Targeting reliable sorghum yields in the western zone – matching row spacing, plant population and hybrid type to the environment.

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

NSW Department of Primary Industries, Tamworth[1] and Moree[2]

Pacific Seeds, Toowoomba[3]

Key words

Sorghum, dryland, western, row spacing, plant population

This project is funded by GRDC (DAN00150), NSW DPI and Pacific Seeds.

Take home message

- Sorghum yields are highly variable west of the Newell Highway.
- In a high yielding season:
  - Plant populations of 30,000/ha are too low to achieve yields above 3.5 t/ha.
  - Plant populations of 50 and 70,000 plants/ha (4-6 t/ha) have performed equally.
  - Solid plant (1m) configurations out yielded the other configurations, single skip, super-wide and double skip.
- The hybrids that were low tillering and high staygreen have been yield limited in comparison to hybrids with moderate to high levels of tillering in high yielding seasons or when above average rainfall was received post-flowering.
- In more "normal" or average seasons, suggestions for sorghum growers are:
  - Plant populations should target around 50,000 plants/ha based on preliminary results.
  - Row configurations are still being evaluated but a single skip or superwide (1.5m) row is showing greatest promise.
- Further research across a greater number of sites and seasons to explore sorghum production options in the western zone is currently underway.

Background

Dryland sorghum research in the western zone (west of the Newell Highway) has rarely focused on matching management to the environment and appropriate hybrids. Commercially the adoption of double skip row sorghum has assisted in improving the reliability of sorghum in this zone but there has been little research on appropriate plant populations and the impact of hybrids with traits such as tillering and staygreen.

The results contained in this paper are from two years of research, a third is being conducted this season (2011-12) which it is hoped will provide information from across a range of different seasonal conditions.

This project is investigating the combination of plant populations (30, 50 and 70,000 plants/ha) and different row configurations: solid plant, single skip (SS), super-wide (SW) (1.5 m) and double skip (DS), all on 1 m base row spacing

Three contrasting hybrids were used with differing levels of staygreen and tillering:

1. Low tillering, high staygreen - PAC2436 (2009) and LT10 (2010)
2. Moderate tillering, moderate staygreen - MR43
3. High tillering, low staygreen – MR Bazley

Trials

Trials were conducted over two seasons, 2009-10 and 2010-11. In the first year, one site was located at Cryon, while in the second year; sites were located at Gurley, Mungindi and Rowena. This current seasons trials are located at Rowena and Mungindi and have also included early and late plantings.

2009-10 Season

The trial was sown at Cryon on the 14th and 15th September 2009. The site received good in-crop rainfall until the end of November, when significant pre-anthesis stress occurred with high temperatures and high evaporative demand.

Post Christmas this stress was relieved by significant rainfall, which resulted in effectively two generations of heads. There were the early generation heads that set grain during the period of pre-anthesis stress and the second generation of more productive heads, which resulted from the relieving rains.

Final grain yields at the site averaged 1.6 t/ha, with no difference in yield between the different planting configurations. Differences between hybrids were significant with the hybrid with high tillering and low staygreen yielding 0.4 t/ha more than the low tillering and high staygreen hybrid. In comparison, the predicted yields in the absence of the post Christmas rains would have been only 0.3 t/ha. This was determined by collecting and threshing heads from the first generation that were produced.

2010-11 Season

The three sites located at Rowena, Gurley and Mungindi were sown one week apart, commencing on the 17th & 18th September with other plantings on 24th & 25th September and 29th & 30th September, respectively.

Table 1 Established populations at all sites in 2010/2011.

Target Population (Plants/m^2)	Gurley		Mungindi	
	Plants/m^2	Yield (t/ha)	Plants/m^2	Yield (t/ha)
3	3.0[c]	3.5	3.6[c]	4.0[b]
5	4.1[b]	3.7	5.6[b]	4.3[a]
7	5.1[a]	3.7	7.3[a]	4.4[a]
5% l.s.d	0.2	-	0.3	0.3
Significance	<0.001	0.07	<0.001	0.01

Crop establishment was good at all sites although target populations were not reached at Gurley and Rowena (data not shown) (Table 1). At Mungindi, plant populations slightly exceeded the target levels. At all sites the low tillering, high staygreen hybrid had poorer establishment compared with the other hybrids.

The 2010/11 season was an exceptionally good sorghum growing year west of the Newell Highway with dryland yields above 5 t/ha for solid plant treatment at the Mungindi site (Table 2).

Table 2 Grain yield (averaged across population and hybrid) at Gurley and Mungindi in 2010/2011

Configuration	Gurley	Mungindi
	--------t/ha--------	
Solid	4.6[a]	5.4[a]
Single Skip	3.5[b]	4.3[b]
Super Wide	-	3.8[bc]
Double Skip	2.8[c]	3.4[c]
5% l.s.d	0.5	0.8
Significance	0.002	0.004

Summary of Results

Mungindi

The Mungindi site had the best seasonal conditions, resulting in the highest yields. There were significant differences in the ideal population, row spacing and hybrid type. Solid plant significantly out yielded all other configurations. Single Skip and SW performed the same while DS was the lowest yielding (Table 2).

In terms of population, the 50 or 70,000/ha yielded comparably, while the 30,000 plants/ha yielded significantly less. In a repeat of the results from the first year the low tillering, high staygreen hybrid yielded significantly less than the other hybrids across all row configurations and populations.

Table 3 Grain yield from three hybrids (averaged across configuration and population) at Gurley and Mungindi in 2010/2011

Hybrid	Gurley	Mungindi
	--------t/ha--------	
LT10	3.3[b]	3.6[b]
MR Bazley	3.8[a]	4.5[a]
MR43	3.8[a]	4.6[a]
5% l.s.d	0.2	0.2
Significance	<0.001	<0.001

Gurley

There were only 3 row configurations at the Gurley site - Solid, SS and DS. Maximum yields were close to 5.0 t/ha. For the three configurations solid plant out yielded SS, while DS had the lowest yield (Table 2). With respect to population, 50,000 and 70,000 plants/ha were comparable, while 30,000 plants/ha yielded significantly less. Hybrid performance was similar to what was observed at Mungindi with LT10 producing lower yields compared to the other two hybrids. (Table 3)

Rowena

The Rowena trial site suffered from poor seed set, most likely as a result of cold, wet conditions during flowering. Prior to Christmas it was evident that many of the florets would not produce grain. The site was continued through to grain harvest but the final grain yield and quality were significantly compromised and will not be reported. However, tillering and head number data has still provided useful comparisons.

Commercial implications for sorghum in the Coonamble & Walgett districts?

Row configurations

While commercially DS configurations have been widely adopted in the west, in effect half of the paddock area remains uncropped. This has additional rotational implications, which are still being investigated as part of this project. The bare uncropped areas of DS, provides an opportunity for weeds, potentially impacts on winter cereal stubble breakdown and impairs the even distribution of water and nutrition in the field for following crops. Double skip offers a very "safe" option for growing sorghum but potentially reduces the ability to capitalise on the better seasons, through yield "capping" as we have seen in the 2010/11 season. In the high yielding season of 2010/11 using a DS configuration meant forfeiting between 1.8 – 2.0 t/ha when compared to solid plant.

Solid plant configurations confer high risk to sorghum growers in the west, even though they demonstrate the ability to achieve the highest yields in the better seasons. Solid plant configurations also offer more uniform water and nutrition use, ground cover and competitive ability for weeds.

Superwide (1.5m) rows and single skip configurations potentially offer a reasonably compromise. Although a reduced level of yield sacrificing has been observed for SW compared to the DS, the question remains on the overall impact on the rotation.

Plant populations

Results from the current project indicate that establishing 50,000 plants/ha is optimum for western, low rainfall (sometimes!) areas. Emphasis should be placed on evenness of seed distribution which can be difficult to achieve when targeting less then 50,000 plants/ha with an airseeder. Although 70,000 plants/ha offered comparable yields, there were no real benefits compared to 50,000.

Hybrid selection

Hybrids with a moderate level of tillering have performed best to date under higher yield potential seasons. These hybrids offer some level of compensation should seasonal conditions change markedly through the season. As lower tillering hybrids become available there is potential for these hybrids to be incorporated in solid plant configurations with less risk of crop failure, however there is still an increased reliance on the main head and a reduced number of tillers.

Conclusions

At the end of the second season results indicate that the low tillering, high staygreen hybrids did not have the same level of yield potential in high yielding seasons (4-6 t/ha) and were unable to compensate in seasons with significant levels of pre-flowering stress to achieve yields similar to hybrids with a moderate level of tillering. The potential advantage of staygreen hybrids in seasons with high post-flowering stress has not been able to be tested in this series of trials due to wetter and cooler summers then can often be experienced.

Populations of 30,000 plants/ha have consistently produced lower yields under the same conditions. Plant populations should be targeted at the 50-70,000 plants/ha target, but commercially

populations of 70,000 plants/ha are not likely to be viable due to higher cost of seed with little economic benefits.

In order to finalise these suggested guidelines for sorghum plant populations, row configurations and hybrid types additional trials are being conducted to develop a more robust data set in a broader series of environmental conditions and across a range of planting windows.

Acknowledgements

Thanks to Dave & Fiona Denyer “Wattle Plains” Cryon for hosting the 2009/10 season trial, Scott Carrigan “Kelvin” Gurley, Charles Boyle “Amaroo” Mungindi and Philip Harris “Wandahree“ Rowena for hosting the 2010/11 season 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.

Contact details

Name	Guy McMullen
Organisation	NSW DPI
Phone	02 6763 1100
Fax	02 6763 1222
Email	guy.mcmullen@industry.nsw.gov.au

Name	Loretta Serafin
Organisation	NSW DPI
Phone	02 6763 1100
Fax	02 6763 1222
Email	loretta.serafin@industry.nsw.gov.au