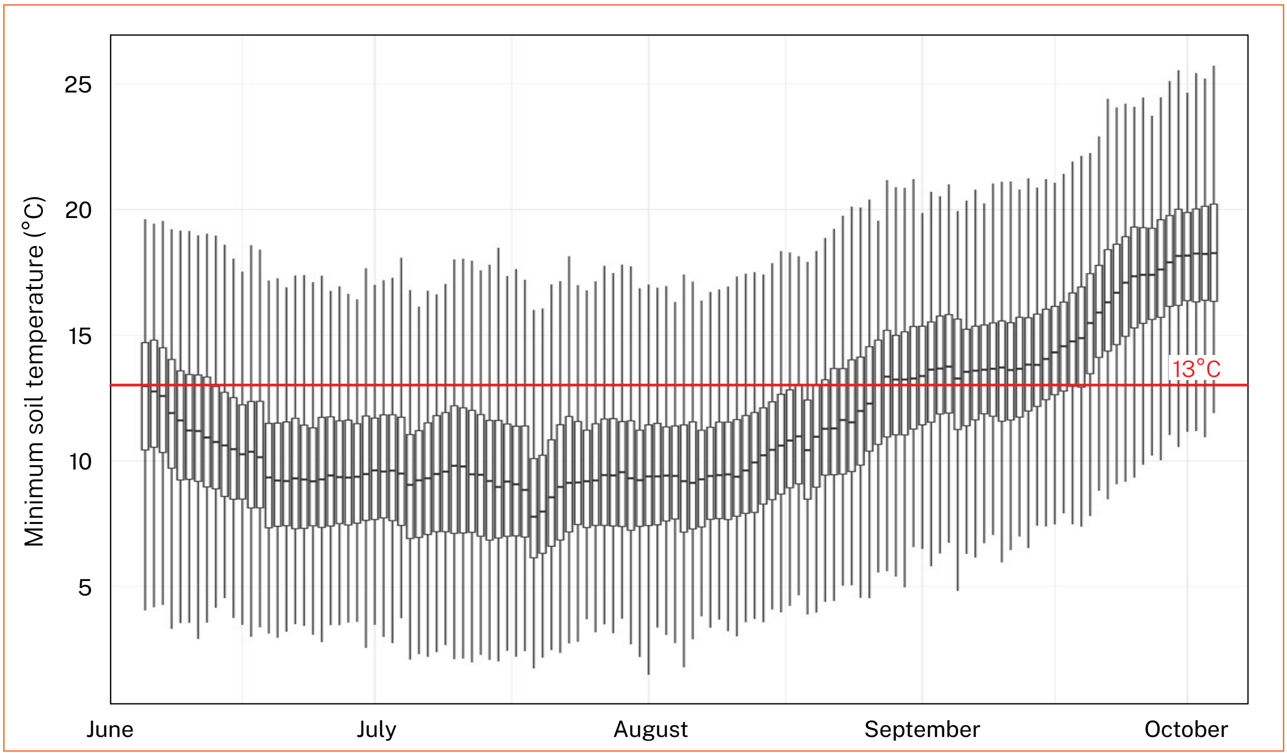

Figure 19. APSIM simulations of soil temperature for Warra, Qld using from data from SILO.

Emerald, Central Highlands, Queensland

Emerald on the Central Highlands, SILO data (1950–present) were used to estimate the distribution of surface (0–150 mm) minimum soil temperature during each spring (Figure 20). The graph shows the planting window for sorghum would be based on flowering time and heat risk as opposed to minimum soil temperatures as soil temperatures rarely fall below 13 °C. The only brief windows for low soil temperatures are during early–mid July. This is when the median soil temperature at the planting depth (black line) reaches 13 °C (red line).

The main reasons for the differences between site and long-term values relate to season-to-season variations, differences in ground cover and soil moisture and differences in aspect and position in the landscape. See Historical soil temperature (http://apsimpoama.ddns.net/HistoricalChill/).

There is a wide spread of values above and below the 13 °C for the range of planting dates (Figure 21). The figures should be used as a reference with soil temperatures in each intended paddock measured before planting.

At Emerald, the risk of frost damage is nil for all the planting times, with risks of heat stress lower than 50% for plantings between 1 June and early July (Figure 20).

Sorghum crops in central Queensland rely on in-crop rainfall, particularly at flowering, in combination with a full profile of soil water to produce good yields. However, planting time can help improve the chances of successful crops. Of all the regions, the risk of heat stress at flowering is greatest at Emerald. By late July–early August the risk of the crop being affected by heat stress is nearly 70% and remains high for several months (Figure 20). In contrast, there is a very low risk of frost damage all year round.

The traditional planting window encompasses January–February, which exposes the crop to the risk of ergot damage at flowering. Research conducted through this project has helped identify a second viable planting window in mid-June to early August.

The Central Highlands suggested planting windows are:

1. early January to mid-February, the traditional planting window
2. mid-late June to early August

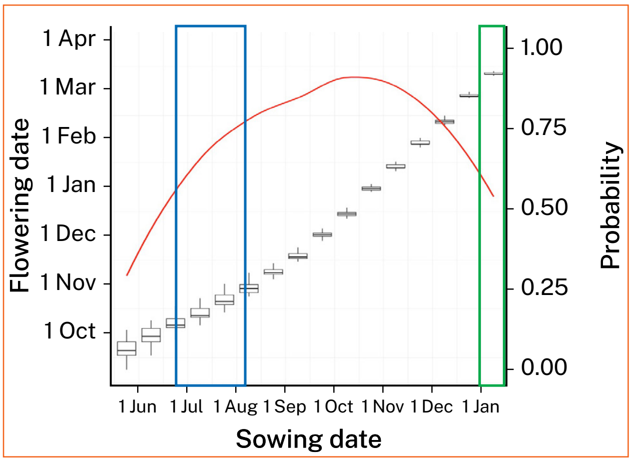

Figure 20. Predicted flowering dates (APSIM simulations)for sorghum sown from 1 June to 15 January at Emerald, Qld. The red line indicates the risk of heat stress at flowering for each sowing time, and the blue/green boxes are the suggested sowing windows.

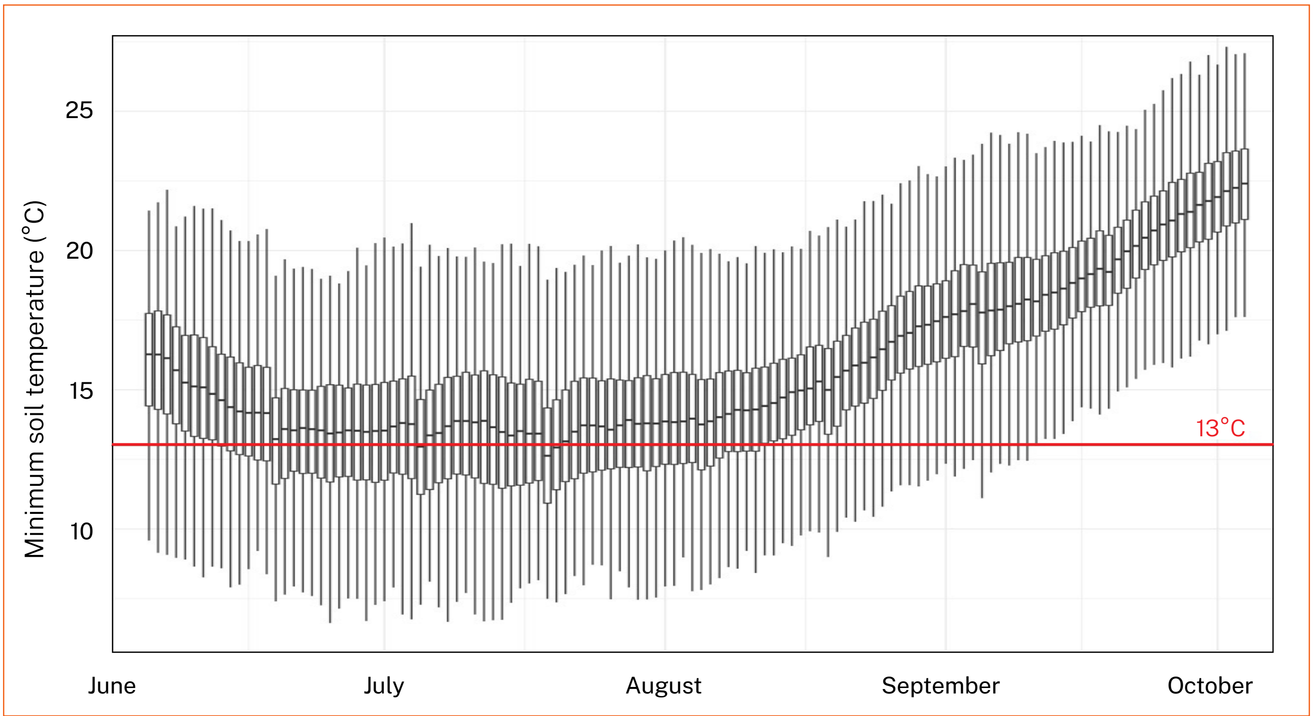

Figure 21. APSIM simulations of soil temperature for Emerald from data from SILO

The information in Table 2 was kindly supplied by seed companies and is not based on NSW DPI data. Only varieties commercially available in NSW are listed. Consult seed companies before final selection of sorghum hybrids for specific markets and for particular localities.

Table 2. Sorghum hybrid characteristics.

Sorghum hybrid characteristics 2023–24									
Hybrid	Maturity	Days to 50% flower	Height	Standability	Sorghum midge rating#	Staygreen	Head type	Tillering	Irrigation suitability
BARENBRUG									
Cracka	M	68–78	S–M	5	3	L	SO	M–H	Yes
Liberty White	MS	70–80	MT	4	4	L	SO	H	Yes
Bar Cyclone	MS	70–80	S–M	5	6	M	SO	M–H	Yes
Pacific Seeds™									
MR Bazley	MQ	65–75	S–M	5	4	ML	SO	H	Yes, limited
MR Taurus	MQ	66–74	M	5	6	ML	SO	M	Yes
MR Buster	M	69–77	S–M	5	4	ML	SO	M–H	Yes
Sentinel IG*	M	69–77	MT	4	5	L	SC	H	Yes
Resolute	M	70–80	M	5	8+	M	O	M	Yes
Halifax	MS	72–82	M	5	7	M	O	M	Yes
Viper IG*	Q	62–72	S	5	4	ML	SO	M	No
Acclaim	M	69–77	M	5	7	M	SO	H	Yes
Pioneer®									
84A66	M	66–77	M	5	7	L–M	SO	M	Yes
84A75	M	70–79	M	5	6	L	SO	H	Yes
84A88	M-L	71–80	M	5	4	M	O	M	Yes
85G33	MQ	65–76	S–M	5	6	L–M	SO	M–H	Yes
85A14	M	67–79	M	5	7	M	SO	ML	Yes
Radicle Seeds									
Agitator	MQ	65–75	M	5	4	M	O	L	Yes
Brazen	MS	70–80	M	5	5	M	SO	VL	No
S&W Seed Company									
Tanami	MQ	68–71	M	5	5	H	SO	L	Yes, limited
Gibson	M	70–74	M	5	6	M	SC	LM	Yes

* indicates these hybrids are imidazolinone-tolerant.

Maturity: Q – quick; MQ – medium quick; M – medium; MS – medium slow
Days to 50% flower – is an estimate
Height: S – short; M – medium; MT – medium tall
Standability: 1 – poor; 2 – fair; 3 – good; 4 – very good; 5 – excellent
Staygreen: L – low; M – medium; H – high
Head type: O – open; SO – semi-open; SC – semi-compact; C – compact
Tillering: VL – very low; L – low; M – medium; H – high

Irrigation suitability: seed company recommendation
Sorghum midge rating: 1 – susceptible; 2 – low; 4 – moderate; 6 – high; 7 – very high; 8+ – excellent; P – preliminary
Midge rating is the factor by which a hybrid's midge resistance exceeds that of a fully susceptible hybrid (rating 1). For example, if it is cost effective to control 2 midges/head in a rating 1 hybrid, then cost effective control in a rating 7 hybrid occurs when there are 14 midges/head.

Figure 22. Commercial sorghum crop at Nangwee, Queensland. Photo: Daniel Rodriguez, UQ.

Other resources

Growers, researchers explore sorghum winter start, GRDC GroundCover 13, January–February 2019 (https://grdc.com.au/resources-and-publications/groundcover/groundcover-138-january-february-2019/growers,-researchers-explore-sorghum-winter-start).

Early planting grain sorghum in northern NSW, Management guide, 2021, NSW DPI (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/1343982/Early-planting-grain-sorghum-in-northern-NSW.pdf).

Can sorghum establishment be improved under sub-optimal soil temperatures? Gurley 2021–2022, Northern NSW Research Results 2022, NSW DPI (https://www.dpi.nsw.gov.au/?a=1431842)

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Figure 23. Growers and agronomists at the Mungindi field walk, January 2023. Photo: Daniel Rodriguez, UQ.

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QAAFI Queensland Alliance for Agriculture and Food Innovation

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