Optimising benefits from soil amelioration using pulses and oilseeds

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Key messages

- No crop type on any soil achieved optimum plant density at this site, with canola treatments having extremely poor establishment.
- Overall, wheat had a significantly higher biomass than canola, lupins or chickpeas.
- Wheat yields were average to above average for the area depending on the soil type, which is a favourable result given the average decile 4 growing season rainfall.
- Canola yielded extremely poorly and proved to be a risky crop choice for the given season and soil types

Aim

To evaluate different sequences of pulses and canola after soil amelioration when transitioning into cereal cropping to capture maximum benefit from amelioration.

Background

Growers in the eastern wheatbelt are ameliorating increasing areas of soil each year by deep cultivation as a means of correcting soil compaction and, when paired with lime application, acidity issues. When the amelioration is performed in a fallow year, growers can achieve the added benefits of reducing weed populations and providing residual soil moisture to the crop grown in the subsequent year reducing the risk of poor crop performance.

Significant areas of pulses have not been grown in the low rainfall eastern wheatbelt since the late 1990s and early 2000s. A number of factors led to the decreasing popularity of pulses in the eastern wheatbelt, including poor disease and herbicide tolerance, fragile stubbles, narrow soil type adaptation and variable yields (Seymour et al. 2012). However in the past twenty years there have been considerable improvements in varieties of the main pulse species chickpea, lentil, field pea, and lupin in disease and herbicide tolerance, harvestability and yield potential and stability. The narrow soil type preferences of lentil may also have been broadened however it is unlikely that a single pulse species would be adaptable across a whole farm due to the range of soil types in Western Australia.

These advancements open up new potential for the inclusion of a pulse phase in crop rotations in the eastern wheatbelt. It is therefore important to investigate the species and rotations where pulses prove most beneficial and viable to growers as a break crop including growing pulses in the years following soil amelioration.

Warrakiri Farms in South Burracoppin, at which these trials are located, currently follow the amelioration year with canola giving a year to reduce grass weed populations while reducing the canola production risk prior to returning to a cereal rotation. However, soil N levels will decline under this system which is one of the contributing factors to declining grain protein levels in WA wheat (Lemon 2007). Incorporating a pulse phase into the system would provide another opportunity for grass weed control and a cereal disease break as well as increase soil N (Seymour et al. 2012, Harries et al. 2015).

Research in 2018 showed economically viable yields across a range of soil types of the species mentioned after soil amelioration at Warrakiri Farms; however, a number of questions remained including: Are these results transferrable across growing seasons? Is it better to follow the amelioration year with canola, and then a pulse before returning to cereal, or to follow the amelioration year with a pulse, and then canola before returning to cereal? How do the economics of a two-year cereal break after amelioration compare with the one year break currently practised?

Method

Three small plot rotation trials were established at Warrakiri Farms in South Burracoppin in 2019. The trials were located over three different soil types classified as heavy, medium and light soil to determine the best break crop rotation options on varying eastern wheatbelt soil types.

The three locations contained seven treatments with three replicates. Treatments in 2019 consisted of faba bean, lupin, chickpeas, lentils and 3 canola treatments. In 2020, all pulse treatments from the previous year were sown to canola and canola treatments from the previous year were sown to either chickpeas, lupins or wheat (Table 1). In 2021 all treatments will be sown to wheat.

Measurements made in the trials in 2020 consisted of crop establishment counts, biomass cuts at anthesis, harvest index cuts, harvest grain yield and grain quality. Data was analysed with Genstat 19th edition using ANOVA with Fishers unprotected LSD tests (LSD significance level 5%, P=0.05).

Table1. Trial treatments (crop type) in 2019, 2020 and 2021

Treatment No.	2019 Crop	2020 Crop	2021 Crop
1	Canola	Chickpea	Wheat
2	Canola	Lupin	Wheat
3	Canola	Wheat	Wheat
4	Chickpea	Canola	Wheat
5	Field Pea	Canola	Wheat
6	Lentil	Canola	Wheat
7	Lupin	Canola	Wheat

Results

Crop establishment was, on average, significantly lower on the light soil and significantly higher on the heavy soil site (Figure 1). On any soil type, no treatment achieved its optimal plant densities of 150 plants/m^2 for wheat, 50 plants/m^2 for chickpeas, 45 plants/m^2 for lupins and 30 plants/m^2 for canola. Canola establishment was particularly poor and averaged only 4.4 plants/m^2 on the light soil site. On any soil, there was no significant difference between pulse treatments from 2019 in regards to canola establishment in 2020 with no canola performing significantly better or worse on a particular stubble. There was also generally no significant difference between chickpea and lupin establishment on any soil type.

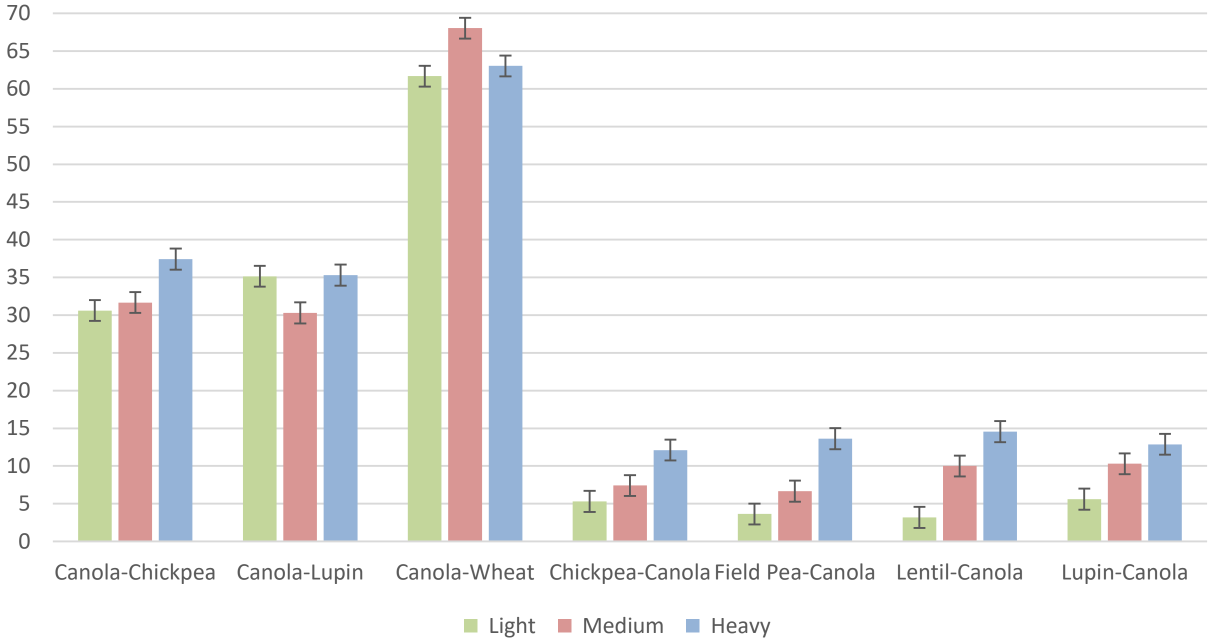

Figure 1. Crop emergence (plants/ m^2) of grain at harvest from light, medium and heavy soil site. Error bars represent LSD (P<0.05)

Crop biomass was measured at anthesis (flowering) (Figure 2). In general, biomass was significantly lower on the light soil and higher on the heavy soil site which would be expected given the trend seen with crop establishment. Overall, wheat had significantly higher biomass compared to all other treatments.

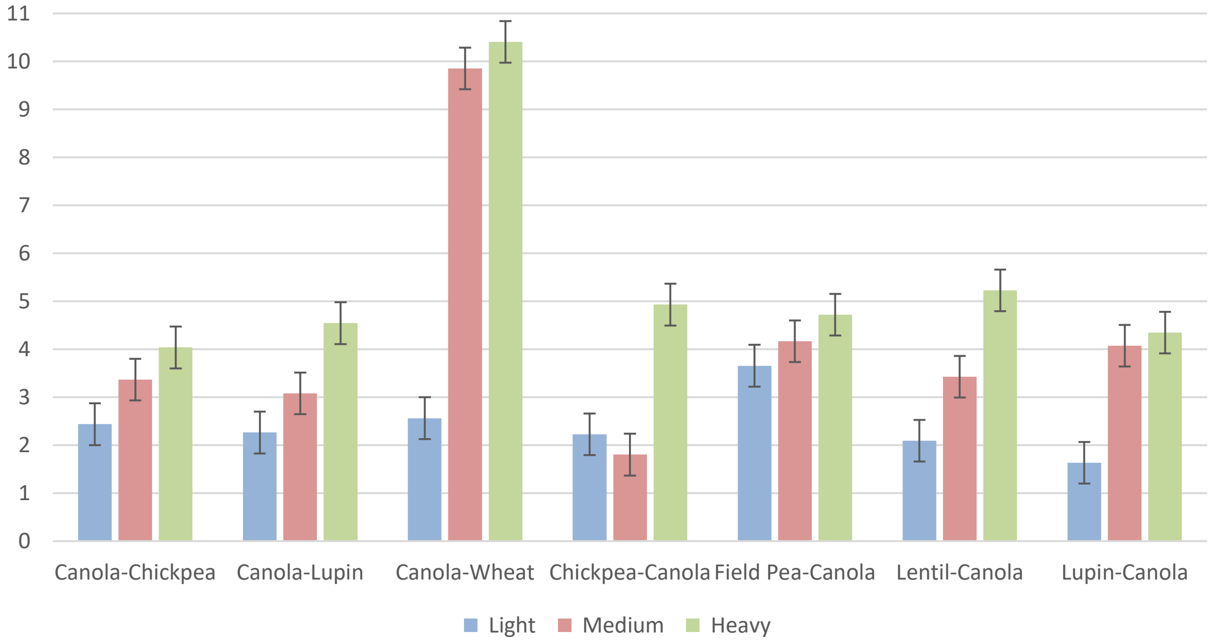

Figure 2. Crop biomass at flowering (anthesis cuts) (t/ha) from light, medium and heavy soil site. Error bars represent LSD (P<0.05).

On the medium and heavy site, wheat following canola (canola-wheat) had significantly higher biomass than all canola, chickpeas or lupin treatments. This trend was not seen on the light soil where canola following field pea had the highest biomass but was statistically similar to a number of other treatments. Overall, canola following field peas had a significantly higher biomass than canola grown following chickpeas and may be a result of higher residual N levels in the soil after field peas.

Yield was measured at harvest using an off board weigh system (Figure 3). All canola treatments were extremely poor yielding having had very low plant numbers throughout the season. Canola plots at the medium and heavy site had almost completely shattered by harvest and thus yielded nothing. The canola grown on the light soil averaged between 0.14 and 0.17 t/ha with no significant difference between treatments.

Wheat treatments provided an average yield on the light soil and above average yield for the area on the medium and heavy soil. Lupins yielded around the district average across the three soils however as expected performed best on the light soil. Chickpeas yielded very well, above district average, on the heavy soil however were much lower yielding on the medium and even more so on the light soil. Given the extremely poor yield of all canola plots, wheat or legumes were a safer and more suitable crop rotation choice under the seasonal conditions of 2020. It should be noted that legumes performed best on their preferred soil type and a legume with a narrow soil type preference such as chickpeas would still carry production risk if grown outside of its preference, s seen on the light soil.

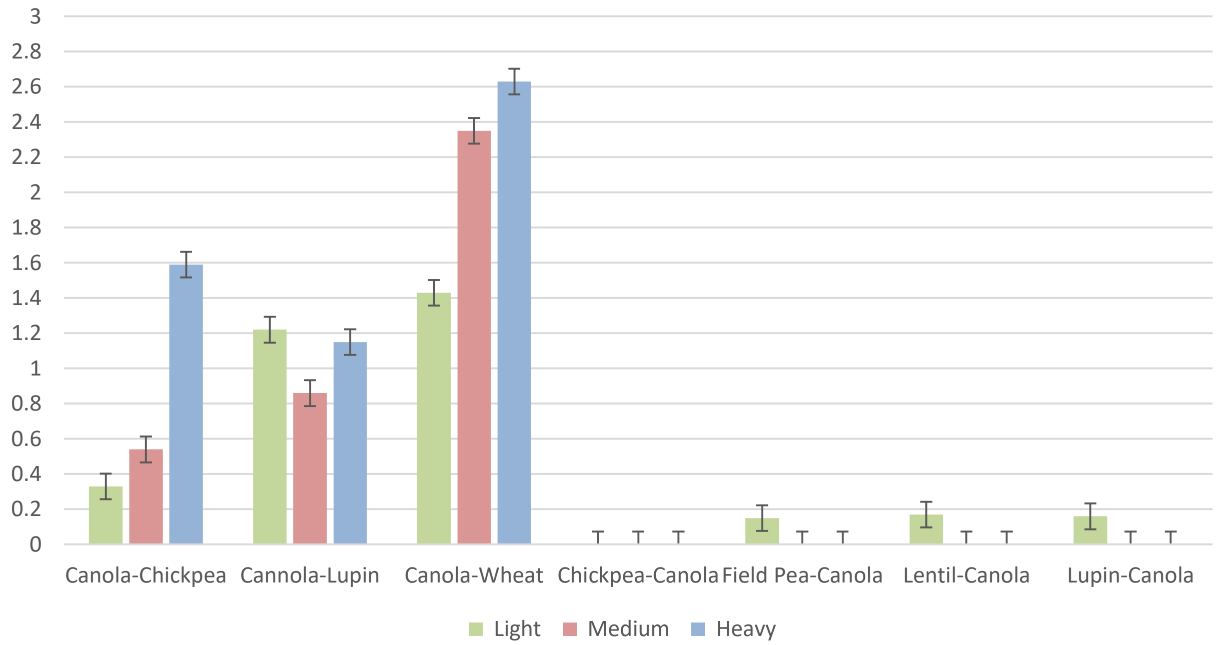

Figure 3. Yield (t/ha) of grain at harvest from light, medium and heavy soil site. Error bars represent LSD (P<0.05).

For all treatments sown to canola in 2020 as well as the wheat and lupin treatment, harvest index decreased as soil became heavier (Table 2). For the canola treatments, this decrease was dramatic, with an extremely poor harvest index on both the medium and heavy soil site. This reflects the trends seen in the canola yield data. Wheat, chickpeas and lupins had a good harvest index across the three sites however these did not follow the yield data as strongly as that seen with canola.

Table 2. Harvest index (%) of break crop rotation on light, medium and heavy soil at harvest.

Treatment	Harvest Index (%)		
	Light Soil	Medium Soil	Heavy Soil
Canola-Chickpea	49	50	52
Canola-Lupin	52	43	44
Canola -Wheat	55	50	46
Chickpea-Canola	18	4	3
Field Pea-Canola	23	4	2
Lentil-Canola	16	3	2
Lupin-Canola	18	4	3
Overall	33	22	22

Conclusion

No crop type on any soil achieved an optimum plant density, with canola treatments having extremely poor establishment.

Overall wheat had a significantly higher biomass than canola, lupins or chickpeas. When considering soil types separately this was still the case except for on light soil where no significant difference between wheat and the other treatments could be observed.

Wheat yields were average to above average for the area, depending on the soil type, which is a favourable result given the average decile 4 growing season rainfall.

Canola yielded extremely poorly and proved to be a risky crop choice for the given season and soil types.

Harvest index for most crops was generally highest on the light soil and decreased as soil became heavier, with the trend strongest in the canola treatments.

References

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