One-off tillage options for water repellent gravel soils

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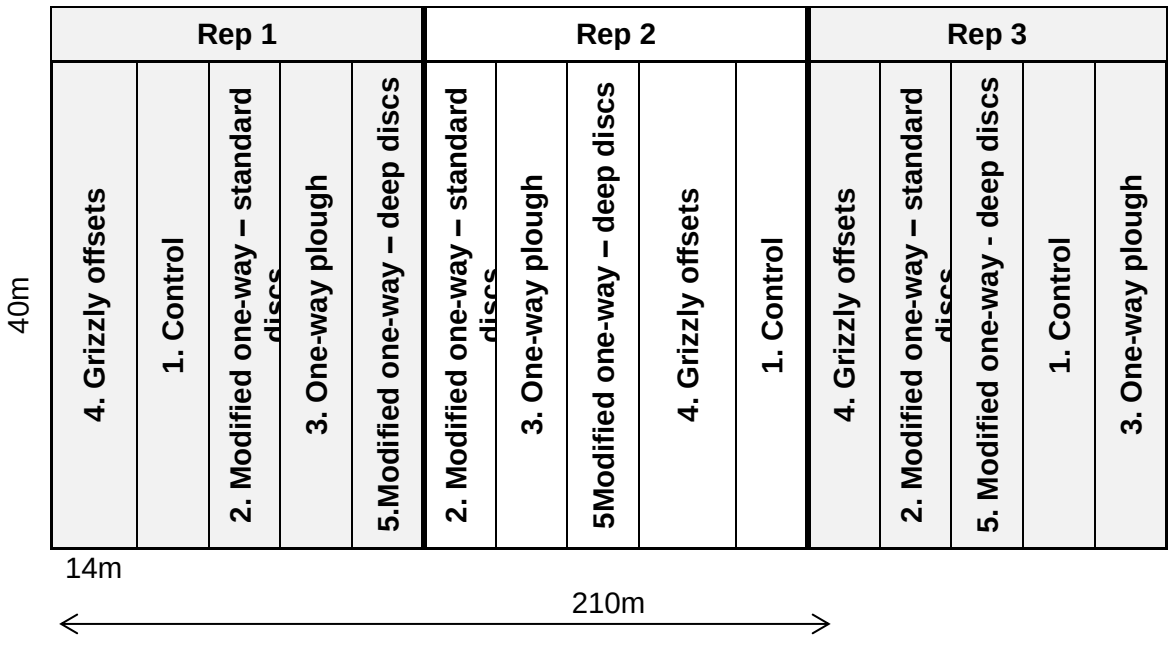
Purpose:	To compare and assess the effectiveness of one-off tillage treatments on soil water repellence, water infiltration, crop establishment and productivity on a water repellent gravel
Location:	Erin Cahill and Tony Snell, Moora
Soil Type:	Water repellent sandy gravel
Growing Season Rainfall (1 April- 31 October 2015):	299 mm

BACKGROUND SUMMARY

Grain growers report that water repellence is an increasing problem on their gravel soils in the West Midlands. Over the past 5 years considerable research has been undertaken assessing options for water repellent sands but less has been done for the gravel soils. The aim of this research is to compare one-off tillage options to ameliorate repellence on gravel soils over a 4-year period.

TRIAL DESIGN

The trial was established on April 2015 as a randomised block with three replicates of one control treatment and four different cultivation types: “Grizzly” large offsets; One-way plough; Modified one-way plough with either standard (‘shallow dish’) discs or ‘deep dish’ discs. The modified one-way disc plough had every second disc removed allowing more space for soil to turn and was fitted with larger discs to increase the working depth. In this experiment two disc types were tested with the modified one-way plough: 1) standard setup used ‘off-the-shelf’ large 76 cm (30 inch) discs which had a ‘dish depth’ of 115 mm and 2) a modified, more concave, disc was used which was built to have more curvature to promote greater turning of the soil, it had a diameter of 79 cm (31 inch) and a deeper dish depth. Each strip plot measures 40x14 m.



The site was sown on 2 June to Hyola 559TT canola at a rate of 2.5 kg/ha.

RESULTS

Figure 1: Water repellence measured from 0-5cm and 5-10cm depth of the treatments. Higher values of MED (Molarity of Ethanol Droplet) correspond to greater water repellence. LSD (5%)treatments*depth=1.44

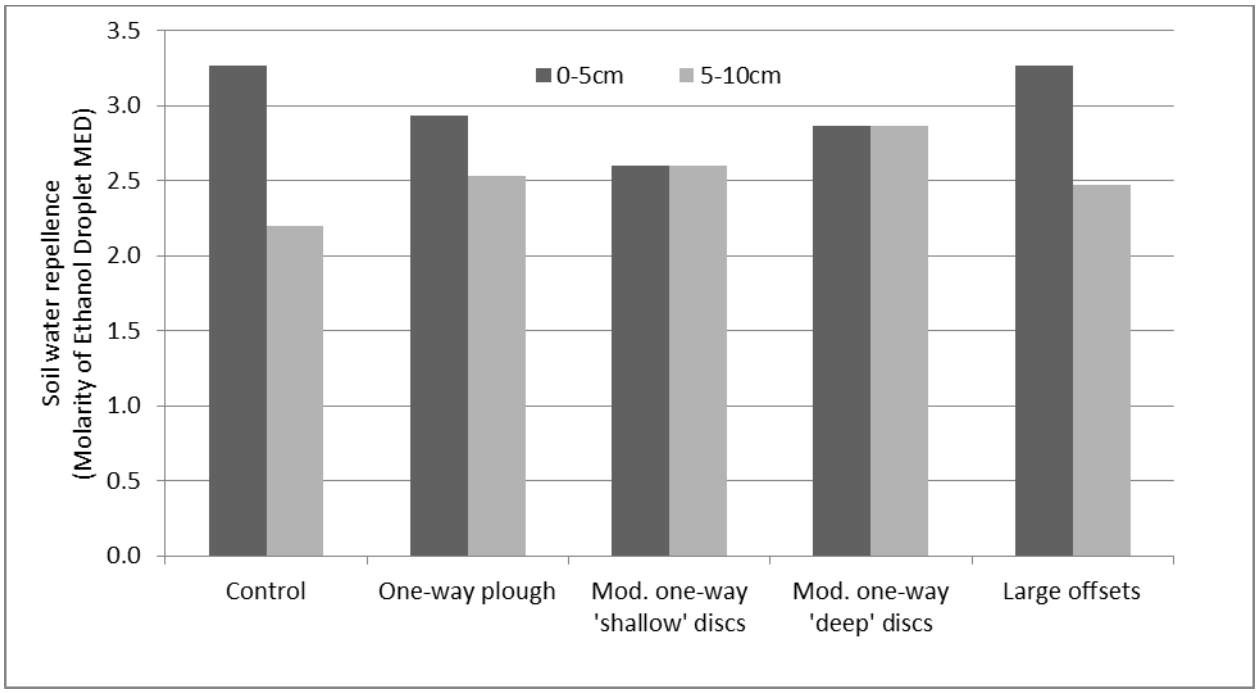


Figure 2: Average number of plants per square meter at early canola emergence on the 9th of July.

LSD (5%) =5.4

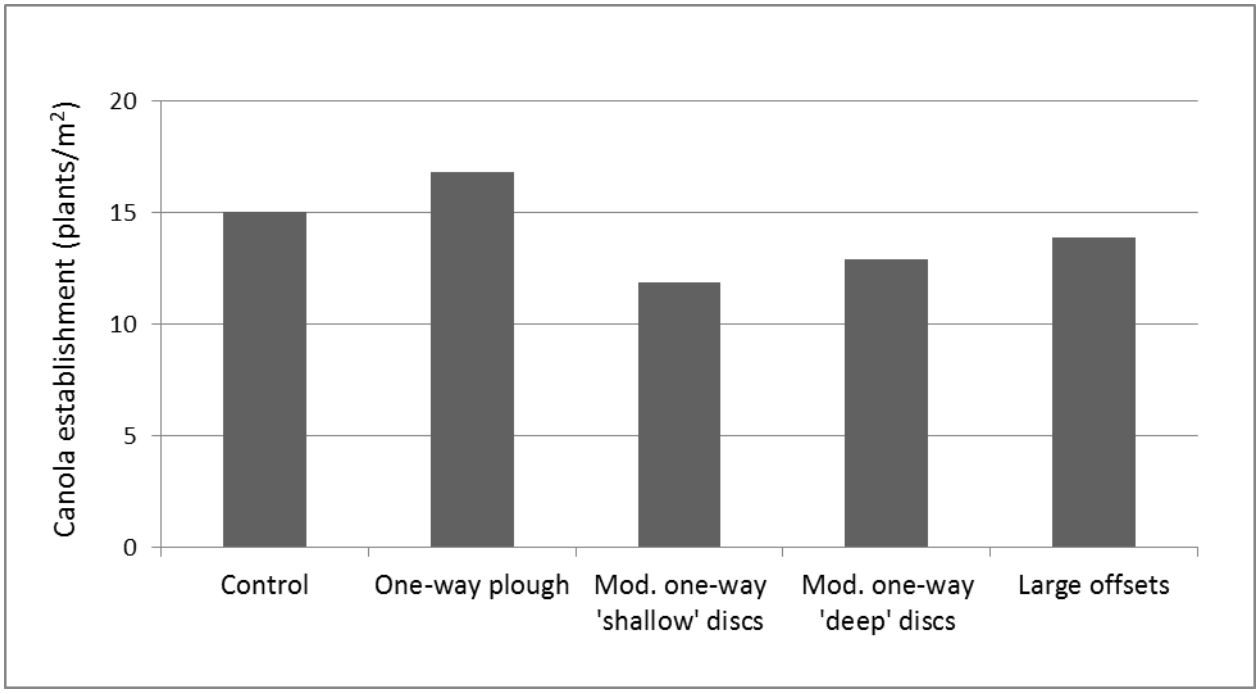
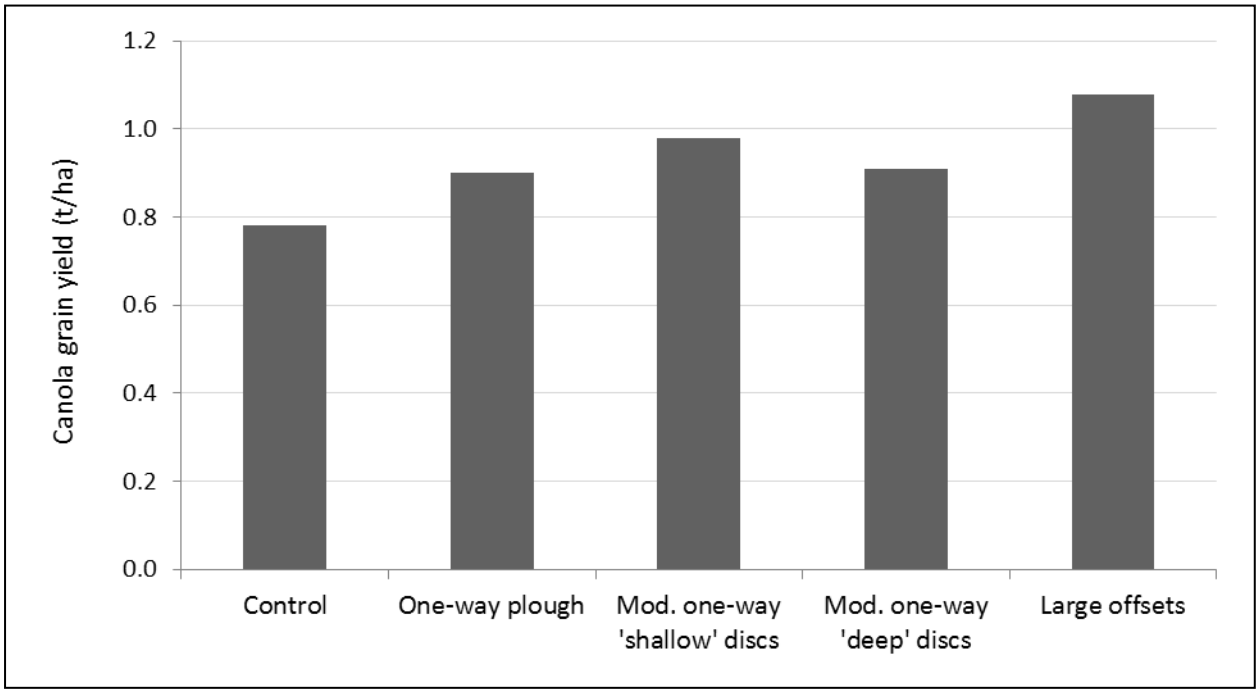


Figure 3: Grain yields (t/ha) affected by the treatments in the 2015 season. LSD (5%)=0.13



FINANCIAL ANALYSIS OF RESULTS

Table 1: Grain yield, yield responses and increases and changes in income and profit as a result of the strategic tillage treatments.

Treatment	Grain yield (t/ha)	Yield increase compared to control (t/ha)	% Yield increase compared to control	Gross income increase compared to control ($/ha)*	Cost of tillage treatment ($/ha)	Profit increase compared to control ($/ha)
Control	0.78	0	0	0	0	**0**
One-way plough	0.90	0.13	16%	69	40	**29**
Modified one-way – standard	0.98	0.20	26%	108	50	**58**
Modified one-way - deep discs	0.91	0.13	17%	71	50	**21**
Large offsets (Grizzly)	1.08	0.30	39%	163	80	**83**

*based on approximate market price of canola of $540/t (January 2016, awb.com.au)

DISCUSSION

The soil water repellence (SWR) was particularly severe at the trial in Moora (Fig. 1), with MED values (Molarity of Ethanol Droplet) of the topsoil on average greater than 2.5. The severe SWR was found near the soil surface (0 to 5 cm depth) as well at the depth of 10 cm. It should be noted that the sampling was carried out in winter time when SWR is expected to be at its lowest yearly expression.

The initial properties of the soil may explain the little or no-effect that the tillage treatments had on the management of SWR (Fig. 1), which remained severe (MED>2.2, King 1981). It appears that the soil disturbance achieved with the tillage treatments simply mixed the two water repellent layers rather than introducing wettable soil at the soil surface (Fig. 1).

Not surprisingly, the crop establishment in all plots was poor (Fig. 2) with no significant differences between the control plots and the tillage ones, ranging from just 12 to 17 plants/m^2. This poor establishment was no doubt due to severe repellence but there was also little rain immediately leading up to or directly after seeding.

However, the tillage treatments improved the yields (Fig. 3). The “Large offsets” (or Grizzly) and the “Modified one-way plough with standard discs” treatment increased the yield by 0.3 and 0.2 t/ha, respectively, in comparison to the control treatment. The other tillage treatments also increased the yields but the differences with the control plots were not significant. Given the high value of canola these yield increases were sufficient to cover the estimated cost of the ploughing in the first year (Table 1). The capital cost of purchasing a second-hand one-way plough and having it modified is relatively low (estimated $15-20K) compared to other tillage implements which dramatically reduces its cost.

CONCLUSION

All tillage treatments had a little effect on the management of SWR and plant establishment in the severe water repellent gravel sand at Moora. Nevertheless, yield improvements were recorded, in particular with the “Large offsets” and the “Modified one-way with standard discs” treatments.

At this stage, it is not possible to clearly state what changes drove the yield increase. Given the little effect that the cultivations had on the SWR it is possible that improved soil structure, increased nutrient availability and nitrogen mineralisation may have played a role on the increased productivity.

The yield potential of the canola crop in 2015 was low given it was sown relatively late, plant numbers were low and there was a dry finish, this may have compromised the response to the tillage treatments. Observation of the trial in the following growing seasons and the response of a cereal crop in 2016 will help us to better understand the long term effect of the treatments on crop growth.

PEER REVIEW

Chad Reynolds (DAFWA)

ACKNOWLEDGEMENTS

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