Manipulating row spacing to improve yield reliability of grain sorghum in central Queensland

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Abstract

Historically grain sorghum is a mainstay of summer cropping in central Queensland (CQ). However, during drier than average seasons grain growers in the area encounter problems with reliability due to low and erratic rainfall resulting in poor yields and poor quality grain. Wide row and skip row planting configurations which conserve stored soil moisture in the interrow area for plant use during the critical flowering and grain fill growth stages were proposed as a means of addressing these issues.

Eleven experiments were conducted between 2001 and 2004 to determine the impact of wide (>1 m solid rows) and skip row (single skip - 2 in every 3 rows planted; double skip - 2 in every 4 rows planted) configurations on grain sorghum yield. The results suggested that the row configuration which provides a yield benefit depends on the yield potential. The 1.5 m solid or 1 m single skip configurations were preferred at yields below 3 t/ha while the 1 m solid configuration was of most benefit when yield potentials were greater than 3 t/ha. This suggests that growers need to understand their yield potential before selecting a row configuration in order to improve yield reliability. Further, growers who have adopted wide and skip row configurations are discovering impacts of these configurations on other aspects of their farming system, such as stubble distribution, weed management and plant establishment. These issues can further impact on the yield reliability of sorghum in CQ, and need to be considered when selecting a row configuration.

Key words

Row configuration, grain sorghum, yield penalty, wide rows, farming systems

Introduction

Grain sorghum is a major component of dryland farming systems in central Queensland (CQ), with the main end use being feed grain for intensive livestock enterprises. Although rainfall in CQ is summer dominant, both the frequency and amount of rainfall can be quite variable. This has meant that, although summer crops such as sorghum are more likely to receive in-crop rainfall, these farming systems rely on stored soil moisture from a fallow period in order to reduce production risk. As a result of this variability, growers have sought to identify a row spacing and configuration that would produce reliable yields over a range of seasonal conditions. Despite much research since the 1960’s, Myers and Foale (1981) noted that the yield response to row spacing varied significantly from year to year and site to site, making it difficult to determine the optimum row spacing.

Prior to the mid 1990’s, standard row configurations for sorghum were commonly solid rows planted on 1 m spacing, as suggested by Foale and French (1984). They summarised the results of more than 20 row configuration experiments including 0.33 m and 1 m spacing and twin rows 0.33 m apart on 2.0 m spacing. They concluded that 1 m rows did not sacrifice much yield in the occasional good seasons and performed reasonably well in dry seasons. Similarly, Thomas *et al.* (1981) concluded from 15 row configuration experiments in central and southern Queensland with row spacing from 0.33 m to 4.27 m in both single and twin row configurations that single rows spaced 0.33 m to 1.07 m apart would produce optimum yields over a range of seasonal conditions.

By the mid to late 1990's, CQ grain growers had experienced a series of dry seasons and poor sorghum yields. Low and variable rainfall resulted in crops suffering moisture stress at critical growth stages impacting on both yield and grain quality. As a result, the GRDC-funded "Sustainable Farming Systems for Central Queensland" project began working with growers and local agribusiness to identify alternative row configurations. These configurations were based on either single wide rows or skip rows on 1 m spacing, able to meter out soil moisture use and preserve stored soil moisture for the critical flowering and grain fill stages, particularly when little in-crop rain occurred. This would increase yield potential in seasons with below average rainfall and therefore improve yield reliability over time.

Methods

Between 2001 and 2004 11 replicated and randomised trials were conducted on both departmental research stations and on-farm. Trial details are listed in Table 1. Several row configurations were tested including the standard 1 m row spacing (referred to as 1 m solid), 1 m single skip (1 m spacing but missing every third row) and 1.5 m solid rows. The latter two configurations are referred to as wide rows.

Table 1. Site and experimental details

Site	Date planted	Date harvested	Soil depth	In crop rainfall (mm)
Kilcummin	19/01/02	03/06/02	deep (120 cm)	130
Comet	11/02/02	23/06/02	deep (150 cm)	291 (inc. 100 after maturity)
Gindie	16/01/02	11/05/02	medium (75-90 cm)	73
Theodore	04/12/01	20/03/02	medium (90-100 cm)	177
Clermont	07/02/02	17/06/02	medium (60-90 cm)	46
Jambin	30/11/01	09/04/02	deep (150 cm)	216
Gindie	20/02/03	01/07/03	medium (75–90 cm)	171
Biloela	15/01/04	10/05/04	deep (> 150 cm)	207
Emerald	07/01/04	20/04/04	medium (85 – 90 cm)	247
Theodore	08/01/04	20/04/04	deep (150 cm)	205
Biloela	27/01/04	20/05/04	deep (>150 cm)	205

The on-farm trials were planted and managed by growers as part of a commercial crop and harvested using commercial harvesting equipment or small plot harvester, depending on the trial. Those trials conducted on departmental research stations were managed as small plot trials and were harvested using a small plot harvester. In both cases, grain was collected from a measured area and weighed using a mobile weigh bin and final yields adjusted to 13.5% moisture content.

Results and Discussion

Figure 1 illustrates that in all except one trial, yield of the standard configuration was less than about 2 t/ha or greater than 3.5 t/ha. There is an indication of a crossover at about 2.5 t/ha with the standard 1 m solid configuration outperforming the wide row configurations when yield was above this and vice versa for yields below this. However, due to limited data in the range 2 – 3.5 t/ha it is difficult to confidently determine the crossover. The trend is similar to that found by Routley *et al.* (2003) who suggested that the crossover point was about 2.6 t/ha in western parts of southern Queensland and northern New South Wales. Observation by the authors of the widespread adoption of wide row configurations by CQ sorghum growers since the late 1990's, when yields have been typically low, confirms the trend reported here that wide rows provide a yield benefit when yields are below 2.5 – 3.0 t/ha.

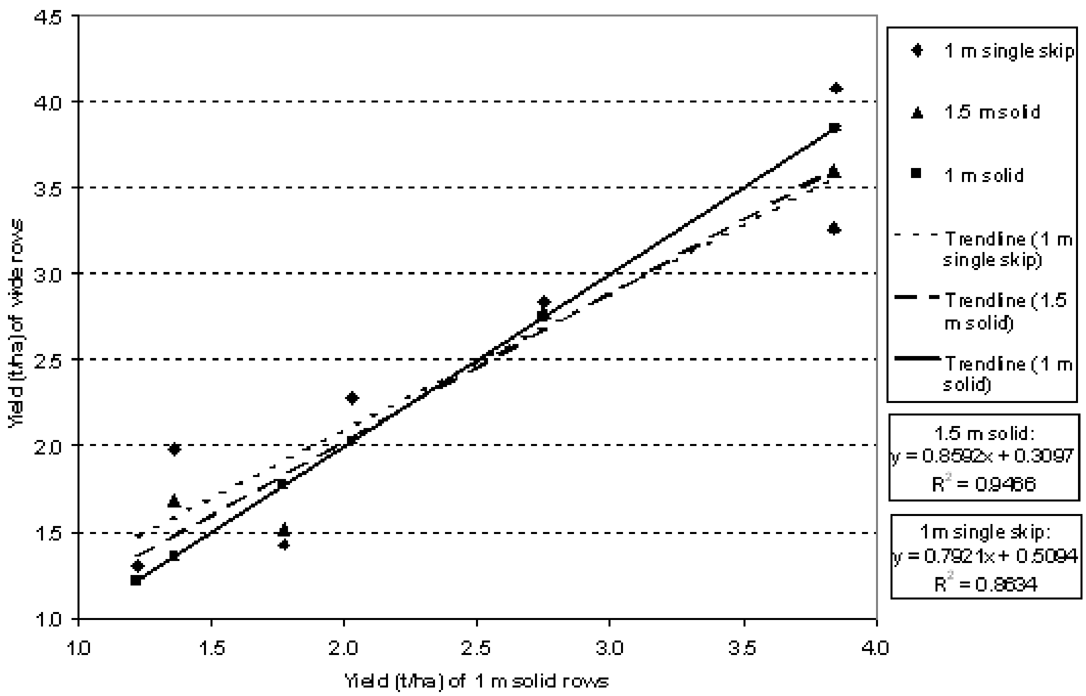

Figure 1. Relationship between yield of wide rows and yield of standard 1 m solid rows

The relative yield benefit or penalty of wide rows compared with the standard 1 m solid configuration, based on a crossover of 3 t/ha, indicated that for a yield potential less than 3 t/ha there was a 13% chance of suffering a yield loss by using wide rows incurring an average loss of 0.29 t/ha (Table 2). Alternatively, there was a 50% chance of obtaining a yield benefit of an average 0.17 t/ha. Conversely, if yield potential was greater than 3 t/ha there was a 67% chance of suffering a yield loss of, on average, 0.50 t/ha whilst there was a 33% chance of obtaining a benefit of wide rows of an average 0.23 t/ha. This is similar to the general trend reported by Whish *et. al* (2005) where wide rows prevented crop failure in dry years but were outperformed by solid rows in average to above average seasons.

Table 2. Yield benefit or penalty of wide row configurations

?	Penalty with wide rows	Benefit with wide rows	No difference
Yield less than 3 t/ha	1 out of 8 trials (13%)	4 out of 8 trials (50%)*	3 out of 8 trials (37%)
Average yield loss or gain (t/ha) when different	0.29 loss	0.17 gain	-
Yield greater than 3 t/ha	2 out of 3 trials (67%)	1 out of 3 trials (33%)	nil
Average yield loss or gain (t/ha) when different	0.50 loss	0.23 gain	-

* includes 2 trials where yield, although not statistically different, was greater for wide rows with lower plant populations which may have impacted on yield.

Our data indicates there are yield benefits in using wide row configurations when expected yields are less than 2.5 – 3.0 t/ha. However, it has been suggested that the low and erratic rainfall patterns experienced in CQ since the late 1990's have had an impact on the outcome of row spacing experiments during this time. A long term modelling analysis of the relative performance of 1 m solid and wide row configurations in CQ showed that there are more years in which 1 m solid rows produced greater yields than wide row configurations (Collins *et al.* 2005). However, since 1990 when yield potential has been lower than the historical average due to low and erratic rainfall, this analysis also showed a similar percentage benefit for wide rows to that described in Table 2 above.

In recent seasons, growers who have adopted wide row configurations have found that it has impacts on other parts of the farming system. Poor stubble distribution across the paddock as a result of continuous wide row cropping leads to reduced rainfall infiltration in the interrow and can reduce planting opportunities for subsequent crops. The need for good weed management to avoid increasing the weed seed bank is even more critical when using wide row configurations due to the reduction in competition between the crop and weeds. Reduced plant establishment on wide rows has also been experienced, with the reasons yet to be fully explained. These issues can further impact on the yield reliability of sorghum in CQ, and need to be considered by growers when selecting a row configuration.

Conclusion

These data suggest that the yield benefit or penalty from using wide row configurations in CQ depends on crop yield potential. In recent years where starting soil moisture and in crop rain have been poor and hence crop yield potential has been low, there have been benefits in using wide rows. This trend may not occur in all years so growers need to understand their yield potential before selecting a row configuration in order to improve yield reliability. Growers who continually plant on wide rows are likely to suffer reduced yield in wet seasons but will experience improved yield reliability in the long term due to avoiding crop failure in dry seasons. They should also expect effects on other parts of their farming system which need to be managed appropriately to limit negative impacts. As the approach to risk and impacts on other aspects of the farming system varies between enterprises, the optimum row configuration in any season will also vary.

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