Department of Primary Industries
and Regional Development

Growing profitable sorghum in northern NSW – the latest research

Key management factors to optimise sorghum production

- Use no-till farming techniques to best utilise stored fallow soil moisture. Ensure soil water profiles are full or close to full, with a minimum of 120 cm of soil moisture available before dryland crop planting.
- Choose seed with good germination and vigour, especially if early planting.
- Recent experiments have shown the potential for planting sorghum earlier in minimum soil temperatures of 13°C, where temperatures are forecast to rise following planting. This is a lower temperature than the traditional range of 16–18°C.
- Planting should be timed to avoid periods of extreme heat and moisture stress during flowering and grain fill.
- Match the plant population and row spacing to the target yield and location.
- Use nitrogen (N) fertiliser rates based on target yields, soil tests and/or previous crop yields and protein levels.
- Implement effective weed control, especially for grass weeds.
- Check previous herbicide applications for potential residues or plant back issues to avoid herbicide damage.
- Monitor and, if necessary, control insects, especially wireworms (at planting), midge, *Helicoverpa* (heliothis) and Rutherglen bug (flowering–grain fill).
- Sorghum is resistant to the *Pratylenchus thornei* (*P. thornei*) species of root lesion nematodes (RLN) and as such can be grown as part of a management strategy to reduce nematode numbers.

dpird.nsw.gov.au

Figure 1 Sorghum time of sowing experiment at Breeza on the Liverpool Plains.

Introduction

Grain sorghum is the dominant summer crop grown in New South Wales (NSW), with most of the crop grown in northern NSW. Sorghum is primarily used in the domestic intensive livestock industries as a source of starch and protein. There is also an increasing human consumption market. Grain sorghum is more drought tolerant than maize.

Growing sorghum enables growers to include a summer crop in predominantly winter cereal based rotations. This allows the use of alternative herbicide chemistry, the capability to spread labour and machinery use and increase cash flow. Sorghum stubble also provides ground cover for the following crop, which can increase water infiltration and retention, and N mineralisation. Sorghum provides an important disease break as it is not a host of fusarium crown rot and is resistant to the RLN, *P. thorneii*.

Sorghum production in northern NSW is in 2 main regions:

1. The Liverpool Plains
2. North West (NW) NSW.

The Liverpool Plains has a long history of reliable, profitable sorghum production with the current focus on increasing the yield frontier and improving resource efficiency. In contrast, NW NSW has a shorter history of growing sorghum, especially west of the Newell Highway. This environment is characterised by high temperatures in summer, variable rainfall and winter dominated crop rotations. This region's focus is on improving yield and reliability and optimising the efficiency of water capture and use.

Figure 2 Sorghum field experiments at Breeza.

Since 2018, the Grains Research Development Corporation (GRDC), University of Queensland (UQ), NSW Department of Primary Industries and Regional Development (DPIRD) and Queensland Department of Agriculture and Fisheries (QDAF) have undertaken research into planting sorghum earlier under the GRDC Optimising Sorghum Agronomy project (UOQ 1808-001RTX).

Optimising sorghum production in variable climates
https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/1487287/Optimising-sorghum-production-in-variable-climates.pdf

During the 2023–24 summer cropping season, GRDC and NSW DPIRD continued their joint investment in sorghum research through a 12-month project titled "Increasing sorghum area in NW NSW through understanding and adoption of early sown sorghum principles" in the 2 key regions in NSW mentioned above, the Liverpool Plains and Mungindi/Moree west in NW NSW. The results of these experiments form the basis of this guide.

Paddock selection

Most sorghum crops are planted using no-till or minimum-till farming methods following a long-fallow after a winter cereal. Grain sorghum grown under no-till farming systems has been shown to consistently yield ~0.5–1.0 t/ha more than sorghum grown under conventional tillage.

Consider the following when selecting your paddock:

1. Soil type

Both dryland and irrigated sorghum is usually grown on heavy clay soils with high water-holding capacity (WHC). These soils are capable of supplying moisture to the plant until flowering in most seasons, even in the absence of rain.

2. Soil water

Sorghum should not be planted in a dryland situation unless there is a full soil moisture profile to a depth of 120 cm. A sorghum can have a water use efficiency (WUE) of ~15 kg/ha/mm of available soil water plus in-crop rainfall, but this can vary greatly between sites and seasons.

3. Weeds

Paddocks with poor grass weed control are not suited to sorghum, as sorghum is also in the grass (Poaceae) family. Select paddocks with low weed burdens, especially if you are planning an early plant as many winter weeds will still be able to germinate at the same time as the emerging sorghum crop. Identify problem paddocks, such as those with high populations of black oats, and look for cleaner paddock options.

4. Disease

Sorghum is a good disease break from many winter crop diseases such as fusarium crown rot. However, sorghum is a host of charcoal rot and several other Fusarium species which can cause stalk rots and lodging under ideal environmental conditions.

Planting times

Traditionally sorghum planting starts in mid-September in NW NSW and late October on the Liverpool Plains when soil temperatures in both regions reach 16–18°C.

Research conducted under the optimising sorghum agronomy project has shown that planting early, when soil temperatures are at 13°C and rising, is a feasible option. This roughly correlates to mid-late August at Mungindi/north of Moree and mid-September on the Liverpool Plains, depending on the season.

Soil temperature should be measured at the intended planting depth and at the same time of the day e.g., 8 am EST, which is close to when soil is at the minimum temperature in a 24-hour period. A traffic light system can be used to help determine when soil temperatures have reached levels suitable for sowing. An example is given in Figure 3 below using soil temperature data from the 2021 season. Long term soil temperature data can help to predict likely soil temperatures.

Research result
Planting sorghum early (soil temperature 13°C and rising) can be successful.

The ideal soil temperature for rapid crop emergence is 16 °C and rising. Planting sorghum earlier into cooler soils results in delayed seedling emergence compared to traditional planting. Planting into cold soils will extend the time to crop emergence to ~14 days but will also move the flowering window forward. There needs to be adequate moisture around the seed at planting to ensure the seed does not dry out and stop the germination process.

When planted at the traditional temperature, plants emerge in 5–7 days. This can be as short as 3 days in summer when soil temperatures are well above 20° C. Early planted crops can take 14–21 days to emerge, or longer if cold conditions prevail.

The traditional planting window enables quick seedling emergence under warm temperatures and still ensures warm conditions for crop maturity and harvest. The main draw-back of traditional planting times has been the increased risk of exposure to extreme temperatures during flowering and grain fill.

Soil moisture is one of the major factors determining crop yield. Ways to manipulate soil water use to produce the highest water use efficiency (WUE) are key profit drivers for growers.

Early planted sorghum uses less water in the vegetative phase, allowing more soil water to be available for grain fill.

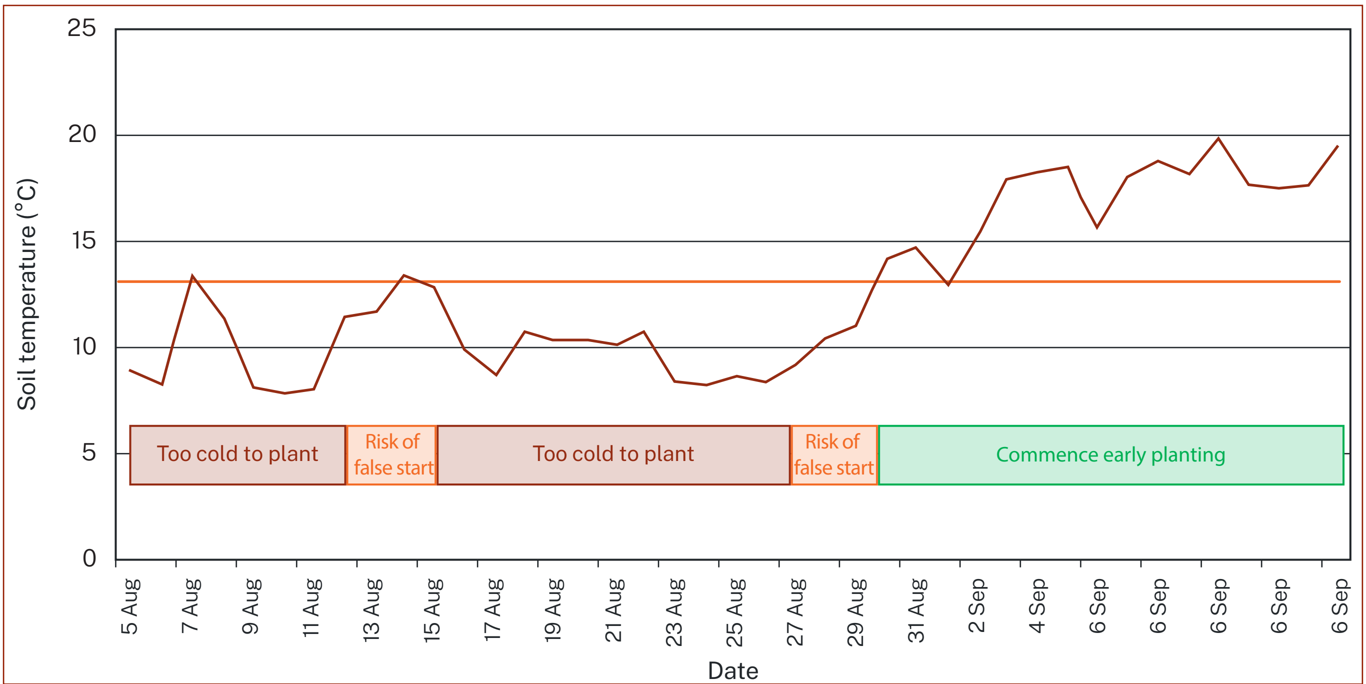

Figure 3 An example of using soil temperatures for planting time from Mungindi 2021. Red = too cold to plant, orange = planting possible with risk of false start, green = commence early planting.

Early planting means harvest will commence in mid-January in the Moree/Mungindi region, and late January on the Liverpool Plains (Figure 4) when conditions are more favourable, with longer daylength and warmer temperatures. Summer harvesting allows harvest length to be minimised and grain moisture contents are typically lower than harvesting in Autumn.

This also results in more time for fallow soil moisture to refill for following winter crops. Some pros and cons of early and late sorghum planting times are compared in Table 1.

> Early planting grain sorghum in northern NSW
> https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/1343982/Early-planting-grain-sorghum-in-northern-NSW.pdf

Optimum planting times for the Liverpool plains

The Liverpool Plains can be exposed to periods of heat and moisture stress, but these effects are largely abated by the combination of cooler night temperatures and higher average rainfall compared with the Moree/Mungindi region. This enables a wider planting window. Planting usually commences around mid-September when soil temperatures are rising (blue box). There is also the opportunity to plant crops later (i.e., from early November–early January, Figure 5, green box) which helps avoid flowering during the peak heat stress period.

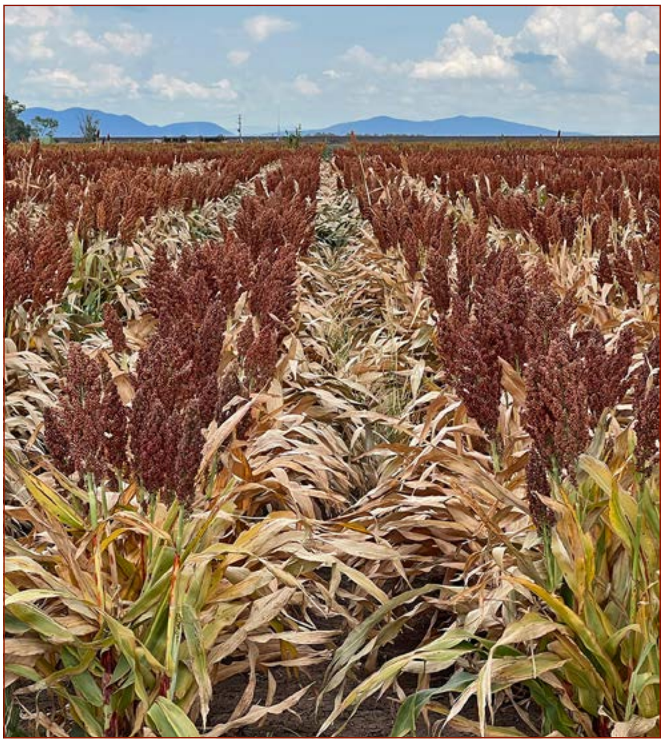

Figure 4 Sorghum planted on 19 September 2023 at Breeza on the Liverpool Plains was ready for desiccation at the end of January 2024.

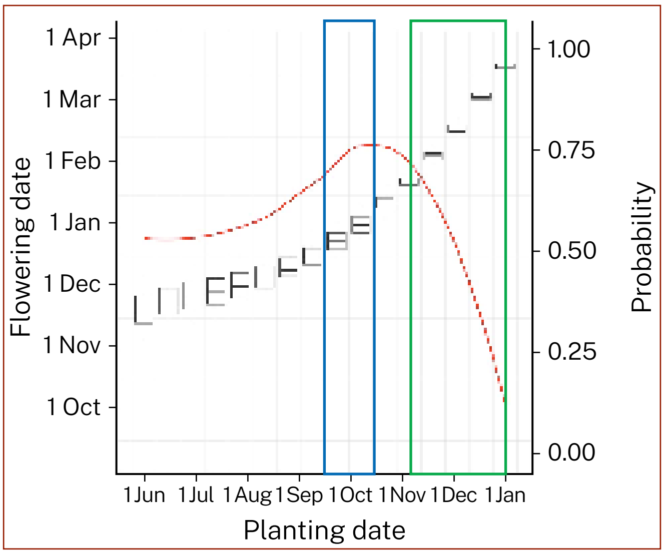

Figure 5 Predicted flowering dates (APSIM simulations) for sorghum planted from 1 June to 15 January at Breeza. The red line = risk of heat stress at flowering. The blue and green boxes are the suggested early and late planting windows. Source: APSIM, Peter de Voil, UQ.

> **Research result**
> Early planted sorghum produced grain yields better than or equal to normal planting times.

Optimum planting times for Moree/Mungindi

The main challenge to growing a profitable sorghum crop in NW NSW is limited planting opportunities due to soil moisture deficits. The area can also experience periods of extreme heat and moisture stress during and after flowering. An early planting window opens from mid-August and the late planting window opens in December, as the risk of heat stress at flowering starts to recede (Figure 7).

Figure 6 Sorghum sown on 100 cm rows at Gurley, near Moree.

Table 1 Pros and cons of early or late planting times for Liverpool Plains and North west NSW.

Early planting (August/September)		Late planting (December/January)	
Pros	**Cons**	**Pros**	**Cons**
Crops should flower before the extreme heat period.	Soil temperatures need to reach a minimum of 13°C and rising. False starts can reduce establishment.	**Effective fallow weed control can be undertaken.**	Soil temperatures can be very hot, reducing seed emergence and drying out the seedbed quickly.
Crop yields will be the same or better than normal planting time.	Slower crop growth and development. Crops will take more days to reach 50% flower.	**Seed will rapidly emerge due to very warm soil temperatures.**	Later flowering, slower maturity and grain dry down. With late harvest, grain may need to be dried due to high moisture content. Shorter days = fewer harvest hours.
Earlier harvesting e.g., from mid-January, starting the fallow re-fill earlier, with the possibility of double cropping.	Paddocks need to be clean of winter weeds, e.g., black oats, as the crop will be emerging when these species can still germinate.	**Opportunity to wait longer for a full soil moisture profile prior to planting.**	Harvest can clash with winter planting.
Avoid clashes with winter crop planting and harvest.	High quality seed is needed. Hybrid cold tolerance varies so hybrid choice is important.	**The crop will grow and flower quicker; 65–70 days for most hybrids.**	No double cropping opportunity. A long fallow period is required before a winter crop can be planted.

Growth patterns

Cooler temperatures in late winter and early spring result in a longer time to accumulate day degrees, the driver of plant growth for early planted crops.

Sorghum plants produce more tillers when planted earlier and have a longer period of vegetative and panicle growth. As a result, it takes more days for early planted sorghum to reach 50% flowering when compared to a traditional planting time. Earlier flowering reduces the risk of heat stress and reduced pollen viability from high temperatures (Figure 8).

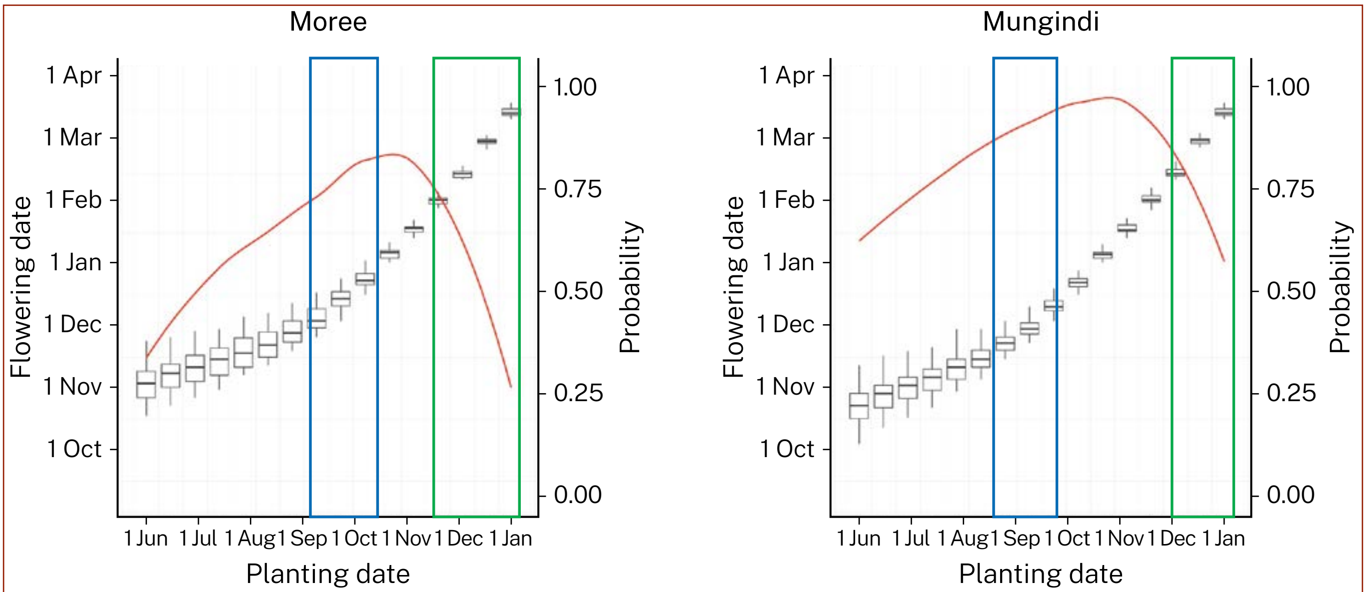

Figure 7 Predicted flowering dates (APSIM simulations) for sorghum planted from 1 June to 15 January at Moree (LHS) and Mungindi (RHS). The red line = risk of heat stress at flowering. The blue and green boxes are the suggested early and late planting windows. Source: APSIM, Peter de Voil, UQ.

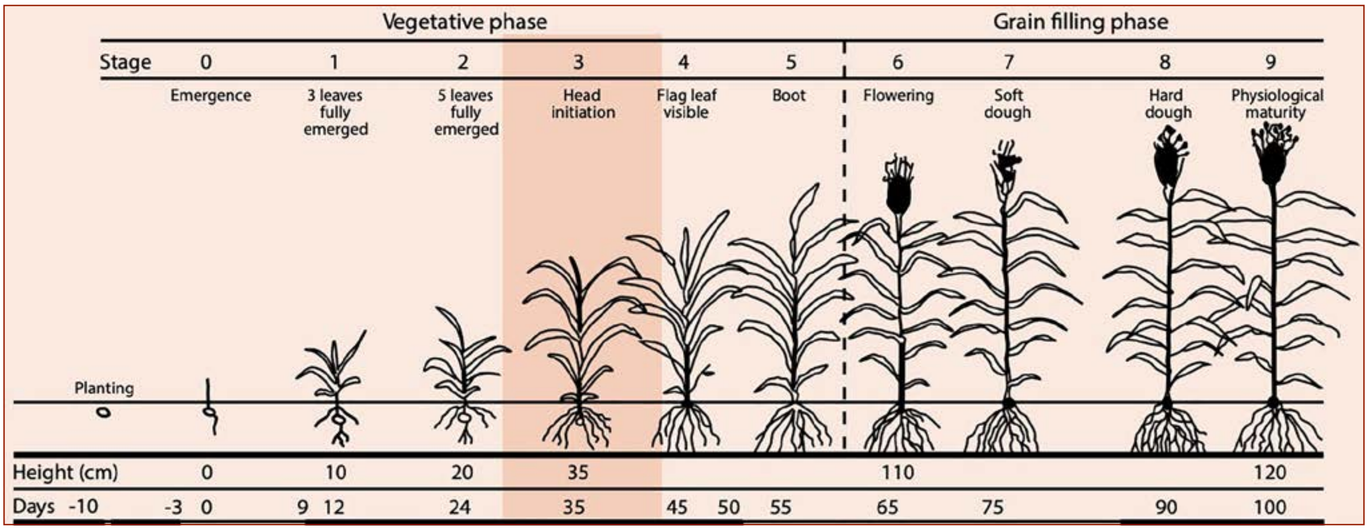

Figure 8 Sorghum growth and development stages. Source: NSW DPIRD.

Seed quality

Successful establishment starts with seed with both good germination and vigour. Germination can vary between hybrids and seed lots. Cold soil temperatures are an additional stress on seedlings, so only use the best quality seed available. Poor vigour can lead to reduced and prolonged emergence, particularly when planted into cool soils.

Planting depth

Recommended planting depth for sorghum is 3–5 cm, depending on the available soil moisture and planting time. Crops planted later in the window may need to be planted deeper as the seedbed can dry out quickly. Sorghum can be planted as deep as 10 cm, however an establishment penalty of around 10 % may apply.

Plant population

The effect of varying plant stand has been tested across a range of very low (~1.5 plants/m^2) to very high (~12 plants/m^2) populations over the last 15 years. These populations were tested across the main row configurations used by farmers in the region:

- 100 cm solid
- single skip (SS)
- double skip (DS)
- superwide (SW, 150 cm solid).

Current research is investigating the effects of varying plant population under narrow row spacings e.g. 33, 37 or 50 cm. Narrow row spacings will also vary the amount of biomass produced.

Sufficient plants need to be established to achieve the maximum potential yield and to minimise seed cost expenditure. Plant establishment is primarily about maximising yield, but has implications for weed competition, improving resource capture and efficiency (water, sunlight etc), crop evenness for pest control and desiccation.

As a guide, establishing 5–6 plants/m^2, regardless of the row configuration, is the most reliable option in Northern NSW. NSW DPIRD research has tested higher plant populations (9 and 12 plants/m^2) and found no yield benefits from the increase in plant number, only higher seed costs. Establishing <3 plants/m^2 limited the crops yield potential. Very low plant populations also had additional challenges with gaps and uneven plant stands in a paddock allowing weeds to compete.

Plant populations may vary depending on the hybrid type. Lower tillering hybrids may warrant higher plant populations and conversely high tillering hybrids can be planted at lower populations.

For more information on how to calculate planting rates for sorghum refer to: Summer crop management guide https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/summer-crop-management-guide

Row spacing

It is recommended to match your row spacing to your region, expected yield and the available soil water.

Traditional row spacing recommendations are:

- for yields >3.5 t/ha use 75–100 cm
- for yields <3t/ha, row spacings of 100 cm solid or skip (single or double) or SW (Figure 10).

Sorghum can be successfully established and grown on row spacing's as close as 25 cm or as wide as a double skip (effectively 200 cm). The choice of row spacing depends on your attitude to risk in your growing environment, starting water, seasonal forecast, availability of machinery and the farming system fit.

NSW DPIRD and GRDC responded to the current interest in narrow row sorghum (30–50 cm) by conducting a series of experiments in 2023–24 (Figure 9) to evaluate any potential advantages such as:

- enabling the use of one planter for summer and winter crop planting
- improved ground cover and fallow efficiency following harvest
- improved weed control from crop competition.

The likely disadvantages from narrow rows include:

- greater crop biomass produced which results in increased stubble load which may make sowing the following winter crop more difficult due to planter blockages
- increased risk of crops using all available soil water prior to flowering.

The advantage of wide (120 or 150 cm) or skip row spacing is the ability to conserve moisture in the skip areas for flowering and grain fill, as the plant roots are generally unable to fully explore this area before flowering. Weed control is more critical in wide row spacings. Wider or skip rows are very reliable, but yield is capped in high yielding seasons.

The use of precision planters enables less seed to be used, more uniform seed spacing and a more even crop maturity. However, sorghum can still be established using air seeders.

Regional row spacing research

Liverpool Plains

Experiments in 2023–24 produced high yields. Row spacing experiments were conducted at Breeza, Spring Ridge and Mullaley with a selection of results presented here. The experiments compared 50 cm, 100 cm and SS at Spring Ridge and Mullaley and 75 cm, 100 cm and SS at Breeza.

Figure 9 Sowing sorghum experiments into wheat stubble at Gurley, near Moree.

The main results from these experiments were:

- the solid row spacings produced higher yields, compared to the SS at both Spring Ridge and Mullaley
- planting time interacted significantly with row spacing this season at Spring Ridge and Mullaley
- at Spring Ridge, time of sowing (TOS) 1 produced highest yields on 50 cm rows, followed by 100 cm and then SS. In contrast TOS 2 showed no difference in the grain yields at 50 or 100 cm (Figure 11a)
- at Mullaley in TOS 1, the yields of the 50 cm and 100 cm were the same, and both were better than the SS. Time of sowing 2 produced higher yields at 50 cm than at 100 cm, both were better than SS. The SS yields were equivalent at both TOS's (Figure 11b)
- while the responses to narrow row spacing were not consistent between the 2 TOS's at each site the 50 and 100 cm spacings were always higher yielding than the SS.

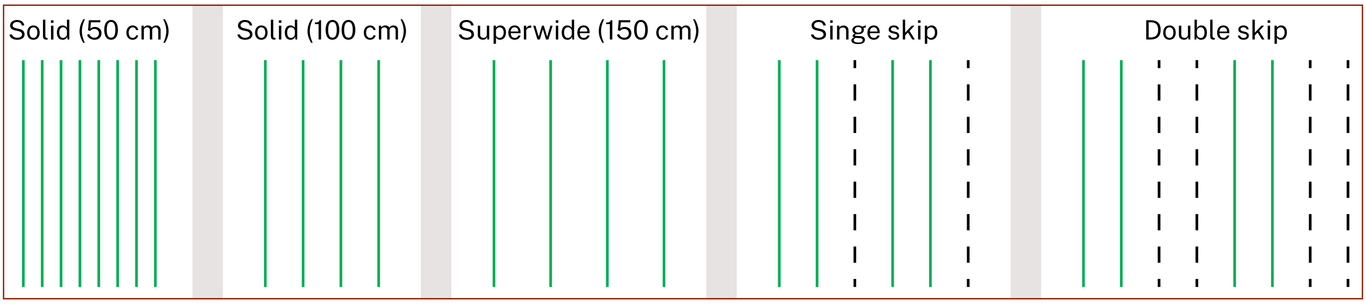

Figure 10 Illustration of row spacing options suitable for grain sorghum in northern NSW.

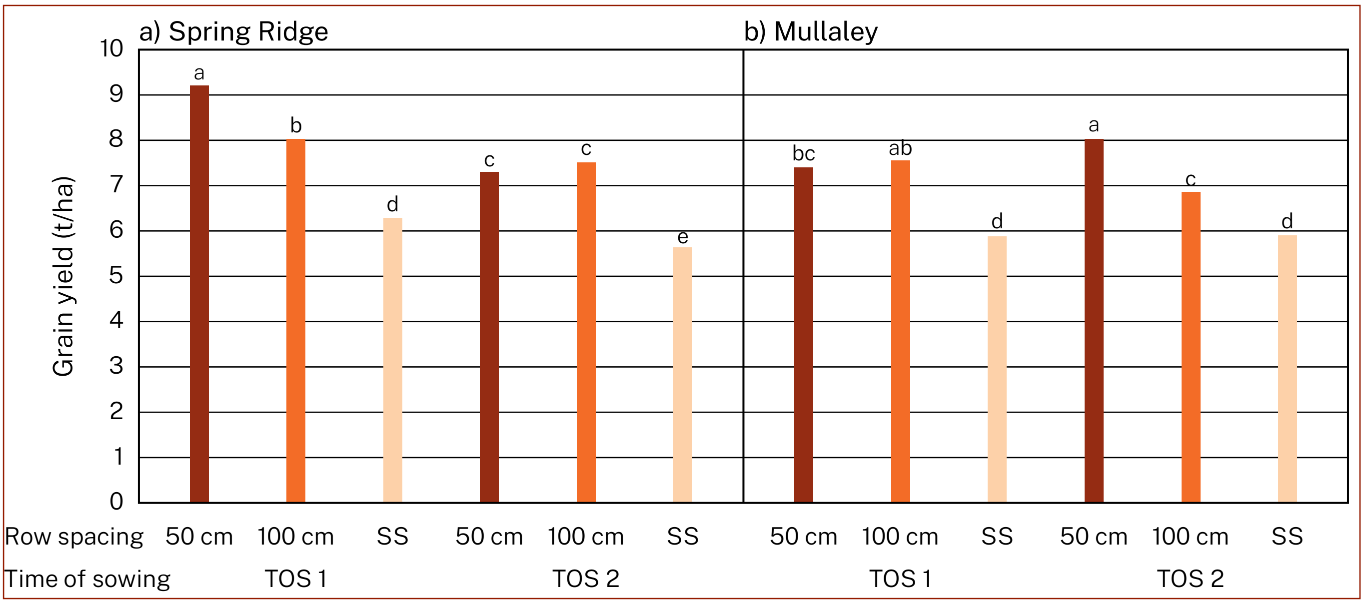

Figure 11 Grain yield × row spacings at a) Spring Ridge and b) Mullaley in 2023–24. Data with the same letter are not significantly different (*P*<0.05).

Research result
In seasons where yield was >4 t/ha, there was no yield difference between 50 and 100 cm row spacing.

Moree/Mungindi region

Research results from the last 2 seasons, including narrow rows, were from sites with above average yields. All the sites yielded >4.0 t/ha.

- In the 2021–22 season, with site mean yield of 8.2 t/ha at Mungindi, there was no significant difference between 33, 50 and 100 cm row spacings.
- In 2023–24 at Weemelah, the site mean yield was 6.1 t/ha, with no difference between 50 and 100 cm solid row spacings. Yield declined by around 1.0 t/ha for the SS treatment (Figure 12).
- At Millie in 2023–24, site mean yield was 4.31 t/ha with an interaction between hybrid and row spacing. There were no significant yield differences between 50 and 100 cm row spacings at this site. Single skip yields were lower for the quick maturity Viper IG (Figure 13) compared to the other longer season hybrids.

Based on the data collected by NSW DPIRD in seasons yielding >4 t/ha, there was no difference between 50 and 100 cm row spacings.

In the 2024–25 season NSW DPIRD will be continuing research on narrow rows versus 100 cm rows and hopes to collect data from lower yield scenarios (2–4 t/ha).

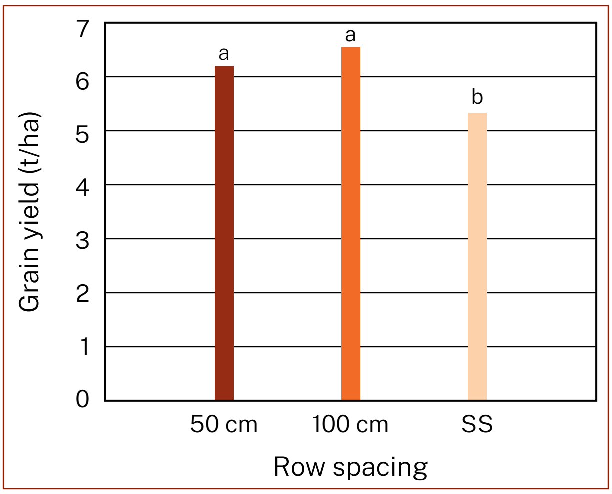

Figure 12 Grain yield × row spacings at Weemelah 2023–24. Data with the same letter are not significantly different (*P*<0.05).

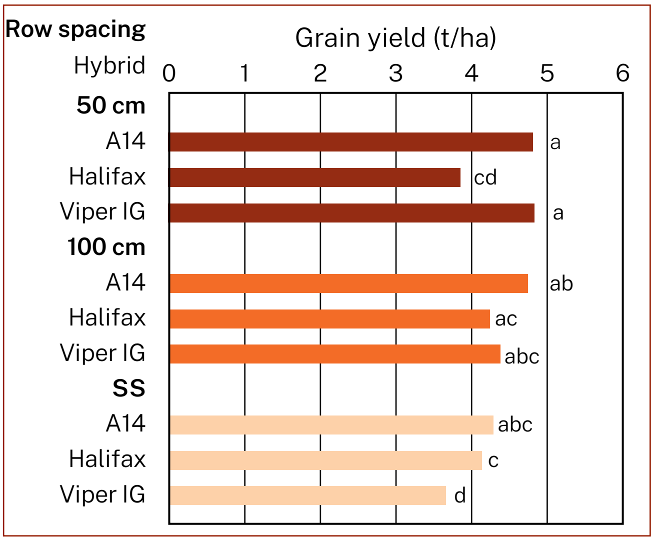

Figure 13 Grain yield across row spacings × hybrids, Millie 2023–24. Data with the same letter are not significantly different (*P*<0.05).

Hybrid selection

Selecting the right hybrid depends on both the location and the seasonal forecast. Characteristics of current commercially available varieties in NSW are listed in Table 2.

For the latest midge ratings, head to NVT Disease Ratings | NVT (grdc.com.au)

Table 2 Sorghum hybrid characteristics, 2024–2025.

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
Sterling	MQ	66-74	S- M	8	6	M	SO	M	Yes
Acclaim	M	69–77	M	5	7	M	SO	H	Yes
Pioneer									
84A66	M	66–77	M	5	7	L–M	SO	M	Yes
84A88	MS	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	6	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

* Imidazolinone tolerant hybrids.

Maturity: Q – quick; MQ – medium quick; M –medium; MS – medium slow.

Days to 50% flower: estimated, will vary based on planting time, location and seasonal conditions.

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.

This information is kindly supplied by seed companies and is not based on DPIRD data. Only varieties that are commercially available in NSW are included. Please consult seed companies or your advisor before final selection of sorghum hybrids for specific markets and locality.

Building the package – time of planting, row spacing, plant population and hybrid

Maximising yields combines use of the best genetics, sound management and favourable environmental conditions. While the environment is beyond our control, management and genetics can be influenced to optimise potential yields.

In marginal environments, maximising fallow water capture to ensure a full profile at planting is one of the key strategies to reduce the risk of crop failure. Maximising ground cover (crop biomass) levels in these environment's aids in water infiltration and retention.

Experimental work has included varying row spacing, hybrid types (quick, medium and long season maturity) and plant populations. This allowed development of different ground cover levels through narrow rows (50 cm), solid plant (100 cm) and SS across early and main season plantings.

In 2023–24 on the Liverpool Plains (Mullaley site) (Figure 14), the highest yields were obtained from:

- early planting (mid-September – early October)
- 50 cm or 100 cm row spacings
- populations of either 4 or 6 plants/m^2
- medium – long maturity hybrids.

In contrast at Moree/Mungindi, dry spring conditions prevented planting in the earliest part of the window (August) so there was only one TOS, which was late. The highest yields were achieved with either 50 or 100 cm spacings at 3 or 6 plants/m^2 with either the medium or quick maturity hybrids.

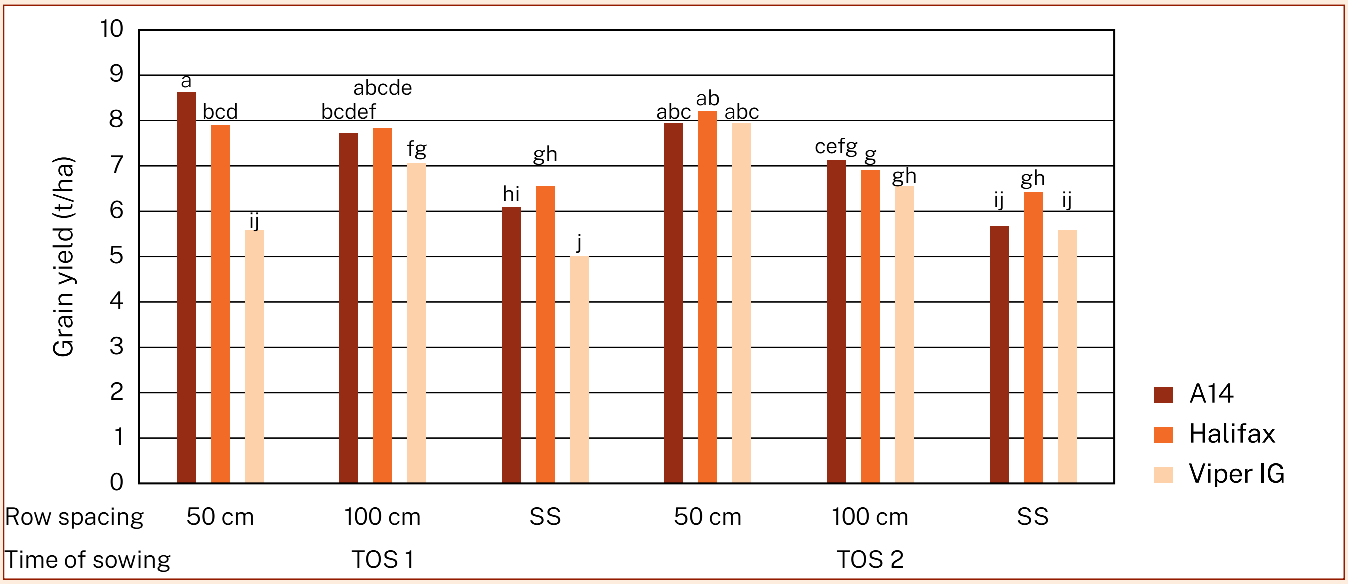

Figure 14 Grain yield × planting time, row spacings and hybrids, Mullaley 2023–24. Data with the same letter are not significantly different (*P*<0.05).

Nutrition

High yielding sorghum crops require adequate nutrition and appropriate fertilisers should be applied. Rates of fertiliser will vary depending on locality, soil type, previous crop and fertiliser history.

Nutrient inputs should match the crop demands of increasing yields while maximising economic returns. In the more variable sorghum environments of NW NSW there is generally a lack of fertiliser application. In this region fertiliser programs have historically been tailored to winter cereal crops with the following sorghum crops expected to use any N remaining in the profile, along with any N mineralised during the long fallow period.

Fertiliser decisions are driven by expected yields, attitude to production risk and the logistics of product application. In low yielding seasons (<2 t/ha), economic returns are marginal and there is likely a negative return on investment (ROI) from fertiliser application.

Data from the Australian Bureau of Statistics on sorghum production in NSW shows that in the 10 year period between 2005–06 and 2015–16, average yields have increased by more than 1.0 t/ha, from 2.72 t/ha in 2005–06 to 3.80 t/ha in 2015–16.

Nitrogen and potassium (K) are the nutrients with the highest removal rates in sorghum. These removal rates are a useful tool to help calculate fertiliser needs. Ranges of nutrient removal per tonne of sorghum are outlined in Table 3.

Table 3 Typical nutrient removal in grain sorghum Source: (More Profit from Crop Nutrition).

Nutrient	Removal	Range
Nitrogen (N) (kg/t)	15.0	9–26
Phosphorus (P) (kg/t)	2.9	1.9–4.0
Potassium (K) (kg/t)	3.3	2.6–4.1
Sulfur (S) (kg/t)	1.3	0.9–1.7
Zinc (Zn) (g/t)	18.0	13–24

Grain sorghum removes ~15 kg of N/t of grain, so for example, a 4 t/ha sorghum crop exports on average ~60 kg/ha. For sorghum a 50% N use efficiency is assumed, as such, the crop requires twice the amount of N removed in the grain. A 4 t/ha crop therefore needs ~120 kg of available N in the soil for growth.

Nitrogen is recommended to be applied either pre-plant or at planting in NW NSW as opportunities for post-emergent application are considered riskier due to variable in-crop rainfall. In-crop applications are an option where rainfall is predicted to allow movement of the N into the root zone.

Sorghum is reported to have taken up 60% of its total N requirement by 60 days post-emergence (flag leaf). Hence in-crop application needs to be applied early enough for N to be taken up by the crop prior to peak demand. NSW DPIRD experiments conducted in the 2023–24 and 2024–25 seasons have been investigating the yield response to in-crop applications at the 6 and 10-leaf stages. Results to date have shown equivalent yield responses to N application at the 10-leaf stage of crop development compared to applications at planting or at 6 leaf stage.

Sorghum grain protein levels <9% generally indicate that yields have been limited by N availability. Numerous commercial sorghum crops in northern NSW over the last few seasons have had low protein levels. The prestigious Liverpool Plains' Premer Shield sorghum competition, which judges the region's best crops, demonstrated this with 73% of the 15 crops judged in 2023 and 2024 having grain protein levels <9%.

NSW DPIRD and GRDC trials in 2023–24 evaluated N application timings and rates. The 3 sites, located at Mullaley and Spring Ridge on the Liverpool Plains and Millie, west of Moree, included 3 hybrids and 8 N strategies (using urea). Urea was applied upfront or in-crop at 6 leaf and 10 leaf stages to test if late fertiliser timings can still increase yield or protein levels. Nitrogen rates were matched to potential site yields based on background N and soil water levels.

A 4 t/ha sorghum crop requires approximately 120 kg of available soil N.

While the focus of these experiments has been on lifting sorghum productivity, there are potential legacy implications for farming systems if N levels continue to be exploited for sorghum production without replacement. Running soil N reserves low during the sorghum phase can be logistically and economically difficult to replace with fertilisers in following winter crops.

Liverpool Plains: responses to nitrogen

Results from 2 sites on the Liverpool Plains indicate that significant yield is possibly being missed by current commercial N application rates.

- A yield increase of up to 1.4 t/ha was recorded at Spring Ridge (Figure 16a) over the nil treatment.
- Yield increases were between 1.5–2.4 t/ha at Mullaley (Figure 16b) over the nil treatment.

Grain protein levels increased by 1–2% after N application at any rate in these experiments. The paddock starting N levels were 65–70 kg/ha N for 0–120 cm depth at both sites, which is sufficient for a 2.0–2.5 t/ha yield. Further experiments are underway in the 2024–25 season across environments to help growers to refine their sorghum N management strategies.

Figure 15 Sorghum response to nitrogen. Pale green plants indicate deficiency. Photo: Pacific Seeds.

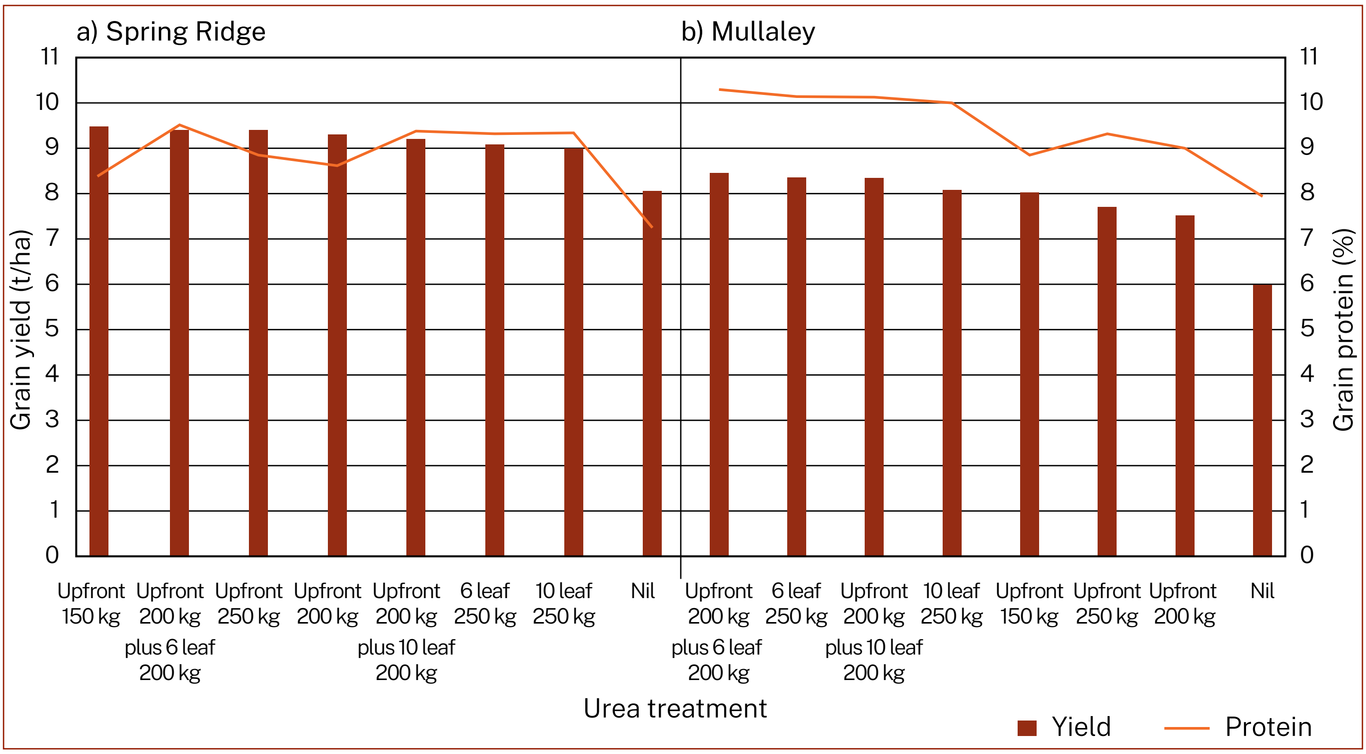

Figure 16 Grain yield × urea treatments at a) Spring Ridge and b) Mullaley in 2023–24.

Moree/Mungindi: responses to nitrogen

In NW NSW growers are targeting seasons where starting soil water levels are high and seasonal forecasts are positive. These are the “money making” years where sorghum crops can yield >4 t/ha. Current grower practices of little or no fertilisation is limiting yields and preventing many growers from ‘cashing in’ on higher yields.

In 2022–23 and 2023–24, experiments were conducted at Millie to test N application timing and rates:

- in 2022–23 the site had a starting soil N level of 81 kg N/ha in the top 120 cm. The average site yield was 3.4 t/ha, with yield responses of more than 1.0 t/ha to any additional N applied (140–420 kg urea/ha) (Figure 17a)
- in 2023–24, the site had a starting soil N level of 137 kg N/ha to a depth of 120 cm. The average yield was 5.04 t/ha. There was an increase in yield of ~0.3–0.4 t/ha from the application of any N (60–240 kg urea/ha) over the nil treatment (Figure 17b).

In 2023–24 there was no ROI to applying the highest rate of urea of 240 kg/ha. There was a positive ROI from applying the 60 and 120 kg/ha rates of $58.20 and $6.20/ha for those treatments respectively. Those calculations were based on grain prices of $320/tonne and urea at $700/tonne, plus $15/ha spreading cost. Grain protein also had a positive response to N, with >1% increase from 8.36% to 9.99% from applying 240 kg of urea (data not shown).

Yield responses to N application will vary between seasons and application decisions should be based on starting soil N levels to depth, N fertiliser price, starting soil water, potential crop yield and price. To date, research results support that additional N can provide higher yields in the Moree/Mungindi region.

Phosphorus, sulfur and potassium

Large nutrient removal rates on the Liverpool Plains due to the high yields are creating concern that the current starter fertiliser regime is not supplying sufficient amounts of S and K.

In the Moree/Mungindi regions, some growers include starter fertiliser in their cropping program. Starter fertilisers may aid early root and plant growth and help reduce “ill thrift” signs caused by planting early into cold soils such as leaf purpling.

Two experiments on the Liverpool Plains in 2023–24 included application of 20 kg P, 20 kg S and 50 kg K, which are key nutrients for early plant growth and development. Due to a lack of planting moisture the experiments were not able to be sown into cold soil temperatures (~13 °C) so the effects of adding these nutrients under cold conditions could not be evaluated. No yield differences were measured in these experiments.

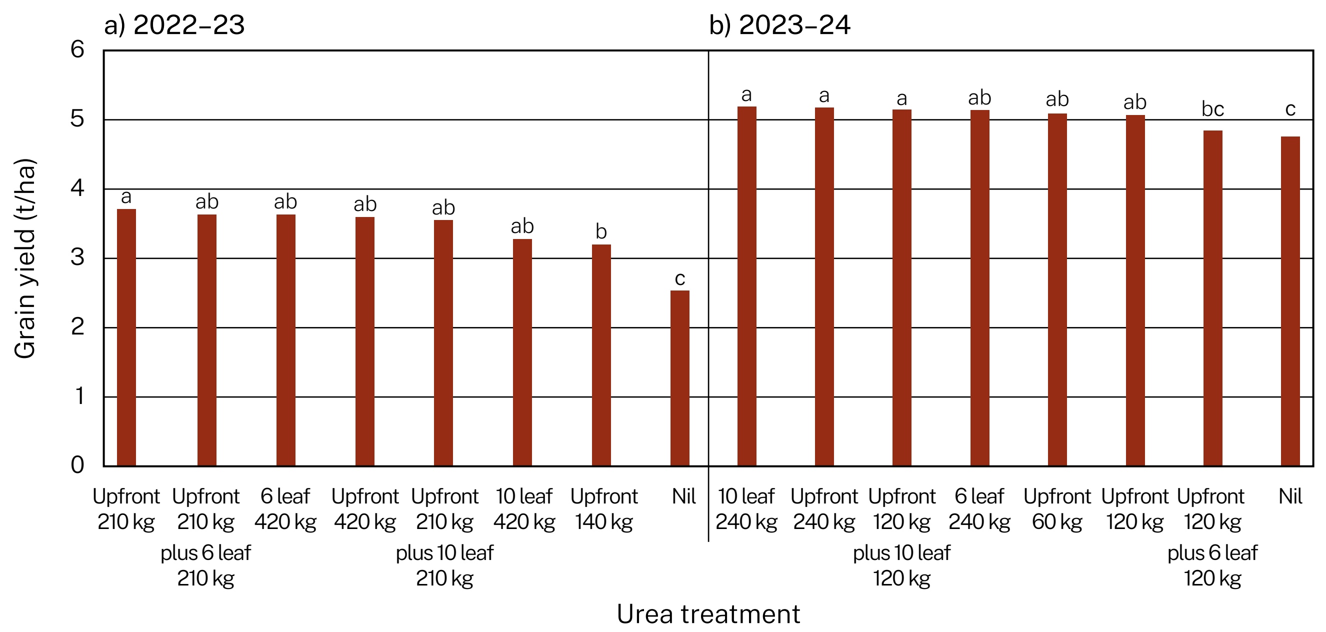

Figure 17 Grain yield × urea treatments at Millie in a) 2022–23 and b) 2023–24. Data with the same letter are not significantly different (P<0.05).

Phosphorus

Sorghum is more tolerant of low soil P levels than wheat or barley as it can more efficiently extract P from the soil profile. Earlier planting times can result in slower root development and lead to these crops displaying visual symptoms of P deficiency (Figure 18).

Figure 18 Phosphorus deficiency on left versus healthy sorghum leaf on the right. Photo. N Grundon.

Sulfur

Sulfur (S) responses have been more commonplace in Queensland than NSW. In many soils in northern NSW, levels of S are borderline–low. However, gypsum at depth can supply large amounts of S to the crop once the root system is established. Where soil tests show S levels are below 4 mg/kg it may be possible to obtain a response to S application (Figure 19).

Figure 19 Pale yellow sorghum leaf on the top with low S versus a healthy leaf on the bottom. Photo: N Grundon.

Potassium

Potassium deficiency is rarely seen in grain sorghum crops but is a nutrient which should be monitored as successive high yielding crops remove significant amounts of K (Figure 20). Potassium fertilisers need to be side banded or applied pre-plant or as part of fallow operations as applying K based fertilisers can cause emergence issues due to fertiliser burn, if applied with the seed.

Figure 20 Upper and lower leaves with leaf margins affected by K deficiency. Photo: N Grundon.

Does sorghum row spacing affect post-harvest fallow efficiency?

Varying agronomic practices, such as changing row spacing, can affect other parts of the farming system such as ground cover, water capture and fallow efficiency.

Following harvest of the 2023–24 experiments, a selection of plots were soil cored on the sorghum row across the different row spacings to determine the finishing soil water. The plots were sampled again during the fallow to see if there was any difference in the re-fill of the profile.

Results from Spring Ridge (Figure 21) showed no difference in the top 30 cm for soil water. However, at depth (>30 cm), more water remained unused under the SS treatments than the 50 and 100 cm treatments. This effect was still evident 5 weeks later after 44 mm of rain.

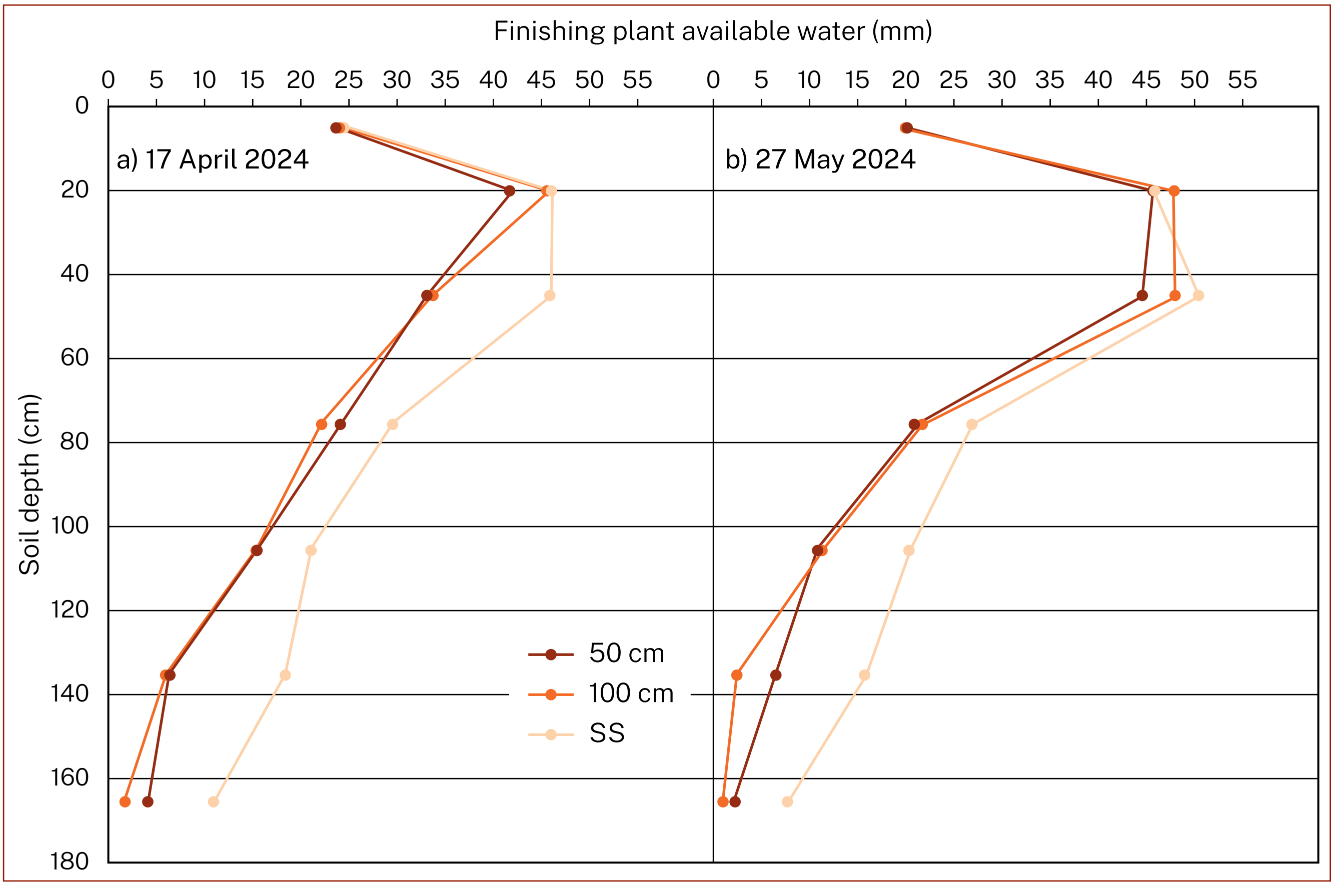

Figure 21 Soil water a) post-harvest 17 April 24 and b) five weeks later 27 May, Spring Ridge.

At the Millie site, 212 mm of rain fell during the growing season. Soil coring was carried out on 22 April 2024, after harvest on the 15 March. Between harvest and soil coring, 72 mm of rain fell. There was no significant difference in the PAW at any depth between the 3 row spacings, except in the top 10 cm where there was more water in the 50 cm and SS than under the 100 cm rows (Figure 22). At this site, the profile was close to full again in April. As such chickpeas were double cropped into the paddock.

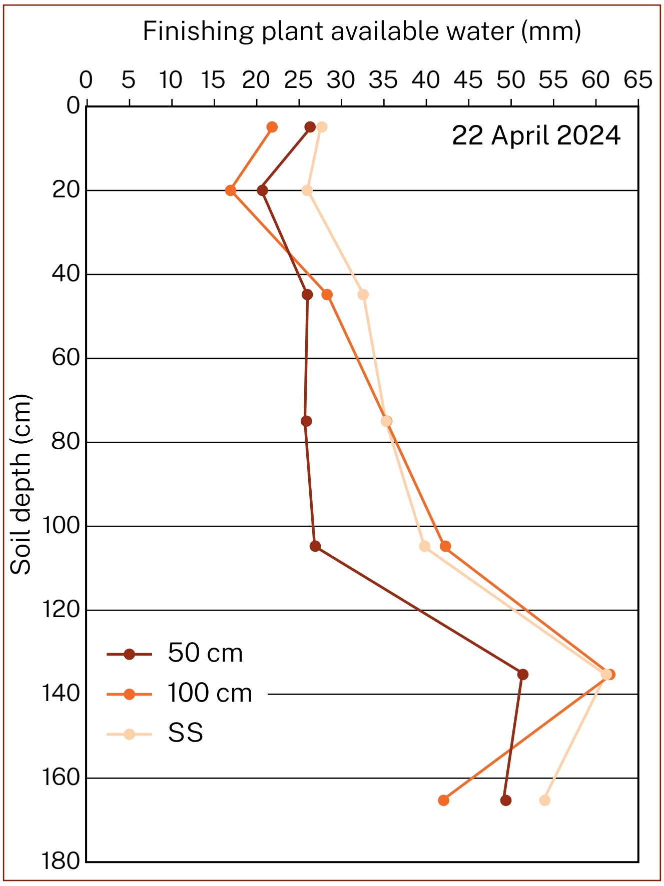

Figure 22 Post-harvest PAW at Millie in April 2024.

Other resources

GRDC-GrowNotes-Sorghum-Northern.pdf

OUR GUIDES

Optimising sorghum production in variable climates https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/summer-crops/sorghum,-maize-and-other-summer-cereals/optimising-sorghum-production-in-variable-climates

Early planting grain sorghum in northern NSW

https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/1343982/Early-planting-grain-sorghum-in-northern-NSW.pdf

Podcast: “Early sowing sorghum, with Loretta Serafin”

https://soundcloud.com/user-889937785/early-sowing-sorghum-with-loretta-serafin

References

More Profit from Crop Nutrition, 2015, Range of P, K and S removal (kg/t) for 192 sorghum crops in NSW and Qld 2006 -14. GRDC Northern Communication Project DAQ 000183.

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