# Species by Time of Sowing Trial in Chapman Valley, Western Australia.

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## Abstract
In 2023 a trial investigating the response of 11 crop species to sowing time was established in the northern grain belt of Western Australia, at Chapman Valley. There are many studies of sowing time effects on each crop species in separate trials, but this trial is unique because it compares several crop types, including eight legume broadleaf species: albus lupin, angustifolius lupin, vetch, lentil, field pea, desi chickpea, kabuli chickpea and faba bean to canola, wheat and barley. By sowing each of these crop species at two sowing dates the aim of the trial in 2023 was to provide growers with data from which to inform decisions on when to change species sown, relative to sowing opportunities.

In 2023 yield of Vixen wheat was 2.6 t/ha when sown on May 24 and 2.4 t/ha when sown on June 14. From the May sowing time Maximus barley yielded 107% of the wheat, Invigor 4520P canola 57%, and legumes ranged 20% (Genesis 090 kabuli chickpea) to 80% (Butler field pea). From the June sowing time Maximus barley yielded 86% of the wheat, Invigor 4520P canola 45%, and legumes ranged 35% (Genesis 090 kabuli chickpea) to 69% (Butler field pea).

The trial will continue in 2024, with wheat sown over each plot to assess legacy effects on wheat. Key observations will focus on nitrogen and water, to assess Nitrogen Use Efficiency (NUE) and Water Use Efficiency (WUE) on the different crop type x sowing time combinations.

## Keywords
Dryland farming systems, cereals, oilseeds, legumes, legacy effects of legumes.

## Introduction
The Western Farming Systems project is a $20 million DPIRD, GRDC co-investment that started in 2022. This is a medium-term project with 5 years of rotational field trials that commenced in 2023. The three main systems field trials are located in Northampton (Medium Rainfall North), Merredin (Low Rainfall) and Lake Grace (Medium Rainfall South), with other smaller satellite trials also being conducted in each region.

The Chapman Valley Species by Time of Sowing trial is a satellite site of the Western Farming Systems project, the project was established to investigate strategies to increase profit across the rotation while managing weeds, diseases, soil fertility and risk.

The trial will assess the relative yield of different crop species, so growers can make more informed decisions on when to change species sown, relative to sowing opportunities. It will also assess the impact and legacy effects of legumes, which is important when assessing the impact of more diverse rotations.

## Methods
The trial was sown on a property 60km to the North/East of Geraldton, in the Shire of Chapman Valley. The soil is a red loam typical of the valley floors in the region. Time of Sowing (TOS) 1 occurred on May 24 and TOS 2 June 14 (3 weeks apart). Plots were 20m long by 2.0m wide, with varieties grouped into species blocks for ease of management (Figure 2).

**Figure 1: Drone Imagery of the Chapman Valley Species by Time of Sowing trial in 2023.**

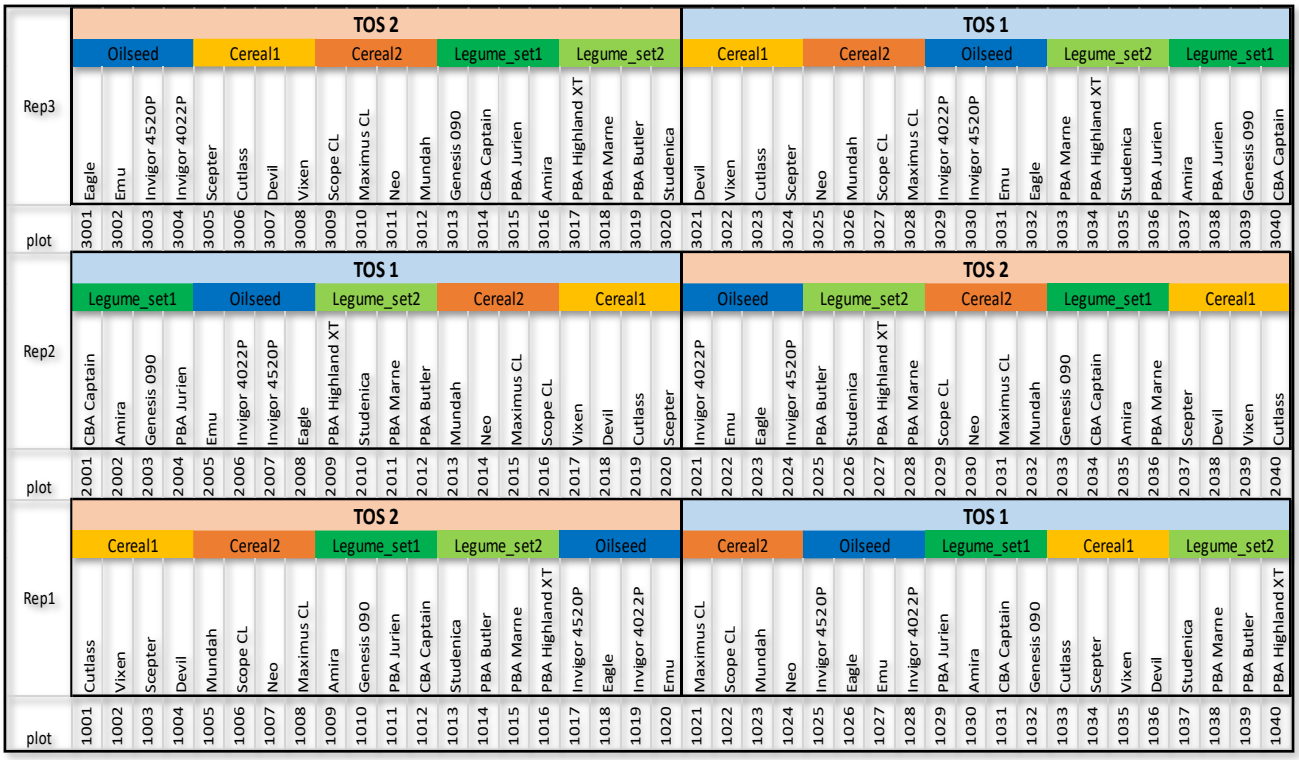


**Figure 2: 2023 Trial Design - varieties grouped into species blocks.**

For cereals (wheat or barley) and oilseeds (canola), 4 varieties were selected to provide a range of maturity types. For the two legume sets, a range of legume species were selected, which also provide a wide range of maturity types. This resulted in 40 treatments (20 varieties/species x 2 TOS), by three replicates. Target plant densities ranged according to species.

## Results

*Meteorological*

Climate of experimental site is subtropical with hot dry summers and mild winters (winter dominant rainfall). Mean rainfall for years from 1905 to 2024 for the Chapman Valley region is 437.6 mm (Bureau of Meteorology 2024). In 2023 the site received 198 mm of yearly rainfall and 172 mm of growing season rainfall, which positioned the site below decile 1 for the 2023 season, 54% lower than average. There was limited moisture at seeding TOS 1 (May 24), with only 38 mm of rainfall falling January to May in 2023 before seeding. Fortunately, TOS 2 (June 14) was sown into reasonable soil moisture, with 26 mm falling the week prior to seeding, resulting in better establishment rates at TOS 2, compared to TOS 1.

*Plant Establishment*

Due to unfavourable conditions at seeding most species established below the target density. As expected, given the large difference in target density of the varieties/species, there was a significant difference in establishment between varieties/species and crop types ($P$ = 0.001). Overall mean plant density from TOS 2 (70 ppm$^2$) was greater ($P$ = 0.023) than TOS 1 (64 ppm$^2$). For all crop types, plant density was greater at TOS 2, due to the more favourable conditions at seeding. Hence, there was no significant interaction effect of crop type and sowing time.

*Root Nodulation*

Most species of legumes nodulated better from TOS 2 seeding, as the conditions at seeding were more favourable for inoculum survival. Marne faba bean received the highest average root nodulation score, followed by field pea, vetch, lentil, albus lupin, narrow leafed lupin, desi chickpea and lastly kabuli chickpea. Lupin root nodulation was lower than anticipated and both the kabuli chickpea and the desi chickpea did not nodulate in TOS 1, despite being inoculated.

*Harvest Cuts*
Harvest cuts were conducted on all plots at maturity, but prior to senescence. This was therefore at different dates dependant on variety/species/TOS. Unsurprisingly, Butler field pea had the highest accumulated foliage biomass and Highland XT lentils the least.

Overall biomass from TOS 1 was 4337 kg/ha and for TOS 2 3825 kg/ha with no significant difference (P = 0.138). However, there were differences between crop types (P< 0.001).

*Yield*
Overall yield for the site was 1.8 t/ha from TOS 1 and 1.4 t/ha from TOS 2. This reflects results from previous research in the region on canola, that demonstrated yield advantages of earlier seeding (Harries and Seymour2016). There were obvious differences in yield based on crop type, interestingly barley yielded more than wheat and legume set 2 more than legume set 1.

Cereal set 2, barley, had the greatest average yields from TOS 1 at 2.3 t/ha and legume set1 TOS 1 had the lowest average yields at around 0.9 t/ha (Figure 3). The highest yielding treatment was Maximus CL barley in TOS 1 and the lowest yielding treatment was Genesis 090 kabuli chickpea in TOS 1 (Figure3).

There were different responses of crop type and varieties/species within crop type to time of sowing. Hence significant differences between Variety/TOS and Crop Type/TOS (*P*< 0.001), meaning time of sowing needs to be considered when comparing crop type and or variety (Figure 3).

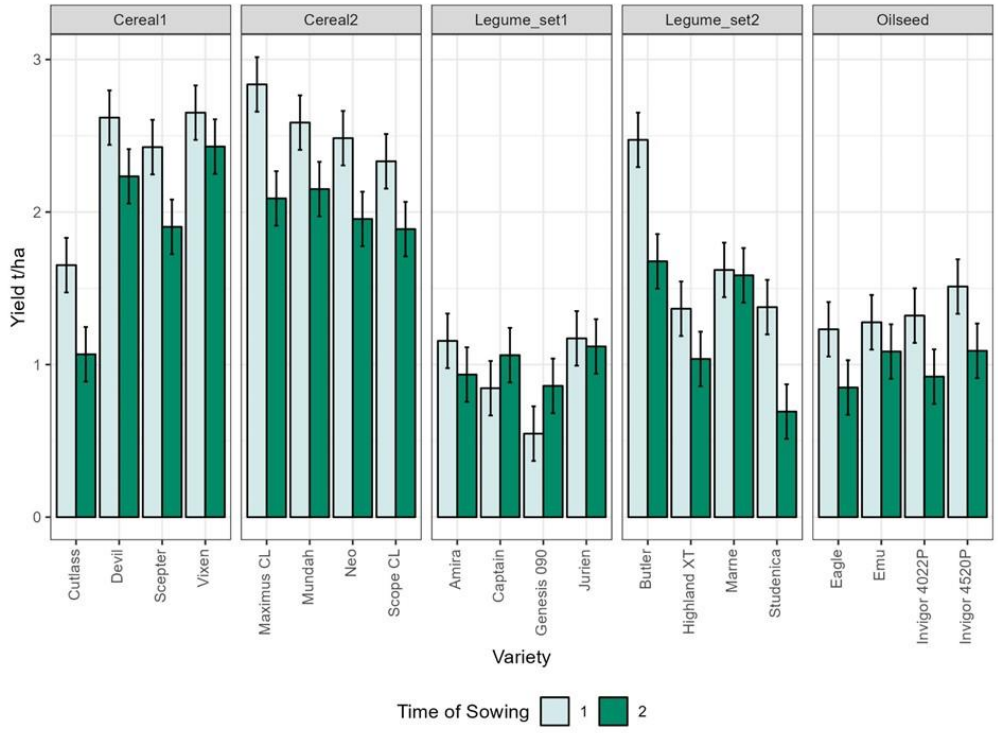


**Figure 3: 2023 Hand harvested yield results.**

*Grain Quality*
Mean protein level for the site was 16.6% for TOS 1 and 18.0% for TOS 2. The lowest protein levels were obtained from the barley plots with an average of 8.9% for TOS 1 and 10.6% for TOS 2. The highest protein levels were observed in legume set 1, with 25.0% for TOS 1 and 24.7% for TOS 2.

*Soil Moisture - Post Harvest*
Soil moisture was measured to a depth of 1.5 m after harvest. Gravimetric soil water content differed between crop types (Table 1) and was unsurprisingly greatest in the fallow areas between plots and surprisingly lowest in wheat plots at all depths in the profile. Previous studies have reported canola to use more soil water than other crop species, however, due to the small plant size and modest canola yields canola did not utilise more soil moisture compared to wheat. Both legume sets had similar gravimetric soil contents at depth (100-150 cm) to the fallow plots, indicating that at least some legume species roots did not reach

this depth in this experiment.

**Table 1: Post Harvest Gravimetric Soil Water Contents.**

| Post harvest gravimetric soil content (%) | Cereal1 | Cereal2 | Fallow | Legume_set1 | Legume_set2 | Oilseed |
|---|---|---|---|---|---|---|
| **0-10** | 5.3 | 5.9 | 7.0 | 5.6 | 5.6 | 5.7 |
| **10-30** | 8.3 | 9.0 | 11.7 | 8.5 | 9.1 | 9.0 |
| **30-50** | 10.0 | 10.1 | 14.8 | 10.2 | 10.8 | 10.3 |
| **50-100** | 12.2 | 12.5 | 17.1 | 13.5 | 14.8 | 12.1 |
| **100 -150** | 13.2 | 12.3 | 18.4 | 16.0 | 17.5 | 13.6 |
| **Mean** | 9.8 | 10.0 | 13.8 | 10.7 | 11.5 | 10.1 |

## Conclusion

In recent decades Australian and global agricultural inputs have increased, with nitrogen fertilizer and herbicide use tripling since the early 90's (Harries 2023). With these increases in inputs, yields have also increased, but this in-turn has also increased financial risk and greenhouse gas (GHG) emission scrutiny. An end goal of the project is to better understand GHG emissions, increase profit across the rotation, while managing weeds, diseases, soil fertility and risk. All trials in this series, will undergo economic analysis.

Minimal summer rainfall, a late break, below average growing season rainfall and high temperatures resulted in lower-than-average yields for the trial and the district in 2023. Given the seasonal conditions, yields from TOS 1 cereals and canola were impressive. The trial showed responses to sowing time for both growth and yield that differ for species and varieties.

In 2024 all plots and bare areas between plots, that were managed as clean fallow, will be over-sown with wheat to measure the legacy effects (NUE and WUE) of each crop species x TOS combination on wheat. Furthermore, in 2024 the plots will be split into 10 m lengths of high or low nitrogen treatments.

The poor 2023 season may impact the results in the 2024 trial, due to the low nodulation scoring, limited nitrogen fixation and mineralisation. Nevertheless, this trial will be enhanced and expanded to other sites in Western Australia in 2025, with more of a focus on an early seeding opportunity. However, growers need to consider risks associated with sowing early, this can include considerations of existing soil moisture, probability of follow up rainfall, vertebrate and invertebrate predation, frost and or heat stress at critical development stages, diseases, staggered or low emergence rates.

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