Sorghum agronomy to manage risk and improve yield in the western zone

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Take home message

- Early plant sorghum currently offers a more attractive proposition to growers than late plant sorghum, mostly for logistical and rotational reasons.
- Yields during the trial seasons 2010-2013 were generally more than 1.0 t/ha higher than the long term average for this region. In these seasons, yield declined as effective row spacing increased. Solid plant > single skip = super wide > double skip where average site yields were 3.46 t/ha.
- Yields during the seasons 2013-2015 were lower yielding than the long term average, with site yields averaging 1.37 t/ha. In these seasons, there was no significant difference in yield across row configurations for three of the four sites. At the fourth site, solid plant yielded significantly less than all other configurations.
- Plant populations should be targeted in the range of 30 – 50,000 plants/ha where the expected yield is 2.0 t/ha or greater. Where expected yields are less than 2.0 t/ha, plant populations as low as 15,000 plant/ha can provide slight improvements in yield compared to 30 and 50, 000 plants/ha.
- Hybrids should be selected which have a moderate to high level of tillering as this mechanism allows plants to respond to variable environmental conditions.

Introduction

Grain sorghum remains the main summer crop in the northern grains region, with northern NSW planting on average 160,000 ha and Queensland 470,000 ha annually. The main zones for sorghum production continue to be the area east of the Newell Highway and the Liverpool Plains in NSW and the Darling Downs in Qld.

NSW DPI, GRDC and Pacific Seeds partnered in a project focused on sorghum production west of the Newell Highway in NSW in 2010. This project "Sorghum in the western zone" was targeted at investigating a range of agronomic factors in order to improve both the reliability and yield of sorghum in these areas where sorghum is not an established part of the rotation. In the area west of the Newell Highway, sorghum production is variable in area as well as production tonnes. In an attempt to boost confidence in sorghum as a reliable summer cropping option by increasing the reliability and yields of sorghum a research project was commenced in the 2010-11 season targeting the matching of suitable hybrid types to optimum plant populations and row configurations. This research has led to a series of recommendations for the low- medium rainfall zone.

The data presented in this paper is a compilation of the results of five years of research in the western zone.

A series of twelve dryland trials was conducted over five years; from 2010 – 2015 at sites west of the Newell Highway. Trials were located at; Mungindi, Morialta Junction, Rowena, Tulloona, Gurley,

Garah, Bellata, Ashley and Bullarah. The trials focused on establishing a data set around three primary factors; row configuration, plant population and hybrid selection although additional data was gathered from each site on issues such as crown rot, soil water and nitrogen use.

In order to reduce the risk of total crop failure as well as increase yield potential for sorghum producers in this zone, four primary areas are discussed in this paper; sowing time, plant population, row configuration and hybrid type selection.

Sowing time

Seven of these trials were planted in the early planting window, between September and October and five of these trials were planted in the late planting window of January. The five late plant trials were in the 2012/13 and 2014/15 growing season.

Average yields from the seven early plant trials ranged from 4.53 t/ha down to 0.74 t/ha. In comparison yields from the five late planted trials, ranged from 4.30 t/ha down to 1.59 t/ha.

While it is not possible to draw firm conclusions on which planting time is preferred from this data set (long term modelling would assist), it is worth suggesting from this data that early plant sorghum (Sept/ October) has yielded more and also has been a better fit within the farming system than late plant sorghum.

Early plant sorghum, typically sown in September/October is intended to escape the summer heat at flowering; as well as splitting the labour/ equipment requirements more evenly across the year so winter crop planting and summer crop harvest rarely coincide. Early planted sorghum is also typically harvested while conditions are still warm meaning a quick dry down time without grain drying and harvest before the pressures of winter planting. The early harvest timing also allows the option of a double crop back into chickpeas or a winter cereal should sufficient rainfall occur to fill the profile sufficiently, thus expediting the move back into a winter cropping sequence. On the downside, cool soil temperatures with the early planting time can slow early growth and sometimes affect establishment.

Late planted sorghum typically avoids the heat at flowering, but is planted into high soil temperatures which rapidly dry out the seedbed. In addition most growers in this western zone are unwilling to let an early planting opportunity pass them by in case there is not another opportunity to plant. Late plant sorghum also comes with the risk of cool temperatures during flowering and sorghum ergot. Late planting also means late harvest where dry down may be slow and difficult due to high grain moisture resulting in the need to dry sorghum grain as well as the crossover with winter planting causing additional demands on labour and machinery. Late planted sorghum also usually means the need to either short fallow to another summer crop or long fallow to the next winter crop, reducing the cropping frequency and subsequent cash flow.

Currently the case for or against early or late sowing time is largely based on the impacts on the farming system as there is insufficient data to build a more robust case on the impact on crop yield.

Crop modelling has provided simulated data across multiple years and seasons which suggest late planted sorghum to be the more reliable.

Hybrid selection

In this research project three hybrid types were selected with diverse plant characteristics to compare hybrids with varying levels of tillering and staygreen. The three hybrids selected and their characteristics were:

1. Low tillering, High staygreen – 2436 and LT10 (both experimental lines) and MR Apollo
2. Moderate tillering, moderate staygreen – MR 43

3. High tillering, low staygreen – MR Bazley

In these trials, across all sites and seasons, the hybrids with moderate to high levels of tillering have produced higher yields with the hybrids MR Bazley and MR 43 have been higher yielding than 2436, LT10 or MR Apollo by on average 0.35 t/ha (Table 1). The full potential of stay green as a plant characteristic has not been seen in this research either as the majority of seasons had higher than average yields or post-anthesis stress did not occur.

The general conclusion has been that hybrids with a low level of tillering have not been able to respond to the variable seasonal conditions by producing additional tillers (which equates to more heads) to capture additional yield potential unlike the hybrids with moderate to high levels of tillering, in this case MR 43 and MR Bazley. There has been very little difference in the grain yields of the moderate and high tillering hybrids.

Row configuration

The most common row configuration in the western zone was double skip until recent years where there has been more interest in the 1.5 m super wide row configuration.

Four row configurations were used at the trial sites; a 1.0 m solid plant, single skip, double skip and a super wide (1.5 m solid) with the exception of Byra in the 2012/13 season which was on raised beds so a 2.0 m solid plant was substituted for a super wide configuration.

Across these twelve trials, where site yields were greater than 1.0 t/ha, the yields declined as effective row spacing increased, hence solid > single skip = super wide > double skip. At only one site; Ashley 2014/15; where yields were below 1.0 t/ha for all configurations, was the solid plant significantly lower yielding than all other configurations.

The solid plant configuration produced the highest yields, on average 3.50 t/ha, compared to 2.98 and 2.91 t/ha for single skip and super wide respectively and 2.40 t/ha for double skip. The one trial site with a 2.0 m solid plant treatment averaged 3.13 t/ha. This equates to solid plant yielding 15-17 % more than the single skip or super wide and 31% more than the double skip.

The average yield of these sites was 2.94 t/ha which is around 0.5 t/ha higher than the long term average for grain sorghum in the North West NSW at 2.49 t/ha (NSW DPI Grains Report 1992-2012). This reinforces that the majority of the sites have been conducted in seasons that were more favourable than is the norm for these environments.

The data supports two conclusions, firstly that in above average seasons the solid plant configuration will always yield the highest, however it also comes with a greater risk of total crop failure in the low yielding seasons. Secondly, that double skip configurations sacrifice significant yield potential but are inherently a safer option as they store more water in the “skip” area for use during grain fill.

Overall, to date it seems that single skip or the super wide treatment are the preferred options for growers in this zone as they offer a more reliableoption in the dry seasons, and higher yields than the double skip, reducing the overall risk of growing sorghum in these environments.

Plant population

Over the research project four plant populations were targeted; 15, 30, 50 and 70,000 plants/ha; but only three populations were trialled at each trial site. The 30 and 50,000 plants/ha treatments were included in all trials.

In the 2010/11 and 2011/12 seasons there was no statistical difference between the yields from the 50 and 70,000 plants/ha treatments; which both produced the highest yields; as such the 70,000 population was dropped from the treatment set as it incurred additional seed costs without providing additional return and lower populations were preferred by growers.

The 15,000 plants/ha treatment was added as “how low can we go?” ; a common question from growers and advisors. From this research the 15,000 treatment has always yielded lower than the 30 and 50,000 plants/ha except where the average site yield was less than 1.6 t/ha. At the two sites where average yields were less than 1.6 t/ha, the 15,000 plants/ha treatment yielded significantly more than the 30 and 50,000 plants/ha treatments.

It should be noted though that establishing a uniform plant stand with a target plant population of 15,000 plants/ha commercially is a lot more difficult with airseeders, the more common planter in this zone for sowing sorghum.

Average yields of the twelve trial sites showed an increase of 1.55 t/ha as plant population increased from 15 to 70,000 plants/ha. However there was little distinction between the 30 and 50,000 plants/ha treatments.

Conclusions

In order to minimise risk and optimise yield in grain sorghum in the low- medium rainfall zone there is a greater emphasis on matching agronomic management to the environment than there is on hybrid selection.

Certainly hybrids have a role to play based on their suitability for environmental conditions and the relevant plasticity of their characteristics such as tillering, however in the trials conducted across both projects to date, the genetic potential of the hybrid has rarely been the limiting factor.

Currently the recommendations for sorghum in this zone, is to plant as early as possible, selecting either a single skip or super wide configuration and establish an even population of between 30 – 50,000 plants/ha using a hybrid with at least a moderate level of tillering. An additional season of trial data is planned for this coming season, 2015/16 and will hopefully provide the final conclusions to the main management decisions for sorghum growers in this region.

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Table 1. Impact of hybrid type on yield (t/ha) in 2010-2015

Hybrid Type	Site/ hybrid	Gurley 1011	Mungindi 1011	Rowena 1011	Morialta 1112	Rowena 1112	Bullarah 1213	Byra 1213	Gurley 1213	Tulloona 1314	Ashley 1415	Gurley 1415	Bellata 1415
Low tillering, high staygreen	**2436**	-	-	-	3.32	4.13c	3.71b	3.89	3.09b	0.80c	-	-	-
	LT10	3.31	3.58c	2.59b	-	-	-	-	-	-	-	-	-
	MR Apollo										0.76	2.11	1.41b
Mod. tillering, mod. staygreen	**MR 43**	3.81	4.63a	3.05a	3.24	4.62b	4.63a	3.91	3.80a	1.00b	0.71	2.22	1.64a
High tillering, low staygreen	**MR Bazley**	3.81	4.47ab	2.46b	3.34	4.81a	4.61a	3.77	3.67a	1.32a	0.76	2.10	1.73a
	CV%	*n.s.d*	*10.6*	*25.8*	*18.3*	*7.2*	*12*	*13.6*	*19.2*	*16.1*	*15.8*	*19.8*	*14.7*
	L.s.d.	*n.s.d*	*0.20*	*0.33*	*n.s.d*	*0.16*	*0.25*	*n.s.d.*	*0.32*	*0.08*	*n.s.d*	*n.s.d*	*0.12*

Table 2. Effect of row configuration on yield (t/ha) in 2010-2015

Site/ Row Configuration	Gurley 1011	Mungindi 1011	Rowena 1011	Morialta 1112	Rowena 1112	Bullarah 1213	Byra 1213	Gurley 1213	Tulloona 1314	Ashley 1415	Gurley 1415	Bellata 1415
Solid (1.0m)	4.58a	5.38a	3.22a	3.47	5.24a	5.29a	5.29a	4.46a	1.04	0.58b	1.87	1.55
Single Skip	3.52b	4.28b	2.63b	3.42	4.59b	4.22c	4.26b	3.33bc	1.07	0.74a	2.24	1.52
Super wide (1.5m)	-	3.84bc	2.88ab	3.83	4.73b	4.42b	3.13c	3.64ab	1.02	0.78a	2.27	1.75
Double Skip	2.83c	3.41c	2.08c	2.48	3.52c	3.32d	2.75c	2.64c	1.04	0.87a	2.19	1.60
CV %	*11.6*	*10.2*	*25.8*	*18.3*	*7.2*	*12.0*	*13.6*	*19.2*	*16.1*	*15.8*	*19.8*	*14.7*
L.s.d	*0.52*	*0.78*	*0.38*	*n.s.d*	*0.37*	*0.17*	*0.55*	*0.96*	*n.s.d*	*0.16*	*n.s.d*	*n.s.d*

Table 3. Effect of plant population on yield (t/ha) in 2010-2015

Site/ Plant Population	Gurley 1011	Mungindi 1011	Rowena 1011	Morialta 1112	Rowena 1112	Bullarah 1213	Byra 1213	Gurley 1213	Tulloona 1314	Ashley 1415	Gurley 1415	Bellata 1415
15,000	-	-	-	-	-	4.15	3.66b	3.25b	1.05	0.87a	1.97b	1.83a
30,000	3.48	3.99	2.82a	2.56b	4.40	4.39	3.90a	3.60a	1.02	0.71b	2.13ab	1.62b
50,000	3.70	4.28	2.75ab	3.48a	4.60	4.40	4.01a	3.70a	1.05	0.65c	2.33a	1.33c
70,000	3.75	4.41	2.53b	3.87a	4.58	-	-	-	-	-		-
CV%	*12.0*	*10.6*	*25.8*	*18.3*	*7.2*	*12*	*13.6*	*19.2*	*16.1*	*15.8*	*19.8*	*14.7*
L.s.d.	*n.s.d*	*n.s.d*	*0.22*	*0.61*	*n.s.d*	*n.s.d*	*0.21*	*0.29*	*n.s.d*	*0.05*	*0.22*	*0.15*