Evaluating the importance of sowing rate and time of sowing on emergence and yield - lentils

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Key findings

- Despite all times of sowing (TOS) having high starting soil moisture (21 – 30%), TOS influenced lentil establishment (plants/m^2), with reduced plant numbers observed at later sowing times (TOS 3).
- Lentil grain yields achieved from late April (TOS 1) and early June (TOS 2) sowing dates were similar, however a 13% yield reduction was observed when sown in late June (TOS 3).
- Increasing seed densities above 120 plants/m^2 did not improve lentil grain yield (t/ha).

Background

In recent years, lentil production in Australia has increased significantly with over 525,000 tonnes produced in 2022 (Maphosa et.al., 2023). Although the cropping area of lentils is much smaller than wheat, it is a high value crop and remains a common inclusion within farming systems where climatic conditions are suitable. The Mid-North of South Australia is one of the largest lentil producing areas in the nation, meaning that constraints limiting production should be prioritised and explored (Maphosa et.al., 2023).

As a result of increased farm size and inconsistent autumn rainfall, many farmers are opting to sow dry, or earlier in the growing season to ensure seeding programs are completed in a timely manner, in some cases improving crop access to early moisture and early establishment prior to cold conditions (Flohr et al., 2021).

Recently, new research across the Mid-North of SA has investigated early sown pulses including lentil and faba bean as a frost avoidance tool, in addition to other agronomic opportunities aiming to improve pulse yield in areas outside high production zones (Roberts et.al., 2023). A lentil trial at Hart, SA in 2023 investigated techniques aiming to improve the effectiveness of dry or early sowing, complimenting current and past research. The effects of sowing rate on plant establishment, crop growth and grain yield under varying conditions and times of sowing (TOS) were explored.

Methodology

A split-plot trial was implemented at Hart to investigate the effect of time of sowing (TOS) and seeding rate on lentil establishment, crop biomass and grain yield. Lentil variety GIA Thunder was sown at three TOS, ranging from April 27 to June 20 (Table 1), at three sowing rates. Sowing rates targeted 120, 150 and 180 plants/m2, equivalent to 100%, 125% and 150% of the standard sowing density respectively.

Table 1. Site details for 2023 lentil TOS trial at Hart, SA.

Plot size	1.75 m X 10.0 m	**Fertiliser**	Seeding: MAP Zn 1% @ 80kg/ha
Seeding date (TOS 1)	April 27, 2023		
Seeding date (TOS 2)	June 2, 2023		
Seeding date (TOS 3)	June 20, 2023		
Harvest date	November 2, 2023		
Previous crop	Mulgara oaten hay		

The number of plants/m^2 was measured to determine the effect of TOS and sowing rate on establishment. Soil moisture in the top 10 cm was also recorded at sowing and monitored until emergence for each TOS was complete. Normalised Difference Vegetation Index (NDVI) was measured frequently after emergence to track plant growth (higher NDVI values indicate less exposed soil and greener vegetation). Additionally, the timing of key phenological events (e.g., flowering) was recorded for all plots to determine potential treatment effects on plant development. Data was analysed using a REML spatial model (Regular Grid), in Genstat 23rd edition.

Season and rainfall

The first TOS was on April 27, one week after a 20 mm rain event observed across a four-day period. At this time, soil moisture in the top 10 cm was 21.1%, the lowest of all three TOS (Figure 1). The TOS 1 lentils emerged early May after only 6 mm of follow up rain. Rainfall continued to be marginal until May 26 when the site received 16 mm rain. Soil moisture at TOS 2 (June 2) was 27.5%. The late sowing time (TOS 3) was completed on June 20, when soil moisture was 30.4%.

June recorded above average rainfall (68 mm), however the remaining months of the growing season received below average rainfall. Early TOS were able to utilise the significant June rainfall for growth, however TOS 3 was still emerging at this time.

Dry spring conditions resulted in a quick finish for all TOS. Despite the variation in sowing time, desiccation dates and harvest dates were the same for all three treatments. The dry finish to the season shortened the season length of late sown crops.

Results

Time of sowing

Lentil establishment (plants/m^2) was influenced by TOS and was highest at TOS 1 (April 27) and TOS 2 (June 2) (Table 2). When sowing was delayed until late June (TOS 3), lentil establishment was reduced by up to 14%, although soil moisture (%) was similar at each TOS (Figure 1). Average plant establishment for TOS 1 – 3 was 82%, 87% and 73% respectively.

Lentil grain yield was reduced from sowing late (TOS 3 on June 20), however there was no significant difference in yield between TOS 1 and 2 (Figure 1). Time of sowing 1 and 2 lentils were able to use earlier rainfall to establish, increasing their growing season length. Additionally, TOS 1 and TOS 2 lentils flowered up to two weeks earlier than TOS 3 (Figure 2) and had a longer period to set pods in cool conditions, prior to water and heat stress later in the season, likely contributing to higher grain yields.

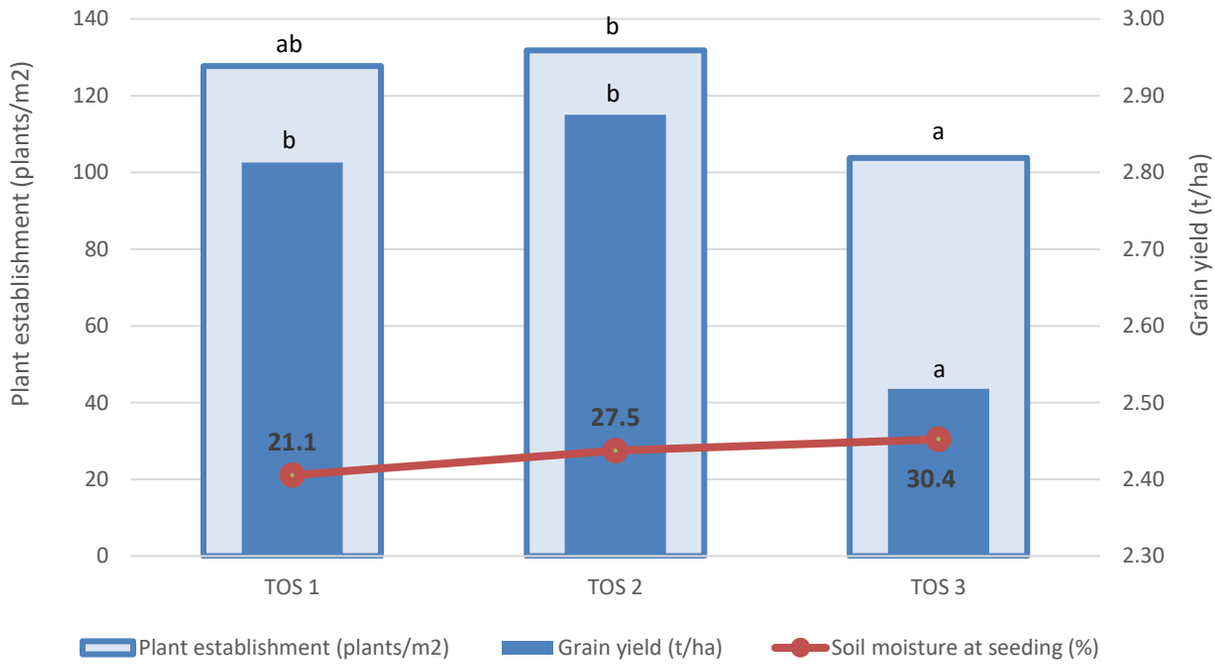

Figure 1. Plant establishment (plants/m^2), grain yield (t/ha) and soil moisture at seeding (%) for lentil TOS at Hart. Plant establishment ( ) or grain yield ( ) for each TOS with the same letter are not significantly different.

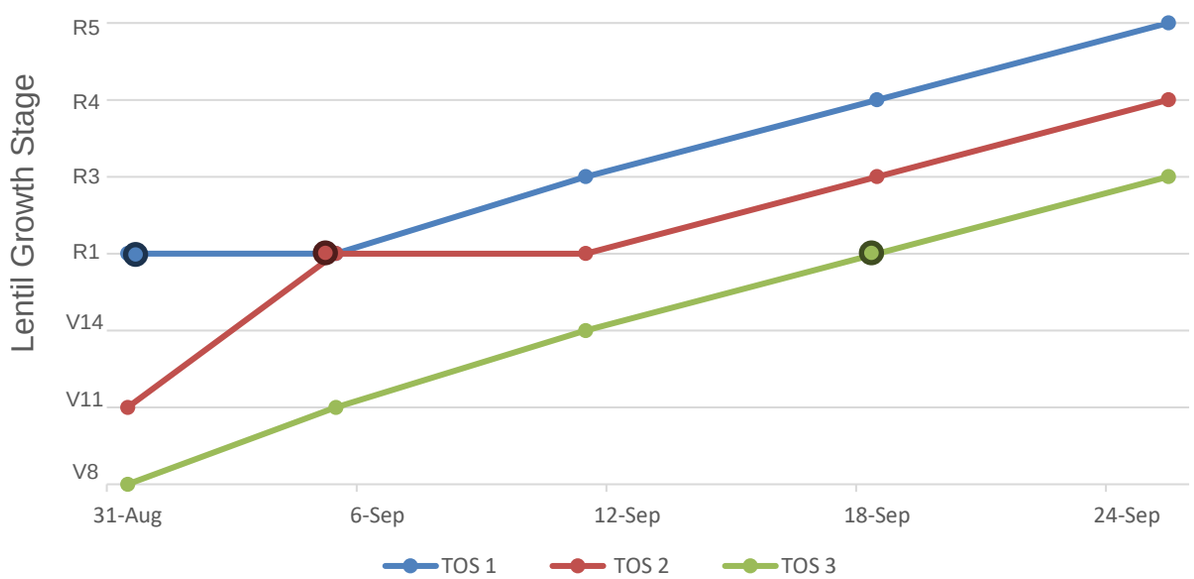

Figure 2. Growth stages for lentil TOS trial at Hart. Large, coloured circles indicate the date of first bloom for all TOS.

Yield reductions in lentil crops sown on June 20 likely resulted from a shortened growing season and exposure to higher temperatures and water stress during critical periods of growth later in the season. In similar 2023 trials with canola and wheat, delayed sowing resulted in improved emergence due to higher soil moisture levels (Morgan et. al., 2023), however later sowing dates showed a negative effect on lentil emergence. Recent studies conducted by NSW Department of Primary Industries found optimum sowing dates for lentils to be between late April and mid-May, with yield penalties noticed outside of this window (Maphosa et.al., 2023). The Hart trial found no yield difference between late April and early June sowing in 2023, however sowing on June 20 resulted in a 13% yield reduction when compared to earlier sowing.

Table 2. Treatment effects on plant establishment (plants/m^2) for lentil. Significant differences in plant establishment between treatments are indicated by different letters after plant count (plants/m^2). Shaded values indicate the treatments with the highest plant establishment.

Effects of sowing date			Effects of sowing rate		
Sowing date	**Plants/m^2**	**Establishment %**	**Sowing rate**	**Plants/m^2**	**Establishment %**
April 27 (TOS 1)	123^{ab}	82	**120/m^2**	101^{a}	84
June 2 (TOS 2)	131^{b}	87	**150/m^2**	119^{b}	79
June 20 (TOS 3)	109^{a}	73	**180/m^2**	143^{c}	79

Sowing rate

The standard sowing rate targeting 120 plants/m^2 recorded the lowest plant establishment (Table 2), however this treatment had the highest level of crop establishment (84%) compared to sowing rates targeting 150 and 180 plants/m^2 (79% establishment). Sowing rates targeting 180 plants/m^2 recorded the highest plant density, achieving 143 plants/m^2. Despite sowing rate influencing plant establishment, this did not translate to differences in crop yield. Results at Hart in 2023 show that no yield benefits were observed by increasing lentil sowing rate above standard practice.

Grain weight

Grain weight of lentils was negatively affected by early sowing in 2023 (Table 3). This may result from an extended reproductive window, increasing crop branching and seed set, reducing individual seed weight due to a dry spring finish. Delayed maturity time of lentils sown on June 20 (Figure 2) likely reduced yield potential as a result of below average rainfall during reproductive stages, resulting in larger individual seed weight despite lower yields.

Table 3. Time of sowing effect on 1000 grain weight (g) for lentils. Significant differences in grain weight are indicated by different letters. Shaded value indicates best performing treatment.

TOS	1000 Grain weight (g)
April 27	32.5^{a}
June 2	36.4^{b}
June 20	38.3^{c}

Summary

No yield gains were observed by increasing seeding rates of lentil above 120 plants/m^2 target (101 plants/m^2 achieved). Similar to wheat and canola, earlier sowing also resulted in higher yields for lentils, regardless of sowing rate (Morgan et, al., 2023). Delaying sowing until late June reduced both plant establishment and yield. Sowing in late April and early June provided opportunities for lentils to access early season rainfall for biomass production. Further investigation into the relationship between soil moisture at sowing, crop establishment and yield potential will be explored in future years of this project.

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Photo: Lentil time of sowing trial at Hart, 2023.