SA Drought Hub Technical Report

Best practice for early sowing opportunities DN1_23_03

PROJECT LEAD: Agricultural Innovation & Research Eyre Peninsula (AIR EP)

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PROJECT SUMMARY

This project aimed to demonstrate and extend the findings of a SAGIT research project conducted in 2019-2021, which found ways to improve plant establishment and crop production by adopting specific early sowing techniques. Separating seed and fertiliser, sowing earlier than district practice, and using longer coleoptile wheat varieties to sow deeper into soil moisture, were trialled at two low rainfall sites on the upper Eyre Peninsula. Improving plant establishment and increasing crop production remain critical components of resilience in low rainfall farming systems. This is the second year these trials have been conducted (2022 and 2023).

EXECUTIVE SUMMARY

Key messages:

- Low crop establishment in an early sown crop did not result in any reduction in grain yield in the 2023 season.
- 55 kg/ha MAP + 5 kg/ha urea sown with the seed resulted in the highest final yield at both Cowell and Penong sites, compared to other treatments.
- Seed priming increased early crop establishment in AGT-Calibre at Penong, but this did not translate to final yield.
- Potassium sulphate (K_2SO_4) solution used to prime seeds improved the final yield compared to unprimed seeds at Cowell.

PROJECT BACKGROUND AND OBJECTIVES

A workshop held in Wudinna by the South Australian Drought Resilience Adoption and Innovation Hub (SA Drought Hub) in August 2021 identified early sowing as a priority topic for the Hub's Minnipa Node, which covers the upper Eyre Peninsula (EP). The workshop was attended by growers, industry organisations, farmer groups, researchers and community members.

As a result, the 'Best practice for early sowing opportunities' project, led by AIR EP and delivered by SARDI Minnipa Agricultural Centre, was developed to extend the results of the SAGIT investment into "Improving the early management of dry sown cereal crops" (EPFSS 2021, p. 76).

The key findings from the SAGIT research project (2019-2021) were:

- Greater plant establishment was achieved with fertiliser placed 3 cm below the seed.
- Lower plant establishment occurred when urea was placed with the seed.
- Place urea below the seed at sowing or consider applying urea pre or post seeding by broadcasting.
- If fertiliser separation cannot be achieved due to seeding systems, then MAP (10:22) with the seed is a safer option than DAP (18:20) placed with the seed.
- New long coleoptile wheats may provide another option for early plant establishment and vigour in areas where soil moisture is available up to 10 cm deep.
- It is important to sow seed at a depth sufficient for utilising soil moisture for germination.

In 2022 and 2023, the SA Drought Hub funded demonstration sites were utilised as a tool for engaging farmers in discussion and increasing awareness of options to improve plant establishment and show the impacts of fertiliser toxicity on seed germination and emergence.

In 2022 the demonstrations showed; early sowing did not mean dry sowing due to available soil water. Urea placed with the seed lowered plant establishment at Cowell when combined with both DAP and MAP, but only reduced early dry matter when placed with DAP. Fertiliser type and placement did not influence grain yield at either site. In 2022 seed priming did not improve crop establishment or grain yield.

METHODOLOGY

Demonstration sites were established in low-rainfall farming systems to:

1. Showcase practices to reduce fertiliser toxicity and increase plant establishment in early sowing situations.
2. Determine if seeding opportunities and crop establishment can be improved by using newly developed long coleoptile wheat varieties and/or seed priming.
3. Determine if early sowing offers other measurable benefits to the farming system, such as biomass production (for livestock feed), weed control or yield.

In 2023, two demonstration sites were established in the low rainfall areas of Cowell and Penong. The primary objective being the extension of outcomes of the SAGIT investment "Improving the early management of dry sown cereal crops" to growers.

The sites were sown on 1 May (Cowell) and 2 May (Penong) with Scepter or Calibre wheat aiming for 180 plants/m^2, which was adjusted for seed weight and germination. Both sites were sprayed with Weedmaster 2L/ha, Li700 400 ml/100ml, Estercide Xtra 680 400ml/ha, Triflurin 1.15 kg/ha and Sakura 118 g/ha.

Fertiliser rates were the district practice of 60 kg/ha DAP, or MAP sown at 55 kg/ha plus 5 kg N/ha as urea (sown 3 cm below the seed) to provide the same amount of nitrogen as with DAP. In addition, 25 kg/ha of urea was applied either with the seed or 3 cm below, depending on the treatment. The primed seeds were soaked in water or potassium sulphate solution (K2SO4) for 4 hours then air dried before sowing (Table 1).

NDVI and early dry matter cuts were collected on 4 July at Penong and 6 July at Cowell. Late dry matter cuts were collected on 30 August at Penong and 8 September at Cowell. The Cowell trial was harvested on 24 October and Penong on 1 November 2023.

Table 1: Early sowing treatments at Cowell and Penong in 2023 Scepter was used in all treatments except for first two (*Calibre was used).

Treatment No.	Treatment	Seeding strategy
1.	*Calibre, primed	Sown at 6 cm with 55 kg/ha MAP + 5 kg/ha urea
2.	*Calibre, unprimed	
3.	DAP + urea below seed	60 kg/ha DAP + 25 kg/ha urea applied 3 cm below seed
4.	DAP + urea with the seed	60 kg/ha DAP + 25 kg/ha urea applied with the seed
5.	DAP with seed	60 kg/ha DAP applied with seed
6.	MAP + urea below seed	55 kg/ha MAP + 30 kg/ha urea applied 3 cm below seed
7.	MAP + urea with the seed	55 kg/ha MAP + 30 kg/ha urea applied with the seed
8.	MAP with seed	55 kg/ha MAP + 5 kg/ha urea applied with the seed
9.	Nil fertiliser	No fertiliser
10.	Primed with K_2SO_4, normal depth	55 kg/ha MAP + 5 kg/ha urea applied with seed primed in K_2SO_4 for 4 hours
11.	Unprimed, K_2SO_4 fluid, normal depth (control)	55 kg/ha MAP + 5 kg/ha urea applied with the seed, K_2SO_4 solution with seed
12.	Primed, normal depth (4 hours)	55 kg/ha MAP + 5 kg/ha urea applied with the seed primed in water for 4 hours

LOCATION

Site # and name	Latitude (decimal degrees)	Longitude (decimal degrees)	LGA
Trial site #1 Penong (Ceduna), Cade Drummond	-31.959291	133.432442	Ceduna
Trial Site #2 Cowell, Paul Kaden	-33.658815	137.140449	Franklin Harbour

Monthly Rainfall (mm)	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total Rainfall (mm)	GSR (mm)
Penong	21.6	0.0	13.8	50.2	24.2	28.6	13.8	16.8	5.2	2.2	9.8	79.4	266	141
Cowell	18.0	7.2	12.0	30.4	27.0	19.4	6.0	19.4	7.2	11.3	15.6	134.8	308	120

RESULTS

Crops were sown into moist soils in the 2023 season due to rainfall in April. The gravimetric soil moisture content measured at sowing (0-90 cm) was 27% at Cowell, with a Phosphorus Buffer Index (PBI) of 74. The key available nutrient levels were phosphorus (P) 7 mg/kg, nitrate nitrogen (N) 11 mg/kg and potassium (K) 303 mg/kg. Penong had 37% gravimetric soil moisture content (0-90 cm), PBI of 91, 13 mg/kg P and N 12 mg/kg and K was 490 mg/kg.

The seasonal rainfall pattern in 2023 at both sites was for good summer rainfall resulting in soil moisture in the profile, and early rain in mid-April which allowed seeding. However, this was followed by a drier than average winter and extremely low spring rainfall which limited grain fill and yields.

Crop establishment averaged at 98 plants/m^2 at Cowell and Penong, both well below the targeted 180 plants/m^2 establishment rate. The highest establishment rates at Cowell were Treatment 4 (60 kg/ha DAP plus 25kg/ha urea) and treatment 10 (55 kg/ha MAP + 5 kg/ha urea applied with seed primed in K_2SO_4 for 4 hours) (Table 2). The lowest plant emergence was recorded in Treatment 3 (DAP and urea placement below the seed) and treatment 5 (DAP with the seed) (Table 2).

Crop establishment at Penong appeared to have two main response groups (Table 2). Most treatments were not significantly different in plant emergence in 2023 (Table 2). The lowest emergence Treatment 3 (DAP and urea placement below the seed) was similar to Treatment 6 (MAP and urea

below the seed), Treatment 2 (Calibre unprimed) and Treatment 12 (Scepter wheat primed 4 hours in water) (Table 2).

Table 2: Crop establishment (plants/m^2) at Penong and Cowell with different seeding strategies in 2023. Scepter wheat was used in all treatments except for first two (*Calibre wheat was used). Significant differences between means at P>0.05 is shown by a different letter.

	Cowell		Penong	
Treatment No.	**Average plant emergence (plants/m^2)**		**Average plant emergence (plants/m^2)**	
1*	101	bcd	132	a
2*	75	ef	72	de
3	63	f	58	e
4	137	a	101	abcd
5	82	def	102	abcd
6	89	cde	75	de
7	109	bc	112	abc
8	89	cde	100	bcd
9	109	bc	115	abc
10	115	ab	110	abc
11	98	bcde	121	ab
12	105	bcd	85	cde
LSD (F prob=0.05)	*26*		*31*	

Cowell Treatment 8 (MAP with seed + 5kg/ha urea) (Table 3) had the highest early dry matter (DM) compared to other treatments, followed by Treatment 9 (Nil fertiliser). However, the difference in DM weight between Treatment 9 and most other treatments were not significant. Treatment 1 (Calibre, primed) and 2 (Calibre, unprimed) had the lowest early DM weights. There were no significant differences in late DM measured at Cowell.

Penong Treatment 8 (MAP with seed + 5kg/ha urea) (Table 3) had the highest early DM weight, but the difference was not significant when compared with most other treatments that include the combination of phosphate fertilisers and urea. Treatment 1 (Calibre primed) had the lowest early DM weight. In late DM measurements, Treatment 5 (DAP with seed) had the highest weight, but it was not significant when compared to other treatments. Treatment 1 (primed Calibre) again had the lowest DM.

Table 3: Early and late dry matter weight (t/ha) with different seeding strategies at Cowell and Penong in 2023. Significant differences between means at P>0.05 is shown by a different letter.

	Cowell			Penong		
Treatment No.	**Early DM (t/ha)**		**Late DM (t/ha)**	**Early DM (t/ha)**		**Late DM (t/ha)**	
1*	1.31	d	5.76	0.29	e	1.17	d
2*	1.48	cd	6.84	0.46	bcd	1.55	bc
3	1.55	bc	7.08	0.39	de	1.33	cd
4	1.7	bc	6.49	0.45	cd	1.51	bc
5	1.62	bc	6.67	0.57	abc	1.98	a
6	1.53	cd	6.55	0.52	abcd	1.42	bcd
7	1.64	bc	6.54	0.47	bcd	1.53	bc
8	1.94	a	7.04	0.61	a	1.6	bc
9	1.78	ab	7.23	0.52	abcd	1.52	bc
10	1.69	bc	6.41	0.52	abcd	1.56	bc
11	1.58	bc	7.15	0.57	abc	1.68	ab
12	1.65	bc	6.81	0.58	ab	1.57	bc
LSD (F prob=0.05)	*0.238*		*ns*	*0.13*		*0.29*	

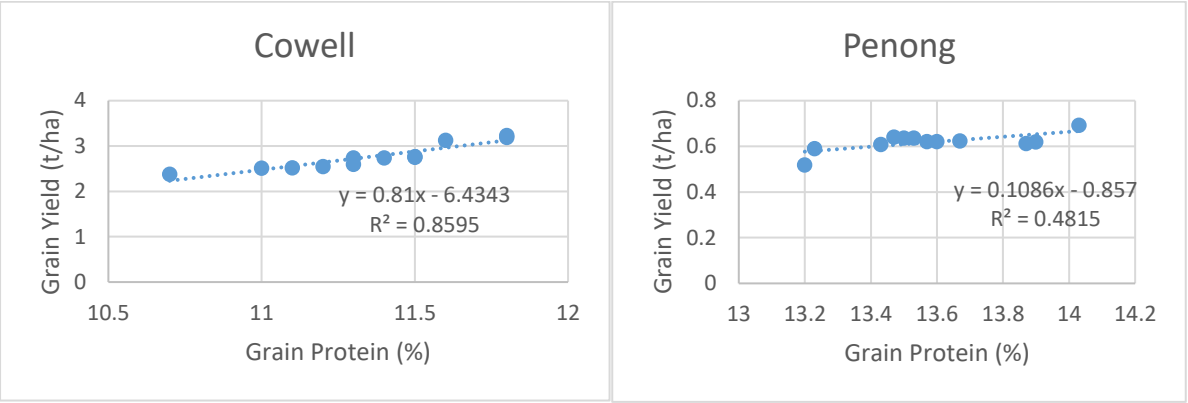
Cowell Treatment 8 (MAP with seed + 5kg/ha urea), Treatment 11 (Unprimed, K_2SO_4 fluid, normal depth (Control)) and Treatment 9 (Nil fertiliser) (Table 4) had the highest yield at 3.2 t/ha, 3.2 t/ha and 3.1 t/ha respectively. Treatment 1,5,6 and 12 had the lowest yields (Table 4).

Meanwhile the Penong site Treatments 12 (Primed, normal depth (4 hours)), 5 (DAP with seed) and 3 (DAP + urea below seed) had lower yields. Treatment 1 (Calibre primed) had the lowest grain yield (Table 4).

Table 4: Wheat grain yield (t/ha) and protein (%) with different seeding strategies at Cowell and Penong in 2023.

	Cowell				Penong		
Treatment No.	**Grain yield (t/ha)**		**Protein (%)**		**Grain yield (t/ha)**		**Protein (%)**
1*	2.38	e	11.5	abc	0.52	c	13.2
2*	2.77	b	11.3	bcd	0.64	ab	13.5
3	2.6	bcd	11.5	abc	0.59	bc	13.2
4	2.74	bc	11.4	abcd	0.62	ab	13.7
5	2.51	de	11.8	a	0.61	b	13.4
6	2.55	cde	11.6	ab	0.64	ab	13.5
7	2.74	bc	11.1	cde	0.62	ab	13.6
8	3.23	a	10.7	e	0.69	a	14.0
9	3.13	a	11.3	bcd	0.62	ab	13.9
10	2.75	bc	11.2	bcd	0.62	ab	13.6
11	3.19	a	11.0	de	0.64	ab	13.5
12	2.52	de	11.8	a	0.61	b	13.9
LSD (F prob=0.05)	*0.21*		*0.45*		*0.07*		*ns*

Figure 1: Wheat grain yield (t/ha) and grain protein (%) with different seeding strategies at Cowell and Penong, 2023.



In terms of protein content across treatments, the final average was 11.4% at Cowell and 13.6% at Penong. While the Penong site had much lower yields than the Cowell site, the protein content was 2.2% higher.

CONCLUSION

The trial results here demonstrate early sowing practice rather than a dry sowing practice due to the very good April rainfall across Eyre Peninsula in 2023.

Even though urea placed with the seed along with DAP at sowing (Treatment 4) had the highest crop establishment at Cowell (opposite of the 2022 trial and previous research), and primed Calibre (Treatment 1) had the highest crop establishment at Penong, these early season advantages did not translate into an increase in either early and late dry matter (DM), final yield, nor protein content. In a season like 2023 with a drier than normal winter rainfall and very low spring rainfall, the higher crop establishment did not necessarily result in higher yields.

MAP with seed (Treatment 8) did not show a high crop establishment at either site, but did have the highest early and late DM's, along with the highest final yield and protein level, indicating low crop establishment in early season did not result in final yield reduction either. In addition, no other phosphate fertilisers and urea combination strategies showed significant improvement in final yield, which is consistent with the findings of the 2022 trials and previous research.

Primed Calibre seeds (Treatment 1) had relatively high crop establishment at Cowell and the highest crop establishment at Penong, but resulted the lowest early and late DM weights and final yield. This indicates that seed priming can induce higher establishment rate in Calibre than Scepter. However, due to the long, dry period during winter in this growing season, the already established plant roots may have drained the soil moisture dry before other treatments, therefore amplifying the impact of drought that hampered biomass production, resulting in lower final yields.

Even though K_2SO_4 solution did not improve crop establishment, it did improve final yields compared to the crop where seeds were not primed at Cowell. This result was not shown in the 2022 trial.

These demonstration trials will be continued in 2024 in other areas of Eyre Peninsula to continue discussion and learning of the impacts of fertiliser toxicity, especially urea, with the seed in dry seeding conditions.

REFERENCES

Tomney, F., Cook, A., Richter, I., Standley, C., & Mudge, M., *Best practice for early sowing opportunities*, Eyre Peninsula Farming Systems Summary 2022, p. 79.

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