Sowing Strategies to Improve Productivity on Sandy Mallee Soils

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Background

Trials in the Mallee have highlighted the benefits of strong early crop establishment and nutrition, particularly on sands. Non-wetting (or water repellent) sands have presented additional challenges. Global Positional System (GPS) guided seeding is increasingly common and presents the opportunity for strategic placement of seed in relation to last season's crop rows. Trials have been established at Karoonda and Loxton to examine when and where on-row (or near-on-row) seeding may have benefits over inter-row seeding in stubble-retained systems.

How was the project done?

In 2015 plots were sown at Karoonda and Loxton with wheat cv. Mace both on-row or inter-row at two sowing dates (April and May). At Karoonda the emphasis was on the effect of the sowing treatment on weed populations and crop performance on two contrasting soil types (a dune sand and a heavier clay loam swale). At Loxton the emphasis was on testing the effect of pre-emergent herbicide (trifluralin) on the response of crops to the position of the seed row in a sand.

Key messages

- In a non-wetting sand, sowing on-row allowed seedlings to germinate in a wetter soil, with increased competitiveness against weed and disease pressures resulting in significant advantages in crop establishment and biomass production.
- Sowing on-row in sands or loam that did not express non-wetting did not capture the same level of benefits.
- Sowing crops on or very near last year's crop row greatly suppressed grass weed populations and reduced brome grass seed set by over 70% compared to inter-row seeding.
- Early sowing in the last week of April instead of the third week of May helped to overcome the dry spring conditions and resulted in yield benefits of 28% at Loxton and up to 13% at Karoonda.
- When sowing crops on last year's row, the potential for higher stubble borne pathogen (Take-All and Fusarium) inoculum and a greater likelihood of N tie-up after opening rains needs to be considered. However, impacts on rhizoctonia disease depend upon inherent biological fertility of soil.

About the 2015 trials

Plots were sown at Karoonda with wheat cv. Mace on the 27th April and 21st May. For each time of sowing, the crop was sown either on or very close to the previous year's crop row (on-row) or between last year's crop row (inter-row) with trifluralin applied @1.5 L/ha. Plots were sown at Loxton with Mace on the 28th of April and the 18th of May. For each time of sowing, the crop was sown either on-row or inter-row, with or without trifluralin @ 1.5 L/ha applied immediately prior to sowing.

At both sites the row spacing used was 28 cm. All plots received a pre-sowing application of 33 kg/ha of potassium sulfate to eliminate K and S deficiency as confounding issues and were sown into cereal stubble with DAP @ 50 kg/ha and Urea @ 24 kg/ha (20 kg N/ha, 10 kg P/ha). A trace element spray of Zn, Mn and Cu was also applied at early tillering. Measurements included disease risk (Predicta B test), disease incidence (measured on 7 week old seedlings), starting nitrogen (N) and water, microbial biomass and activity, N supply potential, crop emergence, biomass and yield, and weed counts.

Results and Discussion

Weather

After a significant rain event at Karoonda in January, conditions were dry for the remainder of the fallow. Overall the growing season was a decile 2 with a total of 172 mm. There was average rainfall in April (31mm) with deficiencies in May (30 mm), and especially in June (6 mm) (Figure 1). Overall the growing season was a decile 5 at Loxton. Following good opening rains in April (46 mm), rainfall was below average for May and June, but close to average for July and August (Figure 1).

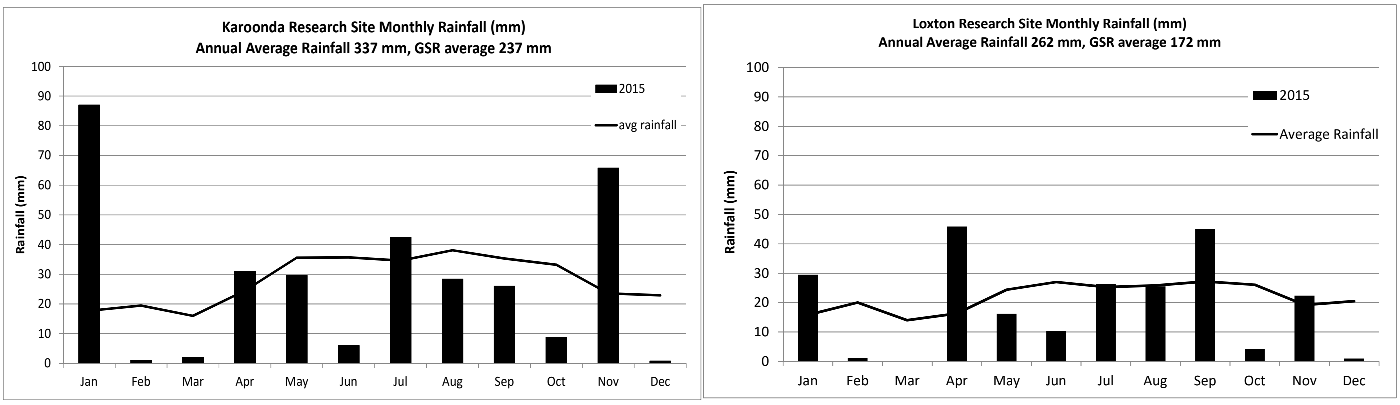

Figure 1. Monthly rainfall for Karoonda and Loxton trial sites compared with the average monthly rainfall.

Sowing Soil Water

Measurements of surface (top 10 cm) soil water at Karoonda showed two important relationships. At both sowing dates, on-row sowing was into a higher level of surface moisture than inter-row sowing ($P<0.05$), and secondly the on-row position accumulated more water than the inter-row position between the two sowing dates ($P<0.05$) (Figure 2). In a season when water repellence expression was quite marked, this difference proved important.

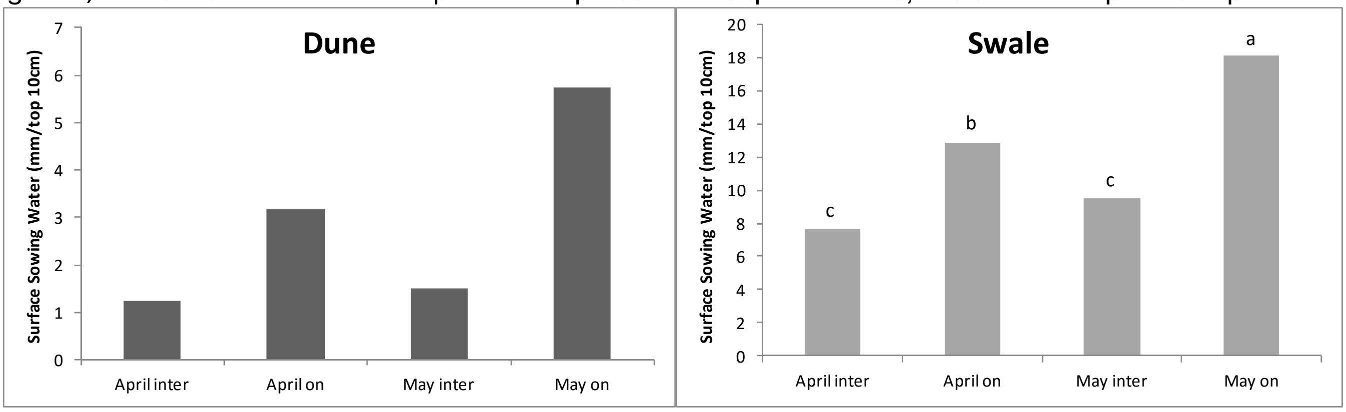

Figure 2. 2015 Karoonda site soil water (mm) measured in the top 10cm layer at sowing at the April and May sowing dates for plots sown on-row (on) and inter-row (inter). Within a soil type, a column annotated with a different letter has a significantly different amount of surface soil water.

Sowing Nutrition

There was a clear difference in the inherent fertility between the two soil types on which the sowing row placements were tested, with higher levels of microbial biomass, mineral N and N supply potential on the swale (Table 1). The early sowing date had higher levels of mineral N and N supply potential but lower microbial biomass. At the second sowing date, the increased microbial biomass without an increase in mineral N and N supply potential suggests immobilisation (tie-up) of N between the two sowing dates (Table 1). The wider ratio between dissolved organic C and N (DOC:DON) on the row is indicative of the presence of a higher load of wheat stubble on-row. Based on the wide DOC:DON and the increase in microbial biomass as the soil started to wet up early in the season, it is likely that this stubble did not undergo very much decomposition during the fallow (Table 1).

Table 1. 2015 Karoonda site microbial biomass carbon (C), mineral N and N supply potential on-row and inter-row at the time of sowing. Within a treatment factor (Soil, row position, sowing date) and measurement, a result annotated with a different letter is significantly different from another.

Sowing Treatment	**Microbial biomass C**	**Mineral N**	**N supply potential**	**[1]DOC:DON**
	µg/ g soil (0-10cm depth)			
Dune	136^{b}	9.4^{b}	21.4^{b}	14^{a}
Swale	314^{a}	18.8^{a}	48.4^{a}	11^{b}
Inter-row	203^{b}	13.8	33.1	11^{b}
On-row	246^{a}	14.4	36.7	15^{a}
April	205^{b}	17.3^{a}	38.2^{a}	12^{b}
May	245^{a}	10.8^{b}	31.6^{b}	14^{a}

[1]DOC:DON, dissolved organic carbon: dissolved organic nitrogen

At the time of seeding at Loxton there was more mineral N measured in the inter-row (11.3 kg/ha) than on-row (6.1 kg/ha). This suggests that there may have been temporary immobilisation of mineral N on-row as the stubble started to decompose at the beginning of the season with the opening rains.

Disease

Previous research has shown that the level of Rhizoctonia disease incidence is due to a combination of inoculum level, microbial activity, N levels at seeding, soil temperature and moisture during seedling growth (Gupta et al. 2014). Surface soils from the inter-row at Karoonda generally had lower microbial activity (microbial biomass C) and microbial catabolic diversity (product of microbial biomass C and DOC:DON)(Table 1) and lower moisture (Figure 2) which would have contributed to the higher rhizoctonia disease incidence through reduced microbial competition in the inter-row sowing treatments.

At Loxton, a delay in sowing between April and May meant that plants established in lower temperature soils resulting in slower root growth and reduced ability to grow through the infection zone. However, in the non-wetting sands at Karoonda, delayed and varied emergence at the earlier sowing date exacerbated disease impact, especially infection on the crown roots (Figure 3). These results suggest that observed benefits of early sowing in reducing soil borne disease impacts may not apply to non-wetting sands.

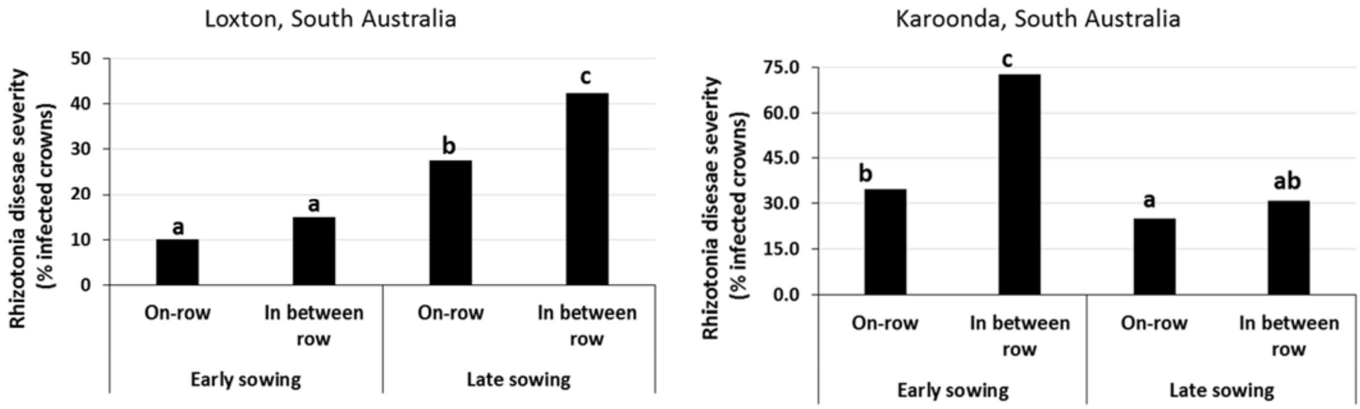

Figure 3. Rhizoctonia disease incidence on sand at Loxton and Karoonda as influenced by sowing date and row position in 2015. Bars with same letters are not statistically different at P<0.05.

Unlike the *Rhizoctonia solani* AG8 fungus, inocula for soil borne pathogens such as Fusarium crown rot and Take-All are more closely associated with stubble, hence inter-row sowing could help reduce disease severity. However, we did not find significant incidence of these diseases at Karoonda or Loxton.

Weeds

Brome grass densities were monitored at Karoonda on three occasions during the growing season using fixed monitoring points in four replicate plots for each treatment. The high level of variation in numbers resulted in no significant difference between treatments in the earlier counts. Brome grass was destructively harvested at crop maturity in order to measure the brome grass plant density and seed production. Both the plant density and seed density showed a response to sowing row position (P<0.05) with significantly more plants following inter-row sowing compared with on-row sowing. This resulted in significantly more seeds following inter-row sowing (Table 2). On-row seeding reduced brome grass seed production by 72%.

Table 2. 2015 Karoonda dune brome grass plant density (plants/m^2), total seed production (seeds/m^2), and plant seed production (seeds/plant) at maturity.

	Plant density (plants/m^2)	Seed density (seeds/m^2)
On-row	28^b	2022^b
Inter-row	105^a	7332^a

There was no substantial grass weed population on the swale at Karoonda or the Loxton site so only results from the Karoonda dune are presented.

Crop Productivity

Establishment at Karoonda was influenced by time of sowing and row placement on the dune, but they were not found to interact. Earlier sowing on-row resulted in 2-3 times better plant counts than the alternative treatments. The biomass accumulated at GS31 (Growth Stage: first node) was affected by sowing date on both soil types, with earlier sowing resulting in up to 3 times more biomass on the dune. By anthesis through to maturity sowing date only significantly affected biomass on the swale with 0.26 t/ha extra grain yield for the April sowing. Row placement only affected biomass production on the dune, but the effect was substantial with 2 times more biomass at GS31 and GS65 (anthesis) in the on-row treatment than the inter-row treatment (Table 3). By maturity this difference was not significant. The mean yield for on-row sowing was 0.32 t/ha more than inter-row sowing. The lack of significant difference reflects variability in establishment on non-wetting soil and the effects of the very dry spring.

Table 3. 2015 Karoonda site crop establishment (plants/m^2) and biomass at first node (GS31, t/ha) and anthesis (GS65, t/ha) and grain yield (t/ha). Within a treatment factor (Soil, row position, sowing date) and measurement, a result annotated with a different letter is significantly different from another.

Sowing Treatment	Establishment (plants/m^2)	GS31 biomass (t/ha)	GS65 biomass (t/ha)	Grain yield (t/ha)	Protein (%)
Dune	44^b	0.37^b	1.87^b	0.85^b	9.69
Inter-row	20^b	0.22^b	1.01^b	0.68	10.08^a
On-row	69^a	0.51^a	2.73^a	1.00	9.31^b
April Sow	60^a	0.59^a	1.95	0.93	9.39^b
May Sow	29^b	0.15^b	1.80	0.76	10.00^a
Swale	129^a	1.13^a	5.33^a	2.13^a	9.74
Inter-row	121	1.15	5.70	2.08	9.84
On-row	137	1.10	4.96	2.18	9.65
April Sow	127	1.44^a	4.15^b	2.26^a	9.16^b
May Sow	130	0.81^b	6.50^a	2.00^b	10.32^a

At Loxton, crop establishment was influenced by the presence of trifluralin, regardless of row placement, but plant density was quite high for both treatments due to small seed size (Table 4). Inter-row sowing resulted in a higher biomass compared with on-row sowing at GS31 but this difference disappeared by anthesis. The effect of sowing date on anthesis biomass was still measurable at maturity with 0.32 t/ha extra grain yield for the earlier April sowing date (Table 4).

Table 4. 2015 Loxton site crop establishment (plants/m^2) and biomass at first node (GS31, t/ha) and anthesis (GS65 t/ha) and grain yield at maturity (t/ha). Within a treatment factor (Soil, row position, sowing date) and measurement a result annotated with a different letter is significantly different from another.

Sowing Treatment	Establishment (plants/m^2)	GS31 biomass (t/ha)	GS65 biomass (t/ha)	Grain yield (t/ha)	Protein (%)
Plus Trifluralin	142^b	1.52	2.91	1.33	9.21
Minus Trifluralin	162^a	1.59	2.89	1.30	9.23
Inter-row	158^a	1.63^a	2.89	1.34	9.12
On-row	146^b	1.48^b	2.91	1.30	9.32
April Sow	154	1.48	3.05^a	1.48^a	8.96^b
May Sow	150	1.62	2.75^b	1.16^b	9.49^a

References

Gupta et al. (2014) http://msfp.org.au/resources/research/2014compendium/

Acknowledgements

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