Achievable sorghum yields under favourable conditions in north western NSW.

Loretta Serafin[1], Ben Frazer[1], Guy McMullen[1], Tim Burley[2] and Trevor Philp[3]

NSW Department of Primary Industries, Tamworth[1] and Moree[2] Email loretta.serafin@dpi.nsw.gov.au
Pacific Seeds, Toowoomba[3]

Abstract
There is a need to improve the reliability of sorghum in low rainfall areas and to assess genetic (G) and management (M) strategies that will improve adaptation to increasingly variable environmental (E) conditions. The introduction of hybrids with Stay-green, or low tillering genetics combined with plant population and row configuration may improve the reliability of sorghum yields in these regions. In north western (NW) NSW crown rot, a stubble-borne fungal pathogen is the most prevalent and damaging disease affecting winter cereals. Altering row configurations wider and reducing plant populations may improve the reliability of sorghum but may also reduce the decomposition of cereal stubble and hence the break crop effect. This research investigated the interaction between plant populations (30, 50 and 70,000 plants/ha) and row configurations: solid plant (1 m spacing), single skip (SS or 1.5m), super-wide (SW) (1.5 m) and double skip (DS or 2m), across three contrasting sorghum hybrids. Trials were conducted over two seasons, 2010-12 at Gurley, Mungindi, Rowena and Morialta.
In high yielding seasons where above average rainfall was received the data presented gives an indication of attainable sorghum yields under different management strategies in NW NSW. At yields greater than 4 t/ha significant differences were detected in configuration, population and hybrid. All row configurations incurred a yield penalty compared to solid planting and plant populations of 50 and 70,000 plants/ha optimised yields. A hybrid with low tillering and high stay-green had lower yields in comparison to those with moderate to high levels of tillering. Although wide row configurations and hybrids with lower tillering and high levels of stay-green may confer greater yield stability in seasons with lower yield potential there are significant penalties associated with these strategies in high yielding seasons such as experienced during the 2010-2012 seasons.

Key Words
sorghum, stay-green, tillering, configuration, population, environment

Introduction
Dryland grain sorghum production in North West NSW is highly variable both in terms of area sown and tonnes produced. Typical farming systems are zero tillage and primarily winter based with cereal dominant rotations; this has led to major issues with crown rot (*Fusarium pseudograminearum*). Currently, the most reliable and profitable break crop is chickpeas however with increasing herbicide resistance and climate variability a reliable, profitable summer crop alternative is needed.
Sorghum producers in this area consider sorghum to be reasonably high risk, and in recent years have been disappointed in the lack of break crop benefits achieved when returning to wheat following sorghum. Minimal dryland sorghum research has been conducted in this western zone (considered to be west of the Newell Highway) and has never focused on the interactions between crop management options, environmental conditions and hybrids. In the more favourable production areas in NE Australia grain sorghum research has shown that systems using skip configurations can reduce the risk of crop failure but often results in reduced yields (Whish et al. 2005). Commercially the adoption of double skip row sorghum has assisted in improving the reliability of sorghum in this zone. Under skip row configurations soil water in the unplanted area is conserved until later in the growing seasonal when the crop is able to access these resources to fill grain (Abunyewa et al. 2010). There has been little research to validate the practice of skip row configurations or appropriate plant populations. The impact of hybrids with differing traits such as tillering and stay-green on crop performance in the low rainfall regions has also not been evaluated. In two high yielding seasons, the impact of varying these three key factors, row configuration, plant population and hybrid type were evaluated.

Methods
Four trials were conducted over two summer seasons, 2010-11 and 2011-12. In 2010-11 trials were located at Gurley (S 29° 44.1903', E 149° 47.989’) and Mungindi (S 29° 1.0375', E 149° 15.216') and in 2011-12 trials were located at Rowena (S 29° 48.7496', E 148° 54.7666') and Morialta (S 29° 16.6403', E 149°

2.3537'). The sowing dates for the trials were 24th and 25th September, 2010 at Gurley, 29th and 30th September, 2011 at Mungindi, 20th and 21st September, 2011 at Rowena and 25th and 26th October, 2011 at Morialta.
Trials were sown with a four row Monosem single disc precision planter using RTK guidance and harvested with a KEW plot header. All sites were sown into wheat stubble from the previous year. Experiments were designed as complete factorials set up as split-plots with planting configuration as main plots with hybrid and populations combinations as subplots, each replicated three times. Each site included four row configurations; solid plant (SP), single skip (SS), super-wide (SW) (1.5 m) and double skip (DS), all on 1 m base row spacing. The solid plant included all rows sown 1 m apart, while the single skip had two rows planted and one row unplanted or "skipped" on 1 m row spacings, the super wide had all rows planted 1.5 m spacing's and the double skip had two rows planted and two rows unplanted on 1m spacing.

Three plant populations were targeted at each site, 30, 50 and 70,000 plants/ha across each of the row configurations.

Three different hybrid types were used. The hybrids were selected for their contrasting characteristics; of varying levels of tillering and stay green. Both tillering capacity and stay green are related to the ability of plants to perform in the hot, dry environments of NW NSW. In particular hybrids with the stay green trait are noted for their ability to conserve water for use post anthesis during seed fill. The hybrids used were:

1. Low tillering, high staygreen - LT10 (2010-11) and PAC2436 (2011-12)
2. Moderate tillering, moderate staygreen - MR43
3. High tillering, low staygreen – MR Bazley

Results
The two seasons of 2010-11 and 2011-12 were unseasonably wet for the NW region and combined with cooler temperatures, resulted in above average yields. Rainfall records from nearby site locations indicate the high rainfall recorded during the experiments.

Table 1 Rainfall from the site locations.

Gurley 10/11 Rainfall (mm) (Source: Bellata Post Office)											
Sept 2010	Oct	Nov	Dec	Jan 2011	Feb	Mar	Apr	May	June	July	Aug
59	59	79	69	47	56	40	50	21	56	2	58
Mungindi 10/11 Rainfall (mm) (Source: Garah Post Office)											
Sept 2010	Oct	Nov	Dec	Jan 2011	Feb	Mar	Apr	May	June	July	Aug
143	58	120	54	34	38	36	45	27	28	13	48
Rowena 11/12 Rainfall (mm) (Source: Rowena Post Office)											
Sept 2011	Oct	Nov	Dec	Jan 2012	Feb	Mar	Apr	May	June	July	Aug
54	42	32	n/a	107	157	16	22	41	28	136	n/a
Morialta 11/12 Rainfall (mm) (Source: Garah Post Office)											
Sept 2011	Oct	Nov	Dec	Jan 2012	Feb	Mar	Apr	May	June	July	Aug
62	40	200	196	132	194	15	36	43	47	67	n/a

Consistent results were achieved from all sites for the factors of configuration, population and hybrid. However there were no significant interactions between these three factors.

Configuration
Responses to configuration under high yield (>4 t/ha) were consistent in these four trials. The SP yielded the highest while the DS configuration was the lowest yielding. At all sites the SS configurations yielded less than the solid, but more than the double skip. The SW configuration results were more variable than the SS, but yield results were generally consistent with the SS yields.

Table 2 Grain yield from varying row configuration (averaged across population and hybrid) in four trials (2010-2012)

Configuration	Gurley 10/11	Mungindi 10/11	Rowena 11/12	Morialta 11/12
		Yield (t/ha)		
Solid Plant	4.6[a]	5.4[a]	5.2[a]	4.2[a]
Single Skip	3.5[b]	4.3[b]	4.6[b]	3.3[b]
Super Wide	-	3.8[bc]	4.8[b]	3.5[ab]
Double Skip	2.8[c]	3.4[c]	3.5[c]	2.3[c]
5% l.s.d	0.5	0.8	0.4	0.8
Significance	<0.01	<0.01	<0.001	<0.05

Plant Population

Responses to changing plant populations were not as clear as those from altering row configuration. At two sites, Mungindi and Rowena the 30,000 plants/ha treatment yielded significantly less than the 50 and 70,000 treatments. At the other two sites, the response although similar was not significant.

Table 3 Grain yield from varying plant population (averaged across configuration and hybrid) in four trials (2010-2012)

Plant Population	Gurley 10/11	Mungindi 10/11	Rowena 11/12	Morialta 11/12
		Yield (t/ha)		
30,000	3.5	4.0 [b]	4.4[b]	3.2
50,000	3.7	4.3 [a]	4.6[a]	3.3
70,000	3.7	4.4 [a]	4.6[a]	3.4
5% l.s.d	-	0.2	0.2	-
Significance	n.s.d	<0.05	0.022	n.s.d

Hybrid Performance

The performance of the three hybrid types was consistent across the four sites. The low tillering, high stay green line (LT10 or 2436) yielded consistently less than the other hybrids in these trials. In the 2010-11 season MR 43 (moderate tillering/ moderate stay green) and MR Bazley (high tillering, low stay green) achieved equal yields. In the 2011-12 season MR Bazley produced higher yields.

Table 4 Grain yield from three hybrids (averaged across configuration and population) from 2010-12

Hybrid	Gurley 10/11	Mungindi 10/11	Rowena 11/12	Morialta 11/12
		Yield (t/ha)		
LT10	3.3[b]	3.6 [b]	-	-
2436	-	-	4.1[c]	3.1
MR Bazley	3.8[a]	4.5 [a]	4.8[a]	3.3
MR 43	3.8[a]	4.6 [a]	4.6[b]	3.4
5% l.s.d	0.2	0.2	0.2	-
Significance	<0.001	<0.001	<0.001	n.s.d

Conclusion

In high yielding seasons, where yield potential is greater than 4.0 t/ha SP configurations consistently produced the highest yields. SS and SW configurations produce similar yield results to each other, but consistently lower than the solid plant. DS configurations yielded considerably less than all other configurations under these conditions. The impact of configuration on grain yield in this study support the findings of Whish et al (2005) in higher yielding regions. Populations of 30,000 plants/ha produced (5-10%) lower yields under the high yielding seasons. Plant populations should target 50-70,000 established plants/ha. Commercially populations of 70,000 plants/ha are not recommended as no benefit compared to the 50,000 population was found and additional seed costs would be incurred. The low tillering, high stay green hybrids used in these experiments were unable to produce competitive yields in favourable seasons, being 10-20% lower in yield possibly due to the inability to compensate for higher yield potentials with additional tillers. Hybrids with moderate to high levels of tillering responded more favourably to the improved seasonal conditions experienced in these two years.

Acknowledgements

This research is funded by the Grains Research and Development Corporation and the NSW Department of Primary Industries. Thanks to Scott Carrigan “Kelvin” Gurley, Charles Boyle “Amaroo” Mungindi, Philip Harris “Wandahree“ Rowena and Tom and Neil Greentree “Morialta” Mungindi for hosting the trials. The assistance of Rod Bambach, Patrick Mortell, Peter Formann, Jan Hosking, Steve Simpfendorfer and Alan

Bowring is gratefully acknowledged. Thanks to agronomists Brad Coleman, Tim Poole and Gary Onus for their assistance with trial sites.

References

Abunyewa A, Ferguson R, Wortmann C, Lyon D, Mason S, Klein R (2010) Skip-row and plant population effects on sorghum grain yield. *Agronomy Journal*, 102-1, 296-302

Whish J, Butler G, Castor M, Cawthray S, Broad I, Carberry P, Hammer G, McLean G, Routley R, Yates S (2005) Modelling the effects of row configuration on sorghum yield, reliability in north-eastern Australia *Australian Journal of Agricultural Research*, 56, 11-23.