Improving yield reliability of grain sorghum in north-west NSW

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Take home messages

- Starting with a full profile of soil moisture is the best way to reduce the risk of crop failure in north-west NSW
- Using skip or wide row configurations can potentially reduce the risk of crop failure by saving soil water for post anthesis but can also limit yield potential. Solid plant offers more advantages in seasons where yields are likely to be above 3.0 t/ha
- Plant populations should target establishing at least 5.0 plants/m^2 to achieve average yields
- Moving the planting window earlier than currently recommended is under evaluation and may be a useful tool to manage heat and moisture stress risk associated with flowering in December
- Further interrogation of current data, in combination with simulation using APSIM, is expected to provide a more robust agronomic package for reliable production of sorghum in NW NSW.

Introduction

Grain sorghum is an important rotation crop in the northern grains region of Australia. However, the inability to provide reliable, profitable yields has prevented its inclusion as a set part of rotations in north-west NSW. The prolonged drought during this decade has further exacerbated these issues and reduced the area sown to sorghum across the region.

The north-west region is defined as the area west of the Newell Highway, stretching from the Queensland border south. This area is serviced by the regional centres of Moree, Walgett and Narrabri.

The typical farming system in this area is highly reliant on winter crop production, namely bread wheat and chickpeas with the opportunistic inclusion of summer crops, predominantly cotton but also occasionally sorghum.

The inclusion of sorghum in NW NSW cropping systems provides for rotation of herbicide chemistry to assist in the management of herbicide resistant weeds and is a non-host of the primary winter cereal disease Fusarium crown rot (*Fusarium pseudograminearum*) plus is resistant to the root lesion nematode *Pratylenchus thornei.* The inclusion of a reliable summer crop option in NW NSW would also assist with splitting of human/equipment logistics for planting and harvesting and provide more even cash flow across the year.

In NW NSW the rainfall pattern favours the summer months. In Moree more than half the average annual rainfall is expected in the months of November through to March. The dominance of summer rainfall increases northwards of Dubbo in central NSW.

The average rainfall amount reduces the further west you go from Moree to Walgett by, on average, 150mm per annum. In contrast the difference in average annual rainfall between Moree and Narrabri is only 16mm. Temperatures also increases as you move further west, with fewer frosts and increasing heat. December, January and February display elevated average maximum temperatures in NW NSW.

This combination of higher temperatures and less rainfall means that the risk of failed or uneconomic sorghum crops increases as you move west. However, there are many tools which can be used to build a package for reliable sorghum production in this region. The most difficult aspect is combining each of these decisions and their complex interactions to offer the most robust and reliable sorghum production package to growers, whilst balancing their attitude to risk.

Agronomic levers to reduce risk

Growers and advisers in NW NSW have a limited number of management levers to pull when choosing to grow sorghum as part of their dryland crop rotation. These include varying row spacing or row configuration, altering plant population, or changing their time of sowing, typically between a spring and a summer plant. There are also decisions around nutrition supply to the crop and the acceptable level of starting soil water to trigger planting which can be used to improve reliability of sorghum production.

To achieve the best possible sorghum yields, the interaction of management practices with the selected genetics (hybrid) and environment need to be at the forefront of growers and advisers' minds.

Row spacing and row configuration

Varying row spacing is a management practice which can be used to better match crop growth and development to the availability of soil water resources and/or expected seasonal conditions.

Where crop yields are likely to be > 3.0 t/ha solid plant will provide higher yields. If a grower is achieving 2.5 to 3t/ha on a skip row configuration, the data suggests it is likely that a solid plant would yield 0.5 to >1 t/ha more (Figure 1). Below 2.5 t/ha responses to varying row configuration and plant population are less obvious (Figure 2).

In summer broadacre cropping, the use of skip row technology became common place in the early 2000's firstly with cotton and later with other summer crops such as sorghum in more marginal environments like NW NSW. Initially, single (miss one row) or double skip (miss two rows) were used and later wide row spacing such 120 or 150cm rows on a solid plant came into use.

The adoption of skip or wide rows provides an area of soil water in between summer crop rows which could not physically be accessed by the plant roots until later in the season. With sorghum, it is estimated that roots growing at 2.5cm/ day will not reach the centre of a double skip area until around 60 days post-sowing. This conserves a reservoir of soil water which can possibly be used during flowering and grain fill to mitigate the risk of moisture stress.

There are trade-offs with using skip or wide row configurations. While the risk of crop failure is reduced, so is yield potential, especially in seasons with higher levels of in-crop rainfall.

Consideration must also be given to the management of the bare inter-row area including weed, nutrient, fallow and stubble management when using skip rows. Single skip leaves one third and double skip one half of the field without crop cover. This area is open to moisture loss through evaporation, invasion with weeds and potentially impacts on lateral nutrient distribution.

Plant population

The sorghum plant population established will depend on the initial target density (i.e. sowing rate), seed quality (germination/vigour and impact of any seed treatments), management (e.g. seeding depth) and environmental impacts on the germination and emergence of the seed, such as adequate soil moisture and temperature.

Trials have included plant populations from 1.5 – 7.0 plants/m^2. These populations have been maintained regardless of the row configuration.

Varying plant population is probably the easiest management lever to pull. The ideal plant population for growing sorghum in NW NSW is influenced by the yield potential and sowing date.

Generally, the higher the yield potential of the crop, the higher the plant population which can be supported. However, populations of 5 plants/m^2 can achieve yields close to 5.0 t/ha in NW NSW (i.e. Mungindi 10/11 – Figure 1), which is much higher than average yields in this environment. Populations above 5 plants/m^2 i.e. 7 plants/m^2 rarely produced statistically significant higher yields (analysis not shown) but incur increased expense due to additional hybrid seed costs.

Plant populations below 3 plants/m^2 have been lower yielding in higher yield potential seasons and are also more difficult to achieve even plant distribution across a paddock.

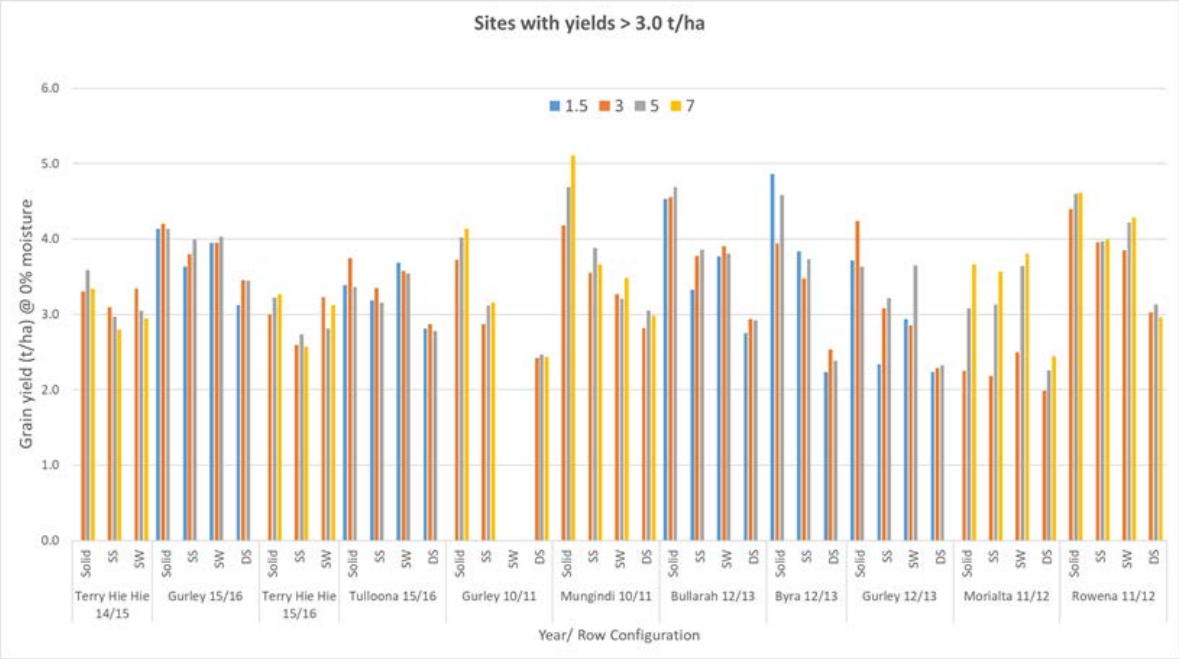

Figure 1. Trial sites with **grain yields > 3.0 t/ha**: Response to varying plant population (plants/m^2) and row configuration in sorghum across north west NSW from 2010-2016
(Solid = solid plant, SS = single skip, SW = super wide (150 cm solid) DS = double skip)

In contrast, at grain yields under 3.0 t/ha, responses to plant population and row configuration tend to be flatter (Figure 2). Some advantages have been seen from very low populations of 1.5 plants/m^2 In these environments responses to row configuration are also less than generally believed, particularly when yields are lower than 1.0 t/ha where this usually indicates terminal moisture stress.

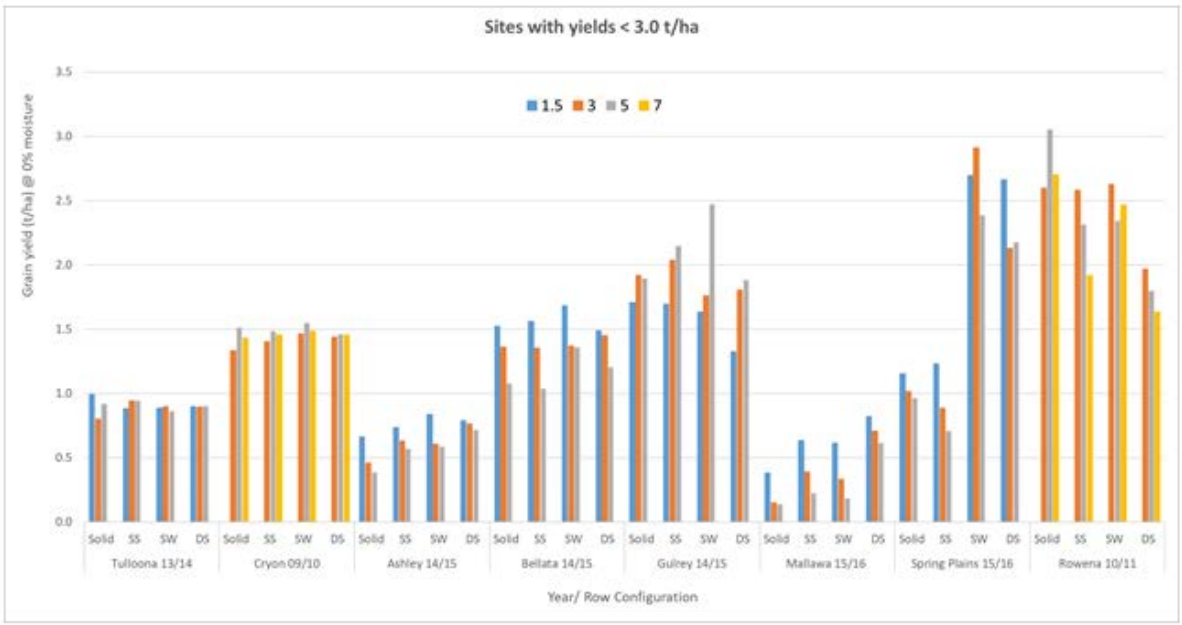

Figure 2. Trial sites with **grain yields < 3.0 t/ha:** Response to varying plant population (plants/m2) and row configuration in sorghum across north west NSW from 2010-2016
(Solid = solid plant, SS = single skip, SW = super wide (150 cm solid) DS = double skip)

Early sown crops often have reduced establishment, hence more seeds may need to be sown to achieve the target plant population. The other important point to consider when deciding on a plant population is that population alone is not responsible for crop yield. The optimum population also depends on the row configuration and the level of tillering within different hybrid sorghum varieties.

Starting soil moisture

Recommendations for sorghum in NW NSW always state that paddocks must have a full profile of soil moisture prior to sowing. Paddocks have been sown with less than a full profile, but the reality is that less moisture at sowing means a higher level of risk as there is a greater reliance on in-crop rainfall, which is known to be highly variable in this environment.

We can compare two sorghum sites (Figure 3), which did not have a full profile at sowing. The first trial had a starting plant available water (PAW) of 50 mm but received 257 mm of timely in crop rainfall resulting in yields up to 4.5 t/ha. The second site started with 100 mm of PAW but only received 15 mm of in-crop rainfall and subsequently failed. Both sites needed significant in crop rainfall to achieve profitable yields.

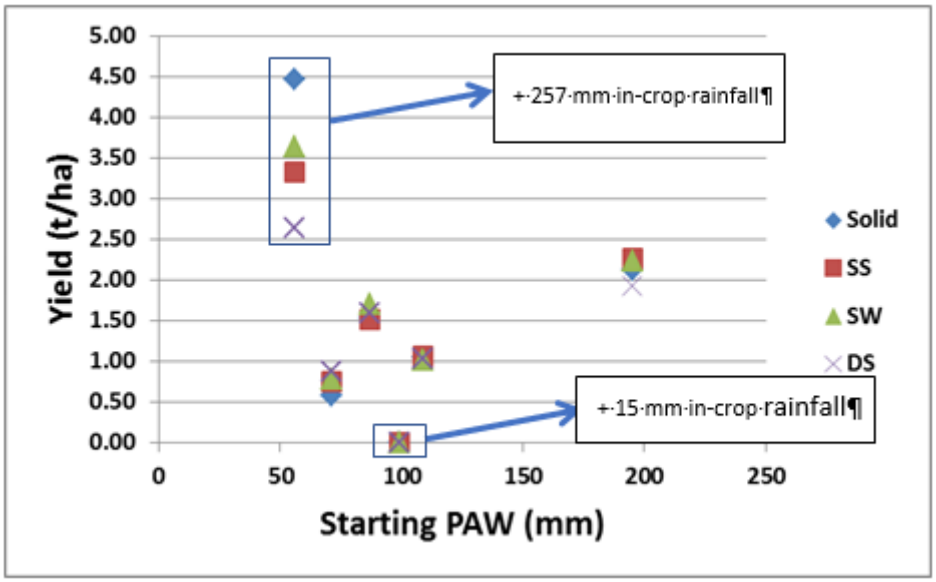

Figure 3. Effect of starting plant available water on sorghum yield at selected sites in north west NSW

If paddocks were only sown when full, they would be starting with a minimum of 150 mm of PAW or more in most soils in northern NSW. If this was combined with average summer in-crop rainfall (September – end January) at Walgett of around 200 mm, then acceptable yield could normally be expected.

There is much less risk from adopting this strategy, than sowing with a half full profile and then hoping to re-fill the deficit during the season via in-crop rainfall when evaporation and transpiration rates are high.

Planting date

Traditionally the sowing window for sorghum in NW NSW was considered to commence in mid-late September. In the last two years, research on the effect of moving sowing times up to 4 weeks earlier has been undertaken.

This results in planting when soils are much colder; a minimum of 12°C; as opposed to the recommended 16-18°C. Planting in late-September, when soil temperature is >16°C, provides rapid emergence (within around 7-10 days), while earlier planting may take 14 days or more to emerge, depending on conditions following sowing. There is often a reduction in establishment in cold soils associated with earlier planting.

However, the goal is to move the period of flowering and grain fill earlier into summer, hopefully closer to early December and away from the peak temperatures seen in late December and January.

Sowing after the end of the first week in August at Moree has enabled flowering to be moved as early as mid-November. In comparison planting in late-September results in flowering from mid-December (Figure 4).

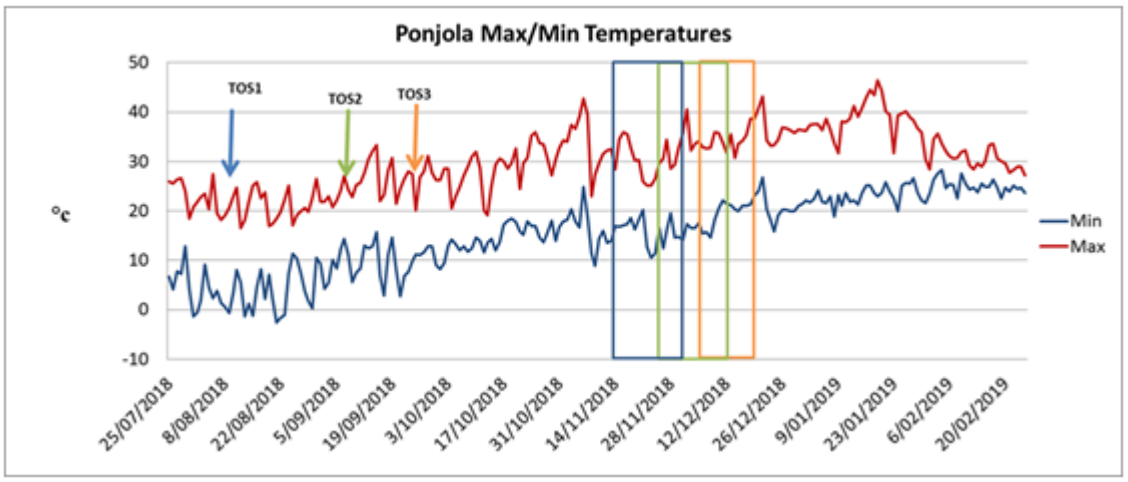

Figure 4. Sorghum flowering windows resulting from sowing 8 August, 11 September and 27 September at "Ponjola" Moree in 2018-19

Moving the sowing window forward has also resulted in improved yields in most of the trial sites such as the Moree site in 2018/19 (Figure 5). The first planting time on the 8th August was the highest yielding at 2.14 t/ha. There was no significant difference in yields achieved between the 11th and 29th September planting dates being 1.51 and 1.68 t/ha respectively.

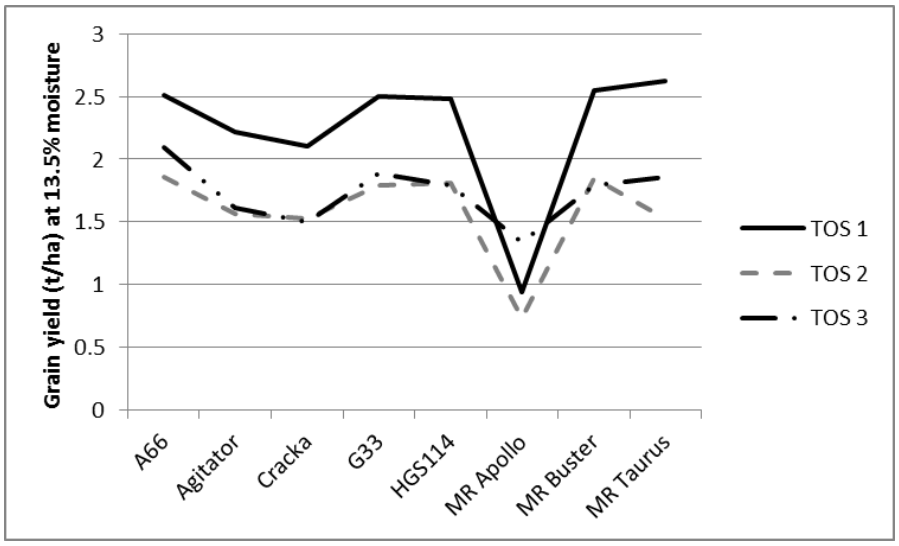

Figure 5. Grain yield at three times of sowing (TOS) at "Ponjola" Moree in 2018-19

Conclusions

Reliable and profitable sorghum production in NW NSW has not been achieved yet. A series of options for improving confidence in growing sorghum in this region have been examined. However further interrogation of this data and extrapolation over an extended period using the crop model APSIM will provide a more robust set of future recommendations.

Currently the sorghum production package for NW NSW to reduce risk is based around only planting with a full profile of soil moisture; using a double skip configuration and aiming to establish around 5 plants/m^2. This package, whilst reducing the likelihood of crop failure, also limits the top end yield potential of a sorghum crop in this region in favourable seasons.

The ideal management package will allow avoidance of the peak heat and lack of soil moisture periods in NW NSW, generate a profitable sorghum grain yield with optimised water use efficiency

whilst still maintaining the system benefits such as stubble cover from a cereal crop. This is a significant challenge for the future of our industry but also a massive opportunity waiting to be exploited.

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