Does varying sorghum row configuration stratify soil nitrogen?

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Abstract
Double skip row configurations have been adopted as standard practice in North West NSW to improve the reliability of grain sorghum production. However, the possibility of soil nitrogen becoming stratified in the skip areas where sorghum plants are not grown has not been previously considered in this region.
The ability of sorghum plants to extract nitrogen evenly across the paddock has been examined through a series of row configuration trials conducted over several seasons. Sorghum roots have been shown to extract water from the middle of the double skip area, however there is often more remaining water in this area when compared to under the plant row. It was hypothesised that the same trend could occur for soil nitrogen.
Four trials were conducted from 2009 – 2013 at Cryon, Mungindi, Rowena and Tulloona in North West NSW. Four different sorghum row configurations were established: solid, single skip, super-wide and double skip. Following harvest soil nitrogen was measured both on the row and mid row for all treatments plus in the centre of the skip for the double skip treatment to a depth of 120 cm. Analysis of the nitrogen levels was used as an indicator of possible stratification across a paddock. Grain yields in these trials declined as effective row spacing increased with solid plant yielding significantly more than double skip, in both sites where significant differences were measured. Soil nitrogen results from the Cryon and Rowena trials showed no difference in the remaining soil nitrogen across the configurations. At the Tulloona trial significant differences in remaining nitrogen were measured but no clear pattern with configuration was evident. Only at the Mungindi site was additional nitrogen found in the skip areas.

Key words
Nutrient, spacing, rotation impacts, core position

Introduction
Grain sorghum is the main summer crop in northern NSW and one of the few rotation crops which growers west of the Newell Highway have been including as alternatives to their winter cereal dominant; wheat and barley; rotations. The average area sown to grain sorghum in North West NSW is 27,600 ha annually (Scott, 2012). There is potential for this area to grow considerably if the reliability of sorghum yields could be improved in combination with profitable returns. Currently the majority of the crop is sown using skip or super wide row configurations, with double skip being the most popular, as this also predisposes the crop to the least level of risk in terms of total crop failure. This concept is supported by research in the more favourable production areas in NE Australia which have shown that systems using skip configurations can reduce the risk of crop failure but often results in reduced yields (Whish et al. 2005). Apart from individual crop profitability there is a need to consider the rotation impacts of sowing skip row sorghum. As part of a project focused on improving the reliability of sorghum in this zone, finishing soil nitrogen was measured as an indicator of the remaining soil nitrogen both across and down the soil profile.

Method
Four grain sorghum trials were conducted in the 2009-10 to 2013-14 seasons. Trial sites were located at Cryon (near Walgett), Mungindi, Rowena and Tulloona in North West NSW. The trials used three hybrids, MR43, MR Bazley and 2436 which were sown each season at three of four plant populations; 15, 30 and 50,000 plants/ha or 30,50 and 70,000 plants/ha. Four row configurations were included; 100 cm solid plant, single skip, double skip and a 150 cm super wide.

The trials were all sown into paddocks which had been long fallowed from wheat. Trials were planted using a Monosem precision planter and Trimble guidance system. The trial was fully factorial in a split plot design to allow blocking by configuration and population to aid in trial sowing. Three replicates were included for each treatment. Trial plots were on average 8 m long and between 4 and 8 m wide depending on the configuration. Only the two centre plant rows of each plot were harvested. Each trial was harvested using a

KEW header and weighed to determine final grain yield and quality results. Final grain yields were adjusted to 13.5% moisture content in line with current receival standards.

Following harvest each of the MR 43 plots only were soil cored to a depth of 120 cm to obtain finishing soil nitrate levels. The solid, single skip and super wide treatments had two soil coring positions from within the plot, firstly an "on row" core, which was on the sorghum plant row and secondly a "mid row" core taken halfway to the next sorghum row. The double skip plots had an additional core taken from the centre of the skip area referred to as the "skip" coring position. Soil cores were taken from all plant populations; however the results compare analysis of the row configuration and soil coring position only.

Results

Grain yield

In two of the four trials; Mungindi and Rowena; grain yields declined as effective row spacing widened (Table 1), that is the 100cm solid plant yielded more than the single skip and super wide; which were comparable and all were higher yielding than the double skip configuration. In the remaining two trials, there was no significant difference in the grain yields from the four row configurations. Both of these trials were in below average yielding conditions due to dry seasonal conditions.

Table 1. Grain sorghum yield across configurations

Site/ Row Configuration	Cryon 0910	Mungindi 1011	Rowena 1112	Tulloona 1314
Solid (1.0m)	1.65	5.38_{a}	5.24_{a}	1.04
Single Skip	1.67	4.28_{b}	4.59_{b}	1.07
Super wide (1.5m)	1.73	3.84_{bc}	4.73_{b}	1.02
Double Skip	1.68	3.41_{c}	3.52_{c}	1.04
L.s.d	*n.s.d.*	*0.78*	*0.37*	*n.s.d*

Finishing soil nitrogen

(a) Cryon near Walgett, 2009-10

There was no significant difference in the remaining soil nitrogen when comparing row configurations in the on row and mid row coring positions. On average there was 36.73 kg of nitrogen remaining in the profile to a depth of 120 cm (Table 2). Further analysis of the double skip treatments (Table 3), including comparison of the on row, mid row and skip core position also showed no difference in the remaining soil nitrogen.

(b) Mungindi, 2010-11

At the Mungindi site there were significant interactions between configuration and the position of nitrogen across the rows, with more nitrogen remaining in the mid row area of the double skip treatment compared to all other treatments (Table 2). When including the skip coring position into the analysis, it is evident that there is close to double the amount of nitrogen available in the mid row and skip areas as there is on the sorghum row.

(c) Rowena, 2011-12

The remaining soil nitrogen levels were similar to those from the Cryon site in 2009-10, with on average 30.75 kg N/ha remaining. There was no significant difference in the amount of nitrogen remaining either across the configurations or comparing between the coring positions.

(d) Tulloona, 2013-14

The remaining soil nitrogen was quite high at this site, with on average 56.40 kg N/ha. When comparing across configurations, there was more nitrogen in the solid plant on row position than the other treatments. There was also a large bulge of nitrogen remaining on row in the double skip treatment (Table 2). There was no significant difference in the nitrogen remaining between the three coring positions in the double skip treatment.

Table 2. Finishing soil nitrogen both on row and mid row across configurations (0-120cm)

Configuration	Core Position	Site			
		Cryon 0910	Mungindi 1011	Rowena 1112	Tulloona 1314
Solid	On	32.90	28.60_{b}	31.72	129.49_{a}
	Mid	40.36	25.00_{b}	30.34	39.60_{bc}
Single Skip	On	38.31	23.60_{b}	29.93	32.74_{c}
	Mid	34.53	34.00_{b}	31.54	37.24_{bc}
Super wide	On	37.06	28.20_{b}	28.35	36.21_{b}
	Mid	39.13	32.90_{b}	30.96	77.42_{b}
Double skip	On	33.69	38.50_{b}	32.19	70.25_{b}
	Mid	36.50	79.40_{a}	30.97	28.16_{c}
Lsd		*n.s.*	16.34	*n.s.*	42.43

Table 3. Finishing soil nitrogen in the double skip treatments (0-120 cm)

Configuration	Core Position	Site			
		Cryon 0910	Mungindi 1011	Rowena 1112	Tulloona 1314
Double skip	On	33.69	38.50	32.19	70.25
	Mid	36.50	79.40	30.97	28.16
	Skip	36.53	75.20	34.22	45.09
Lsd		*n.s.*	20.18	*n.s.*	*n.s.*

Discussion

Nitrogen results for two sites Cryon and Rowena showed no significant impact of varying row configuration on remaining soil nitrogen either on row, mid row or even in the skip area. Interestingly at both of these sites, no nitrogen was applied pre-plant. In contrast at both the Mungindi and Tulloona trial sites, nitrogen was applied as fertiliser at or prior to sowing plus additional nitrogen was present in the soil profile, supplying between 80 - 120 kg N/ha to each crop.

Soil cores taken post-harvest at Tulloona in 2013-14 showed a large amount of nitrogen was still unused in the profile. Most likely this was due to low in crop rainfall which meant nitrogen fertiliser was not utilised by the sorghum crop. This is supported by the low grain yields (Table 1) of around 1.0 t/ha. The “on row” core in the solid plant treatment contained the largest amount of nitrogen, close to 130 kg/ ha. There were also significant amounts of nitrogen in the “mid row” area of the super wide treatment and “on row” in the double skip treatment. At the Mungindi site where grain yields were significantly higher, between 3.4 – 5.4 t/ha the remaining soil nitrogen levels were quite even across configurations both “on row” and “mid row” with the exception of the double skip treatment where close to double the amount of nitrogen was detected both in the “mid row” and also in the skip area of the plots.

Conclusion

There were large differences in sorghum grain yield across the four row configurations from two of the sorghum trials conducted. In these two trials, the solid plant outyielded the single skip and superwide configurations which were comparable while the double skip configuration yielded significantly less than all other three treatments. In the remaining two trials there was no significant difference across row configuration but in both of these trials average yields were extremely low as well, between 1.0 – 2.0 t/ha due to drought stress.

At only one of the four trial sites was data collected which supported the concept that nitrogen could possible become stratified in the skip areas of skip row configurations. At two of the trial sites, no significant difference could be detected and at the third trial, significant differences were measures but a pattern to explain the results could not be established. Additional data is needed to either support or refute the notion that nitrogen can become stratified in the skip areas of sorghum.

References

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