Department of
Primary Industries and
Regional Development
GOVERNMENT OF
WESTERN AUSTRALIA

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Management options for water repellent soils

Stacey Hansch, Department of Primary Industries and Regional Development

Take home messages

- One-way plough reduced subsoil compaction to 30cm depth and improved soil wettability, crop establishment and yield
- Deep ripping reduced compaction to 30 cm depth, improved crop establishment and yield, but not soil wettability
- Knife points established and yielded better than the splitter boot when combined with deep ripping and one-way plough

Objective

To demonstrate various long and short-term management options to mitigate water repellent soils in the Corrigin area.

Background

There are more than 2 million hectares of water repellent soils found in Western Australia and a further 7 million hectares at moderate risk of developing water repellence. Water repellency is caused by degrading organic matter and microbial by-products leaving a repellent, waxy coating on the surface of soil particles and is more common in coarse, sandy, untilled soils.

Water repellence causes poor water infiltration, leading to staggered crop germination, poor establishment, poor nutrient use efficiency, difficult/poor weed control, and an increased risk of water and wind erosion.

Short-term management options to mitigate water repellence include use of boot systems or wings to grade repellent topsoil and herbicides away from the seed, on-row seeding to harvest water and make use of preferential water channels, or soil wetting agents to reduce surface tension and aid water penetration in to the base of the furrow (Davies, et al. 2013). These management options can be cost effective, however they need to be repeated each season to minimise the impacts of water repellent soil.

Long-term amelioration options include increasing the clay content of soil by clay spreading or delving; mixing top and subsoil through ploughing, spading or deep tillage; or inverting soil by mouldboard ploughing. These methods are more expensive to implement, however benefits can last for many years.

Demonstration details

Table 1: Paddock history for the 2017 CFIG water repellent soils demonstration.

Paddock details	
Soil type	Sand over gravel (~20cm), sharp increase in clay below 55cm
Soil pH ($CaCl_2$)	0-10cm: 6.18, 10-20cm: 5.9, 20-30cm: 5.7, 30-40cm: 5.4, 40-70cm: 5.7
Sowing date	24 May 2017
Seeding rate	Mace wheat, 60kg/ha
Paddock rotation	2016 self-sown clover based pasture; 2015 Mace wheat
Fertiliser	24 May: K-Till 100kg/ha
	7 August: Flexi N 35L/ha
Herbicides	6 March: Glyphosate 1.1L/ha, Garlon 80mL/ha, Ester 680 350mL/ha
	24 May: Glyphosate 1.5L/ha, Treflan 2.0L/ha, Sakura 118g/ha
	26 July: SOAR (difluflenican, MCPA and bromoxynil) 950mL/ha
Rainfall	2017: Annual: 460mm, Growing season Apr-Oct: 209mm
	Long-term: Annual: 360mm, Growing season Apr-Oct: 288mm

Table 2: Treatment details for the 2017 water repellent soils demonstration.

Treatment details	
Knife points	38ft flexi coil bar, 22.86cm spacing
Splitter boot	Stiletto paired row seeding boots, 22.30cm spacing. Seed and fertiliser single shoot, placing seed in two rows 75mm apart
One-way plough	4 x 67cm discs, 50cm spacing, 17 May 2017
Deep ripper	9m AgroPlow, 500mm spacing, set to 300mm working depth, 17 May 2017
Surface wetter	SupaSoak, 1.5-2L/ha, blanket applied 13 June 2017. N.B. SupaSoak was mistakenly applied at the in-furrow, rather than the blanket applied (10-25L/ha) rate in 2017

Figure 1: One-way plough being used on demonstration strips.

Results and Discussion

Plant establishment and NDVI readings

After a significant amount (209 mm) of summer rain, no rain was received in April, 10.5mm in mid-May and the next rainfall after seeding was in mid-June. After sowing on 24 May, the crop had a staggered emergence over four weeks following the mid-June rain event. Establishment varied between 38 and 92plants/m^2 across the site (Figure 2). This was much lower than the target density of 100plants/m2 due to the very dry autumn period. Previous research has shown that dry seeding can exacerbate the symptoms of water repellency (Ward, et al. 2017), which is likely what happened in this demonstration.

Strips that were sown with knife points showed better establishment than the splitter boot, regardless of which other treatment they were combined with. Research and grower experience suggests that results from the use of paired row seeding systems have been varied due to many factors, including speed and depth of operation, breakout force, soil surface condition at seeding and placement of seed in relation to moisture (Davies 2018 pers. comm. 16 February).

Normalised difference vegetation index (NDVI) provides a measure of live green vegetation, and can give an indication of plant health and vigour. Higher values are associated with greater density and greenness of the canopy. NDVI readings showed very minimal difference between the treatments (Figure 3) despite large differences in crop establishment and some bare patches in the ploughed strips. This is probably due to increased tillering in the strips that had established at lower plant densities, and/or the mineralisation effect of cultivation leading to greener plants in the ploughed strips.

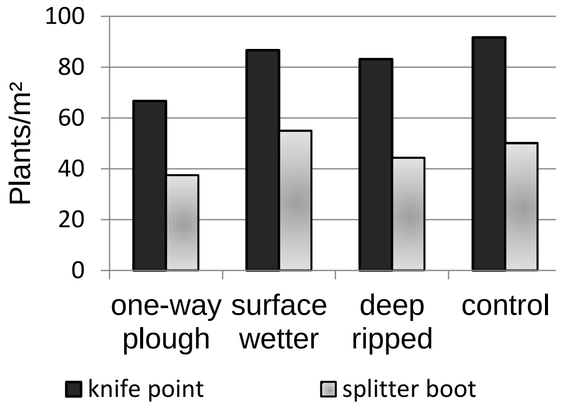

Figure 2: Establishment of Mace wheat for each treatment.

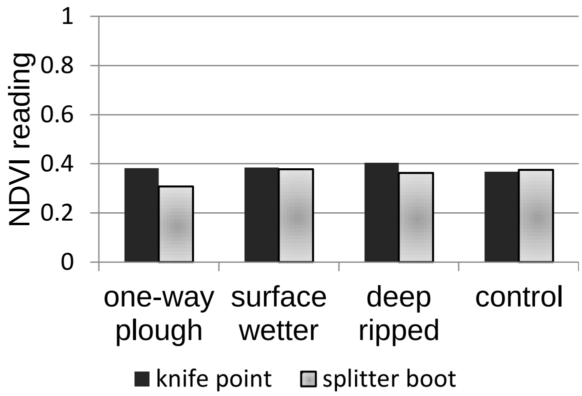

Figure 3: NDVI readings for each treatment on 29 August 2017

Soil wettability and soil strength

Molarity of ethanol (MED) is commonly used to determine the wettability of soil. MED results from the control show that the soil was moderately water repellent prior to any treatment being implemented (Figure 4). There is also root restricting compaction (>2500kPa) from 20-40cm in the control (Figure 5). Compaction has been reduced down to approximately 30cm by both ploughing and ripping. These results indicate that both subsoil compaction and water repellence could be contributing to poor crop growth in this paddock. The deep ripping has improved only the subsoil compaction, whilst the ploughing has ameliorated both subsoil compaction and water repellency. The improvement in soil wettability in ploughed strips is due to mixing the non-wetting topsoil with wettable subsoil, as clay (below 55cm) was too deep to be brought up from subsoil by the plough.

The surface wetter did not improve soil wettability, although this was unlikely to be achieved given the product was not applied at the recommended rate. Previous research has shown that wetting agents can be very effective at improving soil wettability on loamy gravels (Davies, et al. 2016). They are inconsistently effective on sandier soils, although effectiveness is often improved by banding the product rather than blanket application.

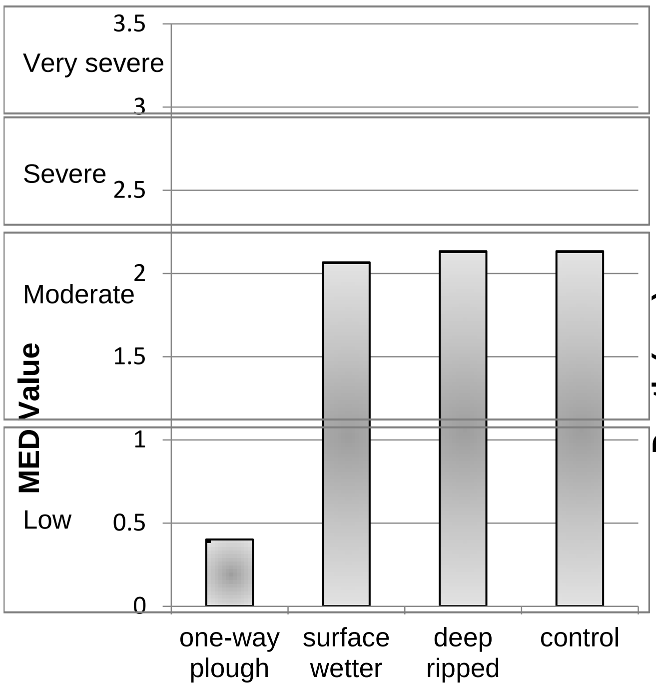

Figure 4: MED values for each treatment.

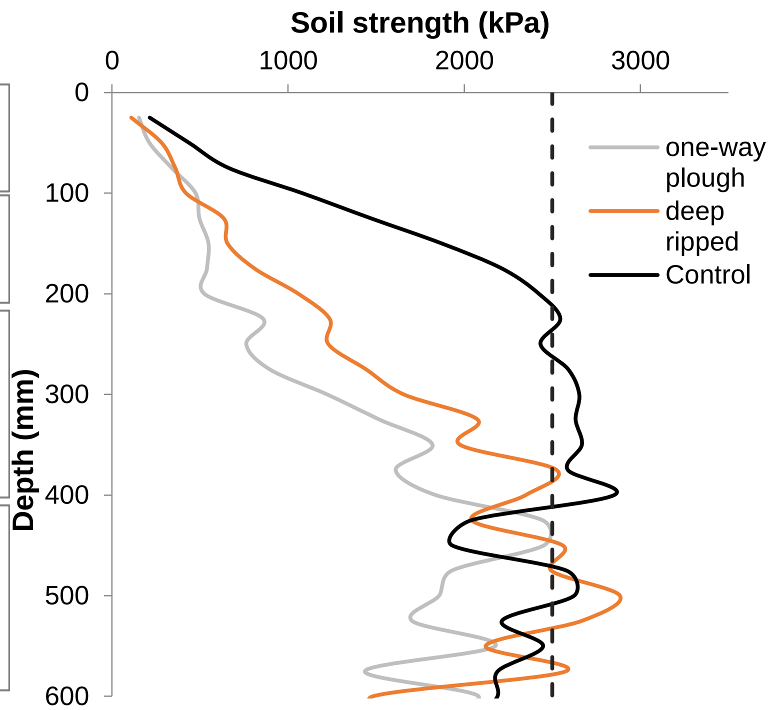

Figure 5: Soil strength for each treatment.

Yield and Quality

This demonstration was not replicated so interpretations should be made with care.

- Knife points yielded better than the splitter boot when combined with deep ripping or ploughing
- There was no real difference between splitter boot and knife point sowing in the absence of cultivation (surface wetter and control treatments).
- When sown with knife points, ploughing improved yield by 1.25t/ha over the control, and improved yield by 0.55t/ha over control when combined with the splitter boot
- When sown with knife points, deep ripping improved yield by 1.07t/ha over the control, and improved yield by 0.56t/ha over control when sown with the splitter boot
- The surface wetter improved yield by approximately 0.25t/ha over the control when used with either the knife points or splitter boot. Due to incorrect application rate, it is likely that the difference in this demonstration was due to site variation and not a treatment effect , although this is difficult to confirm as treatments are not replicated
- Each treatment achieved ASW1 due to low protein

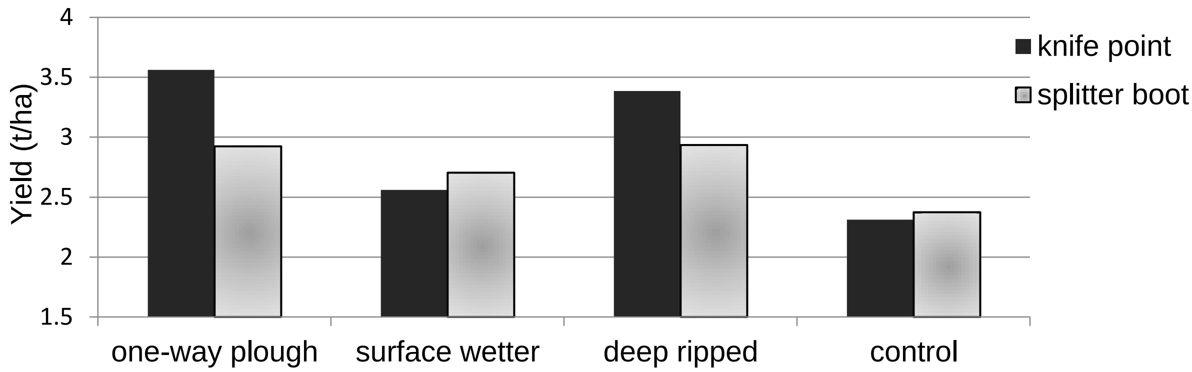

Figure 6: Yield (t/ha) of Mace wheat for each treatment.

Table 3: Grain yield and quality for each treatment.

Treatments	One-way plough		Surface wetter		Deep ripped		Control	
	Knife Point	Splitter Boot	Knife Point	Splitter Boot	Knife Point	Splitter Boot	Knife Point	Splitter Boot
Grade	ASW1	ASW1	ASW1	ASW1	ASW1	ASW1	ASW1	ASW1
Protein	9.7	9.9	9.7	9.7	9.4	9.1	9.55	9.2
Hectolitre weight (kg/hL)	82.1	81.52	83.72	83.72	82.98	82.12	83.04	82.94
Screenings (%)	2.72	2.03	1.95	1.60	2.48	3.04	2.30	3.06

Conclusions

In the first year of this demonstration, knife points sowing on deep ripping or the one-way plough had better crop establishment and yield than the same treatments with splitter boots. The type of sowing point did not make a difference to yield for the surface wetter and control treatments, despite the large differences in crop establishment.

In 2017 the surface wetter product was applied incorrectly. Previous research has shown that wetting agents can be very effective on certain soil types, particularly when combined with paired row seeding systems. Unfortunately, it is difficult to determine whether the slight yield difference in this demonstration was due to a treatment effect or site variation. When the demonstration is sown to a crop in 2019, consideration will be given to banding the wetting agent in the furrow, behind the press wheel to achieve more even wetting of in-furrow soil.

As the surface of the ploughed strips becomes settled over time, it is expected that plant establishment on these strips may improve, which could increase the yield benefit compared to other treatments.

The reduction in soil water repellence is likely to have contributed to the higher yields of the ploughed strips compared to the control, however it appears that subsoil compaction is also having a large impact on yields in this paddock. This is demonstrated by the higher yields achieved by the deep ripped strips without any improvement in soil wettability.

Due to the finding that subsoil compaction was also playing a role in poor yields in this paddock and the incorrect application of the surface wetter in 2017, further investigation to determine the most profitable treatment is required. The paddock will likely be in pasture in 2018, followed by canola in 2019. Monitoring will continue through these years to allow multi-season analysis to occur.

References

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Acknowledgements

This project is made possible by Royalties for Regions and the GRDC through the 'Building crop protection and production agronomy R&D capacity in regional Western Australia' project, DAW00256. Thank you to Corrigin Farm Improvement Group for their assistance in implementing and managing the demonstration throughout the year.

Thank you to Tony Guinness for hosting the demonstration, and to Tony, Vaughan Mills and Greg Smith for the use of their machinery. Thank you to Primaries CRT Corrigin for providing the wetting agent and to CBH for conducting grain quality analysis.

Important disclaimer

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