Claying Gravel Soils – 2023 Results

Hosts: Woogenellup – Brown & Goad Family

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KEY MESSAGES:

- Low clay rates (>200t/ha) can be utilised to ameliorate soils with a high gravel percentage.
- The percentage of gravel in the soil will significantly impact the resulting soil clay percentage after the clay has been applied.
- The claying of gravel soils was effective in increasing productivity at the Woogenellup site in 2023, where the soil type was sandy, non-wetting and had a low OC%
- The claying of gravel soils was not effective at Scotts Brook in 2023, where the soil was loamy, had a high initial clay rate, and had a high OC. However, the seasonal conditions were not optimal for observing an non-wetting response in canola.

Background

Claying has become a vital amelioration tool in the Great Southern region and along the South Coast of WA. The soils in this region are typically sandy, low in organic matter, non-wetting and prone to wind erosion. Claying significantly increases grain yields on these sandy duplex soils by ameliorating one or more of these constraints (predominately non-wetting).

Based on the successful adoption of claying sandy soils to alleviate non-wetting, farmers with sandy gravels and forest gravels, facing similar non-wetting issues, were keen to assess the benefits of claying gravel soils. After encouraging preliminary results in 2022, a variation to the project was approved by GRDC to invest in further research in 2023. The aim was to further quantify the benefits to production and to further explore what clay rates are necessary to alleviate non-wetting issues in gravel soils, especially when gravel content percentage is considered.

Under the variation, two demonstrations trials were established in 2023, one in Woogenellup on a gravelly sand over clay, and the other in Scotts Brook on a loamy forest gravel. The trial site at Woogenellup had two distinct zones across the demonstration site, a dense gravel (60% gravel content) on the hilltop and a sandy gravel (40% gravel content) on the slopes. It provided a great opportunity to test the impact of claying (at two clay rates) across both zones. It should be noted that the organic matter at this site was low. The Scotts Brook site was located on a dense forest gravel with 65-70% gravel by weight. The loamy soil had a clay content of 4.8%, but also a high organic matter content of 3.68% (the main contributor to the non-wetting).

Methodology

Trial Designs

Clay was spread at two trial locations in Autumn 2023. At the Woogenellup trial site (Figure 1), two clay rates (100t/ha and 200t/ha) were assessed over the two distinct soil type zones and incorporated by speed tiller to a depth of 10cm. The two controls included a tilled only (with speed tiller) zone and a nil clay and nil incorporation zone.

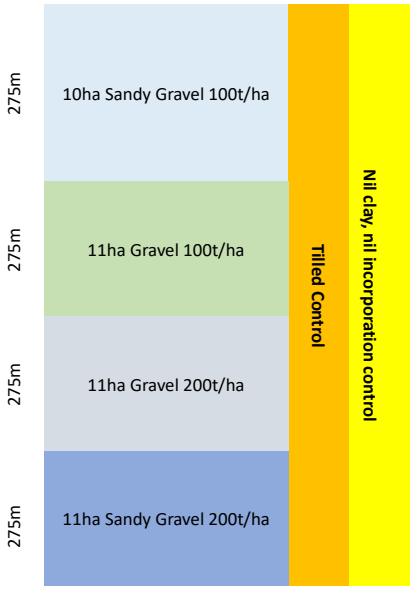

Figure 1: Trial design, Woogenellup, 2023.

12m	12m	12m	12m	12m	12m	12m	12m	12m	12m	12m
Cont. 1 *	Cont. 2 #	100 t/ha clay & Incorp	200 t/ha clay & Incorp	70 t/ha clay & Incorp	Cont. 2	Cont. 1	200 t/ha clay & Incorp	100 t/ha clay & Incorp	70 t/ha clay & Incorp	Cont. 2

** Cont 1 – Nil clay, nil incorporation, # Cont 2 – Speedtill only, nil clay.*
Figure 2: Trial design, Scotts Brook, 2023

The Scotts Brook Trial design (Figure 2) included three clay rate treatments (70t/ha, 100t/ha and 200t/ha). The clay across all treatments was incorporated with a speed tiller, to a depth of approximately 15cm. Again, the two control treatments included a tilled only treatment and a nil clay, nil incorporation treatment.

Monitoring & Measurement

The following monitoring and measurements were undertaken in 2023 across both sites:

- Baseline soil sampling 0-10cm and 10-30cm (incl. gravel, clay and OM content)
- Baseline water repellence assessments (MED test)
- Clay source - clay fraction determination
- Plant establishment counts
- Follow-up MED testing after clay application
- Biomass Assessment
- Soil strength at field capacity (somewhat difficult in gravel)
- Grain yield and quality

Results & Discussion

Clay Test Results

Clay samples from both pits were taken and tested at CSBP for both clay content (wet test) and nutrients. The clay at the Woogenellup site was taken from a new pit, where approximately 1 metre of sand and gravel topsoil was removed. The clay had a high clay content at 36.74% (Table 1). The clay at the Scotts Brook site was excavated out of a dam that was being extended, and the clay source was dug from a depth of between 50cm to 2m. The average clay fraction of the "clay" was 28.07% (Table 2).

Soil Amelioration

The amelioration effect of each treatment at the Woogenellup site was driven by the combination of the clay fraction of the applied clay, the depth of incorporation, the initial clay content of the soil, and the percentage of gravel in the soil. Although the rates of clay applied across both sites are very low for conventional claying, the high gravel content in the soil meant that within the soil zone there was less non-wetting sand that needed to be ameliorated in comparison to a non-gravelly sand. Table 3 shows the initial clay content of the soil, and the resulting clay content after the clay had been applied and incorporated (final clay %).

Plant Establishment

Plant counts were conducted at each site after crop emergence. At the Woogenellup site (paddock planted to canola), claying had a significant positive impact on plant establishment when compared to both control treatments (Figure 3). The higher rate of clay achieved the best result, and it should be noted, that tillage only treatment also provided some benefit to plant establishment, aside from the claying effect. At the Scotts Brook site, there was no significant impact of claying, or incorporation only on canola plant establishment (Figure 4). The paddock was dry sown and had variable emergence after significant June rainfall was received, negating any impact non-wetting may likely have had in a more marginal season break.

Table 1: Average clay source test results, Woogenellup, 2023.

Site	Clay %	Gravel %	P	K	S	PBI	pH
Woogenellup	36.74	5	4	381	38.4	25.9	7

Table 2: Average clay source test results, Scotts Brook, 2023.

Site	Clay %	Gravel %	P	K	S	PBI	pH
Scotts Brook Clay	28.07	15%	8.5	67.3	99	142.7	6.7

Table 3: Impact of clay treatments on final soil clay content at each site (Woogenellup & Scotts Brook), across each treatment, 2023.

Site	Starting Clay %	Clay Percentage	Rate	Incorporation Depth	Gravel %	Final Clay % (Soil Fraction)	Approx. Clay% of the soil (gravel removed)
Woogenellup	1.45	36.74	100	10cm	20	3.1	3.875
Woogenellup	1.45	36.74	200	10cm	20	4.7	5.875
Woogenellup	1.45	36.74	100	10cm	35	3.1	4.278
Woogenellup	1.45	36.74	200	10cm	35	4.7	6.486
Scotts Brook	4.8	28.7	70	15cm	40	5.6	7.84
Scotts Brook	4.8	28.7	100	15cm	40	5.9	8.26
Scotts Brook	4.8	28.7	200	15cm	40	7	9.8

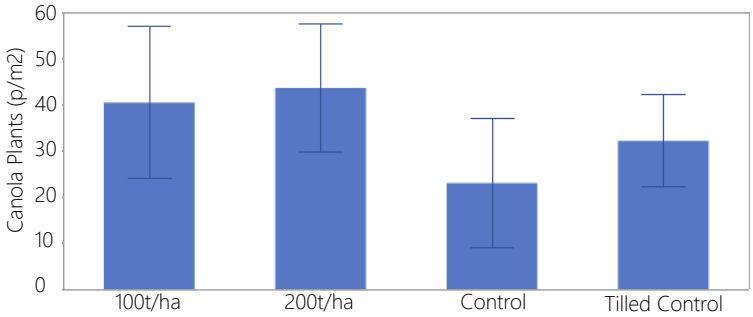

Figure 3: Average plant establishment counts across each treatment at the Woogenellup site, 2023.

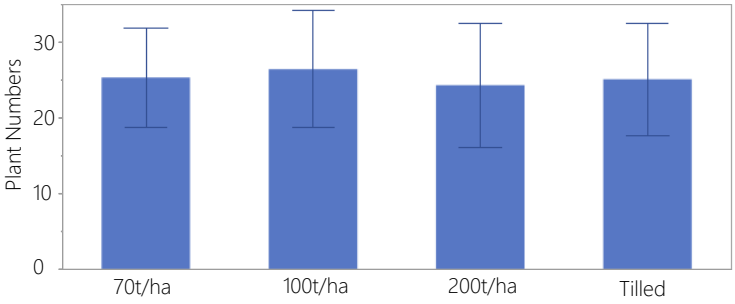

Figure 4: Average plant establishment counts across each treatment at the Scotts Brook site, 2023.

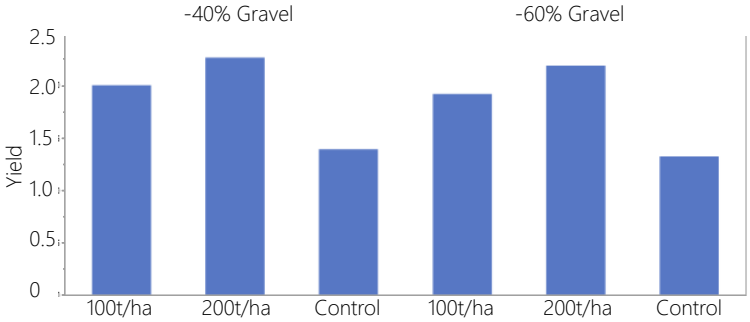

Figure 5: Grain yield results (t/ha) for the Woogenellup trial in 2023.

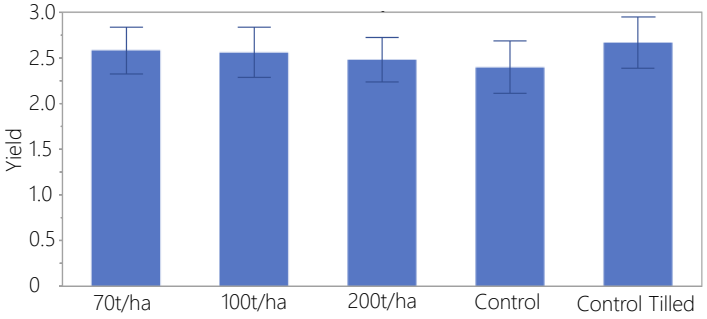

Figure 6: Grain yield results (t/ha) for the Scotts Brook trial in 2022.

Grain Yield Results

Grain yield results at the Woogenellup site showed a significant impact of the claying (Figure 5). Interestingly, yield results were slightly higher across all treatments in the zone with a lesser gravel content (40% compared to 60%). This is likely due to the dry season finish, and a result of a lower water holding capacity in the higher gravel % zone.

The crop yield results from the claying trial at Scotts Brook were a lot less clear. While each clay treatment resulted in a marginally higher yield than the control, the tilled control outperformed all the clayed treatments. Interestingly, the 70 t/ha of clay marginally outperformed the 100t/ha and 200t/ha rates (Figure 6).

Complicating matters, the site at Scotts Brook was seeded into very dry conditions and this was followed by periods of high rainfall in the early growth stages. As a result, there was uneven canola emergence across the whole site. This site will continue to be monitored next season to see if there is a legacy effect of the claying that provides a benefit beyond the tillage only treatment.

Conclusion

Claying sandy gravels that have low organic matter and low initial clay content looks to be very promising. What is also good news, is that it is likely that, depending on the volume of gravel, you may also be able to drop your clay rates to suit the volume of sand.

Claying forest gravels needs more research – the results in 2023 were not all that convincing and we look forward to continuing to monitor the site throughout 2024 to get a better understanding of claying on these soils over time.

Acknowledgements

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David Hall (DPIRD) presenting to members at South Stirling in a claying efficiency workshop - linked to this project, October 2023.