A novel approach for sorghum canopy management in northern NSW

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Abstract

Wide or skip-row sowing, is used in marginal sorghum areas to conserve stored soil moisture for grain fill and improve yield stability. However, in higher yielding seasons wide rows can have a significant yield penalty compared with a solid plant. In-crop conditions can change rapidly due to variable rainfall and temperature. The ability to manipulate plant biomass in-crop could reduce the risk of failure when conditions become less favourable.

In 2019, an experiment with an imidazolinone (Imi) tolerant and non-tolerant hybrid plus mixed hybrid plots was sown at 15, 30 and 60,000 plants/ha. Herbicide applied in-crop to half of the mixed hybrid plots, killed every second non-tolerant row as a novel means of canopy management.

Grain yields were halved in sprayed-out plots (6.0 t/ha vs 3.0 t/ha) but grain protein and test weights increased. Further evaluation in marginal sorghum environments is required to determine if this novel practice could reduce risk and improve yield.

Keywords

Biomass, plant density, imidazolinone tolerance

Introduction

Grain sorghum can produce a large amount of biomass. To achieve maximum biomass requires the most limiting of resources in Australia; water. In water limited growing environments, such as north west NSW the efficiency of converting water into grain is even more critical to ensuring sorghum can be reliably grown. Tillering is well accepted as one of the most flexible traits affecting biomass accumulation and grain yield in many crops (Kim 2010). Selecting low tillering hybrids is an easy pre-sowing management tool for growers to help limit biomass accumulation. However, options to manage biomass production in-crop would also be useful.

A novel approach to managing biomass production is to remove part of the sorghum canopy post emergence, thus creating wide or skip rows. Skip or wide rows are considered to improve yield reliability by slowing crop root access to soil water stored in the centre of the skip area (Routley, 2003).

The introduction of commercial sorghum hybrids with herbicide tolerance presents a unique opportunity to manage in-crop biomass production using this new technology. Traditional sorghum hybrids have no useful level of tolerance to the imidazolinone herbicide and as such are killed by any application post emergence.

Methods

A single pilot experiment was conducted at Breeza, Liverpool Plains of northern NSW in 2019-20. The experiment included two sorghum hybrids, MR Buster; and an experimental line with tolerance to imidazolinone herbicide (ImiExp).

Plots were six plant rows wide and ten metres long. Plant rows were sown 1 m apart using a Monosem precision planter on 18th December. Prior to anthesis alleyways were slashed between each plot, to reduce the harvest length to around 8 metres. Each treatment plot had either all rows sown to one hybrid or hybrids sown on alternate rows. Plant densities were varied by adjusting the number of seeds sown per hectare. Treatments were randomly allocated, with three replicates.

The experiment had eight treatments, with three factors; hybrid, plant density and spray treatment (Table 1).

Table 1: Eight treatment in the canopy management experiment at Breeza in 2019

Treatment No.	Hybrid(s)	Target plant density (/ha)	Id
1	Imi Exp	60,000	ImiExp 60
2	MR Buster	60,000	MR Buster 60
3	Imi Exp+ MR Buster	30,000	ImiExp30+Buster30_Sprayout
4	Imi Exp+ MR Buster	30,000	ImiExp30+Buster30_No Spray
5	Imi Exp+ MR Buster	60,000	ImiExp60+Buster60_Sprayout
6	Imi Exp+ MR Buster	60,000	ImiExp60+Buster60_No Spray
7	Imi Exp	30,000	ImiExp 30
8	Imi Exp	15,000	ImiExp 15

Actual established plant densities were measured by counting 4 x 1m lengths of the centre two rows in each plot.
At 6 leaf stage the treatment plots of ImiExp+ Buster Sprayout (treatments 3 and 5) were sprayed with Intervix® (33 g/L Imazamox present as the ammonium salt and 15 g/L Imazapyr present as the ammonium salt) at 1 litre/ha plus Hasten® (704 g/L Ethyl and methyl esters of vegetable oil with 196 g/L non-ionic surfactants) at 0.5 l/ 100 litres. All plant rows of MR Buster which received the in-crop spray became purple and remained stunted or died. This created skip rows in those treatment plots, and effectively halved the plant population.
At physiological maturity biomass cuts were taken from each plot. These biomass samples were dried in dehydrators until they reached a constant weight to determine the total dry matter produced.
Plots were machine harvested using a Kew header. Grain was weighed and subsampled, and the subsamples were used to obtain grain moisture, protein, hectolitre weight and screenings. A FOSS NIR machine was used to measure these parameters.

Results

Established plant density

Actual established plant densities were higher than the target plant population for all treatments. There were significant differences between each of the populations (Table 2).

Table 2: Established plant densities in the canopy management experiment at Breeza in 2019

Treatment No.	Id	Target plant density (/ha)	Actual established plant density 4 weeks post sowing (/ha)
1	ImiExp 15	15,000	23,333c
2	ImiExp 30	30,000	39,170b
3	ImiExp 60	60,000	78,333a
4	MR Buster 60	60,000	87,500a
5	ImiExp30+Buster30 Sprayout	30,000	37,500b
6	ImiExp30+Buster30 No Spray	30,000	47,500b
7	ImiExp60+Buster60 Sprayout	60,000	78,333a
8	ImiExp60+Buster60 No Spray	60,000	77,500a
		L.s.d	*11,680*

Plant development, biomass production and grain yield

Treatments had an impact on the total number of sorghum heads produced and the final grain yield. Total head numbers were reduced by the application of the spray-out treatment, which effectively halved the plant population in that treatment (Table 3).
Biomass accumulation reported as dry matter (t/ha) was halved by the spray-out treatments. However, there was no significant difference between the spray-out treatments (trt 5 and 7), even though they had double the plant population. Similarly, there was no difference in dry matter between each of the ImiExp treatments, 1 and 2 and 3 even though there was a large plant population and heads/ha difference.
The highest grain yields (7.21 t/ha) were achieved from the MR Buster at 60,000 plants/ha treatment. The use of the spray-out treatments more than halved the grain yields, compared to their no spray counterparts (Table 3). There was a very high correlation ($R^2$0.81) between heads/ha and grain yield and similarly between dry matter (t/ha) and grain yield ($R^2$0.79).

Table 3: Grain yield (13.5% moisture) at Breeza in 2019

Treatment No.	Id	Heads/ ha	Dry matter (t/ha)	Grain yield (t/ha) at 13.5 % moisture content
1	ImiExp 15	61667 cd	23.61 c	4.83 d
2	ImiExp 30	75000 bc	24.53 c	5.69 c
3	ImiExp 60	93333 ab	25.11 c	5.96 c
4	MR Buster 60	108333 a	33.79 a	7.21 a
5	ImiExp30+Buster30_Sprayout	43333 d	15.41 d	3.08 e
6	ImiExp30+Buster30_No Spray	101667 a	31.08 ab	6.04 c
7	ImiExp60+Buster60_Sprayout	55000 d	16.16 d	3.40 e
8	ImiExp60+Buster60_No Spray	93333 ab	28.29 bc	6.57 b
	Lsd	*18999*	*4.995*	*0.47*

Grain quality

Grain protein was lowest for the highest yielding treatment, MR Buster at 60,000 plants/ha (Trt 4). In contrast, the spray out treatments which had significantly reduced grain yields had the highest protein levels. Hence, there was an inverse relationship between grain yield and protein, where yields were lower, protein content was higher (Table 4).

Screenings were low across all treatments and no significant difference was found.

Table 4: Grain quality at Breeza in 2019

Treatment No.	Id	Grain protein %	Hectolitre weight (kg/HL)	Screenings %	Thousand grain weight (grams)
1	ImiExp 15	10.27 bc	77.63 b	1.85	31.37 cd
2	ImiExp 30	9.77 c	77.70 b	2.04	30.89 d
3	ImiExp 60	10.00 bc	79.43 a	1.77	33.45 abc
4	MR Buster 60	7.37 f	77.17 b	2.42	31.69 bcd
5	ImiExp30+Buster30_Sprayout	10.47 b	79.00 a	1.80	32.75 abcd
6	ImiExp30+Buster30_No Spray	8.07 e	75.67 c	1.91	32.57 abcd
7	ImiExp60+Buster60_Sprayout	11.13 a	79.33 a	2.09	34.35 a
8	ImiExp60+Buster60_No Spray	8.70 d	77.80	1.78	33.64 ab
	Lsd	*0.56*	*1.13*	*n.s.d*	*2.15*

Conclusion

In high yielding seasons or favourable sorghum production areas, there is a significant penalty from spraying out every second row to create a wide row environment. In this experiment, grain yields as high as 7.21 t/ha were achieved. Using in-crop applications of imidazolinone as a novel method for reducing plant biomass was proven to be highly effective. However, grain yields were also halved by the spray-out treatment.

The ability to manipulate plant biomass in-crop may reduce the risk of failure when conditions are less favourable or in marginal production areas. Further evaluation in marginal sorghum environments is required to determine if this novel practice could reduce risk and improve yield.

Acknowledgements

Technical assistance from Natalie Aquilina and Bronwyn Clarendon is gratefully acknowledge

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